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Taiwan: Prevention and Protection of the Agriculture Industry from Recurring Typhoon Damage

Country Introduction

The country of Taiwan is located ninety miles east of China's eastern coastline, a small island no more than 13,000 square miles in size (about twice the size of New Jersey). Taiwan is relatively modern and has become well-developed since the 1950's through an export-oriented economy. The twenty-three million people that inhabit the island live under democratic rule; like the U.S, Taiwan has a president, a legislative body and a judicial court system ("Taiwan"). Family income levels are less numerically prosperous when compared to U.S levels, but the Taiwanese middle class makes its living relatively well. Education levels are high, with thirty-five percent of students attending a school of higher education. Government-subsidized health care is available and nearly free to all Taiwanese citizens. In Taiwan, food insecurity is not currently an issue because the country is wealthy enough to import the food its needs ("2009"). However, in the case that China decides to assert its influence over the island, a possibility for insecurity exists.

Farming in Taiwan

Though many of its food resources are imported, Taiwan still supports agricultural smallholders and single family farms. Farms in Taiwan have traditionally been held by small families, each covering roughly a hectare of land (about two and a half acres) with the future likely to be the same (Council, Ho). In the past rice, sweet potatoes and sugarcane were main crops, but today high-quality fruits and produce are grown in addition for export ("Story"). These include bananas, pineapples, citrus fruits, soybeans, peanuts and tea. Years of Japanese occupation helped Taiwanese farmers become proficient with their use of limited land resources; indeed, this was one reason why Taiwan was able to develop so quickly in the latter half of the 20th century. Efficient use of fertilizers, government-instituted incentives for growing food and the bargaining power of the single farmer through farmers' associations were all agricultural practices that helped additionally to increase agricultural growth and eventually form the basis for industries. The agricultural products that Taiwan exported in its past paved the way for its fast-evolving export industry, which earned Taiwan recognition as one of the Four "Asian Tigers" (along with South Korea, Singapore and Hong Kong). With this nickname, the country's new reputation as a global exporter was recognized, though agriculture continues to retain a portion of the GDP.

However, one might well ask why farming is still so important to Taiwan, when it can import its food from more agriculturally-oriented countries and when land is at a premium. It appears that both farmers and the Taiwanese government still agree on agriculture's importance. Since Taiwan joined the World Trade Organization in 2002 and with this year's signing of the Economic Cooperation Trade Agreement with China, more and more foreign products can now be found on the Taiwanese market. Though this may be beneficial to the general economy, farmers have protested against importing agricultural products already grown in Taiwan, a practice which could expose the more sheltered agricultural sector to fierce competition. Even more, the Taiwanese government has heard and responded to such outcries; Chinese farm products will not be sold in Taiwan under the new trade agreement (Lee). Meanwhile, the government continues to support horticultural research. Agricultural stations in several cities study and improve upon the fruit and vegetable crops grown on Taiwanese farms (Wul). Some possible reasons for this continued agricultural development may be to increase food independence from international trading partners, or simply to preserve profits from the reputed high quality of Taiwan's agricultural produce. In

any case, farms and agriculture are still held in high esteem in Taiwan and retain a minor if not major role in the country's economy.

The Typhoon Problem and Possible Solutions

Taiwan has overcome problems of mainland conflict and limited resources to arrive at its current developed state. Yet there are problems which cannot be completely solved or eliminated. Each year from May to November, Taiwan stands a substantial risk of heavy rains, flooding and probable property damage from typhoon season. Over a single 20-year period, the island was hit by an average of 3.7 typhoons per year (Wu). Such natural disasters can be extremely disruptive to the agriculture industry, flooding crops with excess water and causing severe wind damage to trees. Unprotected livestock are defenseless against raging winds and high floodwaters; fertile agricultural farmland can be swept away in the thousands of acres. In 1996, Typhoon Herb set the record in Taiwan for the costliest agricultural storm with over $18 billion Taiwanese dollars (TWD) in damages, worth about $600 million U.S dollars today (Typhoon). Although Taiwanese farmers are well aware of the dangers of typhoons, the timing or severity of such disasters cannot be foreseen far in advance. While humanitarian aid and food supplies pour in internationally during extreme disasters ("U.S"), and although such aid can be critical to recovery, for yearly typhoon damage there is little outside disaster help to spare.

