Economic and Social Commission for Asia and the Pacific

CGPRT Centre WORKING PAPER No. 71

Stabilization of Upland Agriculture under El Nino-induced Climatic Risk: Impact Assessment and Mitigation Measures in the Philippines

Florentino C. Monsalud
Jaime G. Montesur
Edwin R. Abucay

United Nations

The CGPRT Centre

The Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) was established in 1981 as a subsidiary body of UNESCAP.

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1. Introduction

The stability of agricultural production, particularly in the uplands or rainfed agricultural areas, is highly dependent on the normal climatic pattern. For farmers in the rainfed areas, climate variability is a risk that they have to contend with. The occurrence of El Nino-induced abnormal weather would have a great impact on the agricultural sector. Hence, it is necessary to clearly understand the connection between climate variability and agricultural production in order to stabilize agricultural production even under abnormal climatic conditions.

1.1 El Nino-induced climatic risk and agricultural production

The increasing frequency and irregularity of El Nino occurrence is a risk that cannot be ignored. If this El Nino-induced climatic risk is left unmanaged, it could cause a serious problem in terms of shortages of food and livelihood. In the Philippines, the El Nino-induced weather change has resulted in prolonged dry seasons, severe droughts and higher temperatures. This condition could have serious implications on agricultural productivity and consequently on the country's economy. Since large areas are affected by this El Nino-related abnormal weather, the aggregate loss to production could be very significant. This could lead to food scarcity and inadequate livelihoods for the farmers in the affected areas. On a global scale, a sudden drop in food production could create a severe shortage in the world market, which could result in sharp increases in world prices. Hence, a strong El Nino, if mitigation measures are not in place, could pose serious threats to food security not only in the Asia-Pacific region but throughout the world as well.

Impacts of El Nino differ from country to country simply due to differences in the level of preparedness in mitigating the adverse effects of El Nino. Vulnerable countries which have inadequate facilities and institutional support systems to help farmers cope against El Nino would be hit hard by El Nino. At the farm level, the most vulnerable are the resource-limited farmers. In the Philippines, these groups of farmers are the ones cultivating crops which are sensitive to this phenomenon.

It is therefore necessary to establish technological and institutional measures in order to capacitate the farmers in confronting problems associated with El Nino-induced abnormal weather. This needs the full understanding of effective strategies on how to recover from the damage caused by abnormal weather like drought. It is also necessary to elucidate real conditions of agricultural technologies and management of El Nino-induced weather changes. It is likewise of paramount importance to be aware of existing policies and other government initiatives aimed at strengthening relevant institutions assisting the different stakeholders to cope against El Nino.

1.2 Objectives and scope of the study

The significant impacts of previous El Nino episodes that have hit the country created interest in studies related to this abnormal weather. These studies yielded interesting results and provided valuable information on the impacts of El Nino and mitigation measures both on the agricultural and fishery sectors. This study was conducted guided by the findings of these works on El Nino.

This study was conducted to: a) determine the impacts of El Nino-related abnormal weather changes on production of selected crops; b) document and analyze the existing conditions on rainfed farming systems, resources, infrastructure, institutions, and other socio-economic characteristics associated with El Nino vulnerable areas; c) review existing policies related to El Nino; d) draw up recommendations for the stabilization of rainfed agricultural production.

The study focuses on the major crops that are very important to the economy of the country. These crops include corn, rice and selected legumes.

1.3 Organization of the report

This report is organized into six major sections. The first chapter deals with the general rationale of the study as regards to the importance of assessing El Nino-induced climate variability and agricultural production and determining appropriate mitigating measures. This section also presents the objectives and scope of the study.

Chapter 2 provides a description of the general characteristics of the climate in the country, describing some of the normal weather prevailing in the country. This chapter also provides a brief definition of the El Nino Southern Oscillation (ENSO).

The documentation of the impacts of the 1997/98 El Nino episode on the environment and natural resources, agricultural production, and others are presented in Chapter 3.

The mitigating measures and strategies employed by farmers as well as the interventions of the government are enumerated in Chapter 4.

Chapter 5 is devoted to the analysis of the preparedness of the country at various levels in mitigating the effects of El Nino while the last chapter presents the conclusion and the recommendations.

2. Background Information

This chapter provides a brief description of the general characteristics of the Philippine climate, describing the characteristics of the normal climate as a basis for comparison with the abnormal El Nino-induced climatic variability. This section provides a brief definition of the El Nino Southern Oscillation (ENSO) and Southern Oscillation Index (SOI).

2.1 Area and location

The Republic of the Philippines is an archipelago that consists of 7,107 islands covering a land area of about 300,000 km^2. It is situated within 4° 23' and 21° 25' N latitudes and longitudes 116° 55' and 126° 34' E. To the east the Pacific Ocean, to the south the Celebes Sea and to the west and north the South China Sea (http://da.gov.ph/about/profile.htm). It is divided into three major island groups: Luzon with an area of 141,000 km^2, Visayas with an area of 57,000 km^2 and Mindanao with an area of 102,000 km^2. The Philippines ranks 57th among the 146 countries in the world in terms of physical size. Figure 2.1 shows a map of the Philippines by region.

2.2 Climate

2.2.1 Classification of climate

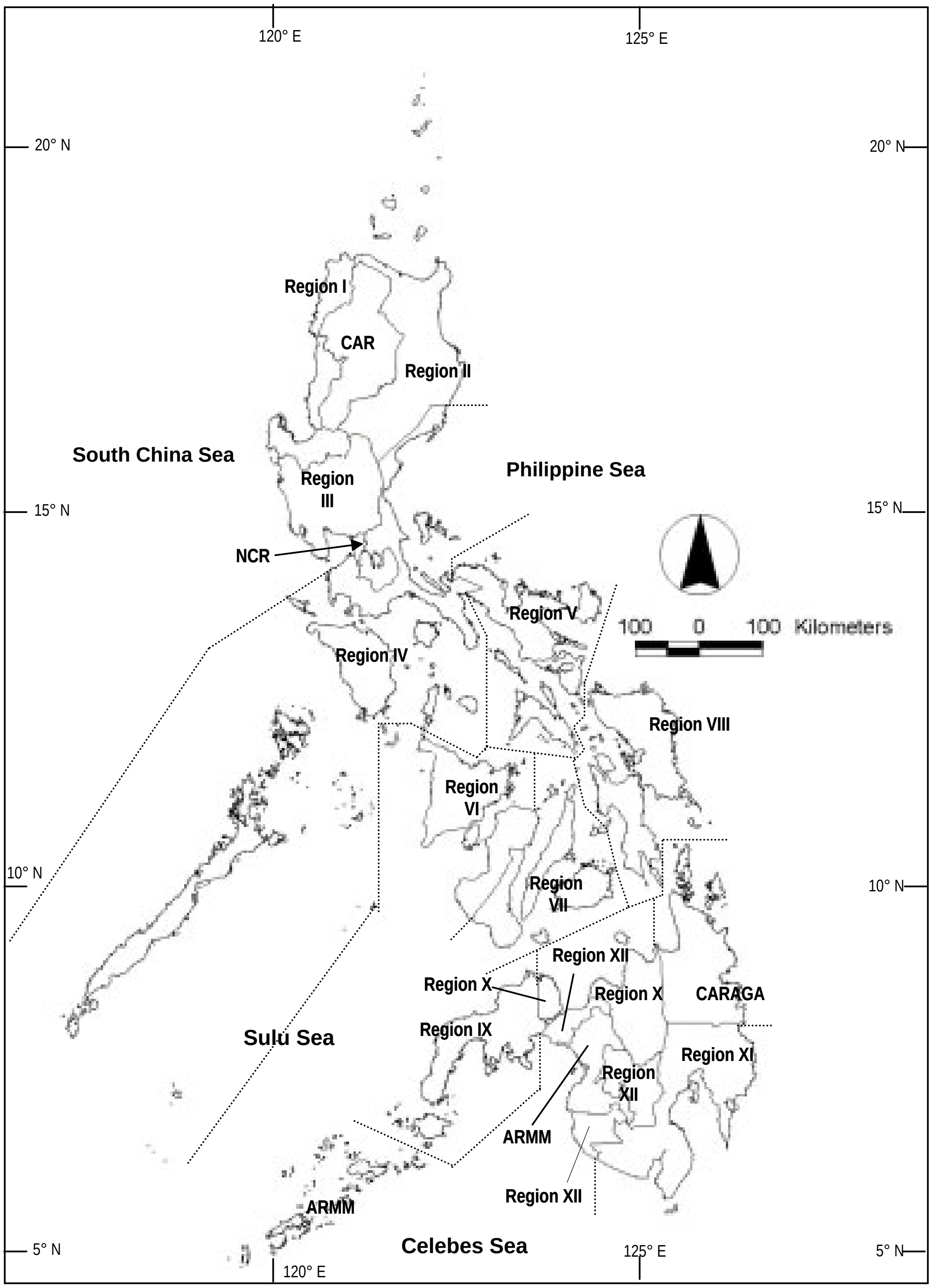
Several systems of climatic classification have been adopted in the Philippines. This classification was taken from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and is based on seasonal rainfall distribution: that is, considering the two most important rain periods in the country. These rain periods generally fall during the prevalence of the southwest and northeast monsoons. The so-called "Modified Corona's Classification of Climate" considers a dry month as that with less than 50 mm of rainfall, although a month with more than 100 mm can still be considered as dry if it comes after three or more very dry months. Using the average monthly distribution of rainfall at different stations, Corona defined four types of such rainfall distribution in the Philippines.

2.2.2 Typology of the Philippine climate

Figure 2.2 shows the climate map of the Philippines based on the Modified Coronas Classification. Type I climate covers the western parts of Luzon and Mindoro, Negros, Panay and Palawan. These areas have pronounced seasons: dry from December to May and wet the rest of the year. The provinces of Catanduanes, Sorsogon and the eastern part of Albay, the eastern and northern parts of Camarines Norte and Camarines Sur, eastern Quezon, Samar, Leyte and eastern Mindanao exhibit Type II climate with no dry season and a maximum rain period from November to January. In Type III climate areas, seasons are not very pronounced; relatively dry from November to April and wet the rest of the year. Maximum rain periods are not very pronounced but short dry seasons last only from one to three months. This type covers the western part of Cagayan, Isabela, Nueva Vizcaya, the eastern portion of the Mountain Province, southern Quezon, Masbate, and Romblon, northeastern Panay, eastern Negros, central and southern Cebu, part of northern Mindanao and most of eastern Palawan. Type IV climate has rainfall more or less evenly distributed throughout the year. This is experienced in the Batanes Island, southwestern Camarines Norte, western Camarines Sur and Albay, eastern

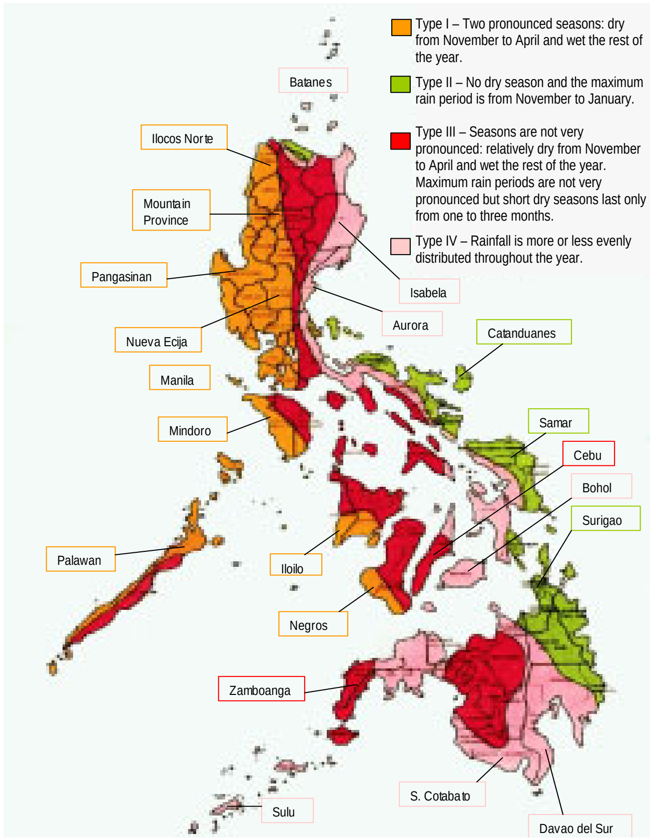
Mindoro, Marinduque, western Leyte, northern Cebu, Bohol, Bondoc peninsula and most of central, eastern and southern Mindanao.

