RECENT DEVELOPMENTS OF PROTECTED CULTIVATION IN THE PHILIPPINES

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ABSTRACT

Vegetable production in the Philippines is highly seasonal in response to temperature, rainfall, and the frequency and intensity of typhoons. Despite the natural conditions which limit year-round production of many vegetables, farmers continue to take the risk of planting under adverse conditions expecting to get exceedingly high prices when the supply is compromised. Protection from strong winds and heavy rains can be provided by various means, but there are obvious trade-offs between protection and cost. There is slow adoption of protected cropping in the country and this is primarily due to the cost of the protective structures. The types of protective structures normally used in the Philippines range from simple structures such as rain shelters, shade-houses, and plastic tunnels, to permanent structures covered in plastic with computerized environmental controls. There are studies showing that protected cropping in the Philippines can be economically feasible. Several studies were also conducted on developing affordable protective structures using indigenous materials. The country still has limited information on protective crop production technology and adoption has to improve. Concerted efforts should be undertaken to accelerate its adoption considering the impact of changing climate in agriculture.

INTRODUCTION

The Philippines is an archipelago of 7,100 islands extending about 1,851 km north to south and with a maximum breadth east to west of 1,070 km. The mean temperature in the Philippines is 27°C. The Philippines is the third most disaster-prone country in the world with vulnerabilities to typhoons, volcanic eruptions, and earthquakes. Year after year, the country is being battered by typhoons leaving millions of pesos worth of damages to agriculture. This weather can also bring destructive winds in excess of 150 km/h which physically damage leaves, flowers and fruit, encourages disease, and pose difficulties in planting, spraying, and harvesting operations.

For decades, Filipino farmers are struggling with various internal and external factors making agricultural growth difficult. Vegetable production in the Philippines is highly seasonal in response to temperature, rainfall, and the frequency and intensity of typhoons. Despite the natural conditions which limit year-round production of many vegetables, farmers continue to take the risk of planting under adverse conditions expecting to get exceedingly high prices when the supply is compromised. To take advantage of higher prices for off-season vegetables, there are growers that plant pahuli (late crop), which is the late, dry season crop produced from February to May and palusot which is the wet season crop produced from August to October. The term palusot refers to the risky nature of planting during that period. During the typhoon season, farmers in Benguet will have lower production and vegetables from Mindanao have an opportunity to fill the gap in supply. Due to these damaging winds and rain, vegetable prices tend to rise significantly in the wet season.

In the Philippines, protected cultivation is an emerging industry from small-scale operations to commercial farms. Protection from heavy winds and rain can be provided by various means, but there are obvious trade-offs between protection and cost. There is slow adoption of protected cropping in the country and this is primarily due to the cost of the protective structures. The types of protective structures normally used in the Philippines range from simple structures such as rain shelters, shade-houses, and plastic tunnels, to permanent structures covered in plastic with computerized environmental controls. The more advanced greenhouse facility in the Philippines can be found in the flower production with automated environment modification, irrigation and fertilization. However, simple rain shelters are also being used to produce flowers in the highlands of the Cordillera Region. At present, the Benguet vegetable farms have a large planting area under rain shelters.
On-farm studies in the Southern Philippines have shown that protected cropping can be economically feasible. As a result of working with farmers, developing skill levels in protected cultivation is very important to be successful for a profitable production. Vegetable farmers find it difficult to finance the investment cost of even a simple protective structure. In the Philippines, for example, the initial cost of establishing protective structures such as greenhouses and plastic houses is considerable ranging from Php 800 to 3,500 per sq m of floor area. The country still has limited information on protective crop production technology and adoption has to improve. Development of a cost-effective protected vegetable cropping system will allow farmers in high rainfall areas and in typhoon-prone locations to sustainably produce high value crops for increased income and food security.