A recent example of the potential scale of typhoon damage is Typhoon Morakot from 2009. The storm shattered the record in Taiwan for amount of total rainfall when over the course of a day, over one hundred inches rain fell during its passage over the island ("Record"). Though only a Category 1 storm out of 5 on the Saffir-Simpson scale, a month-long drought had left the ground hard and unable to absorb much of the rainfall. The immense rains triggered multiple landslides that buried entire villages and left at least 600 dead (Chanson). Floodwaters turned rivers into raging torrents, eroding away their embankments and destroying bridges and other infrastructure. As for the agricultural sector, it suffered an estimated NTD $12.1 billion (U.S $379 million) in damage to crops, livestock and topsoil losses ("Typhoon"). Farmers were obviously devastated by this blow, with government reparations only covering a fraction of losses.

Typhoons on the scale of Morakot do not strike regularly, but when they do occur they have a powerful impact on the food security of the Taiwanese. The loss of crops ruins the harvest of the farmers, who themselves may experience food insecurity, but the lack of produce also trickles down to the market where buyers must cope with rising prices in the face of a food shortage. The farmers in Taiwan and the country as a whole both need sustainable solutions to this perpetuating problem. If the damage caused by typhoons to harvests can be consistently decreased, then markets will suffer less and food security will be preserved. In addition, such methods utilized in Taiwan to protect against typhoons could easily be implemented in other developing countries such as the Philippines, Haiti, or other coastal regions consistently stricken by natural disasters. Greater storm-tracking knowledge and accurate short-term prediction, the use of vegetation and windbreaks as barriers to soil erosion and wind damage, and continued use and improvement of typhoon safety infrastructure are three potential typhoon solutions.

Solution 1: Forecasting and Early Warning

A first step in reducing the impact of these disasters is early and due warning. With ample time, farmers can go through storm preparation thoroughly, or with knowledge of the storm's path and intensity, devise appropriate protections for their crops or animals. Such information is very valuable, but often unavailable until mere days or hours before a storm strikes. In the case of Taiwan, its tall Central Mountain Range (CMR) gives forecasters unusual prediction difficulties; meteorologists have determined that the path of storms is greatly affected by nearby island masses and their geography (Wu). The complex topography of Taiwan, then, interacts with incoming storms in ways that forecasters can't always

accurately predict or explain. For example, in predicting Typhoon Herb's path, the forecast "was essentially correct, [but] the unusually strong winds and torrential precipitation associated with Herb caused tremendous damage" (Wu). If such factors could have been foreseen, greater precautions might have been taken and less structural damage could have been sustained.
At a 1997 workshop on Taiwan typhoon research, major conclusions for future forecasting improvements were drawn as follows:

Inadequate observational systems, insufficient model resolution and influence from the CMR were contributors to the difficulties in typhoon prediction.
A "bottleneck of typhoon research" was occurring due to lack of enough observations, lack of correlation between observations and models, and lack of focus on the wind and precipitation systems of typhoons. Future recommended research would be concerned with the interactions between typhoons, topography in general and the CMR, and effects on wind and precipitation. (Wu)

With more detailed observations and continued research on typhoon-CMR interactions, better models should result and the accuracy of predictions should increase. Improved warnings and appropriate precautions should ultimately lessen the impact of future typhoons on the food security.

Solution 2: Natural and Active Farm Defenses

Although early warnings are greatly beneficial, techniques to reduce the direct effects of typhoons (that is, the soil erosion, heavy winds and flooding) are also necessary. Trees and plants have some ability to strengthen the soil they inhabit and help reduce soil loss during flooding. Agriculture in itself can be destructive of the land's natural ground cover and may increase regional susceptibility to landslide or hurricane damage (Philpott). However, farmers could use the abilities of plants and trees to strategic end by integrating natural, protective vegetation with crops, thereby reducing some of the soil loss. One 2008 study on the effects of Hurricane Stan in Chiapas, Mexico investigated the agricultural settings of landslides and the damages incurred by affected coffee farms, some of which had nearby naturally-occurring vegetation, while others did not (Philpott). In some cases, heavy rains had created landslides that damaged the farms, somewhat similar to landslides that buried villages during Typhoon Morakot. The results showed that "[f]arms managed with higher vegetation complexity suffered less damage from landslide occurrence…thus providing a potential management strategy to lower risk to extreme storm events" and in addition, that "farmers in high-risk areas…may be able to reduce their susceptibility to some types of hurricane damage (e.g. landslides) by increasing on-farm vegetation complexity". Therefore, one possible solution for farmers would be to plant small trees and other cover plants near erosion-vulnerable areas to reduce the topsoil lost to typhoons.