Figure 2.1 Map of the Philippines by region



Adapted from: DENR, Region IV 1996.

Figure 2.2 Climate map of the Philippines based on the Modified Coronas Classification System



Adapted from: PAGASA, 1984.

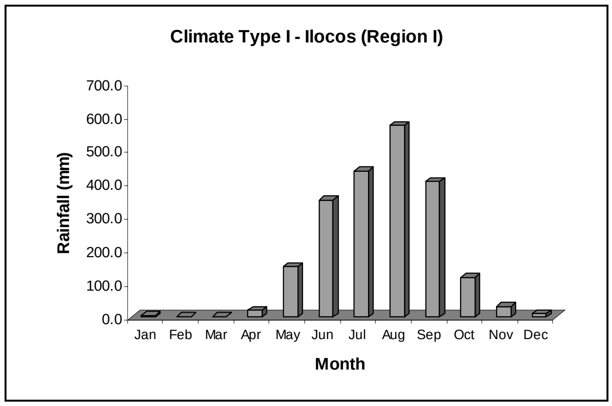
2.2.2.1 Rainfall distribution

Rainfall distribution in the Philippines greatly depends on its topographic features and the direction of moisture-bearing winds. Average annual rainfall varies from 965 mm to 4,064 mm (http://www.philonline.com.ph). The greatest amounts of rainfall are received in Baguio City, eastern Samar and eastern Surigao while the southern area of Cotabato receives the least amount of annual rain. Mean annual rainfall in General Santos City is only 978 mm. Figures 2.3 to 2.6 show the rainfall distribution pattern of representative regions with different climate types.

2.2.2.2 Temperature

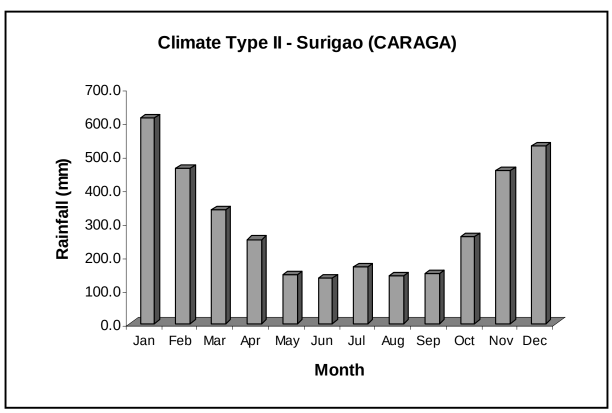
The mean annual temperature for all weather stations in the Philippines, except Baguio, is about 26.6°C (http://www.philonline.com.ph). Warmest months are April and May with a mean temperature of 26.6°C. On the other hand, coolest months fall from December to February with a mean temperature of 25.5°C.

Figure 2.3 Rainfall distribution pattern, Climate Type I (1961-1995)



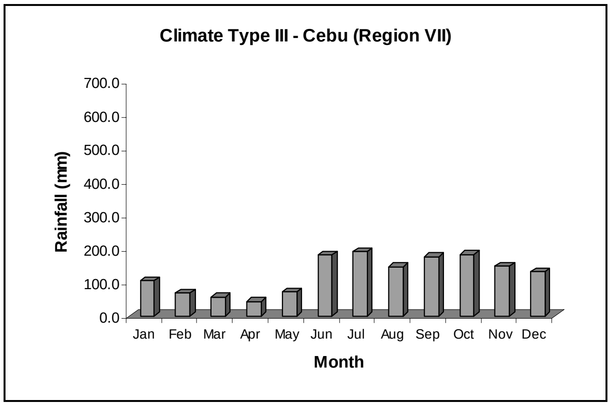
Source of data: PAGASA.

Figure 2.4 Rainfall distribution pattern, Climate Type II (1961-1995)



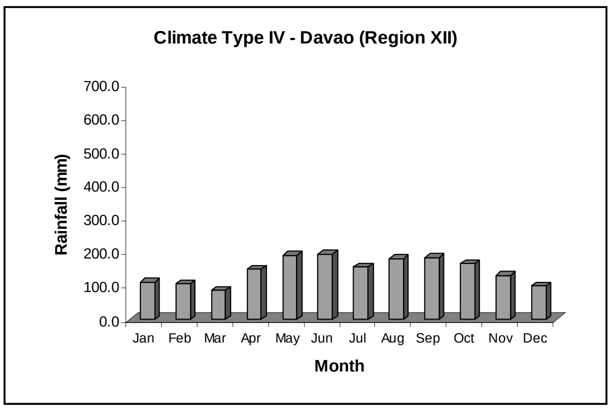
Source of data: PAGASA.

Figure 2.5 Rainfall distribution pattern, Climate Type III (1961-1995)



Source of data: PAGASA.

Figure 2.6 Rainfall distribution pattern, Climate Type IV (1961-1995)



Source of data: PAGASA.

2.2.2.3 Relative humidity

Almost all of the weather stations in the Philippines have a monthly average relative humidity greater than 70 per cent (http://da.gov.ph/about/profile.htm). The Philippines has a high relative humidity due to high temperatures and the surrounding bodies of water. Mean relative humidity ranges from 71 per cent in March to 85 per cent in September (http://www.philonline.com.ph).

2.3 El Nino

2.3.1 El Nino Southern Oscillation

El Nino is defined as "a local warming of surface waters which takes place in the entire equatorial zone of the central and eastern Pacific Ocean off the Peruvian coast and which affects atmospheric circulation world-wide" (Gommes, 1998).

Southern Oscillation is an East-West balancing movement of air masses between the Pacific and the Indo-Autralian areas. It is measured by the Southern Oscillation Index (SOI) and associated with typical wind patterns and El Nino (Gommes, 1998). The El Nino phenomenon is the oceanic component, whereas the Southern Oscillation is the atmospheric one. The combination of the terms El Nino and Southern Oscillation forms the term ENSO. Large negative values of the SOI are associated with warm events although there is no perfect correlation between El Nino and Southern Oscillation.

This phenomenon occurs at more or less regular intervals with an average of 4 to 5 years, sometimes less (2 to 3 years) or even more (8 to 11 years). El Nino is a permanent feature of the Pacific Ocean that lasts 12 to 18 months.

2.3.2 The Southern Oscillation Index (SOI)

The SOI is calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin. Sustained negative values of the SOI often indicate El Nino episodes (http://www.bom.gov.au). These negative values are usually accompanied by sustained warming of the central and eastern tropical Pacific Ocean, a decrease in the strength of the Pacific Trade Winds, and a reduction in rainfall over eastern and northern Australia.

Positive values of SOI are associated with stronger Pacific Trade Winds and warmer sea temperatures to the north of Australia, popularly known as La Nina episode. Waters in the central and eastern tropical Pacific Ocean become cooler during this time. Together these give an increased probability that eastern and northern Australia will be wetter than normal.

2.4 Land resource and agriculture

The Philippines is primarily an agricultural country. A large portion of the country (47 per cent) is devoted to agriculture. Prime agricultural lands are situated around the main urban and high population density areas. About 93 per cent of 14.2 million ha of alienable and disposable lands are classified as agricultural land. Forest lands occupy 15.8 million ha of the total land area of the country (http://da.gov.ph/about/profile.htm).

Rice, corn, coconut, sugarcane, banana, livestock, poultry, other crops and fishery production activities constitute Philippine agriculture. The total area for agriculture is used for food grains, food crops and non-food crops. About 31 per cent is used for food grains (4.01 million ha.), food crops are grown on 8.33 million ha, and 2.2 million ha are used for non-food crops. The average area used for corn production was 3.34 million ha while rice has about 3.31 million ha. Coconut accounted for the largest average harvest area (4.25 million ha) for food crops. Sugarcane has 673,000 ha; industrial crops 591,000 ha; vegetable and root crops 270,000 ha; 133 ha for cut flower and for pasture 404,000 ha.

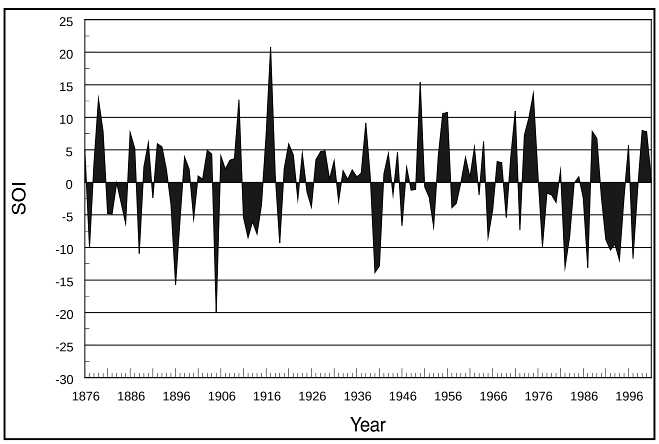
3. Impacts of El Nino-induced Abnormal Weather

This section presents the historical El Nino events in the country. It also contains the documentation of the impacts of El Nino-induced abnormal weather on the environment and natural resources, agricultural production, social and economic conditions, and food security.

3.1 Historical events of abnormal weather

The country has experienced a number of abnormal weather events brought about by El Nino. As per information provided by SOI data (Figure 3.1), the number of El Nino events that have occurred in the country total 25. However, as per the report of PAGASA (Table 3.1), there were a total of nine events that affected the country from 1968 to 1997. Of these nine events, five were considered as strong. It is evident in Figure 3.1 and in Table 3.1 that these strong events occurred in the years 1968/69, 1972/73, 1982/83, 1991/92 and 1997/98. The measure of intensity based on the MEI as presented by Anglo (1999), likewise supports the report that these events felt in the Philippines were strong while others events were weak to moderate (Appendix Table 1).

Figure 3.1 Southern Oscillation Index (SOI), 1876-2001



Source of data: Bureau of Meteorology, Australia (http://www.bom.gov.au).

Table 3.1 Drought events and areas affected in the Philippines during the last three decades

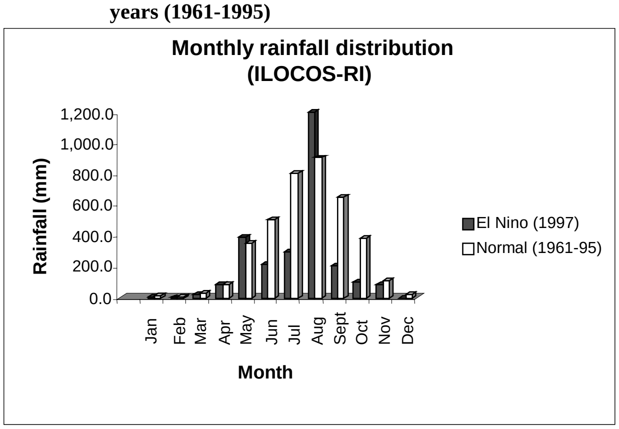
Event	Areas affected
1968-1969	Bicol and the rest of the Philippines except Ilocos and Cagayan Valley
1972-1973	Central Luzon, Visayas and Mindanao
1976-1977	Mindanao except Davao
1982-1983	
(Oct 1982-March 1983)	Central Luzon, southern Tagalog, northern Visayas, western Mindanao, Ilocos, Cagayan Valley, Bicol
(April-September 1983)	Cagayan Valley, parts of Ilocos
1986-1987	
(Oct 1986-Mar 1987)	Western Luzon, Bicol
(April-September 1987)	Most of Luzon, central Visayas, northeastern Mindanao
1989-1990 (Oct 89-Mar 90)	Cagayan Valley, Panay Island, Guimaras, northern Palawan, western Mindanao
1991-1992	Central Luzon, southern Tagalog, northern Visayas, western Mindanao, Cagayan Valley, Parts of Ilocos
1994-1995	Ilocos, Cagayan Valley, central Luzon, southern Tagalog, Visayas, western Mindanao
1997-1998	Northern Mindanao, southern Mindanao, eastern Visayas

Adapted from: PAGASA, 1997.

