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India, Factor 2: Water Scarcity  
**Water Scarcity in Andhra Pradesh, India**

Living in Iowa, next to a soybean and corn farm, I rarely think about the effects of water scarcity on food security. Iowa's steady snowfall and subzero temperatures in the winter help water slowly percolate into the ground during the spring thaw, thereby replenishing ground water. Developed countries like America offer farmers crop insurance and disaster assistance during catastrophes. However, this reality in our nation is a fantasy for many small farmers in India.

Why is it important to look into the small farmer's challenges in a country that is one among the top developing nations? While India's economic growth rate is very high at 5.37% (Rapid Economic Growth), compared with the US growth rate of 3.2% (U.S. Economy), the average unemployment rate in India between 1983 and 2011 was 7.6%, reaching an all-time high of 9.4% in December of 2010 (India Unemployment). Of India's workforce, 60-70% is employed in the agriculture sector making up a quarter of India's entire GDP (Cotton). Of these farmers, 20% are small farmers. That means a staggering 100 million people (roughly 1/3 of the US population) are depending on these small farms to put food on the table. But why not focus on the impoverished, food insecure countries of Somalia, Chad, or the Democratic Republic of the Congo? The combined population that is food insecure in the three countries is 10.62 million, compared with 30 million in India.

The United Nations Human Development Report defined water scarcity as "the point at which the aggregate impact of all users impinges on the supply or quality of water" (Water Scarcity). This doesn't mean there is a fundamental lack of water, but as in India, water scarcity can indicate a culmination of problems like insufficient infrastructure, water mismanagement, and a lack of education about water conservation.

The varying climate and geography of India presents various challenges to small farmers. Monsoon rainfalls are the primary source of water for farms in southern states of India. These states lack the technology and infrastructure to harvest monsoon rains and replenish groundwater reserves. Proliferation of borewells has led to the depletion of underground aquifers, forcing many small farmers to rely on unpredictable rainfalls.

Andhra Pradesh (commonly referred to as Andhra or A.P.) is the fifth largest state by population in India and home to millions of small farmers facing water scarcity. I was inspired to research this state because of a true story of a typical, rural, farmer. The Mannevaru family depended on a 9.9 acre small farm for their livelihood. Like most farmers in the region, the family cultivated rice. A drought in 1990 devastated this water-intensive crop, leading the Mannevaru family into serious financial difficulties. The Mannevaru's were forced to sell 4.9 acres of land to finance their next farming season. The family also moved to a nearby smaller town, Chittoor. Land prices are much lower in Chittoor and here the Mannevaru family could afford 9.9 acres. They also opted for watermelon, a more economically viable and less water-intensive crop. However, heavy rains during the harvest season decimated the watermelon, because the fruits absorbed all the water and lost their sweetness. At this point, the family became concerned about the educational opportunities for their two daughters. They decided to move to the far suburbs of the state's capital where they could continue farming while providing their children with a proper education. The suburbs of Hyderabad, located in the Deccan plateau, is suitable for grapes (Region History), a more profitable cash crop. Grapes take about 3 years to mature and the Mannevaru family went further into debt to manage their meager living expenses and essential farming needs. Three hard years later, to the family's deep dismay, they only received one-tenth of their anticipated yield. This

devastation was due to the unreliable quality of the grape vine. Finally the family was forced to give up farming and take up odd jobs. The family remained in constant poverty until the girls completed their education. Their elder daughter lives and works in Cedar Rapids now and is a close family friend.

Interviewing this family and learning their story made me wonder if this was simply the case of one family haunted by a series of unlucky events or if it was the predicament of the majority of small farmers. After reexamining the events leading to the Mannevaru family's plight and reading stories of other desperate farmers, some of whom committed suicide, I realize that the Mannevaru story is that of a typical farm family in Andhra Pradesh. My research revealed interesting facts on various aspects of water scarcity, government funded research, policies supporting agriculture, the standard of living for small farmers, and corrupt practices in this part of the world.

## 1. The Typical Family

Most rural farm families in India have five people including one to three children and their parents (1.8 children according to Average Size). Most small farmers use their agricultural produce for food and sell surpluses. The typical diet in Andhra Pradesh is rice, lentils, and yogurt.

