# Chapter 1
# Introduction

## 1.1 Background

In countries dominated by agriculture, agrarian structures have profound impact on agricultural output, on equitable distribution and on sustainability of development (Vyas, 1992). The relative emphasis placed on political, equity and productivity objectives have varied widely among countries and over time (Ruttan, 1963). Comparison of national rice programs (Vyas, 1992) revealed that agrarian reform, which was implemented to provide greater security of tenure and property rights, was an integral component of such programs which was done but the degree of success varied accross South, Southeast and East Asia.

The classical political and equity objectives were emphasized in 19th to 20th Century agrarian reform movements. In the Philippines, those objectives were complemented by the productivity objective. The productivity objective was implemented through major policy instruments in the land reform legislation, such as leasehold provisions, expropriation, landlord compensation, credit and public services to agriculture (Ruttan, 1964). The Land Reform Code of 1963 assigned agencies were assigned to take charge of credit, marketing, and extension services for farmers (Montaño, 1974). In October 1972, Operation Land Transfer (OLT) was instituted to promote structural change in the rice and corn sectors through changes in the allocation of land resources, and to complement the agricultural sector's efforts of enhancing productivity of both crops. In 1987, the OLT was further expanded through the Comprehensive Agrarian Reform Program (CARP) in consonance with the Philippine Development Plan and the provisions of the Philippine Constitution. CARP covers 10.3 million hectares of public and private agricultural lands, including other lands of the public domain which are suitable for agriculture, regardless of tenurial arrangement and commodity produced (DAR and TSARRD, 1994). As the coverage of land reform was expanded under the CARP, the remaining workload for OLT was considered and its beneficiaries were made entitled to support services.

The total scope of OLT land distibution is 582,850[1] hectares. It is comparable in scope to the land reform program undertaken in South Korea, in terms of absolute area covered. The reformed area for South Korea was 577,000 hectares (Hayami, Quisumbing and Adriano, 1993). The combined coverage of OLT and Operation Leasehold, an accompaying program, would amount to about half of the area reformed in the Japanese land reform program. The coverages of the Philippine programs, if evaluated relative to total farmland area and total farming population, have been much smaller than those of East Asian programs. Nevertheless, the achievements of Philippine programs surpassed those of most other land reform programs in South and Southeast Asia with few exceptions, such as that of Kerala State in India (Hayami, Quisumbing and Adriano, 1993).

The effect of land reform on productivity can be estimated using cross-sectional and time-series data (Fleming, 1997). A number of cross-sectional data studies on the productivity effects of land reform have been undertaken in the Philippines. Most of them were area specific studies which yielded both positive and negative findings towards the program. A study by Aragon (1985 in CPDS, 1987) found that there have been successes in both redistributing rice lands and in increasing returns during the 1970s. The appropriate timing of distribution just before the widespread adoption of the second generation high yielding varieties (HYVs) implied that the yield increases accrued to the beneficiaries rather than to the former landowners. The substantial increase in farm operators' household incomes for Laguna and Central Luzon farmers were attributed to both land reform and irrigation. Most studies were however, centered on rice.

Sandoval (1983), however, argued that there have been no time series studies which carefully isolated the effects of land reform from those of rice technology in determining the growth of farm productivity. In the same manner, no time series study has isolated the effects of OLT from other exogenous variables at the regional and national levels.

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[1] The original scope is 727,000 hectares, the above figure is based on revisions undertaken by the Field Operations and Support Services Office, DAR.

In the context of this study, OLT is defined as a set of reform measures composed of land distribution and support services within the scope of CARP as implemented by the CARP implementing agencies. The study is based on cross-sectional regional data for 1991, a year when the implementation of OLT was ongoing as a component of CARP.

## 1.2 The Research Problem

The nature of Philippine regional development has been unbalanced. The share of GDP in the National Capital Region (NCR) between 1987 and 1990 increased by 1.4 percent while the share of other primary regions such as Southern Tagalog, Central Luzon and Central Visayas was marginal. The top four regions alone accounted for more than 60 percent of total GDP, resulting in a highly skewed development pattern (NEDA, 1992).

The differences in development patterns of regions exist due to differences in resource endowments, differences in political leadership and variations in the degree by which government programs have been successful. Although the implementation of certain programs are generally centralized in the Philippines, with the central agency planning and allocating the regional budgets, there could be differences in the degree of success achieved by each region. Factors affecting the degree of success include the nature of complementary factors present in the regions and the nature and magnitude of problems affecting the programs.

In addition, there have been varying levels of technological change that affected production in each region. These changes have affected the success of government programs in terms of making regions contribute significantly to national productivity.

The various forms of government intervention imply different consequences for different regions which in turn may modify regional comparative advantages (Rola, 1991). OLT is one of such interventions and is assumed to have produced different outcomes in regional and national productivity.

As of 1995, a fairly large portion (84 percent), of overall OLT scope had been accomplished. The extent of accomplishment has varied across regions, but in general, the work is nearing completion. Hence, this study attempts to conduct an assessment of the program's impact upon rice and corn regional productivity using 1991 as a test period.

