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Taiwan, Factor Number 2: Water Scarcity

The Severe Effects of Water Scarcity on Taiwan Agricultural Production

Taiwan's water crisis 2020-2021: the worst in more than 55 years. By late 2020, the worsening drought in Taiwan had severely impacted the country. As water scarcity continues to ravage the country, its government has eliminated irrigation for farmers, which has created crop shortages in many of Taiwan's agricultural areas. The result: inflated produce prices and job insecurity. Many families and citizens suffer from this drought due to the heavy reliance on water. The goods-producing industry as well as the service-producing industry face extreme uncertainty that result in food insecurity. To combat the severity of the drought and ongoing insecurity for many, several solutions are necessary. These measures include increasing the low price of water, implementing new irrigation systems to reduce usage, and educating the public. By implementing these acts, the government will increase food security for the average citizens and successfully decrease impacts of future climate volatilities.

The island country of Taiwan is located approximately 100 miles off the southeastern coast of China. Taiwan is surrounded by the Philippine Sea, South China Sea, and East China Sea, while the Taiwan Strait separates Taiwan from mainland China. The island is approximately 245 miles long and 90 miles wide and has a population of 23.84 million (Worldometer, n.d.). The east coast of Taiwan remains largely uninhabited due to forest-covered mountains, while the majority of the population resides in urban cities in the northwest and southwest (Britannica). The average citizen resides in tall apartment-style buildings in different cities across the country, while the other half of the population resides in rural communities in farming, traditional style housing. Transportation in Taiwan consists primarily of public transportation, such as subways and public buses. Private modes of transportation are mainly cars and motorcycles.

According to the Taiwan National Statistics, the average family size in Taiwan is 3.02 people with the majority of each household composed of a married couple with children (Textor, 2020). The education system in Taiwan encompasses six years of elementary, three years of junior, and three years of high school. During their third year of high school, students take a national entrance exam in order to attend college. The average citizen in Taiwan receives at least a college degree. According to the Ministry of Labor of Taiwan (2020), the country's labor force consists of 60% of the population working in the services-producing industries, 35% working in the goods-producing industries, and 5% working in the agriculture, forestry, and fishing industries. The average annual salary is NTD \$641,000, or USD \$22,400 (Everingtown, 2020).

A common, yet serious, barrier for the average family in Taiwan during climate volatilities is access to fresh produce. During droughts, crops are not able to meet the standard level for human consumption and are unable to be sold to citizens. During typhoons and hurricanes, many road barriers and large road floods throughout the cities cause loss of electricity for extended periods of time which prevent citizens from accessing fresh food markets (Kutlugün, 2015). Historically, Taiwan citizens have annually endured typhoons or similar harsh rain weather. However, due to climate change in recent years, droughts are the prominent climate challenge that creates shortages in food production, causing food

prices to skyrocket and therefore making fresh produce unaffordable (Batista et al., 2020). Ultimately, the main food security barriers for families in Taiwan are caused by climate that prevent citizens from purchasing or gaining access to fresh produce.

Twenty-four percent of the country's land is used for farming, and over 540,000 people work in the agriculture sector. A majority of Taiwan's farms are small and family-operated with the average farm size of about 1.1 hectares (2.7 acres) (Nations Encyclopedia, n.d.). Due to its subtropical weather, Taiwanese farmers harvest a wide variety of crops, especially grains and fruits. Taiwan's main crop is rice and the country produces around 1.59 million tons annually (Textor, 2020). Farmers also harvest other cultivated crops such as corn, soybeans, and wheat. Besides these harvests, other main food crops grown include bananas, sweet potatoes, peanuts, bamboo shoots, and oolong tea. Citrus fruits, mushrooms, pineapples, and sugar are primary export crops.

The majority of meals in all Taiwanese households consist of grains and legumes, such as rice and soybeans. In recent years, the severe lack of rain throughout the harvesting season has caused many critical crops that heavily rely on water to deplete. Rice farmers, for example, have suffered the most from the droughts. Rice cannot mature properly without adequate water, causing a low-quality grain to harvest and forcing farmers to sell the staple crop at a much lower price. Due to these common and easily accessible crops, such as rice, being unavailable for consumption, many citizens are forced to purchase other, more expensive, foods. Farmers also greatly suffer regarding income as no revenue is made from these inadequate crops.

While Taiwan's agriculture is undeniably a critical component of the country, the 35% of the country's citizens that work in the goods-producing industry also heavily rely on water. The Taiwan semiconductor industry is a large contributor to the country's economy and is a key component to its goods-producing industry. However, computer chips require a great quantity of water to be produced with a typical semiconductor manufacturing utilizing up to 4 million gallons of water a day. With the severity of the drought, semiconductor shortages have been a major cause for concern for those working in that industry: employment continues to fall, creating money insecurity and subsequently food insecurity. The world's reliance on semiconductors, a large portion being produced in Taiwan, has created shortages and problems extending beyond just the citizens of Taiwan. Water is critical in order to support employment in Taiwan as well as across the world in order to ensure food security.

Water scarcity is currently a major obstacle for food production in Taiwan as few rainfalls and the absence of typhoons have caused worsening droughts (Jensen, 2020). Wang Yi-feng, deputy director of Taiwan's Water Resources Agency (WRA), states that Taiwan faced a 50% reduction in rainfall in 2020 which in turn put greater pressure on water resources for the country (Tzu-ti, 2020). Taiwan's freshwater supply comes from reservoirs, rivers, and groundwater, all of which have been experiencing a drastic decrease in supply due to the lack of rainfall (Ferry, 2018). To counter the severity of the ongoing drought, in October of 2020, Taiwan's government suspended irrigation in the west, eliminating its usage for over 74,000 hectares of the country's total farmland (Jensen). Since this major farmland region is unable to grow and sell crops, farmers suffer great losses in revenue, and their own food security decreases. Citizens in urban areas also face food security issues as crops have to be imported and therefore are expensive to purchase.