Rural farmers don't have access to quality health care and medication. According to a survey conducted by the Indian Journal of Medical Research, 69.5% of rural individuals go to non-degree (unqualified) allopathic practitioners (NDAPs) in or near their village for health checkups and treatment. Often NDAPs are the only option in the face of monetary and transportation barriers, from access to certified doctors. About one out of every five sick individuals don't receive proper treatment (First Contact). The life expectancy is also very low in India when compared with developed countries. Life expectancy for females is 67.23 years and for males it is 64.94 years (Life Expectancy). However, in developed nations like America, Canada, and the United Kingdom, life expectancy is 15 years longer (Life Expectancy at Birth).

Farmers' education about water conservation and farming practices also impact water scarcity in Andhra Pradesh. The literacy rate among farmers in Andhra is 55.9% and farmers typically get 3.6 years of education (Sanhati). This has a huge impact on the use of modern agricultural techniques and other practices. The Rural Livelihood Project in the Medak district of Andhra demonstrates how a little education about drip irrigation and water conservation has gone a long way towards improving farming practices, water use, and agricultural productivity. This project and its benefits will be further detailed in the solutions section.

## 2. Typical Farm

Small and marginal farmers in Andhra make up 80% (Sanhati) of the total farmers and each small farmer typically has 3.39 acres (Dev). Animal husbandry is the most common occupation for small farmers. Cows are raised for their milk and dairy products. In addition, 89.9% of small farmers in Andhra grow crops; the main ones being sugar, cotton, and rice. Other common crops include wheat, jowar, bijra, corn, minor millets, and coarse grains (Cotton and Important Agricultural Crop). The high and lowlands of Andhra Pradesh have different climatic conditions. In the lowlands, flooding allows the growth of water intensive plants like sugarcane and rice. However, the highlands, including Telengana districts, are unable to harvest much of the water and thus they tend to grow crops like chilies and cotton that are much less water-intensive. Agricultural practices changed significantly following the Green Revolution. Widespread use of chemicals and pesticides led to the development of genetic resistance among pests. Eventually the benefits of pesticides were outweighed by their high cost (Marten). Recently, small rural farmers in Andhra have shifted back to using organic fertilizer and refrain from the use of second-generation pesticides or other chemicals (Misra). Many farmers also use borewells as a source of water to

irrigate their farms. The borewells harvest water from underground aquifers, but the use of these borewells is reducing as water resources are depleted.

### 3. Major Barriers Facing the Typical Farm Family

Farmers aren't able to earn a living wage despite government price support for crops. Some farmers are unaware of the fixed prices, while others are economically vulnerable and unable to strongly bargain for fair prices. The economic vulnerability stems from debt accumulated throughout the season from loans needed to produce the harvest. The loans are used to buy fertilizer, seeds, pesticides, and to pay for irrigation. Even when market prices for crops are high, it is typically the middleman who benefits. Due to responsibilities on the farm, farmers aren't able to travel directly to large markets and sell their crops. Small farmers typically get 2493 rupees (\$40.13) a month while spending 3148 rupees (\$50.90) a month. This results in a loss of 655 rupees (\$10.59) monthly, or an annual loss of 7860 rupees (\$127.08) (Sanhati). So why not leave farming and find a different job? In rural areas, the only available jobs are related to the agriculture sectors and rural areas don't have factories to employ indebted farmers. The low education levels and cost of moving also prevent farmers from migrating to urban areas and seeking better-paying jobs.

High-priced produce is a barrier for farmers' nutritional needs. Though farmers raise cows, a majority follow the Hindu religion which considers cows to be sacred; so typically beef is excluded from the diet. Even amongst meat-eaters, chicken and fish are only consumed once a week at best, due to high prices (Reddy). Farmers living in coastal regions have the advantage of cheaper seafood options that are high in protein, but the majority does not have this alternative. Thus protein needs must be met through vegetarian options like lentils, chickpeas and yogurt. Though the farmers themselves don't make much money, the middlemen who take the produce to markets greatly increase the price of the food to make a profit. This result is that farmers are unable to afford the very crops they produce and farm families are left with inadequate nutrition.

Local corruption also prevents high-quality seeds from reaching the hands of small farmers as pointed out by Mr. Mannevaru. The government has policies in place to support small farmers with high quality seeds at a reasonable price. However, the corrupt local officials mix poor quality seeds with the imports so that they can resell the high quality seed in the secondary market to industrialized farmers for extra money. These corrupt practices have led to poor yields for Mr. Mannevaru.