Determining the effects of OLT on rice and corn productivity over time using secondary data and carefully isolating the effects due to technological change and those due to OLT and its accompanying support services would be an ideal approach to the problem. However, the feasibility of doing this was limited by the availability of necessary data. A base year, 1991 was used to determine the effects of the OLT program on the Total Factor Productivity (TFP) of rice and corn. The TFP approach to productivity measurement was employed to take account of the productivity differences that may have been due to variations in factor input usage to which OLT have or did not have a close association.

This study was limited to the OLT sub-component of the Comprehensive Agrarian Reform Program (CARP) and its effect on rice and corn productivity. While it is also necessary to assess the over-all impact of CARP on over-all agricultural productivity, the time and resources available for this study were insufficient for an over-all program assessment.

## 1.3 Importance of the Study

The study is particularly important for the Department of Agrarian Reform, the main implementing government agency of CARP. Results of the study may be useful in assessing the effectiveness of land redistribution, and the provision of support services, in sustaining and increasing productivity of rice and corn farmers in the principal regions where OLT was implemented. In addition, implications for increasing support service provision are drawn from this study. These implications are useful for the Department of Agriculture, the Department of Public Works and Highways, the National Irrigation Authority, the Land Bank of the Philippines, and the other CARP-implementing agencies mandated to provide the various support services to OLT beneficiaries.

The estimation of the productivity effects of OLT presented here should provide a framework for estimating productivity effects of other programs under

CARP. Likewise, the results of the study may be useful to other Philippine-based and international agencies which are engaged in agrarian reform and tenure improvement studies. Lastly, the study is a source of valuable insights for regional development planners in further assessing the development prospects of Philippine regions with respect to rice and corn in the context of relevant government programs.

A significant portion of this dissertation is devoted to the problem of constructing transitive multilateral indices and the problem of aggregation in measuring rice and corn productivity. The results provide a benchmark for similar studies within the productivity context.

## 1.4 The Research Objectives and Hypotheses

In general terms, the study aims to (i) analyse the differences in regional productivity of rice and corn and (ii) determine the effects of Operation Land Transfer on the regional productivity of rice and corn. Specifically, the study has the following objectives:

1. To construct index numbers of Total Factor Productivity (TFP) associated with rice and corn production in different regions;
2. To examine the nature of multilateral TFP indices and explore alternative transitive TFP indices;
3. To empirically observe the effects of aggregation in regional TFP measures;
4. To determine the effects of the OLT program, complementary services and other regional factors on TFP of rice and corn; and
5. To formulate policy recommendations and directions for future research based on the results of the study.

Two major hypotheses guide the study in determining the effects of OLT on regional variations in rice and corn productivity. These assumptions can be empirically validated:

1. There are differences in the TFPs of rice and corn across regions; and
2. OLT had a positive overall effect upon TFP of rice and corn.

## 1.5 Organization of the Study

This dissertation proceeds by providing an overview of the Philippine regions, the rice industry, the corn industry and the OLT Program in Chapter 2. In particular, this chapter describes the trends in production, consumption and regional yields of rice and corn; the processes involved in OLT and the trends in OLT land distribution and related activities. Chapter 3 reviews pertinent studies in Total Factor Productivity (TFP) growth, regional productivity differences, the approaches available to estimate transitive index numbers, and land reform and productivity. Chapter 4 develops the theoretical framework, which is derived from existing economic theory; examines the index number methods used in deriving transitive multilateral comparison and the methods employed to construct the index numbers, and to estimate the regression models. Chapter 5 deals with the nature of the data used and their limitations. Chapter 6 presents the results and identifies interregional differences and effects in rice and corn productivity. Lastly, Chapter 7 provides concluding statements based on the scope of the study and its findings, draws policy implications and recommends areas for further research.

# Chapter 2
# Overview of the Regions, Sectors and OLT

## 2.1 Introduction

This Chapter provides a background on the Philippine regions, the rice and corn sectors and the Operation Land Transfer (OLT). A general overview of the regions is given through a brief discussion of their features and a summary of important indicators. The rice and corn sectors are reviewed through a discussion of the trends in production, consumption and prices. Lastly, an overview of OLT is done through a review of its process, the regional accomplishments and work balances.

## 2.2 The Philippine Regions

Regions display considerable diversity in their physical make-up. They differ in size, location and accessibility, climate, quantity and quality of natural resources, and natural amenities (BIE, 1994).

The Philippine archipelago is comprised by fifteen agricultural regions and a National Capital Region (NCR) that constitutes Metropolitan Manila (Figure 2.1). Six of the agricultural regions are located in the Luzon group of islands, three are in the Visayas group and five are in the Mindanao group. The newly formed Caraga Region, created in 1995, used to be part of Region X - Northern Mindanao. The Autonomous Region of Muslim Mindanao (ARMM), created in 1990 was formed by amalgamating the former provinces of Region IX - Western Mindanao and Region XII - Central Mindanao.