Greenhouse technology was introduced by the Department of Agriculture’s (DA) regional office in Bicol Region under the DA’s Agri-Pinoy High Value Commercial Crop Development Program (HVC DP). Participating farmers are now harvesting seasonal crops on year-round basis and realizing increased profits. Its introduction was in response to the growing market demand for fresh, safe and pesticide-free vegetables that only greenhouses could effectively produce. Farmers have been very innovative in constructing the structures using indigenous materials such as bamboos and coconut trunks, among other locally available materials. The greenhouses made from iron pipes, plastics and fine nets were distributed by the DA as prototype structures that could cover up to 60 square
meters of gardens where vegetables like tomatoes, cucumbers, lettuce, broccoli, cauliflowers and melons are grown all year round without using fertilizers and pesticides.

Farmers from Sorsogon in the Bicol Region face the constant challenge of extreme weather conditions which damage their crops. Agricultural crops in the Philippines are frequently at risk due to extreme weather conditions that threaten crop production. The Philippines is the third most disaster-prone country in the world with vulnerabilities to typhoons, volcanic eruptions, and earthquakes. Strong typhoons batter the country yearly leaving millions of pesos worth of damages to infrastructure and agriculture. To help minimize crop damage and provide supplemental income to farmers, the World Food Programme, in partnership with Bicol University and funded by the United States Agency for International Development’s Office of U.S. Foreign Disaster Assistance (USAID/OFDA), is enhancing family-based disaster preparedness by providing a small-scale climate smart technology called tunnel-type agriculture to some farmers in Sorsogon. Bicol University provided tunnel-type agriculture technology and training to farmers in the Province of Sorsogon, in the municipalities of Irosin, Sta. Magdalena, Casiguran, and Juban. The tunnel-type agriculture is a protective structure made from steel brace and fine mesh net used to shield crops from extreme weather conditions. It covers a 10 square meter area and meant to serve one family. They also introduced the use of coco coir production waste by-product called coco pit as a mulch or protective layer of the soil instead of the usual polyethylene plastic. The modified tunnel-type structure is cheaper compared to commercially available structures and designed to fit the small plots in the middle of the different coconut trees. The structure is collapsible and can be kept during very strong typhoons.

One of the projects of Enhanced Climate Change Adaptation Capacity of Communities in Contiguous Fragile Ecosystems in the Cordilleras being implemented by the Department of Agriculture and the Food Agriculture Organization is to demonstrate organic-based vegetable production in greenhouses in Sablan, Benguet. The aim of the project is to document the potential of organic-based vegetable production in greenhouses, determine the labor and material requirement and determine the profitability of the technology. The materials needed for the greenhouse establishment shall be shouldered by the project while labor during installation is the counterpart of the farmer.

There is quite a number of commercial vegetable farm utilizing greenhouses for their production. Basic Necessity operates a 6.5-hectare fully mechanized and computer-operated hydroponics greenhouse facility in Silang, Cavite that produces lettuces, bell peppers, herbs and spices, tomatoes, carrots etc. Yoki’s 15-ha farm in Tagaytay is setup under a controlled weather facility which ensures continuous production of seasonal crops. Yoki’s farm houses at least 5 hydroponics facilities which grow a number of lettuce varieties, mint and water spinach. Most of the clients are restaurant owners from Manila. Eden Nature Park in Matina, Davao City is also engaged in the hydroponics production of lettuce under greenhouse condition.

Figure 3: Hydroponic lettuce production in Yoki’s Farm in Tagytay City
The most advanced greenhouse facilities can be found in flower production. Philippine Cut Flower Corporation (PCFC) in Tagaytay City currently owns and operates some of the most advance greenhouse farming facilities in the country. A computer measures internal and external weather conditions and adjusts ventilation, shading, misting, and cooling fans to give its crop the ideal growing conditions. Water and plant food are controlled via computer so that the plants get the nutrients at exact amounts making them healthy while avoiding wastage. The use of greenhouses in local farming is a distinction earned by PCFC and is a clear innovation from traditional open-field farms common to agriculture production in the Philippines. Greenhouse technology enables PCFC to take advantage of the year round sunlight in the country without getting affected by rain, typhoons, and humidity inherent to the Philippine climate. Controlling the conditions inside the crop area ensures consistent quality and supply all year round. In addition to this, it helps eliminate common pests and diseases.