3.2 El Nino-induced weather changes

Mean annual rainfall in the Philippines is high, exceeding 600 mm everywhere in the country, and well over 1,200 mm in many locations (Table 3.2). In the country, Types I and III are considered vulnerable to drought. Figures 3.2 to 3.5 show the monthly rainfall distribution by type of selected regions in the Philippines compared with the 1997 El Nino episode. In areas with climate Type I, deficits in rainfall were felt from June to July and September (Figure 3.2). Abnormal rainfall distribution was experienced by areas with Type II climate (Figure 3.3). Large deficits were observed during the months of April and August. Type III climate areas experienced a decline in rainfall in May and from August to December (Figure 3.4). Below normal rainfall was observed in Type IV climate areas during July to September (Figure 3.5).

Figure 3.2 Rainfall pattern (Type I), El Nino year (1997) vs normal years (1961-1995)



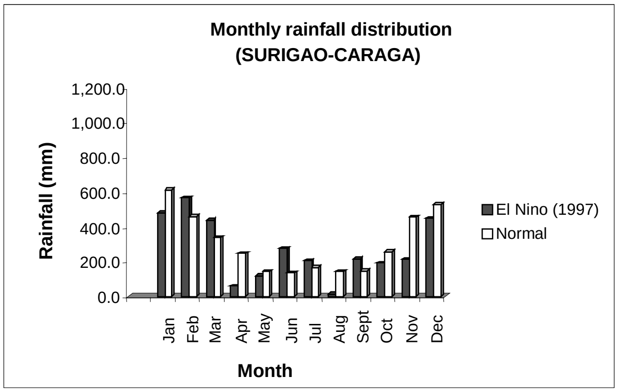
Source of data: PAGASA.

Table 3.2 Monthly and total annual rainfall distribution in the representative regions, the Philippines (1961-1997)

Station/Region	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Baguio (Car)	2.2	0.5	24.6	89.1	388.5	218.0	287.1	1,200.0	209.0	103.0	88.3	0.0	2,610.3
Ilocos Norte (I)	10.2	0.0	n.d.	0.0	230.6	172.0	266.8	571.7	66.3	56.9	19.1	1.2	1,394.8
Pangasinan (I)	6.0	0.0	11.6	91.5	371.6	309.7	333.1	842.4	333.3	83.3	8.6	0.0	2,391.1
Cagayan (II)	5.4	12.3	7.7	55.1	245.7	63.1	127.3	173.0	155.8	516.1	270.6	50.0	1,682.1
Nueva Ecija (III)	0.0	11.6	7.0	151.5	323.7	133.8	268.3	445.2	235.1	21.6	9.2	3.0	1,610.0
Mindoro (IV)	1.2	4.3	9.4	4.8	436.0	199.5	535.7	450.9	168.4	40.3	23.6	0.0	1,874.1
Albay (V)	85.1	250.1	93.3	15.4	163.4	192.0	354.1	120.8	363.5	126.3	285.9	404.5	2,454.4
Iloilo (VI)	6.1	53.3	16.3	25.2	199.4	286.9	481.0	265.9	90.2	113.3	34.1	n.d	1,571.7
Cebu (VII)	29.8	85.5	38.2	55.4	41.1	197.6	339.9	119.1	168.4	149.3	35.6	31.4	1,291.3
Leyte (VIII)	338.4	204.0	191.8	36.6	94.8	204.5	293.9	108.2	211.7	239.1	106.0	170.7	2,199.7
Zamboanga (IX)	2.6	113.9	11.4	7.6	47.1	36.6	176.4	17.9	87.1	54.2	33.4	88.9	677.1
Bukidnon (X)	141.9	110.3	206.2	149.4	318.9	285.3	437.7	256.8	379.2	375.8	118.7	50.2	2,830.4
Davao (XI)	303.4	156.9	119.1	133.8	170.7	60.0	100.6	45.4	170.3	449.3	31.8	71.8	1,813.1
Surigao N. (Caraga)	481.4	567.2	440.9	59.2	119.6	274.8	208.1	14.4	218.2	192.9	211.9	451.4	3,240.0

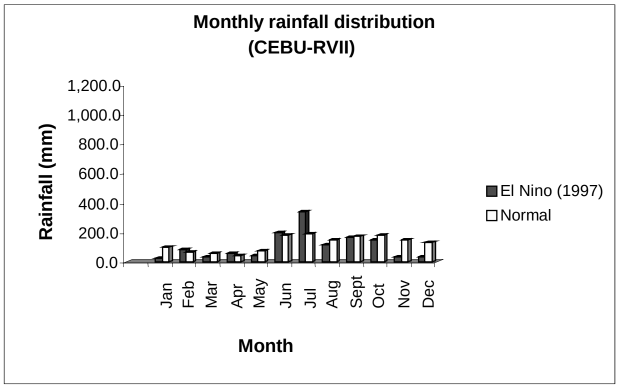
n.d. – no data.
Source of data: PAGASA.

Figure 3.3 Rainfall pattern (Type II), El Nino year (1997) vs normal year (1961-1995)



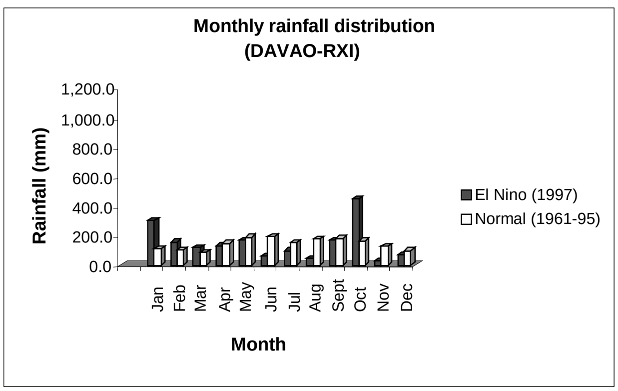
Source of data: PAGASA

Figure 3.4 Rainfall pattern (Type III), El Nino year (1997) vs normal year (1961-1995)



Source of data: PAGASA.

Figure 3.5 Rainfall pattern (Type IV), El Nino year (1997) vs normal year (1961-1995)



Source of data: PAGASA.

In the 1982/83 drought, for instance, areas in western and central Luzon, southern Tagalog, Nueva Vizcaya, Bohol, and northern Mindanao experienced rains which were less than 40 per cent of their normal values. In the latter part of the drought in 1983, areas in the Ilocos region, central Visayas, central Luzon, Bicol, northern Palawan, Iloilo, and Negros Occidental experienced rainfall less than 80 per cent of the normal values (PAGASA as cited by Librero *et al*., 1999).

The report of Librero *et al.* (1999) indicated that except for 1972, the whole country experienced more than a 13 per cent rainfall deficit during El Nino years, with the latest episode exhibiting the highest deficits of 23 per cent and 64 per cent for the two years of the drought. There was no rainfall deficit in 1972 and only minimal deficit was observed in 1973. This does not mean, however, that no drought occurred during this year. Rains in other areas could have offset the rainfall deficits in the drought areas. Moreover, there could have been abnormally rainy months, which reduced the total deficit for the year.

Rainfall is a function of cyclones as well as normal rains. On average, there are twenty cyclones affecting the country every year. Not all the centres of these typhoons passed through the Philippines Area of Responsibility (PAR). During the drought years, however, the number of typhoons was noticeably reduced (Table 3.3). Anglo (1999) concluded that the popularly accepted connection between tropical cyclone activity and the ENSO is an oversimplication and can be incorrect depending on the intensity of the ENSO event. He added that anomalies in tropical cyclone activity also differ geographically. Above average rainfall does occur during La Nina, probably due to precipitation incited by small-scale disturbances or the Asian Monsoon and due to tropical cyclones.

Table 3.3 Average numbers of tropical cyclones entering the Philippine area of responsibility

	TD	TS	TY	Total	No. of months*
All cases	4.0	5.4	10.5	19.9	547
Normal phase	4.3	5.8	10.1	20.2	232
El Nino	3.6	4.1	11.3	19.0	183
La Nina	4.2	6.5	10.5	21.3	132
Weak El Nino	3.5	3.9	12.3	19.6	96
Moderate El Nino	4.4	5.5	11.6	21.5	63
Strong El Nino	2.0	1.5	7.5	11.0	24
Weak La Nina	5.3	8.2	11.6	25.1	66
Moderate La Nina	3.5	5.3	9	17.8	48
Strong La Nina	2.7	4.0	12.0	18.7	18

Legend:
TD – Tropical depression EN – El Nino
TS – Tropical storm LN – La Nina TY – Typhoon

*Refers to the period considered for each case in the computation of the average number of tropical cyclones.
Source: Anglo, 1999.

Table 3.4 Provinces affected by El Nino in Regions I to IV, 1997-1998

Region	Provinces affected
I Ilocos Region	Ilocos Norte Ilocos Sur La Union Pangasinan
II Cagayan Valley Region	Western Part of Nueva Vizcaya Cagayan Valley
III Central Luzon Region	Bataan Bulacan Nueva Ecija Pampanga Tarlac Zambales
IV Southern Tagalog Region	Batangas Cavite Laguna Mindoro Occidental Northern Palawan Rizal Romblon

Source: Acoba-Battad *et al*., 1999.

3.3 Impacts on vulnerable areas

3.3.1 Environment and natural resources

Shortage of water supply due to El Nino was experienced in the different parts of the country. Analyses of the seasonal rainfall by PAGASA covering the period from October 1997 to March 1998 showed that an estimated 90 per cent of the whole country received rainfall less than 50 per cent of the normal values (PAGASA-DOST, 1998). In addition, negative seasonal rainfall departures from normal of more than 800 mm were observed in the provinces of Aurora, Quezon, Bicol, Batanes, Samar, Leyte, Misamis Occidental, Surigao and Davao Oriental. The drought left 32 per cent of water sources, the rivers and springs, totally dry, particularly in Iloilo, Batangas, Cebu, and some parts of Mindanao (Librero *et al*., 1999). In contrast, Davao del Sur still had plenty of water for its residents.

The El Nino phenomenon parched land water resources of potable water in General Santos City and adjacent areas. Davao del Sur also experienced shortages in potable water, hence, residents resorted to cutting down banana trees and boiling their trunks to become a source of water. Moreover, forest fires were reported to affect portions of Mt. Apo, Mt. Matumtum and forested areas in Maragusan (PCARRD, 2001).

The report of Acoba-Battad *et al.* (1999) indicated that mountains in Regions 2 and 3 were affected because trees and grasses died due to a lack of water. Air quality was affected in Region 2 and partially affected in the rest of the regions.