In terms of topography, Cordillera Region is, the most highly elevated and mountainous. The other Luzon regions are flat to rolling, except Southern Tagalog which has the most varied land form consisting of flat coastal areas, upland interior areas of slightly moderate rolling or undulating plains, as well as hills and mountains. Central Luzon is the largest lowland area whose provinces are compacted in a centrally located land mass. Bicol Region is slightly undulating to rolling and

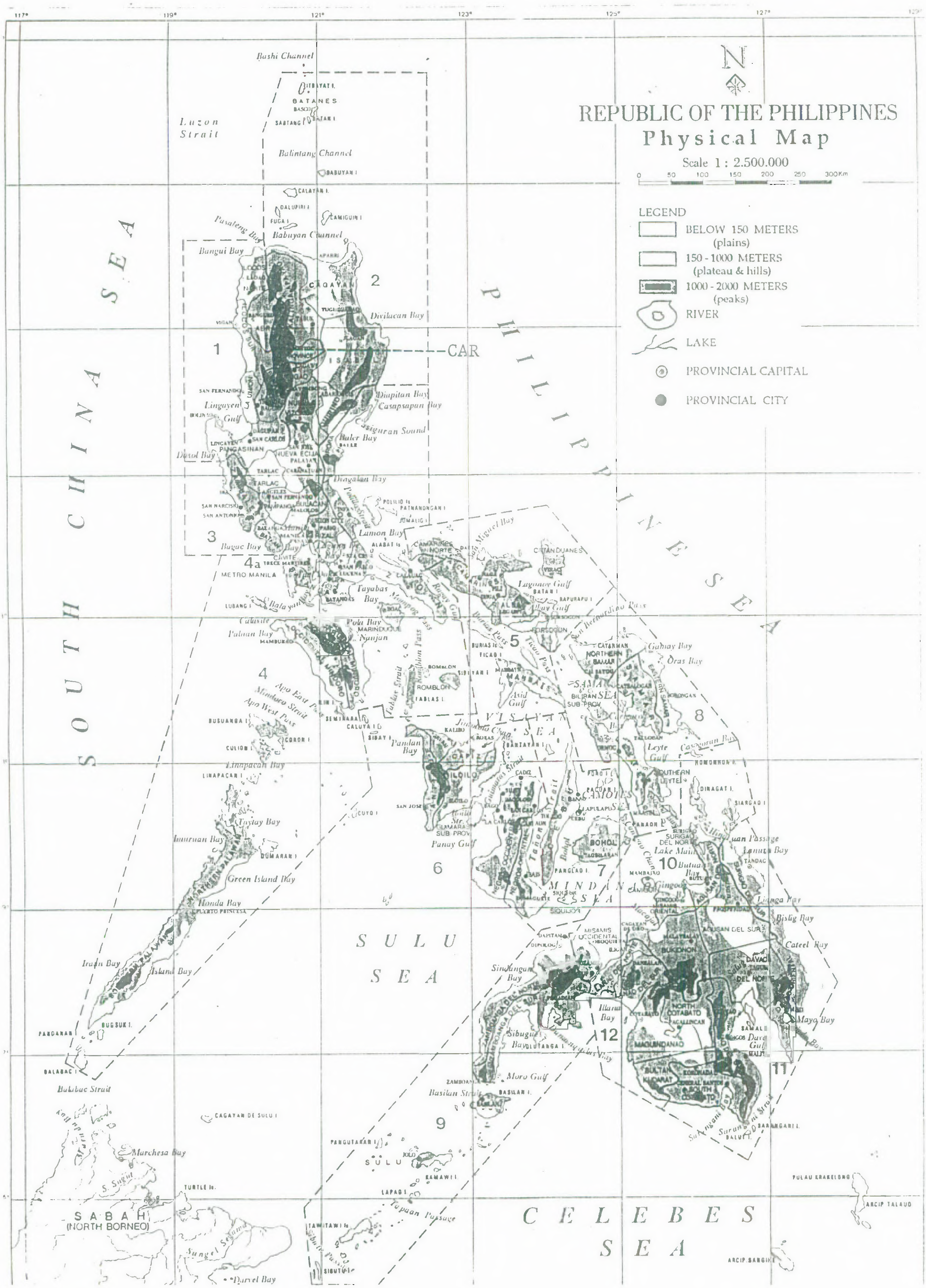



Figure 2.1 Map of the Philippines Showing Regional Delineation

endowed with numerous volcanoes. Central Visayas is rugged except for one island province. Southern Mindanao is characterized by excessive mountain ranges with uneven distribution of plateaus and lowlands (NEDA, 1997).

In terms of land area, Southern Tagalog is the largest followed by Southern Mindanao. Ilocos region has the smallest land area. In terms of arable area, Central Mindanao has the largest while Cordillera Region has the lowest. Despite its size, Southern Tagalog has a comparatively smaller arable area than Central Luzon whose land area is only 39 percent compared to the former region. Table 2.1 provides a summary of major indicators.

The highest regional population outside NCR occurs in Southern Tagalog while the lowest is in the Cordillera Region. Population density is highest in Central Luzon and lowest in Cordillera and Cagayan Valley. Southern Tagalog and Central Luzon have the highest labour force and employment levels. Southern Tagalog and Central Visayas have the most number of farms among all regions (Table 2.1).