**CLIMATE CHANGE AND PROTECTED CULTIVATION: CASE OF CORDILLERAS**

The mid- and high-altitude areas of northern Philippines are blessed with a pleasant climate that allows the production of semi-temperate crops not grown in the lowlands. Coolseason crops such as lettuce, broccoli, strawberry, and other vegetables are grown successfully in these areas and contribute significantly to the local tourism and economy. In fact, the municipality of La Trinidad in Benguet earned the monikers “Salad Bowl” and “Strawberry Capital” of the Philippines. However, a recent study conducted by the Benguet State University (BSU) (Calora et al. 2011) showed that the province of Benguet is not free from the effects of climate change. Observed changes in climate based on 1976 to 2009 records of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) Agrometeorological station in La Trinidad are increase in temperature, warmer noon and colder afternoons, longer drought periods and irregular rainfall, among others. Another study cited in the Philippine Daily Inquirer news (Carino 2010) placed the province of Benguet as the second most vulnerable area to climate hazards - next only to Metro Manila. The region is frequented by typhoons and these caused loss of human lives and significant damage to property and agriculture (PAGASA 2015). Because of this, many farmers follow a common cropping calendar but this resulted into irregular production levels. Most vegetables are produced during the dry, cold months and the oversupply during this period caused prices to plunge sharply (Philippine News Agency, 2014). During the peak of summer, the intense heat causes some plants to wilt – a manifestation of heat/moisture stress in crops. Cool-season crops like lettuce, broccoli and strawberry grow best in full sun but intense heat generally results to proportional reductions in yields. Temperature stresses in lettuce and broccoli result to “bolting” or early flowering. Strawberry, on the other hand, produces smaller fruits. A shorter growing season and smaller fruits mean lesser yields. Some farm workers thus complain of hot conditions inside the structures (Calora et al. 2010). Based on available records of the Bureau of Agricultural Statistics, the average yield of broccoli and lettuce in CAR are 10.1 mt/ha and 13.2 mt/ha, respectively, but can be improved when climate-induced stresses in crops can be minimized and/or eliminated. While these figures seem to indicate sufficiency in supply of the two commodities, the prevailing prices during various months of the year tend to prove otherwise. Average wholesale prices can be as low as P24.10/kg in March for broccoli and P25.33/kg in February for lettuce. The prices gradually
increase during the start of the wet season in May until it peaks in November (P63.09/kg and P54.47/kg for broccoli and lettuce, respectively). This irregularity in prices indicates a corresponding fluctuation in production levels. Favorable production condition during the cool months (November to February) result to higher yields and lower prices of the commodities during the dry season. Consequently, production in summer results into lower volumes of production but higher prices when harvested during the rainy months. This is corroborated by Deryng et al. (2014), who mentioned that extreme heat stress during the crop reproductive period can be critical for crop productivity.

Strawberry production is also adversely affected by changing weather patterns. In 2012, the Municipal Agriculture Office (MAO) of La Trinidad reported a yield decrease from 21 to 16 tons/ha of strawberry (Caluza 2012; Catajan 2012) due to erratic rainfall patterns particularly during the strawberry season. At present, strawberry production is limited to one cropping season, starting in September until the onset of rains in May. Although strawberries are a temperate crop with optimum growth temperatures between 10-26°C (Ledesma et al. 2004), as a field and greenhouse-grown crop it is often subject to high temperatures during cultivation.