3.3.2 Impacts on agricultural production

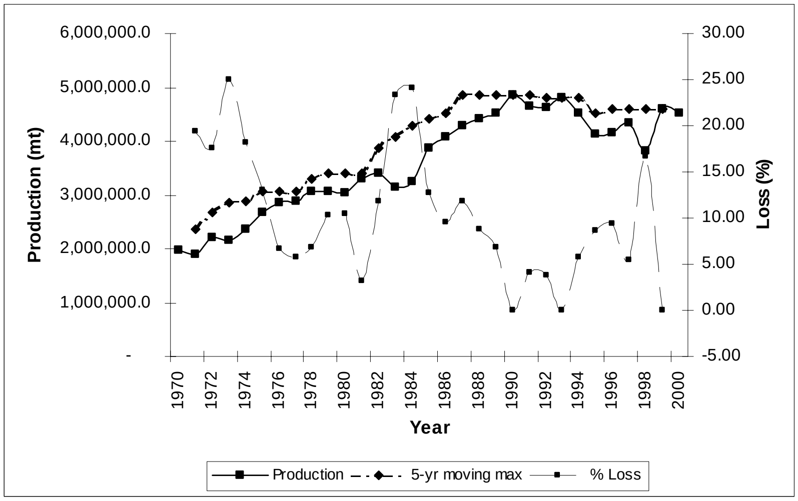
3.3.2.1 Crops

Production of major crops in 1998, as reported by the Department of Agriculture (DA), decreased by 14.36 per cent as a result of the reduction in hectarage due to El Nino and typhoons Emang and Gading. Palay and corn production decreased by 24.09 per cent and 11.75 per cent respectively from the previous year's production. Coconut and sugarcane also slid by 12.94 per cent and 17.30 per cent respectively. Only tobacco and abaca posted an increase while mango, banana, coffee and pineapple declined. The decline in sugarcane and banana was caused by the long dry period. In pineapple production, crop shifting and late planting contributed to its decrease. The financial assistance and contract growing of programs implemented by the National Tobacco Administration (NTA) resulted in an increase in production. Favorable weather conditions also improved abaca production.

To estimate the quantitative losses of selected crops, we used the 5-year moving maximum method by Gommes (1998). For corn and rice production time series data of the selected regions in the Philippines, the maximum production value P_m in a five-year moving interval from Y_{t-2} to Y_{t+2} was taken. To compute the percentage loss in production P_t of the year Y_t the formula $(P_m - P_t)/P_m \times 100$ was used. This method assumes that no significant technological development took place during the five-year interval. Therefore, any changes in production can be attributed to El Nino related weather conditions.

Figure 3.6 shows the estimated corn production losses in the Philippines. Analysis shows that at the national level, average production loss was 10.18 per cent compared with 6.71 per cent in years (1979 and 1981) without an El Nino or La Nina episode (Table 3.5). Among the corn regions, Region II suffered the highest loss (21.98 per cent) followed by Region X (21.89 per cent) and Region XII (16.51 per cent).

Figure 3.6 Estimated corn production loss, the Philippines



Source of data: BAS.

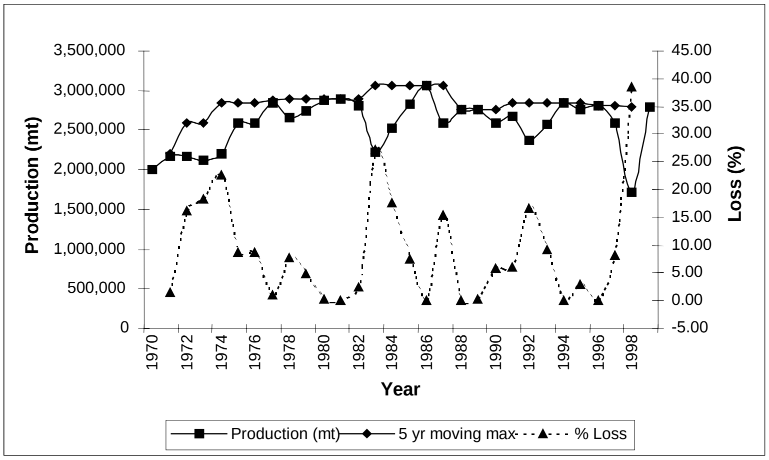
Table 3.5 Estimated mean corn production loss (%) during El Nino events, the Philippines

Year	National	Region II	Region V	Region VII	Region X	Region XI	Region XII
1972-73	21.26	16.55	4.55	17.71	18.91	39.88	11.35
1976-77	6.21	8.41	14.90	1.07	27.48	10.38	16.34
1982-83	17.64	33.20	18.28	3.27	18.03	13.34	31.91
1986-87	10.70	23.92	9.62	8.29	35.28	1.57	20.33
1989-90	3.42	22.89	8.00	2.75	27.30	0.13	11.35
1991-92	3.92	14.07	4.75	17.61	39.17	6.28	12.66
1994-95	7.23	17.05	5.82	6.85	5.06	22.83	13.97
1997-98	11.06	39.75	13.29	5.67	3.89	15.57	14.20
Mean ENY	10.18	21.98	9.90	7.90	21.89	13.75	16.51
Non-ENY and Non-LNY	6.71	3.88	9.49	8.71	21.22	12.58	19.39

Source: Author's calculation.

Production losses to rainfed rice are shown in Figure 3.7. Estimated average rainfed rice production loss at the national level during the El Nino years was 10.51 per cent compared with only 2.40 per cent in years without El Nino or La Nina (Table 3.6). Rice production declined in regions II, X and XI with 27.65 per cent, 28.10 per cent and 27.04 per cent losses respectively. Figure 3.8 shows the losses to irrigated rice production in the Philippines. Irrigated rice production (national level) decreased by 12.87 per cent (Table 3.7). At the regional level, Region XII lost 22.44 per cent of its production followed by Region X (19.15 per cent) and Region VII (16.54 per cent).

Figure 3.7 Estimated rainfed rice production loss, the Philippines



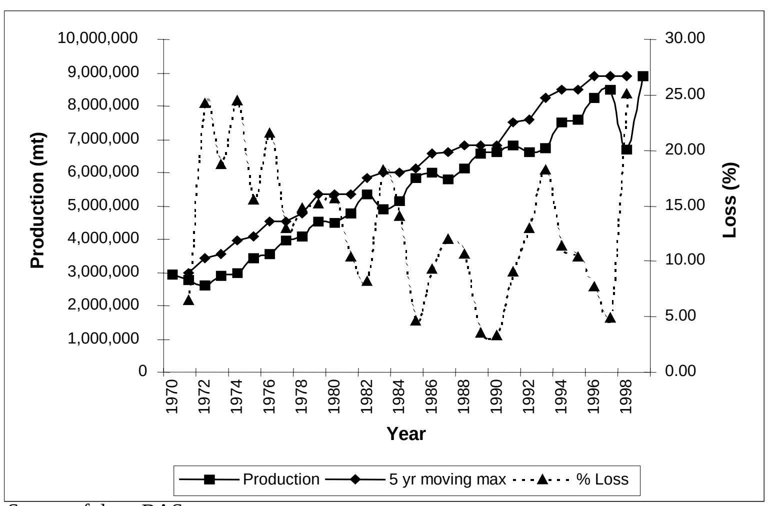
Source of data: BAS.

Table 3.6 Estimated mean rainfed rice production loss (%) during El Nino events, the Philippines

Year	National	Region II	Region III	Region V	Region VII	Region X	Region XI	Region XII
1972-73	17.22	27.72	8.45	32.79	17.30	12.90	44.14	26.39
1976-77	4.94	17.21	14.80	0.17	24.43	46.39	17.17	26.04
1982-83	14.84	19.35	14.12	28.13	33.41	43.49	18.47	27.48
1986-87	7.75	22.78	21.37	10.90	23.06	19.51	23.16	6.62
1989-90	3.15	10.75	17.55	12.74	20.65	22.79	14.60	11.90
1991-92	11.34	52.62	18.87	0.31	43.63	15.58	43.20	53.03
1994-95	1.51	15.73	10.21	20.83	3.79	23.05	18.05	21.62
1997-98	23.35	55.07	23.16	35.42	37.94	41.05	37.50	35.85
Mean ENY	10.51	27.65	16.07	17.66	25.53	28.10	27.04	26.12
Non-ENY and Non-LNY	2.40	0.00	25.28	10.73	34.72	1.30	26.08	19.22

ENY – El Nino Year.
LNY – La Nina Year.
Source: Authors' calculation.

Figure 3.8 Estimated irrigated rice production loss, the Philippines



Source of data: BAS.

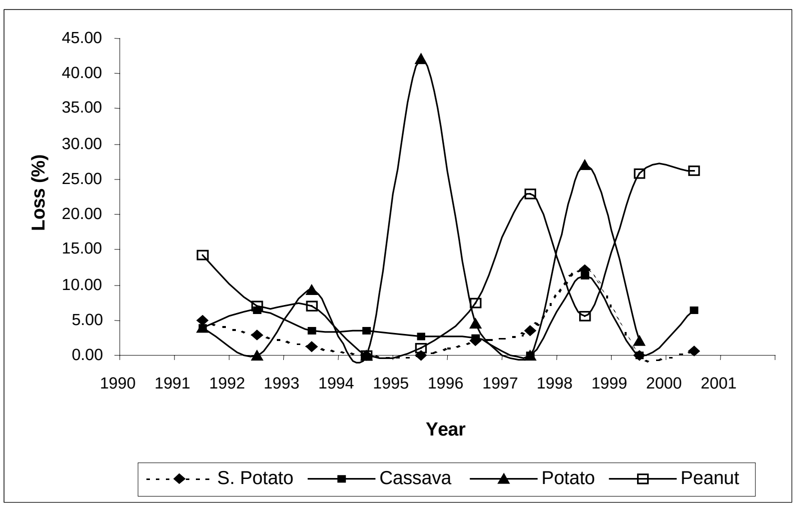
Table 3.7 Estimated mean irrigated rice production loss (%) during El Nino events, the Philippines

Year	National	Region II	Region III	Region V	Region VII	Region X	Region XI	Region XII
1972-73	21.47	16.45	24.20	5.03	20.26	45.36	25.09	31.16
1976-77	17.28	4.13	27.09	15.14	17.66	23.45	31.40	41.98
1982-83	13.23	36.99	9.05	14.00	12.14	2.10	19.66	31.16
1986-87	10.66	15.99	11.68	12.96	43.08	38.30	10.33	6.33
1989-90	3.42	4.27	2.08	8.76	2.92	3.95	2.17	11.70
1991-92	11.02	15.38	9.60	1.12	3.53	20.80	10.93	29.79
1994-95	10.87	17.91	11.40	5.18	15.90	0.67	15.19	14.74
1997-98	15.02	19.10	16.33	11.80	16.86	18.55	9.37	12.65
Mean ENY	12.87	16.28	13.93	9.25	16.54	19.15	15.52	22.44
Non-ENY and Non-LNY	12.77	13.93	17.22	11.00	17.96	23.00	10.85	23.30

ENY – El Nino Year
LNY – La Nina Year
Source: Authors' calculation.

Figure 3.9 shows production loss to sweet potato, cassava, potato and peanut in the Philippines. Peanut showed a high production loss during the 1997-98 El Nino event compared to the other crops mentioned. Sweet potato and white potato also showed a decline in production.

Figure 3.9 Estimated production loss of other crops, the Philippines



Source of data: BAS.

The IPCC (1995) as cited by Gommes (1998) defined vulnerability as the extent to which climate may damage or harm a system. It depends not only on a system's sensitivity but also on its ability to adapt to new climatic conditions. In view of this definition, vulnerability ranking of selected regions was undertaken. The ranking was based on the magnitude of production loss of corn and rice as estimated by the 5-year moving maximum method by Gommes (1998). Production losses during the El Nino years considered in this study were calculated and the average was used in the final ranking. Vulnerability of a region was then based on its rank for the crops considered.

Major corn growing areas in the country were considered in the estimation of the vulnerability ranking. The same regions were used for rice. Region II appeared to be the most vulnerable experiencing production losses of 21.98 per cent (Table 3.8) followed by Region X.

Acoba-Battad *et al.* (1999) also reported that a large corn area was affected in Region II (Table 3.9). Production was also highly affected (Table 3.10).

Regions subjected to vulnerability ranking based on rice production losses were the same as those considered for corn. For this crop, Region X (rainfed) and Region XII (irrigated) received the highest ranking. Region II and X ranked second for rainfed and irrigated rice respectively. Acoba-Battad *et al.* (1999) also reported that a total of 129,904 mt of rice were lost from the 63,109 ha of riceland affected (Table 3.10).

