Delivering Climate Forecast Products to Farmers: *Ex Post* Assessment of Impacts of Climate Information on Corn Production Systems in Isabela, Philippines

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4.1 Introduction

Corn production is the principal source of family income for about 24 million Filipinos. Isabela Province, located in one of the most depressed regions in northern Philippines, is considered the top corn-producing province in the country contributing 17% or 536 353 tons of the total yellow corn production in the country. Corn is grown rainfed in Isabela. Monocropping of corn is predominantly practiced in Isabela and there are two cropping seasons per year – wet season cropping from May to August and dry season cropping from November to February. In 2003, a total of 146 965 hectares were planted to yellow corn in the province. In the same year, average yield of yellow corn was 3.65 tons per hectare (t ha^{-1}) which was comparatively higher than the national yellow corn yield average of 3.03 t ha^{-1}. Most of the corn type being produced in the province is yellow corn which comprised 95% of the total corn produced in the province (Lansigan et al. 2001). Yellow corn is primarily used as animal feed ingredient especially for poultry and swine.

Climate in the agricultural region of Isabela has historically no pronounced dry or wet seasons – relatively dry in the first half of the year and wet during the second half. Average rainfall is 1 844 mm per year, mean temperature is 29 °C and mean relative humidity is 66%. In general, the climate in the vast plains of Isabela is suitable to corn production. However, in 1998, drought devastated 110 996 hectares of corn field in Isabela incurring a production loss of about 219 000 metric tons of corn (BAS 2001). The Philippines is visited by an average of 20 typhoons per year from 1948 to 2000 (PAGASA 2001). The months of July, August, and September have the most frequent typhoon occurrence in the country (Kintanar 1984). Experts have observed that typhoon development in the Philippines has been erratic and almost unpredictable with strongly varying movement and structure (Tacio 2000).

In recent years, improvements in our understanding of the interactions between the atmosphere and its underlying sea and land surfaces, advances in modeling the global climate system, and the substantial investment in monitoring the tropical oceans helped provide a degree of predictability of climate fluctuations at a seasonal lead time in many parts of the world (Hansen 2002). This has allowed critical agricultural decisions to be made in crop production to minimize negative impacts of, or maximize the benefits from the expected climatic conditions (Gadgil et al. 2002). Thus, this chapter seeks to examine the agronomic and economic impacts of advanced climate information on corn production systems in Isabela Province, Philippines as affected by planting date decision.

4.2 Methods

4.2.1 Determining Planting Dates Recommendation for Corn Farmers in Isabela, Philippines

As part of the objective of the case study, crop performance and yields obtained using two planting dates were compared to demonstrate the importance of using the climate forecast, i.e. planting date determined and rationalized by considering the advanced seasonal climate information versus the farmer's choice of planting date. Analysis of seasonal climate forecasts and the use of the historical data on normal precipitation alone suggested that the planting date could not be determined exactly. Thus, an alternative practical approach was to use the available historical rainfall data combined with statistical analysis to determine the distribution of the end of rainfall occurrence and to validate the planting date using crop simulation. The 42-year monthly rainfall data of Isabela were classified into El Niño, La Niña or neutral years leading to the classification of the October 2003–January 2004 corn cropping season as El Niño, La Niña or as neutral season. The historical end of the rainfall occurrence for the October–January cropping season for the grouped years was also determined. Planting date was determined such that the critical stage of corn growth should be synchronized with the period when there is adequate soil moisture so that crop yield will not be significantly affected or reduced. It has been reported that water stress or moisture deficit from tasseling/reproductive stage to maturity is the most critical stage of corn growth which significantly reduced corn yield (Shaw and Thom 1951; Coligado et al. 1963; Papadakis 1966; Classen and Shaw 1970; and Sys et al. 1993). This critical period is about 55 days after planting. Thus, the recommended planting date was obtained by determining the date such that the critical crop growth stage will not coincide with the period of moisture stress (i.e. about 55 days before end of rainfall occurrence). For both Naguilian and Benito Soliven, the recommended planting date is 21 October 2003. However, planting date for Benito Soliven was moved to 27 October 2003 due to technical tribulations. Unlike in Naguilian, farmers in Benito Soliven prepare their land manually (i.e. using animal-drawn plow) that requires longer number of days. Tractors are not used in this area due to its rolling terrain. Each planting date was further validated to be optimal for each site by crop simulation modeling using CERES-Maize model by simulating crop yields with the specified dates of planting as model input data.

4.2.2 Field Implementation

Six (6) corn farmers with a farm size of at least two hectares each were selected as case study cooperators. Three (3) farm sites were established in different villages/communities in the town of Benito Soliven. The municipality of Benito Soliven is located at 16°55' N longitude and 121°60' E latitude. It is about 98 meters above sea level (Fig. 4.1). Corn in this area is produced on rolling terrain and being located in an elevated area compared to the rest of the corn production sites in the province, Benito Soliven's climate-related concern is mainly drought occurrence.