Figure 5: Strawberry production under low tunnels in La Trinidad, Benguet
PREVIOUS AND CURRENT R&D WORKS ON PROTECTED CULTIVATION

Several studies were conducted on developing affordable protective structures using indigenous materials that can provide protection to rains and strong winds. Some studies have focused on environmental modification inside the greenhouse from shadenets to forced ventilation system. There are now on-going research studies looking into the possibilities of growing crops inside buildings providing artificial light and soilless production. In an attempt to promote protected agriculture in the Philippines, a research project was jointly undertaken by the Visayas State University, University of Sydney, and the Applied Horticultural Research of Australia. The goal was to evaluate the technical feasibility of using protected cropping structures of various designs in the production of vegetables in the country. Results showed that average yields were higher under protected cropping compared to the open field cultivation of cauliflower (35%), green onion (253%), lettuce (98%), chili pepper (143%), tomato (125%), sweet pepper (98%), bitter gourd (75%), pechay (318%), muskmelon (77%), broccoli (12%) and string beans (13%). Farmers need a certain minimum level of skill to take advantage of protected cropping, especially in relation to effective management of irrigation and in controlling pests and diseases. Protected cropping can result in higher yields in both the wet season and the dry season. Foliage diseases were easier to control under protected cropping structures but whiteflies, aphids and mites were more difficult to control. The structures studied utilized bamboo or steel frames covered with either plastic or netting materials.

Figure 6: Strawberry production in Benguet under high tunnels
In Benguet, a similar project was undertaken by the Cordillera Highland Agricultural Resources Management Project (CHARM) of the Department of Agriculture (DA-CAR). The goal was to demonstrate the possibility of growing a diversity of high-value crops in a tunnel house as an alternative to the usual open-field crops like chayote, cucumber, and beans. Introduced were 1.5 m wide low tunnels covered in UV-resistant plastic sheets. This is the same type of protective structure used in strawberry production. Surface covers on low tunnels are normally removed/replaced daily for ventilation. Although broccoli, basil, peanut, spinach, and “wansoy” were planted, only the positive results observed on broccoli were reported. In other demonstration projects of the DA, many farmers have complained about the intense heat trapped inside the structures and this can be attributed to insufficient climate regulation. This explains why the use of simple rain shelters where all sides are kept open is still widespread. While the use of plastic sheets in tunnels can easily provide protection against strong rains, it also absorbs and traps considerable heat.

At the Central Luzon State University (CLSU) in Nueva Ecija, several greenhouses and crop shelters of various designs are being utilized for nursery and production of high value crops. The structures are also currently being tried out to house hydroponic systems for the production of selected high-value crops. The university was able to establish the Center for Hydroponics and Aquaponics Technologies (CHAT) where a number of greenhouses are being maintained at CHAT showcasing different hydroponics and aquaponics production modules under protective structures. A research study on production of onion under greenhouse environment is being undertaken by CLSU researchers. The prolonged rainy season during the recent years has been a problem to onion farmers. The more it rains, the lower is the productivity. In 2012, hundreds of hectares of onion farms in the southern part of Nueva Vizcaya were severely hit by a fungus, locally known as amag, causing the average harvest to drop sharply. Severely hit by the fungal disease were nine villages in southern Aritao town. The disease was caused by prolonged rainfall and cold weather during the latter part of 2011 and 1st quarter 2012. According to reports, the infestation caused yields in the affected areas to fall to 4.5 t/ha from the usual 10 t/ha. This has also resulted in the price of onion to drop from P25 to P17 per kilo because of poor quality of the produce. Immediate concern of the onion industry in Central Luzon is to come up with strategies to produce enough onions during the off-season. The critical months are November, December, and January. Greenhouse production provides more flexibility and protection from adverse environmental conditions so that onions can be grown for off-season production and getting higher prices for the produce. The study is focusing on the effect of drip irrigation method and frequency of irrigation on growth and yield of onion. Results of the experiment for onion show that drip irrigated treatments have much lower volume of water applied compared to conventional flooding treatments. Results showed that the total volume of water applied in onion under greenhouse is 5 times higher as compared to drip irrigation treatments. Results also showed that average plant height of onion at harvest had significant differences as affected by irrigation intervals. The bulb diameter of onion grown under greenhouse environment showed highly significant differences in response to irrigation treatments. Average diameters of onions from flooded plots were smallest. Uniformity of drip-irrigated
onions was also found to be higher compared to flood-irrigated plots. Onions should have the right size to have a premium price at the market. The Philippine National Standard had defined marketable onion as having bulb diameter between 3-5 cm. The marketable yield of onion showed highly significant differences in response to irrigation treatments but unaffected by fertilizer application treatments. Irrigating onion at 50% TAW gave the highest IWUE of 9.11 kg/m3 while flooded plots gave the lowest IWUE of 1.23 kg/m3.