The regions vary in terms of the predominant combination of climate types. For instance, Cagayan Valley's climate falls under type III in which there is no pronounced maximum rain period, with a short season lasting from one to three months. Bicol's climate falls in three categories, namely: Type II, where there is no dry season with a very pronounced maximum rain period that occurs in January and December; III; and IV where rainfall is less evenly distributed throughout the year. Southern Mindanao has a generally uniform rainfall distribution making it well suited to crop and livestock production (NEDA, 1997).

Finally, Gross Regional Domestic Product (GRDP) is highest in Southern Tagalog and Central Luzon while Gross Value Added in Agriculture and Forestry (GVA) is highest again in Southern Tagalog and Southern Mindanao.(Table 2.1).

For purposes of this dissertation, the thirteen regions with the most complete set of data are considered in most analyses. Provinces under ARMM and Caraga are still assumed in their former regions because most data available for 1991 were still configured for the thirteen regions. The NCR, a non-agricultural region is thus excluded from any comparison and analysis.

Table 2.1 *A Summary Profile of the Regions, 1991*

| REGION | Land Area ('000 ha) | | No. of farms ('000) | Population | | Labour Force ('000) | | Economic Indicators (In Million Pesos) | |
|---|---|---|---|---|---|---|---|---|---|
| | *Total* | *Arable* | | *Total ('000)* | *Density (pers/sq.km.)* | *Total* | *Employment* | *GRDP* | *GVA* |
| Cordillera Autonomous Region | 1,829.368 | 104.589 | 108.25 | 1,176 | 64.3 | 519 | 494 | 13,404 | 2,712 |
| Reg I - Ilocos | 1,248.019 | 274.208 | 311.76 | 3,578 | 278.7 | 1,406 | 1,275 | 20,807 | 9,217 |
| Reg II - Cagayan Valley | 2,683.758 | 452.701 | 285.72 | 2,529 | 94.2 | 1,058 | 978 | 14,247 | 7,377 |
| Reg III - Central Luzon | 1,823.082 | 505.788 | 335.27 | 6,282 | 344.6 | 2,484 | 2,130 | 67,205 | 16,230 |
| Reg IV - Southern Tagalog | 4,692.416 | 483.571 | 544.63 | 8,313 | 177.2 | 3,387 | 3,009 | 110,404 | 30,636 |
| Reg V - Bicol | 1,763.249 | 289.647 | 377.79 | 4,484 | 254.3 | 1,841 | 1,711 | 22,291 | 8,797 |
| Reg VI - Western Visayas | 2,022.311 | 600.051 | 411.57 | 5,789 | 286.3 | 2,338 | 2,093 | 51,769 | 17,599 |
| Reg VII - Central Visayas | 1,495.142 | 396.905 | 424.83 | 4,701 | 314.4 | 1,929 | 1,753 | 47,238 | 7,302 |
| Reg VIII - Eastern Visayas | 2,143.169 | 253.174 | 321.46 | 3,420 | 159.6 | 1,482 | 1,372 | 18,325 | 6,014 |
| Reg IX - Western Mindanao | 1,867.556 | 326.095 | 251.81 | 3,262 | 174.6 | 1,175 | 1,109 | 21,077 | 10,505 |
| Reg X - Northern Mindanao | 2,832.774 | 544.865 | 374.66 | 3,706 | 134.6 | 1,581 | 1,438 | 36,714 | 13,994 |
| Reg XI - Southern Mindanao | 3,169.275 | 489.390 | 410.46 | 4,436 | 140.0 | 1,840 | 1,639 | 50,441 | 21,381 |
| Reg XII - Central Mindanao | 2,330.281 | 740.181 | 436.70 | 3,013 | 129.4 | 1,222 | 1,132 | 25,558 | 11,172 |
| **Philippines** | 30,000.000 | 4,487.679 | 4,594.91 | 62,868 | 209.6 | 25,631 | 22,951 | 718,942 | 162,936 |

**Notes:** *Total for Philippines includes figures for National Capital Region (NCR)*
*Arable lands include only those under temporary crops and idle lands, while no. of farms include those planted to permanent crops, meadows and those covered with forest growths, hence, no. of farms is larger.*
*Gross Regional Domestic Products (GRDP and Gross Value Added in Agriculture and Forestry (GVA) are in constant 1985 prices, in million pesos*

**Sources:** DAR, Progress Report on Agrarian Reform and Rural Dev't. in the Philippines, 1990-1993
Philippine Development Report, 1991
Philippine Statistical Yearbook, 1994
Census of Agriculture, 1991

## 2.3 The Rice Sector

For the Philippines, as for most Asian governments, rice policy objectives have always involved: the drive towards self-sufficiency; the maintenance of low and stable rice prices to protect consumers; generation or saving of government revenue and scarce foreign exchange; and provision of adequate incomes for farmers (Barker, Herdt and Rose, 1985). The political stability of most Asian countries is strongly linked to their rice economies.

Rice is the Philippines' most important agricultural commodity. It is the staple food for 90 percent of Filipinos (Espiritu, 1993 in BAS, 1991). A substantial portion of the country's labour force is dependent upon rice farming. The major players in the rice industry include an estimated 3 million farmers and their dependents, traders, millers and retailers (DA, 1992).