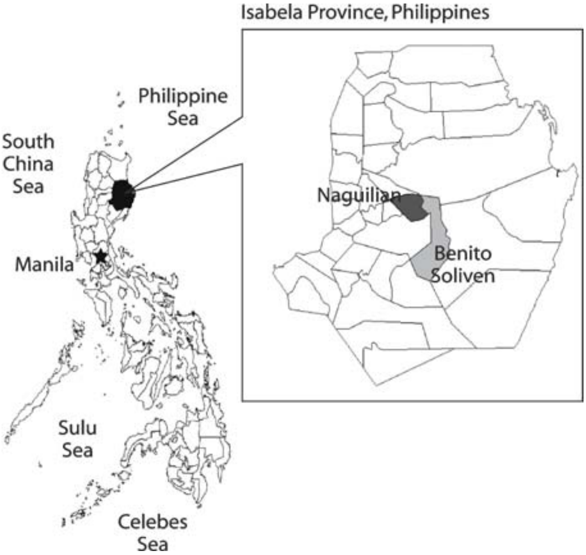

Fig. 4.1. Location of the municipalities of Naguilian and Benito Soliven in Isabela Province, Philippines

The other three (3) farm sites are located in different communities/villages in the town of Naguilian, Isabela Province. Naguilian is located at 17°60' N longitude and 121°50' E latitude. It is about 38 meters above sea level. Naguilian is situated along the Cagayan River, the biggest river system in northern Philippines. The town's major weather-related concern is flood occurrence.

Each of the farms identified was divided into two main plots with timing of planting as the treatment, and each experimental unit measuring 2 500 m^2 with two replications. One plot was planted based upon the recommended planting period derived from the use of climate forecast products combined with the use of statistical analysis of long-term historical weather data of the province. The other plot was planted based on the farmer's choice of planting date. Most corn farmers in Isabela province base their choice of planting dates on the actions of neighboring farmer leaders in the vicinity. Plots owned by same farmer (i.e. with different planting dates) were managed by the same farmer employing similar cultural practices. This was closely monitored by the project staff who lived in the area.

The choice of planting date is the sole recommended modification from established farmer's practice. Since the experimental cropping season is towards the dry season, the main consideration in the choice of planting date is the assurance of moisture availability during the tasseling or reproductive stage in corn production. In the tropics, this is approximately 55 days after planting.

4.2.3
Data Gathering

The case study throughout the cropping season was closely monitored and farm activities were duly recorded to control possible sources of variation other than the planting dates. Yield and income generated were determined at harvest time. Actual farmer's income based on the prevailing price of corn during harvest time was also determined.

4.3 Results

4.3.1 Farmers-Cooperators' Background

Naguilian Farmer No. 1: Mr. Arturo Marfil is 52 years old, has reached collegiate-level of education and has four hectares of farm land solely devoted to corn. He obtains 40% of his farm capital from private lenders/traders. He owns a hand tractor and corn sheller which facilitate easier land preparation and shelling. On the side, Mr. Marfil raises poultry, swine, cattle and freshwater fish to supplement his farm income.

Naguilian Farmer No. 2: Mr. Felipe Ignacio, Jr. is 49 years old, has reached high school-level education and has 28 years of corn farming experience. He grows corn on three and half out of his four hectares of farm land. His wife also assists in his farming activities. He derives 90% of his farm capital from private lenders/traders.

Naguilian Farmer No. 3: Mrs. Herminia Accad is 64 years old and a retired elementary school teacher. She has 20 years of farming experience. She solely manages her 2.3 hectares of corn farm and hires local farm hands to perform the necessary field operations. She derives about 30% of her farm capital from local lenders/traders.

Benito Soliven Farmer No. 1: Mr. Miguelito Santos is 44 years old, has an agricultural engineering degree from a local university and has 24 years of corn farming experience. Mr. Santos works for the local government and hires local farm workers to do the day-to-day farm operations. Mr. Santos allocates 2 hectares out of his 4 hectares of farm land to corn production. He obtains 20% of his farm capital needs from private lenders/traders. He traditionally plants corn in November for the dry season cropping and May for the wet season cropping.

Benito Soliven Farmer No. 2: Mr. Edmund Gauiran is 27 years old, has a university degree and also works for the local government. Just like Mr. Santos, Mr. Gauiran obtains 20% of his farming capital from private lenders/traders. He hires local farm workers to till his 2 hectares of corn plantation.

Benito Soliven Farmer No. 3: Mrs. Esmenia Aquino is 65 years old and has 35 years of corn farming experience. She completed elementary education. Mrs Aquino owns seven hectares of farm land and allots four hectares of her property to corn production. She also hires local farm workers for her crop operations. Corn production is her primary source of income. She utilizes her own funds to finance her farm operations.