What about the heavy winds caused by typhoons? While excessive rains may flood the soil and loosen the roots of trees, it is the raging winds (around 90 mph for Morakot) that can bend tree trunks and pull trees straight out of the ground. Many farms threatened by cyclones have used windbreaks, tall trees grown surrounding a vulnerable area, to protect crops during potential storms. The purpose here is to block the wind (not to minimize soil loss) somewhat like a physical wall might, except that trees can bend with the wind and walls less so. With correct orientation, positioning, careful species choice and relative density, these natural defenses can greatly reduce the wind damage to crops during cyclones ("Windbreak"). Australian pine trees were used in Florida to protect fruit orchards from severe hurricane winds, though these were toppled during a strong hurricane; in the study, no common windbreak species was found to stand against winds above 100 mph (Crane). However, farms that used windbreaks still sustained less damage to fruit and trees, even if the protecting vegetation had toppled during the storm. Because of the short, periodic nature of typhoons striking Taiwan, and the relatively long time it takes to regrow natural windbreaks, man-made windbreaks could provide a stronger and more expendable typhoon defense. One design used in Florida consisted of "aluminum or wooden pole support structures from which shade cloth

[was attached] vertically by cables" (Crane). Though these too fell during Hurricane Andrew, which had sustained winds of ~145 mph, these defenses could be replaced or erected again relatively easily.

Solution 3: Typhoon Resistant Infrastructure

For farmers, adding vegetative barriers is one protection mechanism they can personally control. But higher forces must play a larger role in protecting the entire island from flood devastation, involving the construction of specific typhoon-resistant infrastructure. Indeed, measures have been put in place by the Taiwanese government and civil engineers to protect cities and low-lying areas. But, as Typhoon Herb and Morakot both showed, improvements may be needed to counter the next big storm.
After Herb struck in 1996, a nation-wide investigation was begun to determine which streams were most likely to flood with debris during a typhoon. Many Taiwanese live in the alluvial plains of rivers, which are almost destined to flood each year but are preferred for their fertile soil and for housing; the debate over government protection of these danger-prone regions was quite controversial (Lin). Because of the high number of Herb bridge failures, the government changed the design code of bridges to withstand at least fifty years of storms instead of twenty-five. A new idea for utilizing small-scale structures in the upper regions of watersheds, instead of previously large structures and dams in the lower regions, was implemented in 2002 and could reduce flooding peaks by as much as thirty percent (Lo).
Still, a report issued in 2006 suggested still more recommendations that could be made to the flood control system.

These include:

- Increased construction of flood protection measures such as dikes or levees
- Increased construction of flow diversion systems to aid main flood channels
- Construction of detention reservoirs to reduce flow peaks downstream
- Watershed management and improvement
- Banning flood-prone areas from future development
- Emergency response planning and warning system establishment
- Urban drainage improvements
- Higher-grade coastal protection. (Teng)

With the future planning and construction of elements such as these, Taiwan as a whole will be better prepared to weather typhoons and recover quickly.

Conclusion and Other Recommendations

For the solutions outlined above to be implemented, time as well as public education will help speed the process. Time is necessary for forecasting methods to improve and for new infrastructure to be constructed, and education of farmers may need to occur to keep them aware of new technologies or other typhoon defense methods. As climate change continues to raise sea levels and the temperature of oceans, radical shifts in traditional weather patterns may increase the number of typhoons to strike Taiwan in a given year. In a future of changing typhoon patterns, the Taiwanese government and farmers will need to continue to research and find solutions to mitigate a new and unexpected disaster.

Beyond the research that this paper investigated, governments and local communities must work together to help both parties find areas of improvement. This can be accomplished through constant communication and mutual acceptance of the importance of reducing typhoon damage. Liaisons to the farmers in an area or elected officials might bargain on behalf of their representatives for new government-sponsored defenses, and government officials might respond positively or recommend a different plan of action. The infrastructure improvement tasks listed above might be a starting point for

negotiations with local farmers; implementing an effective warning system to could reach isolated farmers would be another. Techniques or methods of protection found to be useful in Taiwan could also be spread to other countries facing typhoons; for example, island countries might benefit from using modified forecasting models similar to those employed in Taiwan. The United Nations would be well equipped to handle this task, of spreading knowledge to other regions of the world and ultimately benefiting all. International research agencies could help coordinate the tracking of storms and appropriately warn Taiwanese farmers by radio of incoming storms, or offer advice. Aid organizations could be alerted by the Taiwanese government ahead of time if a storm was predicted to cause extreme landslide or flood damage, and could be mobilized in time to reach victims in the heart of a crisis.

The combination of the three described solutions, with the cooperation of the Taiwanese government and international organizations should greatly improve Taiwan's resilience to this yearly problem. For Taiwanese farmers can neither rely on international help nor flee from incoming storms because of the isolated island they live on; instead, they must weather typhoons, protect their farms and live with the geography that is their own. And with the small land owners of Taiwan better protected, they and the rest of the country can worry less about food insecurity.

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