Small farmers often lack access to modern farm equipment. Modernization is still in its infancy in this region and small farmers continue to depend on farm animals to plow and harvest their fields. Affording modern equipment simply isn't feasible with farmers' meager income. This inefficiency is further aggravated by a lack of awareness. About 60% of Indian households don't have information about modern agricultural practices despite many government attempts like fairs, government agencies like Krishi Vigyan Kendra, and radio programs (Sanhati).

The issue of water scarcity dwarfs all of the previously mentioned barriers to agricultural productivity. Many northern districts in Andhra suffer from drought and depletion of underground aquifers. Seasonal variations in water levels leads to unpredictable water availability, devastating farmers (Water Resources). The ground isn't able to absorb heavy monsoon rains during the harvest season because the rain fall practically bounces off the ground. The heavy and intermittent rain often leads to flooding and severe crop damage. Agricultural productivity is severely decreased by the inability to properly harvest and reserve the monsoon rains to utilize throughout the year.

India's central government and the local A.P. government have formulated many policies and committed financial support for small farmers. The Center for Cellular and Molecular Biology, ICRISAT, and Acharya N. G. Ranga Agricultural University are prestigious institutions involved in agricultural research in Andhra. Though infrastructure for irrigation provides adequate water supplies, wealthy industrialized farmers have leverage on these resources leaving little to no water for small farmers. There are increasing concerns about reduced water supply from rivers. This was evidenced in the Hindu Business Line newspaper, which discussed water holdings at the Nagarjuna Sagar Dam located on the Krishna River in Andhra Pradesh. Water holdings have reduced from 182 thousand million cubic feet (TMC) to 162 TMC in just one year (Kurmanath). The lack of restrictions on wells allowed the growth of 2.9 million borewells (Suchitra) which have quickly dried up underground aquifers. As of 2012, 50,000 new borewells were being built a year.

Water scarcity is dire in Andhra. The water scarcity crisis can be broken down into the status of each mandal. India is politically divided into states, each state is divided into districts, and each district is further divided into mandals. In Andhra 219 mandals' water sources are over-exploited, 77 are critical, 179 are semi-critical, and the remaining 760 are safe (Water Resources). Those numbers indicate unsustainable water usage in nearly 40% of the state. Further, in 2012 three-fourths of the mandals in Andhra were affected by drought (Suchitra).

Unfortunately, future trends for the water scarcity crisis are getting even worse. The demand for water in Andhra in 2025 is predicted to increase by 173% over all the sectors. Water demand for irrigation specifically, is predicted to increase by 168% (Water Resources). This increasing demand is of major concern as strain placed on finite water reserves will only worsen. Even if better water techniques harvest more water, the water supply won't even be able to scrape the surface of increasing demand.

#### 4. Solutions

There isn't just one answer to solve the water scarcity issue or improve food security in Andhra Pradesh, but the solution will be the combination of

- Scaling up successful small projects
- Modified agricultural practices
- Effective government policies
- Solutions to corrupt practices
- Water retention areas and drainage

The Rural Livelihood Project (RLP) is a particularly successful local initiative that should be scaled up to benefit small farmers. This project was originally introduced in the Medak district of Andhra and has tremendously aided local farmers like the Reddy family. Mr. Chandra Reddy, a typical farmer, lives on his farm with his wife and two sons in the Kotlya village. Antiquated farming methods drove the family into poverty. By the time the RLP reached the Reddy family, they were about to give up on farming. Chandra had already sent his sons to a school where they could get a decent education. With the introduction of the RLP, Chandra Reddy and many other farmers in the region were trained in agricultural development and learned about water management, soil and water conservation, and the benefits of drip irrigation. With the help of loans and the Project Implementation Agency, he was able to drip irrigate his land. This resulted in much higher yields of his vegetable crops. With the increased yield and the continually increasing demand for vegetables in the capital city, Chandra Reddy was earning Rs. 5000 to 6000 (\$80.84 to \$97.01) daily during harvest season, finally bringing his family out of poverty (Rural Livelihoods Project). To put this in perspective, the average monthly minimum wage in India is Rs. 5,560 (\$90.83) and the living wage is approximately Rs. 13,056 (\$213.28) (Compare Your Wage). Harvest season lasts about four months (Vegetable Crop). Educating all farmers across Andhra Pradesh about

agricultural development will aid them in making smarter decisions regarding water management and crop selection. The RLP can help by educating a representative group of farmers from various regions, who are willing to teach other farmers near them. Once those select farmers are successful, they can invite others to visit their farm to observe the benefits of modified practices. This will effectively educate, convince, and encourage more farmers to change their methods to more efficient practices.