4.3.2 Corn Yields

The choice of planting date is an important decision especially in rainfed, annual crop production system like corn. The planting period, which lasts 30–90 days according to climatic zone and date of onset of rains, is the most critical part of the farming season (Ingram et al. 2002). The difference in planting date during this study ranged from 3 days to 39 days (Table 4.1). The yield and income variation based on differences in planting date are shown in Figs. 4.2 and 4.3. There is an appreciable difference in the levels of corn yields and farm net income in the two sites with distinctly different elevations and agro-environment. Overall, crop yields in the low elevation, flood-prone corn areas in Naguilian are relatively higher that those in the high-elevation, drought-prone corn areas of Benito Soliven.

As shown in Fig. 4.2, the yield in corn areas that followed a planting date based on climate forecast was higher in five out of six farms that participated in the study. This overall yield advantage is about 18% compared to farms with planting dates based on farmer's choice. In the lower elevation areas of Naguilian, areas with planting date based on climate forecast have 11% better yield compared to areas planted following farmer's choice of planting date. Yield in areas that utilized advanced climate information was 25% higher than the overall community yields average. The general trend was similar in the higher elevation and drought-prone municipality of Benito Soliven. Climate forecast-based planting resulted to 12% better yield than areas planted based on individual farmer's choices and 13% better yield than the general community yield average. For Mrs. Herminia Accad (Farmer No. 3) in Naguilian, Isabela, a difference of three days in the choice of planting date resulted to a decrease in yield by 13% or about 770 kilograms of corn yield per hectare.

4.3.3 Income from Corn Production

In terms of farm income, areas in Naguilian that utilized advanced climate information have 18% more income on a per hectare basis compared to farms that depended on individual farmer's choice of planting dates (Fig. 4.3). Income differences based on choice of planting dates ranged from 7.2 to 27% in Naguilian, Isabela. In Benito Soliven, the income advantage resulting from the application of the recommended planting dates based on climate forecast was about 32% on a per hectare basis. Income differences of participating Benito Soliven farmers ranged from 4.3 to 65.7%. The huge 65.7%

Table 4.1. Planting dates based on climate forecast products and farmers' choice of dates of planting corn in Isabela Province, Philippines

Location – cooperator	Planting date	
	Based on climate forecast	Based on farmer's choice
B. Soliven – Farmer 1	27 October 2003	18 November 2003
B. Soliven – Farmer 2	27 October 2003	10 October 2003
B. Soliven – Farmer 3	27 October 2003	18 October 2003
Naguilian – Farmer 1	21 October 2003	17 November 2003
Naguilian – Farmer 2	21 October 2003	30 November 2003
Naguilian – Farmer 3	21 October 2003	24 October 2003

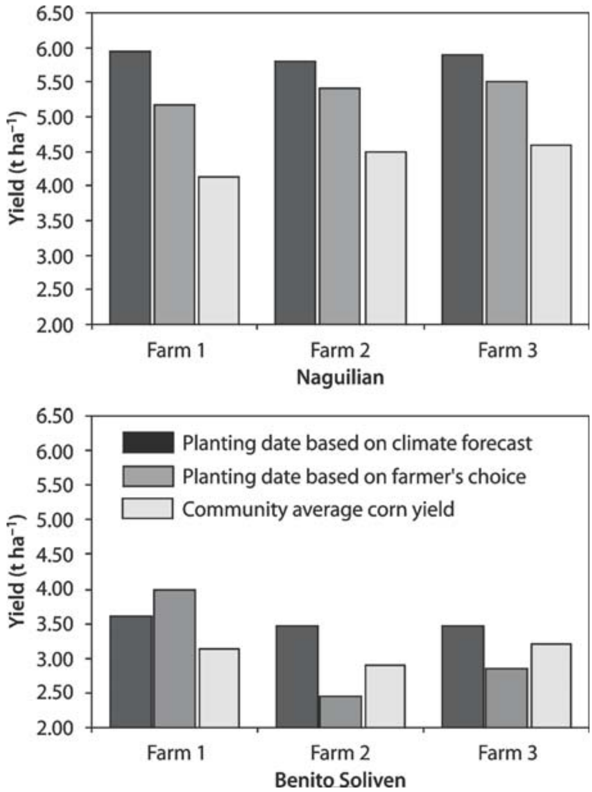

Fig. 4.2. Corn yields at Naguilian and Benito Soliven, Isabela, Philippines as affected by planting dates

difference in the per hectare income of Mr. Edmund Gauiran (Farmer No. 2) of Benito Soliven was brought about by the 29.4% yield advantage and the better price of corn grains when the harvest from area planted using climate forecast was sold in the local trading center.