![Figure 8: Production of drip-irrigated onion under greenhouse environment at CLSU](image)

The Benguet State University (BSU) is another advocate of protected agriculture as a means of improving agricultural productivity. In fact, it currently maintains several crop shelters for high-value crop production. The designs are quite varied ranging from simple rain shelters to the more sophisticated metal frame structures adopted from advanced countries. While all designs offer some degree of climate modification, the level of protection offered and the benefits derived from these vary greatly. The simple rain shelters utilize wooden or bamboo frames where the sides are usually left open. As the name implies, these structures perform only one major function, i.e., protection against torrential rains. Protection against other risks is minimal. They are, however, cheap and easy to install and maintain. Metal frames covered with screens and clear plastic sheets (also called high tunnels) are more functional but their initial costs are often restrictive. While there had been several locally recorded accounts about the use of crop shelters in production, it is surprising to note that only general statements on the benefits are offered. Recent study of BSU dealt with the evaluation of the performance of lettuce, broccoli and strawberry under different roof covering materials in a protected environment. Results of the study showed that crops responded significantly to the shading materials over the seasons.

**ACCELERATING THE ADOPTION OF PROTECTIVE CULTIVATION IN THE PHILIPPINES**

Protected agriculture is a broad category of production methods that can help mitigate the effects of climate change. By providing some degree of control over one or more environmental factors in crop production, protected agriculture has also been recognized as an effective adaptation measure. The use of crop shelters is thus gradually but steadily gaining popularity even among small farmers in the country.

**Appropriate Design.** The utilization of plastic, net houses, low tunnels and rain shelters in the Philippines are slowly attracting growers of high value vegetables and other crops because the protection it provides against prolonged rainfall and other unfavorable climatic conditions. Efforts to determine standard greenhouse design in the country that is technically and economically viable will certainly contribute to accelerating farmers’ adoption of protected cultivation technology for increased income and as a climate change proofing mechanism in the country. Design
considerations that must be improved include lowering the cost per unit area, the use of natural ventilation avoiding energy costs, use of indigenous materials among others.

**Infrastructure and Training Support on vegetable production under protected cultivation.** Most of the government’s efforts are focused on rice production. Government should also have a Comprehensive National Program on High Value Crops focusing on Protected Agriculture. Past studies found that farmer’s level of horticultural training, the adoption of quality system, the use of family manpower for the greenhouse works, and, in a lesser extent, the type of crop and area has been found positively related to productivity. We have very limited training on greenhouse production technology. Seed companies and greenhouse suppliers are the ones conducting such trainings mostly for their customers. A national program on protected cultivation is in order that includes providing support services in terms of subsidies to the construction of protective structures, access to high-value vegetable seeds, training on cultural management under greenhouse, and regular technical assistance.

**Education.** Protected cultivation technology topics should be integrated in the curriculum of agricultural courses in the Philippines not only in the secondary schools but also in the tertiary. In doing this, wider dissemination of the technology can be met. The agricultural students are the future extension workers and farm consultants of the country. They will have a significant role in promoting the technology.

In conclusion, the Philippines is lagging behind in the adoption of protected cultivation technology compared to its Asian neighbours. Concerted efforts should be undertaken to fast track its adoption considering the impact of changing climate in agriculture. Growing of crops under protective structures has many advantages and is gaining more importance in producing off season crops of higher quality and value. Protected cultivation also enables growers to realize greater returns per unit of land and offer other benefits such as early harvest, longer harvest duration, eco-friendly management of pests, weeds and diseases. It is said that climate is changing and so, doing agriculture must also change.

**REFERENCES**