Table 3.8 Vulnerability ranking of selected regions in the Philippines*

Rank	Corn	Rainfed rice	Irrigated rice
1	Region II (21.98 %)	Region X (28.10 %)	Region XII (22.44 %)
2	Region X (21.89 %)	Region II (27.65 %)	Region X (19.15 %)
3	Region XII (16.51 %)	Region XI (27.04 %)	Region VII (16.54 %)
4	Region XI (13.75 %)	Region XII (26.12 %)	Region II (16.28 %)
5	Region V (9.90 %)	Region VII (25.53 %)	Region XI (15.52 %)
6	Region VII (7.90 %)	Region V (17.66 %)	Region III (13.93 %)
7		Region III (16.07 %)	Region V (9.25 %)

*Values in ( ) are the estimated per cent production loss based on the 5-year moving maximum method.
Source: Authors' calculation.

Table 3.9 Report on El Nino affected rice and corn areas

Region	Rice area affected (ha)	Corn area affected (ha)
Region I	2,278	88
Region II	63,109	77,692
Region III	27,544	80
Region IV	60,668	-

Source: Acoba-Battad *et al.*, 1999.

Table 3.10 Report on the production loss of rice and corn

Region	Rice (tons)	Corn (tons)
Region I	4,237	46
Region II	129,904	98,844
Region III	60,747	201
Region IV	79,555	-

Source: Acoba-Battad *et al.*, 1999.

3.3.2.2 Livestock, poultry and fishery

Dolcemascolo noted that in the study of area-specific impacts of Extreme Climate Event (ECE) indicators in the Philippines, livestock and poultry are not sensitive to extreme climate events (http://www.adpc.ait.ac.th/audmp/rllw/themes/th8-glenn.pdf). In fact, livestock and poultry were the most robust among the production sub-sectors with annual average growth rates of 5.0 per cent and 5.5 per cent respectively (http://www.codewan.com.ph/nihan/arrd_today/situationers/agrisitasiaphil.htm). However, FAO cited that El Nino-related drought has had a considerable impact in the Philippines, which could trigger above normal livestock slaughter with depressing effects on prices (http://www.fao.org/NEWS/1998/elnin2-e.htm). Downscaling of the intensive poultry and pig industries might also be a result due to reduced output of feed grains brought about by drought and severe foreign exchange constraints.

Reports from the Department of Agriculture in 1998 showed that the livestock subsector, particularly the carabao and cattle production, increased by 6.51 per cent and 3.71 per cent respectively. The overall performance of livestock grew by 3.63 per cent. However, the poultry subsector slid by 0.43 per cent. Chicken production decreased by 1.10 per cent as the production of broilers tightened during the fourth quarter. Chicken egg production increased by 1.87 per cent as indicated by the expanded inventory of chicken layers.

The effect of El Nino on fishery may not be as severe as for crops and livestock. However, the Department of Agriculture said that the decline in river flow caused low water supply for aquaculture. Increases in water temperature and salinity also affected aquaculture production.

Aquaculture production was the hardest hit in the fishery sector during the 1997-1998 El Nino episode. Production loss was estimated at 260,375 metric tons or about PhP 6.2 billion in terms of economic loss (PCAMRD 1999). Severely affected areas were Regions III and VI where extensive areas have been devoted for aquaculture and marine fisheries (Table 3.11). The report added that the decline in seaweed production significantly contributed to high economic losses in the Autonomous Region of Muslim Mindanao (ARMM).

Total fisheries production dropped by 283,879 mt valued at PhP7.248B over a nine-month period (October 1997-June 1998) during the 1997-1998 El Nino episode. The loss is equivalent to 10.2 per cent of the volume and 8.7 per cent of the value of fisheries production in 1996 (PCAMRD, 1999).

Table 3.11 Vulnerability level of the regions to El Nino, based on the magnitude of economic loss

High (>PhP500M)	Moderate (PhP50-500M)	Low (<PhP50M)
Region III	Region II	CAR
Region V	Region IV	Region I
Region VI	Region VIII	Region VII
ARMM		Region IX
		Region X
		Region XI
		Region XII
		CARAGA

Source: PCAMRD, 1999.

3.3.3 Social and economic impacts

In Negros Occidental, 930,435 villagers in 267 barangays were affected by the El Nino. The declaration of 7,628 ha of sugarland as unfit for production caused widespread hunger among the farming Community. The damage to crops and livestock were assessed at PhP99.7 M and PhP425, 700 respectively.

In Luzon for instance, the 1997/98 El Nino negatively affected the rice and corn areas as shown by the amount of pesos lost in the form of labor and material input used in the damaged area planted to rice and corn (Table 3.12). The report of Acoba-Battad *et al.* (1999) indicated that as a result of the farm production loss, the income of farmers was badly affected. The report added that more than half (54 per cent) of the farmers in Region I had to borrow money from relatives, friends and neighbors to support the household needs while about 48 per cent of the farmers in Region II resorted to a reduction in household and personal expenses. This implies that their social activities were also affected.

Table 3.12 Cost of production inputs lost for rice and corn

Region	Rice (PhP)	Corn (PhP)
Region I	11,467,923	42,682
Region II	271,201,305	406,761,927
Region III	134,196,676	478,200
Region IV	249,776,968	-

Source: Acoba-Battad *et al.*, 1999.

3.3.4 Impacts on food security

In the study conducted by PCARRD (2001a) on Indigenous Knowledge and Practices, respondents were interviewed regarding their ENSO-related problems and their alternative livelihoods during the occurrences of these phenomena. The survey questionnaire included the profile of the respondents, awareness level, attitude, experience of the existence of El Nino and La Nina phenomena, and Indigenous Knowledge and Practices (IKPs). Documentation of the opinions and recommendations of the respondents was also undertaken in this study. The target sampling population per municipality per sector of the survey was 30 respondents. However, problems with the availability of persons for interview were experienced, thus sampling respondents for the fisheries sector was reduced to 12 respondents in some municipalities. The total respondents per province per sector is shown in Table 3.13. Results of the survey were tallied and analyzed by frequency count.

Table 3.13 Total number of respondents per province per sector

Province	Fisheries	Agriculture
Pampanga[a]	158	151
Camarines Sur[b]	149	155
Catanduanes[c]	154	150
Bulacan[d]	-	159
Zambales[e]	152	-
Total	613	615

Compiled from: PCARRD, 2001a.
Municipalities included were the following:
[a] Apalit, Arayat, Guagua, Magalang and San Luis except Magalang for agriculture
[b] Bula, Calabanga, Magarao, Pili and Tigaon; Bato included in agriculture
[c] Virac, Gigmoto, Bato, San Andres and Baras
[d] Bustos, Calumpit, Meycauayan, Norzagaray and Pulilan
[e] Subic

Characteristics of respondents for the agriculture and fisheries sector are discussed below. Most of the fisheries sector respondents (91.68 per cent) were males. The female respondents (8.32 per cent) were generally from Camarines Sur and Catanduanes. A large number of the respondents (46.98 per cent) were able to reach elementary school, about 35.73 per cent reached high school, 14.36 per cent reached college and 5.06 per cent did not have the opportunity to study. As to the respondent’s civil status, 83.03 per cent were married, 10.44 per cent single and 0.82 per cent widows. About 59.87 per cent of the respondents were engaged in fishing. Others were in farming (15.50 per cent), either in farming or fishing (10.11 per cent), self-employed (5.06 per cent), employed (3.92 per cent) or unemployed (5.87 per cent). Those engaged in fishing were mainly from Zambales and Camarines Sur. In terms of the agricultural sector, the study showed that approximately 80 per cent of the respondents were male and about 20 per cent were female. About 42.72 per cent of the female respondents came from Catanduanes. On the other hand, male respondents were from Pampanga (28.03 per cent), Bulacan (27.63 per cent), Camarines Sur (23.26 per cent) and Catanduanes (21.07 per cent). Married respondents made up 82.28 per cent, 6.67 per cent widowed and 3.90 per cent were single. In terms of educational background, 46.67 per cent were able to reach an elementary level and 18.21 per cent were undergraduates. Results also showed that the main source of income of the majority of the respondents (81.95 per cent) was from farming. The remainder were employed in private and government agencies. Other activities of the respondents include fishing, poultry/pig raising, sewing, tricycle driving, carpentry, vegetable gardening, trading and operating a sari-sari store or fishpond.

As reported by PCARRD (2001a), 50.57 per cent of the respondents experienced the ill effects of El Nino in their respective communities primarily in terms of food shortages (Table 3.14.). This was apparently caused by the drying of crops and fishpond areas as cited by more than half (61.66 per cent) of the respondents. Fish catch was observed to have been reduced by 46.33 per cent of the respondents. Some (24.47 per cent) claimed that there was no fish catch or that the fish moved beyond their fishing areas. In addition to food shortages, some respondents (36.22 per cent) noted that there was also an increase in the price of food commodities.

Table 3.14 Effects of El Nino on the environment and community, fishery sector (%)

Parameters	Province				
	Pampanga	Zambales	Camarines Sur	Catanduanes	All regions
Changes in environment*	72.15	53.29	68.46	56.49	62.64
Crops/fishponds dried up	81.01	26.32	69.13	69.48	61.66
Low/no rain	78.48	51.32	71.14	64.94	66.56
High sea/Ocean temp.	15.19	51.32	52.35	33.77	37.85
Food shortage	46.20	34.87	72.48	49.35	50.57
Animals/fish died	33.54	17.11	44.97	24.03	29.85
Incidence of pest	15.19	5.92	25.50	14.94	15.33
Crops dried up	67.72	12.50	60.40	66.23	51.88
Fish moved to other areas/no caught	19.62	23.58	38.93	16.23	24.47
Smaller catch	32.91	54.61	59.61	38.96	46.33
Price of food went up	38.61	28.29	42.28	35.71	36.22
No change	2.53	1.97	7.38	3.90	3.92
Others	5.70	24.34	24.34	11.69	13.21

*Changes in the environment brought about by El Nino
Compiled from: PCARRD, 2001a.

The report also indicates that in the farming communities, all respondents experienced the ill effects of El Nino. Respondents in all regions (52.85 per cent) noticed the changes in environment as brought about by El Nino. About 83.25 per cent of the respondents mentioned that crops, particularly rice and corn, dried up (Table 3.15.). Low or no rain at all was experienced by 63.74 per cent of the respondents. The study also reported the socio-economic effects of El Nino. These include migration, water shortages, decreased crop yield, less rain, increase in prices of basic commodities and health problems (e.g. malnutrition, etc.).

Table 3.15 Perception on the effects of El Nino (%) per province, farming sector[a]

Province	Change in environment*	Crops dried up	Low/no rain	No change
Bulacan	38.36	84.91	54.09	2.52
Pampanga	52.32	70.86	58.94	0.00
Camarines Sur	72.90	83.87	79.35	0.00
Catanduanes	48.00	93.33	62.67	0.00
All regions	52.85	83.25	63.74	0.65

[a] Multiple answers.
*Changes in the environment brought about by El Nino.
Compiled from: PCARRD, 2001a.

4. Coping Mechanisms and Risk Management Strategies

This section presents the coping mechanisms and risk management strategies employed by farmers to mitigate the adverse effects of El Nino-induced abnormal weather.

4.1 National risk management strategies

4.1.1 National awareness campaigns

The efforts of the various institutions to create awareness of El Nino are documented in the compendium of IEC materials on El Nino titled “The Fiery Fury of El Nino” that was published by the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) in 1999. The information, education and communication (IEC) materials that were published in 1997 and 1998 are listed in Table 4.1. The studies and information on El Nino contain information on important research, analytical and discussion materials. The second category of materials focuses on the effects of El Nino on water resources and suggests steps to be taken to save water, both for domestic (household) and commercial use. The third category of materials features the effective measures to combat El Nino in addition to important and recent technologies developed in preparation for its adverse effects. The approaches to El Nino were published in Tagalog. The use of this dialect was perceived to be more relatable to farmers, as contents presented were centred on information and mitigating measures against El Nino.