### 2.3.1 Production

In general, rice production has been increasing with few interruptions in the 1980s. The value share of rice production to over-all agricultural production of the Philippines was 25 percent in 1973 (Table 2.2). Annual shares fluctuated in small ranges throughout the 23-year period until 1995 except in two periods, 1977 and 1985. In 1995, the share of rice to total agricultural output was a high 33.24 percent.

Rice is grown in all regions although the areas planted have been larger in four regions namely, Cagayan Valley, Central Luzon, Southern Tagalog and Western Visayas. Production of these regions accounted for more than 50 percent of total production in 1991 (Espiritu, 1993).

Trends in rice yield on a per hectare basis show that among the Luzon regions (Figure 2.1) Central Luzon achieved the highest yield rates per hectare historically, though fluctuations are apparent in the trend. Despite this, the region's yield rates have always been higher than national yield rates. Cagayan Valley began to achieve rates higher than the national average beginning in 1984.

For Bicol and the Visayas regions (Regions V-VIII), yields per hectare were generally lower than the national average except for Bicol from 1975-1977 and for

**Table 2.2** ***Value of Agricultural Production Including Rice and Corn, 1991, In Current Prices***

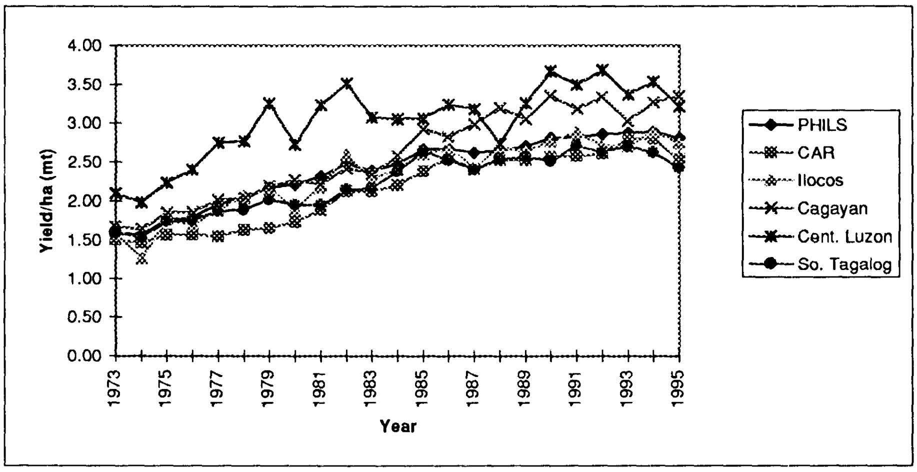
| YEAR | AGRICULTURAL PRODUCTION | | | | | | |
|---|---|---|---|---|---|---|---|
| | Quantity (m.t.) | | Value (Million Pesos) | | | | |
| | Rice | Corn | All Crops | Rice | Corn | Percent Share | |
| | | | | | | Rice | Corn |
| 1973 | 5,386.8 | 1,842.8 | 10,930.7 | 2,771.2 | 831.4 | 25.4 | 7.6 |
| 1974 | 5,548.5 | 2,257.6 | 18,031.2 | 5,180.1 | 1,504.6 | 28.7 | 8.3 |
| 1975 | 6,381.3 | 2,513.9 | 20,329.4 | 5,579.5 | 2,100.9 | 27.4 | 10.3 |
| 1976 | 6,542.6 | 2,716.7 | 20,433.8 | 6,200.1 | 2,394.6 | 30.3 | 11.7 |
| 1977 | 7,254.5 | 2,774.8 | 28,092.2 | 6,890.1 | 2,605.3 | 24.5 | 9.3 |
| 1978 | 7,211.6 | 2,796.1 | 27,065.2 | 7,093.5 | 2,671.4 | 26.2 | 9.9 |
| 1979 | 7,684.3 | 3,090.3 | 34,032.2 | 7,573.9 | 2,851.1 | 22.3 | 8.4 |
| 1980 | 7,646.3 | 3,050.2 | 37,992.1 | 8,376.6 | 3,024.1 | 22.0 | 8.0 |
| 1981 | 7,910.7 | 3,295.8 | 42,368.1 | 9,304.5 | 3,501.7 | 22.0 | 8.3 |
| 1982 | 8,333.8 | 3,404.1 | 41,355.2 | 10,924.1 | 3,985.7 | 26.4 | 9.6 |
| 1983 | 7,294.9 | 3,134.1 | 38,217.3 | 10,721.9 | 3,949.3 | 28.1 | 10.3 |
| 1984 | 7,829.0 | 3,250.3 | 63,706.1 | 15,311.8 | 5,166.8 | 24.0 | 8.1 |
| 1985 | 8,805.7 | 3,862.8 | 81,545.6 | 24,969.5 | 9,542.6 | 30.6 | 11.7 |
| 1986 | 9,246.6 | 4,090.8 | 103797.6 | 26,389.7 | 10,528.0 | 25.4 | 10.1 |
| 1987 | 8,539.8 | 4,278.2 | 107,472.8 | 26,122.3 | 12,176.8 | 24.3 | 11.3 |
| 1988 | 8,970.9 | 4,428.0 | 125,313.1 | 30,612.6 | 12,573.6 | 24.4 | 10.0 |
| 1989 | 9,458.6 | 4,522.2 | 144,407.1 | 39,359.6 | 18,103.5 | 27.3 | 12.5 |
| 1990 | 9,318.9 | 4,853.9 | 155,123.4 | 45,671.6 | 19,027.0 | 29.4 | 12.3 |
| 1991 | 9,673.3 | 4,655.0 | 163,552.1 | 43,884.5 | 16,349.4 | 26.8 | 10.0 |
| 1992 | 9,129.0 | 4,618.9 | 173,048.7 | 43,788.0 | 21,255.0 | 25.3 | 12.3 |
| 1993 | 9,434.2 | 4,798.0 | 180,682.6 | 51,492.6 | 20,831.8 | 28.5 | 11.5 |
| 1994 | 10,538.1 | 4,519.3 | 209,018.2 | 62,515.6 | 22,289.1 | 29.9 | 10.7 |
| 1995 | 10,540.7 | 4,128.5 | 233,679.3 | 77,684.7 | 25,925.1 | 33.2 | 11.1 |
| Annual Growth Rates (%) | | | | | | | |
| 1973-1982 | 5.08 | 7.27 | 17.62 | 18.41 | 20.93 | | |
| 1983-1992 | 1.28 | 2.16 | 16.84 | 16.64 | 20.89 | | |
| 1993-1995 | 5.86 | -7.23 | 10.63 | 21.09 | 7.11 | | |