Although Taiwan has been eliminating irrigation for farmers, the government has enacted other measures to counter the severe water shortage that could benefit farmers. According to the Taiwan Ministry of Economic Affairs, the island has placed 159 emergency wells and built emergency desalination plants across the country. The desalination plants have contributed 200,000 tons of water, and the emergency wells have contributed 336,000 tons of water for both the agricultural and industrial sectors to utilize so far (Oung, 2021). However, desalination plants themselves are an expensive method due to the large amounts of electricity required to channel saltwater through the filter in order to obtain freshwater. Freshwater obtained from a desalination plant can cost more than two times the price of conventional freshwater. Furthermore, these plants can cause adverse environmental problems, such as dislodging sea creatures. Overall, the measures enacted thus far to counter the effects of the drought have been underwhelming. Implementing wells to store water requires freshwater in the first place, and desalination plants are a complex and overly expensive solution.

The Taiwan government could implement other methods to counteract the water shortage and therefore provide an increased level of food security for the entire nation. According to the Taiwan Water Corporation, Taiwan's government has not increased water prices in the last two decades. The average monthly water price is approximately forty cents per 100m³ of water (Taiwan Water Department, n.d.). Consequently, agricultural and industrial sectors rarely consider implementing conservation methods to limit water usage as doing so would be unreasonably costly compared to the inexpensive price of water (Freyberg, 2015). With the cost of water so low, farmers are not conscious of the devastating effects of water over usage. So, increasing water consumption prices would be the first step towards motivating consumers to carry out water conservation. Through this change, both agricultural and industrial water users would strive to make improvements within their work, such as implementing technological advances as well as updating old methods. However, it is important to note that this taxation would not be as strongly enforced for agricultural users as opposed to other users in order to promote crop growth and increase food security for the country. The typical family will be more conscious of the methods in which they use water and strive to conserve money by using less freshwater and using more recycled water.

The next step in abating the effects of water shortage on individual farms is for the Taiwanese government to require all farms, no matter the hectares, to implement a Tailwater Recovery System (TWR) combined with Polypipe irrigation. Since individual small farms are usually adjacent, this combination system could be shared among multiple farms simultaneously, saving the farmers installation costs. A TWR allows farmers to capture, store, and re-use irrigation run-off to minimize the amount of water used. Irrigation run-off is captured and stored in a ditch or nearby reservoir and relocated to a pumping system that is attached to flexible pipelines located throughout the crop fields (United States Department of Agriculture, n.d.). The Polypipe system is then able to distribute the recycled water in designated areas through gate holes that are punched in the pipe (Encisco & Peries, n.d.). A combination of Polypipe and Tailwater Recovery System will not only increase irrigation control and efficiency but also greatly reduce freshwater usage. The overall system is also reusable throughout different harvest seasons, decreasing farmers' total water expenses.

The Polypipe and Tailwater Recovery System has proven results that demonstrate its effective and efficient power. In the United States, the Tailwater Recovery System has been implemented along constructed wetlands at the Louisiana Water Resources Research Institute. The result of the research in evaluating the effectiveness of the system was determined through three water samples placed along the runoff flows in the wetlands. The system was found effective in greatly reducing concentrations of nutrient levels as well as suspended solids (Jeong, n.d.). Several users of such a system state that the need

to utilize fresh groundwater or surface water is reduced. This provides assurance to farmers as they are less reliant on government-owned or limited water resources (Shock & Welch, 2011).

Costs for installation of the Polypipe and Tailwater Recovery System can be subsidized by the government. The Taiwan government currently grants about 500 dollars USD per hectare to farmers to compensate for their lost crops due to the suspended irrigation policy (Jensen, 2020). Instead of the government setting aside this money to reimburse farmers, that money along with the tax money from the increased water tariff could be used to subsidize the irrigation system for farmers. By doing so, the government is not only assisting its farmers in a solution that would support them long-term but also ensuring food security for the country.

Interventions to limit the severity of future droughts are also necessary. Reducing a typical family's consumption of water before a drought is forecasted can create unconscious habits that limit the impact of future climate volatilities. From small, simple acts such as taking shorter showers to more intricate steps such as replacing leaky pipes and installing low-flow plumbing, every measure is important. Educating the public on taking these steps is also a vital component the government should take in order to allow the public to truly understand the impacts of this problem. In order to encourage daily water conservation habits within the public, the government could also incorporate incentives, such as water-saving tax reforms. These interventions should be made to ensure all communities realize the importance of water conservation in order to ensure future food security for their country. The daily routine of citizens would also change to recognize the value in limiting use of freshwater and placing more use on recycled water.

The worst drought in more than 55 years. Due to the water scarcity caused by the ongoing drought, the Taiwanese government has eliminated irrigation for farmers, resulting in the improper growth of crops and other produce that are unable to be sold for human consumption. Consequently, prices for available food crops are inflated, inhibiting the typical Taiwanese family's food security. The average citizen faces food security due to restricted access and inability to purchase fresh produce. One solution is to first increase the price of water, which would pressure farmers to be conscious of their irrigation usage in the future. The second step is to require all farms or large farming areas to install a Tailwater Recovery System with Polypipe that reuses irrigation run-off. This system would not only decrease consumption of fresh ground/reservoir water but would also allow farmers to monitor their usage. The government would help subsidize the farmers' wastewater irrigation system by reallocating the tax revenue and the money used to compensate farmers affected by the irrigation shut-off. Furthermore, government and citizen movement towards limiting daily water consumption and subsequent over-use is necessary. These water conservation acts would provide food-security relief for farmers as well as other families by making crops affordable and accessible.

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