Table 4.1 Information materials disseminated during the 1997/98 El Nino, compiled by PCARRD published under the El Nino R&D Program

Materials	1997	1998	Total
Studies and information on El Nino	14	8	22
El Nino and water	2	8	10
Measures and technologies	14	2	16
Approaches to El Nino	4	-	4

Adapted from: PCARRD, 1999.

It is also interesting to note that many agencies contributed to the campaign to prepare for the El Nino. As shown in Table 4.2, the agencies that participated in the campaign include: PAGASA, PCARRD, DA, DENR, BSWM, El Nino Task Force, PIA and others (DOH, FAO, UPLB, Time Magazine, WMO and NIA).

The study conducted by the Philippine Information Agency (PIA) to measure the effectiveness of their Information Education Campaign, showed a favorable response, 725 of the respondents reported that they had encountered material containing information on the weather phenomenon. Ninety-seven per cent of those who had seen the materials found the information provided to be useful in their struggle to cope with the effects of the El Nino (El Nino Task Force, PIA 1998). Of all the respondents, 97 per cent felt that there is a definite need for the government to conduct this kind of campaign on El Nino. The survey was composed of 2,200 respondents in the National Capital Region and 21 other provinces which were hit hardest by the El Nino.

Table 4.2 Information materials disseminated by different agencies during the 1997/98 El Nino

Source of Materials	Studies and information on El Nino	El Nino and water	Measures and technology	Approaches to El Nino
PAGASA	6	0	0	0
PCARRD	2	0	9	0
El Nino Task Force	5	0	0	0
DA	1	0	2	1
DENR	1	3	2	1
PIA	0	0	0	1
BSWM	0	6	0	1
Others	7	2	3	0
Total	22	11	16	4

Adapted from: PCARRD, 1999.

4.1.2 Technology interventions

The technology interventions include the shallow tube wells (STWs), small water impounding projects (SWIPs), small farm reservoirs (SFRs), seeds, fertilizers and others. The reports of Librero *et al*. (1999) and Acoba-Battad *et al*. (1999) provide comprehensive information about these interventions.

The current study discusses the effectiveness of the different interventions introduced by the government and evaluates its appropriateness to the different agro-ecosystems and socio-economic environments. This provides the merits as well as weaknesses of each intervention.

The DA identified the following measures that would minimize the negative effects of drought such as: 1) establishment of small water-impounding projects; 2) small farm reservoirs; 3) installation of shallow tube wells; 4) rehabilitation of communal irrigation systems; 5) cloud seeding. The DA has reportedly stepped up irrigation and other water management projects as well as the distribution of sweet corn and vegetable seeds in areas where water is inadequate for rice production (Policy Forum, 1997).

The President has directed the release of PhP80M in contingency funds for the purchase of giant plastic sheets for water collection projects of 10 provinces. Also released was PhP500 M for the small water impounding projects. Cloud seeding operations are being carried out in areas where there is no or insufficient rain. (Policy Forum, 1997).

Farmers in areas with Types III and I climate are encouraged to plant alternative crops which are not too water-dependent during the next season. For rice, land preparation should be shortened from 30 to 20 days.

The Department of Agriculture considers preparedness as the best strategy to ensure agricultural production and food security, even if El Nino, as reported by PAGASA, is a weak one or its prediction remains uncertain.

Due to the effects of El Nino on food security, especially for the poor farming and non-farming rural communities and because of the uncertainty of the magnitude and timing of El Nino, the Department of Agriculture has prepared contingency plans for areas that are identified as vulnerable and have been historically affected by even normal dry spells and by past El Nino events.

The Department of Agriculture has opted to give priority funding and quick action to the following:

1. Establishment of small-scale irrigation systems, such as small water impounding projects, small river diversion dams, shallow tube wells and small farm reservoirs.
2. Rehabilitation of communal and national irrigation systems.
3. Seed procurement and the establishment of provincial seed systems, which enable the department to collaborate with small farmers in the production and distribution of high quality seeds.
4. Proper use of farm inputs, especially the judicious use and combination of inorganic and organic fertilizers through the adoption of the Balanced Fertilization Strategy. A total of PhP 55.60 M was released to the BSWM to implement the balanced use of

organic and inorganic fertilizers in rice growing areas that have been producing rice yields lower than the national average of 3.2 tons per hectare.

4.1.2.1 Shallow tube wells

As presented in Table 4.3, the potential irrigable area through shallow tube well pumps is more than 5.0M ha. However, as of 2000, only a total of 24,193 STWs were installed in the country. These STWs covered a 72,594 ha service area (Table 4.4).

David (2000) enumerated a number of advantages of shallow tube well as follows:

1. Cost-effective.
2. It is amenable to privatization, and as such, does not require subsidies in investment, operation and maintenance. Hence, it is sustainable. David (2000) argued that irrigation subsidies must be removed to achieve efficiency and sustainability. He pointed out the case of the National Irrigation System (NIS) where the government fully subsidizes the construction and about half of the operation and maintenance cost. He added that irrigation investments must be fully recovered.
3. It has a short gestation period, taking only 3-5 days to design, drill and initially develop a tubewell.
4. It has high water use efficiency compared to gravity systems.
5. It is simple to operate and maintain.

Table 4.3 Groundwater potential in the Philippines (in thousand ha)

	Luzon	Visayas	Mindanao	Total	%
Shallow well areas[1]	2,759	914	1,625	5,298	17.7
Deep well areas[2]	4,823	2,681	4,111	11,615	38.8
Difficult areas[3]	6,558	2,036	4,465	13,059	43.5
Total	14,140	5,631	10,201	29,972	100.0

[1]Shallow well areas – wells of not more than 20 m deep could be developed.
[2]Deep well areas – water bearing layers are encountered at more than 30 m below ground surface.
[3]Difficult areas – groundwater supply is minimal and the probability of encountering non-productive bore is very high.
Source: As cited by Rondal, 1999.

Table 4.4 Completed shallow tube wells project, as of 2000

Region	No. of projects	Service area (ha)
CAR	843	2,529
Region I	2,610	7,830
Region II	3,630	10,890
Region III	4,178	12,534
Region IV	1,397	4,191
Region V	1,576	4,728
Region VI	2,207	6,636
Region VII	651	1,953
Region VIII	994	2,982
Region IX	954	2,862
Region X	1,361	4,083
Region XI	1,301	3,903
Region XII	1,186	3,558
CARAGA	701	2,103
ARMM	604	1,812
Total	24,193	72,594

Adapted from: Lucas and Contreras, 2001.

In spite of the economic attractiveness of the different minor irrigation technologies, including the STWs, their promotion was hindered by the following (David, 2000):

1. Total neglect of some minor irrigation support services by the agencies concerned.
2. Lack of baseline information on shallow aquifer characteristics, dependable flows of streams and rivers and hydrology of potential areas for inundation schemes (e.g. swamps, marshes and wet season waterlogged flood plains).
3. Lack of benchmark information on suitable well development and well drilling techniques.
4. Lack of affordable and suitable drilling rigs.
5. Unavailability of cheap pump sets.

According to David (2000), STW expansion could lower the groundwater level down to a minimum of about 7.5 m in the vicinity of pump wells. Such a lowering of the groundwater level may result in the following:

1. Increasing the number of inoperative STWs and hand tubewells (HTWs) at certain hours during the dry months. This is more in the case of tube wells located upstream of major aquifer systems. A widening area of deep water levels will have negative impacts on irrigation development and on village water supply and sanitation.
2. A decrease in the dry season flows of natural waterways. Some aquifers (e.g. unconfined aquifers) are hydraulically connected to river systems. They feed the river system with water during the dry months. The lowering of the groundwater levels will reduce the base or dry season flows of natural waterways. There will be adverse effects on water quality (e.g. concentrations of agro-chemicals and animal waste), on water supply for low lift pump and gravity irrigation systems downstream, on navigation and on aquatic life.
3. A decrease in groundwater flow towards mangroves and other coastal area ecosystems. The groundwater gradient toward coastal areas is usually very small. A decline in groundwater levels during the dry months will further reduce this gradient and will cause a reduction in fresh water inflow into coastal areas. This may result in increased salinity of brackish water ecosystems, which may trigger a chain reaction within the marine resources food chain.
4. Increased salt-water intrusion in coastal areas. A reversal of hydraulic gradient due to a decline in groundwater levels may lead to salt water intrusion in coastal areas. In fact, a decrease in the dry season flows of waterways may induce salt-water intrusion much further inland through river networks.
5. Induced recharge and the possibility of groundwater pollution. Where groundwater aquifers are hydraulically connected to the river systems, a reversal in groundwater gradient near the river system will induce inflow or recharge from rivers. Hence, there are potential risks of groundwater contamination.

4.1.2.2 Small water impounding projects

A series of small water impoundments, if constructed in several points, can conserve water more efficiently while reforestation is being carried out.

SWIPs serve upland portions of agricultural lands. A SWIP is designed as a flood mitigation measure as well as to provide water for crop diversification and intensification, livestock production and fish production.

In the Philippines, small water impounding projects (SWIPs) have gained nationwide acceptance and recognition not only as an effective soil and water conservation technology but also as a source of irrigation water for paddy soils. As shown in Table 4.5, there have been 268 SWIPs and diversion dams (DDs) completed with El Nino funds covering a total area of 52,331 hectares in all regions (Lucas and Contreras 2001). In a study conducted by Lucas *et al.* (2000), SWIPs have improved productivity of paddy soils in Talugtug, Nueva Ecija. Results of the soil and water regime analyses in the area confirmed that natural rainfall is sufficient for only one cropping of rice, thus a second cropping is not possible without irrigation. This proves that a supplemental source of water such as a SWIP is crucial in improving the productivity of paddy soils. SWIP's in Talugtug have increased production area, initially by about 225 hectares and increased annual farm production per hectare in the service area by an average of 116 per cent.

Diversion dams (DDs) are systems of weirs established across small river systems with continuous flow to raise the water level and allow diversion of water by gravity to the adjoining farmlands. A weir can be a permanent or temporary structure, made of concrete, boulders, sandbags, logs, and slabs, or a brush dam. DDs also serve as a provision to control stream bank erosion.

Table 4.5 Completed small water impounding/diversion dam projects, as of 2000

Region	No. of projects		Total service area (ha)
	SWIP	DD	
CAR	8	116	1,841
Region I	34	102	5,418
Region II	83	32	6,291
Region III	41	61	4,005
Region IV	5	72	2,429
Region V	17	75	4,345
Region VI	23	66	3,414
Region VII	8	20	896
Region VIII	10	62	2,970
Region IX	7	45	1,796
Region X	5	55	3,032
Region XI	13	46	4,956
Region XII	8	51	7,257
CARAGA	5	83	3,476
ARMM	1	2	205
Total	268	888	52,331

Adapted from: Lucas and Contreras, 2001.

4.1.2.3 Small farm reservoirs

A small farm reservoir (SFR) is a water-impounding earth-dam structure used to collect rainfall and runoff. It is designed for use on a single farm. Typically, it has an area of about 300-2,000m^2. The embankment height above ground level is less than 4 m. It can be easily constructed manually or using a bulldozer. The SFR enables farmers to raise fish and livestock. It provides irrigation for dry-season crops and supplements water for wet season cropping. Irrigation is carried out with PVC siphon pipes or pumps (Lucas 1999).

The construction of small farm reservoirs is complementary to the diversification needs of farmers. Instead of dredging canals thus allowing the water to flow into the rivers SFRs can conserve water and in turn can be used to raise fish and for supplementary watering of vegetable crops after the rainy season crop.

The construction of small farm reservoirs with a size of 20 m x 20 m x 1.5 to 2 m depth is practiced in Pangasinan province.

Small farm reservoirs are limited to no more than 2 hectares and catchment not exceeding 10 hectares. SFRs give higher benefits in areas with a unimodal pattern of rainfall. They are established in areas that receive most of the run-off from the farm.