Another local project with great potential is the Kuppam project. This project began as a pilot in 1997 and was first tested on 182.86 acres of farm land. The project combines modern agricultural techniques like drip irrigation, fertigation, deep plowing, mechanization, and the use of existing borewells. Drip irrigation allows for an optimal schedule and reduces water consumption by as much as 80% (Carter). Fertigation, the process of incorporating water soluble fertilizers and pesticides into irrigation water, provides essential nutrients for the plants and reduces the use of pesticides. Deep plowing increases rainwater infiltration into soil, replenishing underground aquifers and increasing the storage capacity of the soil. Lastly, the use of machines allows for deeper plows, quickening the planting and harvesting process. The Kuppam Project utilizes water from existing borewells, but more importantly, the project doesn't construct new wells (Dhillon). Despite the many possible benefits, corruption and misallocation of funding has prevented the project's proliferation. Water will be available for all farmers if this modern agricultural technique can be implemented state wide through non-profit cooperatives.

India has provided innovative solutions for difficult problems in the past; and similar ideas can be applied to modernize farming practices, reduce water consumption, and increase farmers' incomes. The White Revolution in India has allowed the country to become the world's largest milk producer and exporter. Amul, a cooperative non-profit organization made this possible by working with marginal farmers. In the cooperatives formed, farmers produced milk and sold it to Amul for pasteurization and marketing. Both sides are seeking to maximize mutual benefits rather than individual profits, allowing the cooperative to thrive. Farmers should form similar cooperatives to

1. Buy modern farming equipment to share among farmers
2. Implement modern irrigation practices
3. Access the marketplace more effectively
4. Buy quality seeds and fertilizers
5. Support members in disaster management

By sharing the cost, a group of farmers can afford expensive machinery and systems, like fertigation and drip irrigation. When combined with sensor feedback for ground moisture and atmospheric humidity, drip irrigation will be even more effective. These sensors will report to a region-wide big-data analytics system that can process and predict regional water availability along with pest presence to increase yields tremendously. These cooperatives will also help small farmers have the same competitive edge and market power of a large, corporate farm. If these cooperatives are funded by philanthropist organizations like the Bill and Melinda Gates Foundation, millions of people will become food secure in India.

Andhra should also follow its neighbor Karnataka's lead in implementing a policy where the government will provide a 90% subsidy on drip irrigation systems to rejuvenate land. Karnataka has also implemented the "Free Waiver Scheme" to fund the education of children in drought prone regions of the state. However, to work on a long-term solution, Karnataka's government is calling on the state universities to conduct research. The problem of water management can largely be mitigated if similar measures are implemented in Andhra Pradesh. (Murdeswar).

Another simple and practical solution is developing water retention areas for monsoon rains. This could include ditches on road-sides and man-made lakes in farm fields to allow monsoon rains to accumulate and slowly percolate into the ground. These drainage basins will reduce damaging floods and increase farmers' water access and availability during certain times of the year. Though this solution reduces available land for farming, the benefits greatly outweigh the costs. To alleviate the adverse effects on

farmers who are losing land to the conservation efforts, the government should implement policies to compensate farmers. However, these policies should be crafted carefully and should not incentivize farmers to leave all their land idle.

There is hope for the water scarcity crisis in Andhra Pradesh. The barriers and research discussed in this paper provide clear evidence that there isn't any one solution that will better the lives of small farmers in Andhra. By the expansion of several small scale projects discussed previously, water can be managed and equally distributed, to ensure food security for generations to come. A few of the changes are as easy as better informing farmers about water conservation and crop selection; while other solutions entail years of funding and construction. Despite obstacles, these changes can be implemented in the next five years to produce dramatically improved results for the millions of Indians affected by water scarcity. These solutions will prevent families like the Mannevarus from giving up on farming and result in many more families, like the Reddy family, with a happy story.

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