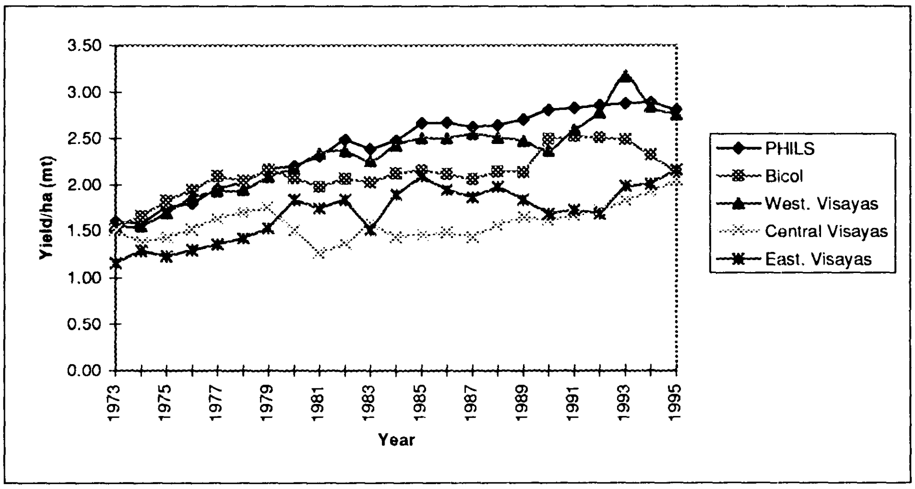
***Sources:***

CGPRT Crops in the Philippines, A Statistical Profile, 1960-1990, PCARRD

Philippine Statistical Yearbooks, 1986 and 1995, NSCB

Regional Rice Statististics Handbook, 1972-1992, Philrice-BAS



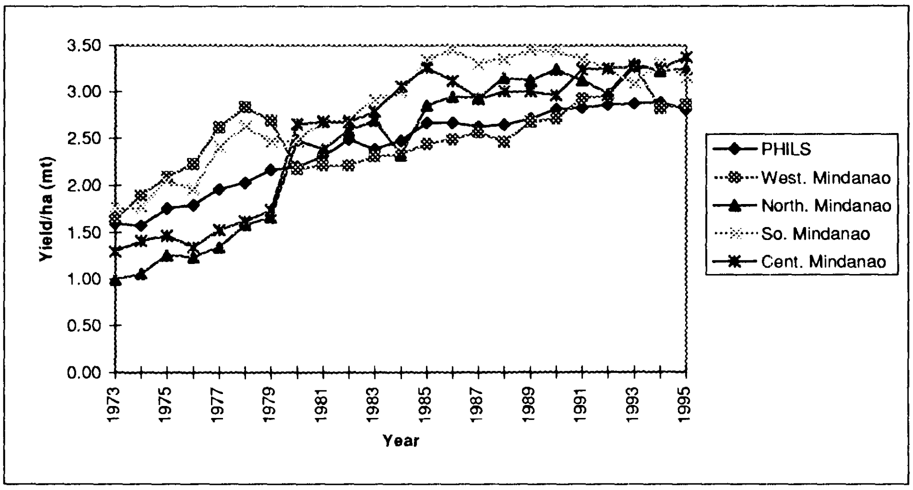




Figure 2.2 **Regional Trends in Rice Yield per Hectare**

Western Visayas for 1993. Western Visayas' yield rates increased at increasing rates from 1989 to 1993 and declined thereafter. Central Visayas had the lowest yield per hectare from 1979 to 1995 while Eastern Visayas had the most erratic trend in yield rates.

For Mindanao regions (Regions IX-XII), yield rates were generally higher than the national average beginning in 1980 except for Western Mindanao. From 1973 to 1979, yields of Northern and Central Mindanao Regions were lower than the national average but increased drastically between 1979 and 1980.