Table 4.6 Completed small farm reservoirs, as of 2000

Region	No. of projects	Service area (ha)
CAR	1,676	1,676
Region I	3,682	3,682
Region II	2,949	2,949
Region III	5,893	5,893
Region IV	461	461
Region V	385	385
Region VI	948	948
Region VII	748	748
Region VIII	1,064	1,064
Region IX	709	709
Region X	480	480
Region XI	866	866
Region XII	1,183	1,183
CARAGA	120	120
ARMM	21	21
Total	21,185	21,185

Adapted from: Lucas and Contreras, 2001.

As reported by PCARRD (2001), the following is a description of an SFR as a recommended technology in El Nino vulnerable areas:

Requirements for the adoption of an SFR:

Minimum

1. Loam, sandy loam, clay loam and sandy clay loam are ideal soil types for embankment construction.
2. Sufficient catchment area to harvest runoff must be present.
3. Farm size must be 0.5 ha or larger and must have no tenurial problems.
4. Topography must be undulating.
5. Unimodal type of climate, with defined wet and dry seasons, will give highest benefits.
6. The average cost must be PhP8,000-12,000 per 1,000 m^3 of reservoir capacity.

Support system

1. Technical support for proper site selection and construction specifications should be provided.
2. Farmer adoptor should be trained on SFR utilization for optimum benefits.

Equipment

1. Bulldozers should be provided.
2. Manpower for manual labor should be made available if heavy equipment is not available.

Advantages

1. SFR's address the water requirement of rainfed farms, particularly those situated in sloping and undulating areas.
2. It is a time-tested practice among rainfed farmers in central Luzon and other parts of the country.
3. Its viability has been tested at the farm level.
4. It allows additional rice yield of 0.3 t/ha during the wet season on rainfed farms.
5. It allows for other income-generating activities such as dry season cropping, fish culture, agroforestry and livestock raising.
6. It reduces the velocity of water flow from higher areas, thereby minimizing soil erosion and nutrient losses.

7. It aids groundwater recharge.
8. It has a cheaper investment cost per hectare of service area than deepwells, run-of-the river systems, or surface pumps.

Limitations

1. Its limited capacity makes SFRs suitable only as supplemental water resources for crop production.
2. Typical SFRs dry up during the dry season or after several months without rain.
3. Farm production operations must be timed with water availability in the reservoir.
4. Use of stored water in the SFR must be budgeted to consider all uses the farmer intends for it (e.g. fish culture vs crop irrigation).

Recommendations

1. The use of SFRs for rainfed farms with undulating topography and appropriate soil texture.
2. SFR is designed for individual use, hence, the farmer must own the land (or have tenurial consent) and have the required tenacity and level of interest.
3. The reservoir must be located above the service area to facilitate irrigation by gravity. If this is not possible, a pump is needed to draw water from the reservoir into the service area.
4. Observe the following recommended specifications for SFR construction:
   - Design the SFR with least earth movement for minimum cost.
   - Solicit government bulldozers to cut expenses.
   - Mark the limits of the reservoir with stakes.
   - Free staked-out area from rocks, brushes, weeds, trees, and other debris.
   - Scrape topsoil to the sides to later cover the embankment.
   - Place coarse soil at the downstream side, medium-textured soil at the upstream face, and fine-textured soil at the centre.
   - Compact embankment repeatedly every 0.5 m.
   - Give 20 per cent allowance in the final reservoir height for slumping.
   - Make embankment side slope not too steep and top width at least 3 m. The embankment should be well compacted and its width should conform to the recommended measure to avoid excessive seepage and eventual breakage. The spillway must also be properly designed to accommodate the flow of excess water from the reservoir and prevent water from overtopping/destroying the embankment.
5. Maintain the SFR unit properly. The embankment must be regularly cleaned to prevent it from harboring pests. It must also be protected during periods of heavy downpour to avoid being damaged. The reservoir must also be desilted, as needed, to maintain optimum capacity.

4.1.2.4 Cloud seeding

The drought stricken agricultural areas can be relieved of continuous dry spells by cloud seeding operations. The Bureau of Soils and Water Management maintains two airplanes, RP C1243 and RP C1244 to make artificial rain. Ground verifications are conducted to assess the success of cloud seeding. Table 4.7 shows the cloud seeding operations in Luzon.

Table 4.7 Observations on cloud seeding operations in Luzon

Region	Target areas	Remarks
CAR	Watershed of Ifugao, Kalinga Apayao	Minimal number of sorties conducted due to unfavorable weather conditions.
Region I	Eastern Pangasinan	Operations had to be suspended due to unfavorable weather conditions. Only slight drizzle was experienced in the target areas.
Region II	Eastern Isabela, northern and eastern parts of Cagayan Quirino and Magat watershed	Minimum number of sorties conducted over the area.
Region III	Angat/Pantabangan Dams and their watersheds	Results over Angat dam and its watershed were more satisfactory than the Pantabangan area.
Region IV	Batangas	Operations had to be suspended due to unfavorable weather conditions.

Source: Librero *et al.*, 1999.

4.1.3 Livelihood options

During the occurrence of an El Nino, livelihood activities should be more oriented towards non-farm-based activities. Small-scale livelihood options like food processing, candy making, sewing, food vending and others could be promoted.

Provision of planting materials is not always a good option. According to a study by Librero *et al*. (1999), vegetable seeds distributed to the affected farmers were only wasted because of inadequate water for vegetable production.

4.2 Local initiatives

Aside from the national government's assistance (provision of shallow tube wells, planting materials, etc.) to El Nino vulnerable areas, some local government units (LGUs) took the initiative to help the farmers. For instance, in General Santos City in Mindanao, the city government advised farmers on what type of crops to plant during an El Nino. Free vaccination of farm animals to prevent the outbreak of an epidemic was also given (Canuday and Zonio, 2000).

4.2.1 Indigenous technologies

As reported by PCARRD (2001a), based on the study they conducted on indigenous technologies for El Nino, only half of the respondents knew traditional practices (IPs) that can lessen, if not prevent, the effects of El Nino. Of the four provinces surveyed, Catanduanes and Pampanga had the highest knowledge level of IPs. According to the respondents, they were the ones who developed or initiated these technologies/practices. Although some also acknowledged that information from friends and parents contributed to their knowledge on some of these practices.

The indigenous practices for crops and livestock in the provinces of Bulacan, Pampanga, Catanduanes and Camarines Sur are summarized in Tables 4.8 and 4.9. Indigenous technologies for crops are used in the different stages and components of the production system. The provinces surveyed have their own practices for pest control, fertilization, cultivation, irrigation and post-harvest practices. For livestock production, they have their practices for pest and disease control, feeding and housing.

Table 4.8 Indigenous practices for crop production

Indigenous practices	Area being practiced (provinces)[1]			
	Pampanga	Bulacan	Catanduanes	Camarines Sur
Pest control				
Smoking (*pausok*)		**	*	*
Herbal pesticide	*		*	*
Lighting	*			
Poison frog	*			
Soapy water			**	*
Fertilization				
Animal manure	**	***	**	*
Guano	*			
Production technologies				
Soil cultivation		*		
Covering of young plant			*	
Non-weeding				*
Irrigation				*
Post-harvest				
Bangan	*			
Tiklis	*			
Abaca sack	*			
Drying	*			

[1] The indigenous practices (IP) are used in the provinces with an asterisk. An increasing number of asterisks means a relatively higher number of municipalities practicing the IP.
Source: PCARRD, 2001a.

Table 4.9 Indigenous practices for livestock

Indigenous practices	Area being practiced (provinces)[1]			
	Pampanga	Bulacan	Catanduanes	Camarines Sur
Livestock Production				
Pulot		*		
Giniikan		*		
Ipa	*			
Kumpay				*
Vegetable rejects				*
Boiled roots and leaves of plants/crops				*
Water from washing				**
Indigenous material for housing	*	***	**	**
Tree shade	*	**	*	*
Pest and disease control				
Smoking	*			
Quarantine				*
Rattan ring				**

[1] The indigenous practices (IP) are used in the provinces with an asterisk. An increasing number of asterisks means a relatively higher number of municipalities practicing the IP.
Source: PCARRD, 2001a.

The respondents who showed knowledge of indigenous technologies/practices share the mitigating measure they use for planting methods, soil conservation, pest and disease control, fertilizer application, storage, feeding procedure in animals, housing and other practices. The Camarines Sur respondents identified *pagtanim ng palihis sa lupa* (diagonal planting) and ratooning as their indigenous practices in planting. In Catanduanes, the plants were covered when still young to prevent from withering, especially during intense heat or El Nino periods. Mulching technology was the one identified by the four provinces as the indigenous practice in conserving soil moisture. In Camarines Sur, removal of grass around the tree was not practiced. Similarly, placing of *bunot* or coconut coir around the base of the plant was practiced in Catanduanes. Moreover, respondents in Bulacan and Pampanga practice the cultivation of soil around the roots of the tree. This was believed to be one way of allowing the roots to breathe.

In terms of pest control for plants, several practices in Pampanga were enumerated. These include the use of herbal pesticide/botanical spray, *pailaw sa bukid* (lamps lit at night to scare insects), and poison frogs placed in the field to ward off insects. On the other hand, smudging technology, soapy water spray or water mixed with *siling labuyo* (small pepper) juice extract is practiced in Catanduanes. This practice is also similar to that in Camarines Sur.

Use of different fertilizers was also put into practice by the respondents. Guano and animal manure was used as fertilizer during El Nino periods in Pampanga, while the three other provinces used only animal manure. Composting was also practiced in Pampanga.

Post harvest practices include the use of *bangan* and *tiklis* to store crops and grains in Bulacan. The *bangan* is popularly known as *kamalig*, a nipa shack which farmers build for storing grains, cereals and crops after harvesting. The *tiklis* also known as *kaing* is made of bamboo or abaca and is used for storing fruits, vegetables and other farm products. In Pampanga, the simultaneous drying of harvest before storage to prevent pests was practiced.

Alternative feeds and feed supply were also reported by respondents from Camarines Sur during the occurrence of El Nino. Used corn and sugarcane stalks (through silage), reject vegetables, boiled *gabi* (taro), *kangkong* (water spinach) leaves, cassava and *ubod ng saging* (banana pith) and *ubod ng niyog* (coconut pith) were among the alternative animal feeds. Moreover, when the supply of *darak* (rice bran) is abundant, respondents mix this with commercial feeds to serve as filler. During long dry periods, respondents in Camarines Sur noted the use of the *supak* method of feeding and *kumpay* (a kind of grass or coarse food fed to horses or cattle) as indigenous practices. The *supak* method is a force-feeding method for animals using bamboo tubes containing the rice bran. The bamboo tube is placed inside the mouth to feed the animal. Used rice bran, *pulot* (molasses), *ginikan* (rice straw) and *ipa* (rice hull) were used as substitutes for animal feeds in Bulacan and Pampanga during El Nino.

Practices for the prevention of pest/disease of animals during El Nino were mentioned by respondents from Catanduanes. They pointed out the use of *huag* or rings made of rattan as one of their IPs. This is placed around the neck of the animal, which is believed to ward off insects. In Pampanga, *pausok sa gabi* (smoking) was their practice. This uses dry leaves, twigs and other plant parts, which are set on fire near plants to build smoke usually done at night. It is believed that this method keeps the insects/pests away from the animals. However, strict quarantine was practiced in Camarines Sur, thus nobody was allowed to enter animal cages to avoid contamination and the spread of diseases.

The majority of the respondents (86 per cent), mostly from Catanduanes and Camarines Sur, said that they would continue to use the said IPs. They believe that the IPs had helped them to survive and continue earning. On the other hand, 8 per cent had decided to discontinue use while 6 per cent were undecided to continue or not and were still looking forward to other means or technologies to combat the ill effects of El Nino. They thought that the practices were not effective and did not mitigate the effects of El Nino. Forty per cent of the respondents suggested that the IPs/technologies should be published and disseminated to a wider group. Some of the IPs have been proven effective through time, however, some of the respondents (37 per cent) still believe that these IPs/technologies needed further study. Others (28 per cent) noted that government intervention and support is needed to make these technologies more effective and widely disseminated.