4.4 Conclusions

For rainfed corn production systems in Isabela, Philippines, the recommended planting date for the location can be estimated by determining the historical end of the rainfall occurrence based on available climate data, and deducting from this period about 55 days to avoid water stress during the critical period of the reproductive stage from flowering until the end of grain formation. During wet season cropping, however, the use of advanced climate information to determine the recommended planting date may not be useful and practical as the crop will not experience significant water stress throughout its growing period since there is adequate soil moisture available. This excludes the fact that the wet season is also characterized by atmospheric disturbances due to typhoons with strong winds and heavy rainfall which may destroy the crops.

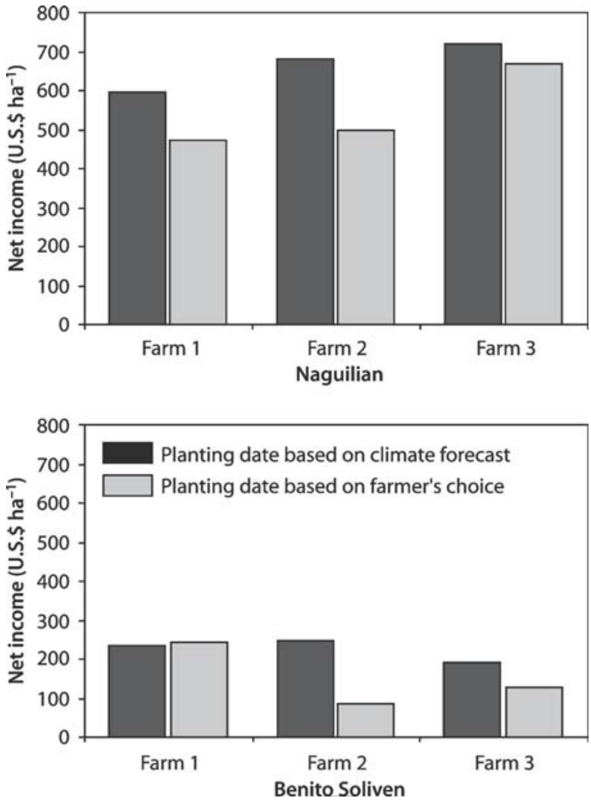

Fig. 4.3. Net income of corn farmers in Naguilian and Benito Soliven, Isabela, Philippines as affected by planting dates

Field research results have demonstrated that corn farms which used climate information to base the planting date obtained higher crop yields and higher net income compared to areas which were planted based on farmers' decision of planting date. Farms which used advanced climate information-based planting date had a generally higher yield than the average level in the entire village. These results had shown that using advanced climate information in farm-level climate-related decisions in corn production system can lead to increased yield and farm income and can minimize risks due to climate variability.

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References

BAS (Bureau of Agricultural Statistics) (2001) Corn: estimated production, area harvested and yield/hectare, Philippines, 1990-2000. Bureau of Agricultural Statistics, Quezon City, Philippines

Classen MM, Shaw RH (1970) Water deficit effects on corn. II. Grain components. Agron J 62:652–655

Coligado MC, Aglibut AP, Sandoval AR (1963) Agricultural drought and its effect on corn. Philipp Agriculturist 46:602–617
Gadgil S, Seshagiri Rao RR, Narahari Rao K (2002) Use of climate information for farm-level decision making: rainfed groundnut in southern India. Agr Syst 74:431–457
Hansen JW (2002) Realizing the potential benefits of climate prediction to agriculture: issues, approaches, challenges. Agr Syst 74:309–330
Ingram KT, Roncoli MC, Kirshen PH (2002) Opportunities and constraints for farmers of west Africa to use seasonal precipitation forecast with Burkina Faso as a case study. Agr Syst 74:331–349
Kintanar RL (1984) Climate of the Philippines. PAGASA, Quezon City, Philippines
Lansigan FP, de los Santos WL, Perez RE, Fabellar MT (2001) The corn profile of Isabela. Yield Gap Analysis Project. UPLB-DA-BAR Publications, College, Laguna, Philippines
PAGASA (Philippine Atmospheric, Geophysical, and Astronomical Services Administration) (2001) Tropical cyclone statistics in the Philippine area of responsibility (1948–2000). Philippine Atmospheric, Geophysical, and Astronomical Services Administration, Quezon City, Philippines
Papadakis J (1966) Climates of the world and their agricultural potentialities. Buenos Aires, Argentina, pp 104
Shaw RH, Thom HC (1951) On the phenology of field corn, the vegetative period. Agron J 43(1):9–15
Sys IC, Ranst EV, Debaveye IJ, Beernaert F (1993) Land evaluation. Part III: Crop requirements. Agricultural Publications, Belgium
Tacio ED (2000) Understanding our weather. Philippine Panorama Sunday. Manila, Philippines, pp 10–11, 13