### 2.3.2 Consumption

Per capita consumption of rice was estimated to be 88.47 kg in 1991 (Table 2.3) and, on average, 89.23 kg from 1973-1992. This was far below the average annual per capita consumption for the principal rice consuming countries of Southeast Asia. Vietnam's average annual per capita consumption was 239 kg while Thailand's was 203 kg (Chandler, 1979). The differences in regional consumption of rice for the Philippines explain why the country consumes a relatively low quantity of rice on a per capita basis. In Central Visayas, corn is consumed in far greater proportion than rice. In Central Luzon, corn consumption is insignificant, wheat is relatively unimportant and rice dominates the diet (Barker, Herdt and Rose, 1985). Consumption of rice in Central Luzon was on the average 105 kg per capita per year during the period 1980-1992 while for Central Visayas, it was 82.81 kg per capita per year for the same period. Per capita consumption before 1980 was even smaller for the latter region but increased almost continuously in the 1980's (Philrice-BAS, 1994).

Southern Tagalog consumed the largest amount of rice for food requirements in 1991. There was a considerable deficit that needed to be met for the region, which has the largest population. Central Luzon utilised the greatest amount for seed requirements, and used more of its production for feed and wastes (Table 2.3). While it was mentioned that Central Visayas is not an exclusively rice consuming region,a large production deficit is evident from the table.

**Table 2.3** ***Rice Production and Use Estimates by Region, 1991 (In '000 mt of Milled Rice)***

| REGION | PRODN | UTILIZATION | | | | | SURPLUS (Deficit) |
|---|---|---|---|---|---|---|---|
| | | Food Use | | Seed | Feed & Wastes | Total | |
| | | Total | Per Capita (kg) | | | | |
| Cordillera Autonomous Region | 99.50 | 117.18 | 99.55 | 2.91 | 6.47 | 126.55 | (27.05) |
| Reg I - Ilocos | 587.67 | 378.15 | 104.11 | 15.32 | 38.20 | 431.67 | 156.01 |
| Reg II - Cagayan Valley | 676.19 | 215.09 | 89.78 | 15.96 | 43.95 | 274.99 | 401.19 |
| Reg III - Central Luzon | 1,414.51 | 629.87 | 98.62 | 24.52 | 74.33 | 728.72 | 685.80 |
| Reg IV - Southern Tagalog | 731.23 | 1,451.78 | 86.56 | 20.20 | 47.53 | 1,519.52 | (788.29) |
| Reg V - Bicol | 486.72 | 370.04 | 90.30 | 14.50 | 31.64 | 416.17 | 70.55 |
| Reg VI - Western Visayas | 774.26 | 560.77 | 101.87 | 22.37 | 50.33 | 633.47 | 140.79 |
| Reg VII - Central Visayas | 135.84 | 370.39 | 78.83 | 6.10 | 8.83 | 385.32 | (249.48) |
| Reg VIII - Eastern Visayas | 250.45 | 293.04 | 94.93 | 10.87 | 16.28 | 320.20 | (69.74) |
| Reg IX - Western Mindanao | 260.97 | 235.79 | 72.71 | 6.89 | 16.96 | 259.65 | 1.33 |
| Reg X - Northern Mindanao | 347.78 | 262.44 | 72.66 | 8.34 | 22.61 | 293.39 | 54.39 |
| Reg XI - Southern Mindanao | 450.15 | 365.89 | 79.36 | 10.09 | 29.26 | 405.24 | 44.92 |
| Reg XII - Central Mindanao | 381.97 | 266.62 | 80.85 | 9.81 | 24.83 | 301.26 | 80.71 |
| **Philippines** | **6,597.25** | **5,517.05** | **88.47** | **167.87** | **411.21** | **6,096.12** | **501.12** |

**Note:** *Food use (total) is in '000 metric tons while per capita consumption is in kg.*
*Figures in this table represent milled rice while rice produced referred in the discussion pertains to 'rough' rice*
**Source:** BAS-Philrice, Regional Rice Statistics Handbook, 1972-1992

Aggregate demand for rice has grown proportionately with population increases. However, demand for rice tends to be relatively responsive to price changes due to limited income and the substitution effect for wheat and corn.

### 2.3.4 Prices

Farmgate price of rice was stable from 1974 to 1978. It moved steadily from 1979 to 1983 and rose dramatically thereafter. A decline was experienced in 1986 and 1991 but continuous increases occurred from 1992 onwards. Averaging of monthly prices from 1970 to 1992 shows that retail prices increase from August to November (Philrice-BAS, 1994).