4.2.2 Household risk management strategies

A study in Lantapan, Bukidnon, by Rola *et al*. (1998) showed that upland farmers have been severely affected by the El Nino phenomenon. To cope with the problem and maintain their household food security, upland farmers sold their livestock, sold or rented out their farm land, planted root crops, consumed less, did not participate much in market activities and sold a smaller proportion of their production. Others migrated to favorable areas for cropping. Some resorted to off-farm/non-farm activities such as hired laborers or food vending, e.g. selling boiled bananas in places with water and cash.

According to the study by Reyes (1999) some of the strategies adapted by households during a crisis such as El Nino were: 1) reallocation of household budget; 2) availment of credit; 3) sale of assets. Households had to reallocate their budget to more essential needs such as food, education, health, transportation and housing expenses to cope with the problem. They also sought credit or loans by relying on informal lenders, usually with much higher interest. About 84 per cent used loans for consumption purposes. Others resorted to selling their assets. Reports of the study showed that 17 per cent of households sold some of their assets. Land accounted for 20 per cent of the assets being sold. Other assets sold were appliances and jewelry. In farming households, 77 per cent sold their animals (e.g. carabao, cattle, hogs and goats).

4.2.3 Farmers coping mechanisms

According to the study by Acoba-Battad *et al.* (1999), many farmers installed water pumps and shallow tube wells in order to have water supply as coping mechanisms. To further cope with the crisis, the farmers limited farm and household expenses. A few others engaged in other jobs such as fishing, tricycle driving, vending/selling, raising animals and carpentry to raise additional support for family expenses.

Some farmers borrowed money to buy rice, while others used sweet potato as a substitute for rice. They borrowed money from relatives, friends and neighbors to maintain the family needs while waiting for the next cropping.

The study also reported that the livestock in Region 1 was affected, especially in raising swine. As a coping mechanism, hog raisers were frequently bathing their pigs while some decided to sell their animals.

5. Institutional Preparedness

Institutional preparedness means measures put in place to mitigate the adverse impact of El Nino-induced abnormal weather. This chapter presents the major mitigating measures undertaken by the different institutions concerned.

5.1 Climate monitoring and forecasting

In the Philippines, the agency responsible for the monitoring and forecasting of climate variability is PAGASA. As reported by Maglinao and Armada (1998), PAGASA established the National Drought Early Warning and Monitoring System (DEWMS). This was established to provide decision makers at all levels with information about the onset, continuation and termination, and severity of drought conditions.

The Agroclimatic Impact Assessment Bulletin released by PAGASA aims to provide a reliable, yet inexpensive weather-based information system for continuous monitoring and assessment of the impacts of weather, drought, flooding, tropical cyclones and others on rainfed agriculture. This drought monitoring and crop condition assessment, represents an additional tool to supplement crop production forecast systems of the DA and the National Food Authority.

PAGASA issues drought advisories to governors of the provinces. Plans for disaster preparedness and mitigation are prepared through the Provincial Disaster Coordinating Council. Local press releases and information dissemination through broadcast media are also made.

5.2 Research and development

Research and development activities addressing concerns related to either normal droughts or El Nino-induced ones are continuously being undertaken in the country. The Bureau of Agricultural Research of the Department of Agriculture (DA-BAR), the PCARRD-DOST, the State Universities and Colleges (SUCs) and other research institutions have put much effort into the development of new technologies as measures to reduce the vulnerability of agricultural production to climate variability.

5.2.1 El Nino R&D Program

A multi-agency collaborative program was implemented in 1998 as a response to the El Nino that was being experienced at that time. The Department of Agriculture gave financial support to PCARRD for the conduct of research and development on the phenomenon.

The major objectives of the El Nino R&D Program were: 1) to provide a stronger basis for a more effective and efficient information, education and communication (IEC) campaign on El Nino; 2) conduct research and technology demonstration trials on a short term basis; 3) research and develop technologies which would help alleviate El Nino’s impact.

With PCARRD and PCAMRD of the Department of Science and Technology (DOST) as coordinating agencies, this program was implemented by six government organizations and one private corporation. A total of 16 institutions from the government and private sectors were involved in this program as cooperating agencies. Names of specific agencies/institutions involved in this El Nino R&D Program are listed in Appendix Table 35.

5.2.2 R&D projects on water resource management

Water resource management and utilization remains a major challenge to the country. This problem plus the climate variability phenomenon are clear situations in which we need to seriously consider the management of our water resources.

A total of 183 R&D projects on water resource management were recorded by PCARRD (2001) from 1980 to 2000 (Table 5.1). The bulk of these projects (80 per cent) were concentrated on management of water resources for irrigation. It should be noted that less than 1 per cent focused on watershed management and rehabilitation. Particular attention given to climate change, impacts and mitigation was also low with only about 2 per cent. This observation suggests that the focus of these R&D activities were not specifically on El Nino-related drought but on drought in general.

Table 5.1 Completed and ongoing R&D projects on water resource management (1980-2000)

R&D Area	No. of completed projects	No. of ongoing projects	Total	%
Water resource assessment	4	-	4	2.2
Watershed management and rehabilitation	-	1	1	0.6
Management of water resources for irrigation	111	36	147	80.3
Computer simulation for predicting optimum use of water resources for irrigation	7	-	7	3.8
Water quality management and monitoring	11	-	11	6.0
Agrometeorological studies	9	-	9	4.9
Climate change impacts: assessment, mitigation and management	4	-	4	2.2
Total	146	37	183	100

Source: PCARRD, 2001b.

Table 5.2 shows that the R&D institutions active on water resource research are from Regions III, IV, and NCR. These agencies include the SUCs and the national government agencies such as DA, DOST, BSWM, NIA and DENR. About 73 per cent of the R&D projects were conducted by these institutions.

Table 5.2 R&D institutions active on water resource research in the Philippines

Region	Implementing agencies	No. of projects	%
CAR	DA-RFU-CAR	1	0.5
I	MMSU, DMMMSU, DA-RFU-I, DOST-I	21	12
II	NVSIT, ISU, CSU, DA-RFU-II	10	6
III	CLSU, TCA, PAC, DA-RFU-III, PhilRice	46	25
IV	UPLB, PCARRD, DOST-IV, IRRI	42	23
NCR	BSWM, NIA, DENR	45	25
V	SPCP, CSSAC, DOST-V	3	2
VI	DOST-VI, DA-RFU-VI	2	1
VII	USC, DOST-VII	2	1
VIII	UEP, DOST-VIII	2	1
IX	DA-RFU-IX	1	0.5
X	DA-RFU-X, NIA	4	2
XI	DA-XI	1	0.5
XII	USM, DA-RFU-XII	3	2
Total		183	100

Source: PCARRD, 2001b.

5.2.3 Irrigation R&D

The rules and regulations of the Agriculture and Fisheries Modernization Act states that the Department of Agriculture (DA) particularly through the NIA, BAR and BSWM, in coordination and collaboration with the rest of the Irrigation Research and Development Network (IRDN) shall conduct R&D activities to improve the management, affectivity and efficiency of irrigation systems, the protection and sustainability of watersheds, and the adaptation or adoption of modern irrigation technology. Irrigation research shall be a specific component of the National Research and Extension Agenda (NAREA) under the overall coordination of the Council for Extension, Research and Development in Agriculture and Fisheries (CERDAF). The NIA shall also strengthen its Irrigation Engineering Center by upgrading its research facilities and technical training programs.

In collaboration with DENR, National Water Resources Board (NWRB) and DOST, the DA particularly through the IRDN shall increase its level of financial, manpower and logistical support for the Comprehensive Irrigation R&D Umbrella Program (CIRDUP), on concerns such as:

i. The assessment of surface water potential for irrigation, protection and management of critical watersheds, enhancing water and resources capability and the identification and zoning of areas potentially irrigable by various modes of irrigation.
ii. The assessment of drainage and irrigation efficiency.
iii. The aquifer characterization program.
iv. The assessment of development priorities in the rehabilitation of gravity irrigation versus other modes of irrigation.

The DA, particularly through entities collaborating under the CIRDUP, shall institutionalize and strengthen the IRDN. The IRDN shall be expanded to include private sector entities, POs, NGOs, SUCs and appropriate research institutions. Technical support for the research activities shall be provided by the appropriate National Center of Excellence (NCE) in Agriculture and Fisheries Education while the BAR, in collaboration with the IRDN, shall monitor CIRDUP activities.

The DA shall lead, through the BSWM, in coordination with the DENR and appropriate R&D institutions and SUCs, in the planning and implementation of R&D and action programs concerning the preservation and rehabilitation of watersheds.

5.3 Policies on watershed management

The implementing rules and regulations of the Agriculture and Fisheries Modernization Act (AFMA) states that the Department of Agriculture, particularly through the NIA, BSWM and FOS, shall collaborate with the DENR and concerned LGUs, SUCs, POs and NGOs in the preparation and implementation of the programs and projects for watershed protection and rehabilitation.

There are other existing policies on water resources and watershed management that, if properly implemented, will contribute to the preparation of the farmers in coping against El Nino-abnormal weather. These are as follows:

1. Presidential Decree 1067 (1976) – The Water Code of the Philippines governs the ownership, appropriation, utilization, exploitation, development, conservation and protection of water resources.

2. Executive Order 374 (1996) – Provides for the creation of the Presidential Task Force on Water Resources Development and Management mandated to oversee and coordinate the adoption and implementation of water resource policies and programs.

3. Republic Act 8041 (Water Crisis Act of 1995) – Directs the government to adopt urgent and effective measures to address the national water crisis and provides for the identification and designation of critical watersheds where development undertakings are to be suspended.

4. The Philippine Environment Code (PD 1152 – 1996) – Prescribes management guidelines aimed to protect and improve the quality of Philippine water resources through the improvement of the quality of Philippine water resources.

5. The Indigenous Peoples Rights Act of 1997 (RA 8371) – Ascribes rights of the Indigenous Cultural Communities/Indigenous Peoples sustainable use, management, protection, conservation of land, water and other areas of economic value; ascribes the right to formulate and pursue their own plans for sustainable management and development of land and natural resources; provides that the government adopt effective measures of land use.

6. Conclusions and Recommendations

6.1 Conclusions

This study showed the vulnerability of Filipino rice and corn farmers to climate variability. The production losses to rice and corn attributed to El Nino-induced abnormal weather suggest that the current mitigation measures being employed by farmers are inadequate.

The R&D sector has directed research projects on commodities like crops, soil and water resources and livestock. Partnerships among government organizations and the private sector were operationalized in implementing programs on El Nino. The R&D institutions have the expertise and facilities to implement research projects but experience has indicated that resources limit the quantity, quality and pace of such activities.

Policies for water resource development and management are in place. The provisions of the Agriculture and Fisheries Modernization Act (AFMA) clearly indicate the government's support for water resource and irrigation development and management. These are crucial in El Nino mitigation.

While the government is working towards the stabilization of rainfed agriculture in the country, it appears that the Filipino farmers and the concerned institutions mandated to assist them still lack the capacity to mitigate the adverse impacts of El Nino. Adequate resources and proper institutional arrangements are limiting the ability of the farmers to respond appropriately against the El Nino-induced abnormal weather.

6.2 Recommendations

The following are recommended:

1. Priority for R & D on technologies for water conservation and management. The importance of water, whether during El Nino or normal weather, must be recognized. The national research system should recognize this as a number one priority. Adequate financial support must be given to this vital resource.

2. Further enhance the capability of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and relevant institutions in weather forecasting and early warning systems. Technical and institutional support and attractive incentive systems should be provided to the agencies and individuals involved in this work.

3. Favorable credit policy and crop insurance. Credit access and crop insurance are two important measures in coping against El Nino.

4. Reforestation and watershed rehabilitation. Massive and fast reforestation will help the country better prepare for El Nino.

5. Integration of more non-agriculture-based livelihood components in the package of appropriate and site-specific El Nino-abnormal weather mitigating measures.

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