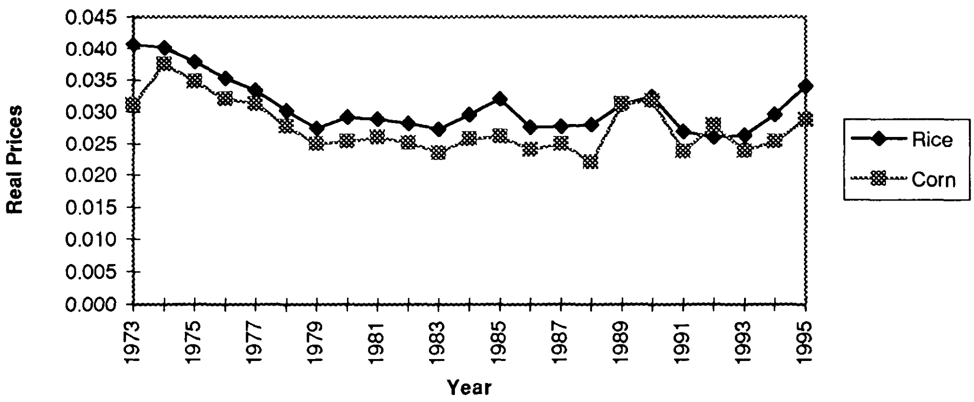



Figure 2.3 **Trend in Rice and Corn Real Prices, Deflated from 1985 Prices, In P/kg.**

Countries were classified by IRRI into three groups in terms of percentage of farm-gate price relative to world prices. The Philippines, along with China, India, Sri Lanka, Bangladesh and Indonesia belong to the group of low-income traditional importers that have maintained domestic prices somewhat below world market prices (Barker, Herdt and Rose, 1985). Domestic price movements were consistent with world price trends in 1989 with local price slightly lower than world prices. In 1990, world prices fell below domestic levels (DA, 1992).

Nominal prices generally had increasing trends since 1972. Real prices (Figure 2.3) on the other hand, decreased from 1973 to 1983. Farm prices were generally lower than government support prices. They exceeded the government price beginning in 1988 until the government increased the support price in late 1989 (DA, 1992).

Grain price stabilization policies are implemented by the National Food Authority (NFA). The mechanisms by which producer and consumer price goals are achieved involve imports and government purchase from producers through price support operations. NFA buys rough rice at guaranteed support prices whenever farm prices drop below such levels and sells rice whenever prices rise above the designated ceiling price. Support and cieling prices are reviewed periodically to reflect inflationary and other forces at work in the economy (DA, 1992).

## 2.4 The Corn Sector

The corn industry is strongly linked to the swine and poultry industries, which accounted for 7.6 percent of GNP and 25.4 percent of Gross Value Added (GVA) in agriculture respectively, from 1981 to 1990. About 70 percent of total corn output is used as animal feed. Hence, any increase in the demand for feed corn brought about by increases in swine and poultry production stimulates growth in the corn sector. In the same way, the availability of sufficient corn supply enables the two industries to expand (DA, 1994). and therefore, minimize the country's external dependence for cornfeed materials.

### 2.4.1 Production

Similar to the trend in rice production, there is a generally increasing trend in corn output although fluctuations are evident (Table 2.2). The share of corn value to over-all agricultural production value are also fluctuating. A rather drastic downward movement in corn's share occured in 1984 while aggregate crop value increased substantially. The increase in aggregate crop value was due to the increase in general price levels from 1983-1984. But the decrease in corn's value share implies that the crop diminished in relative importance during the year.

Corn is also grown in all regions but areas planted have been larger in such regions as Cagayan Valley, Central Visayas, Southern Mindanao and Central Mindanao. Both white and yellow varieties are planted throughout the country. The white variety is consumed for food while the yellow variety is used as feed.

Trends in corn yield on a per hectare basis show that for Luzon regions (Figure 2.4), Cagayan Valley and Central Luzon were achieving rates higher than the national average beginning 1988. In general, yield in Central Luzon is increasing while in Southern Tagalog, an important corn growing region it declined in the latter part of the 1980s and rose in 1992 onwards.

For Bicol and the Visayas regions (Regions V-VIII), yields per hectare were generally lower than national rates except for Eastern Visayas from 1981-1982 and 1984-1985. While Central Visayas is considered to be a corn-consuming and not a major rice-eating region, its corn production has been the lowest in all periods. Western Visayas had the most fluctuation in corn yield rates from 1973-1995.

For the Mindanao regions (Regions X-XII), yield rates were lower for Western Mindanao for most of the period (1980-1995). Southern and Central Mindanao had higher yield rates than the national average, although Southern Mindanao yield declined beginning in 1994.

### 2.4.2 Consumption

Available food per capita for milled corn declined from 1978 to 1989, from 22 kg to 4 kg/year (CGPRT, 1992) while domestic utilization of corn from 1980 to 1990 rose. Feed use expanded annually by 5.4 percent while industrial uses and seeds grew at 4.8 percent and 1.7 percent respectively (DA, 1992). The highest feed utilization was recorded in 1989 at 3,039,000 mt (CGPRT, 1992). Although food use has increased by 0.5 percent per year, its relative share to total utilization has been declining at 2.8 percent annually over the same period (DA, 1992).

Average annual imports of corn between 1980 and 1985 were about 300,000 metric tons. This constituted 8 percent of the total corn supply. In 1984, a 50 percent tariff (NEDA, 1989) on corn was imposed to protect domestic producers. This resulted in a dramatic decline in corn imports to an average of 65,000 mt or 1.5 percent of total supply (DA, 1992). But the import restriction was only shortlived. Imported corn reached a 376,000 mt level in 1990. Increased corn output was not

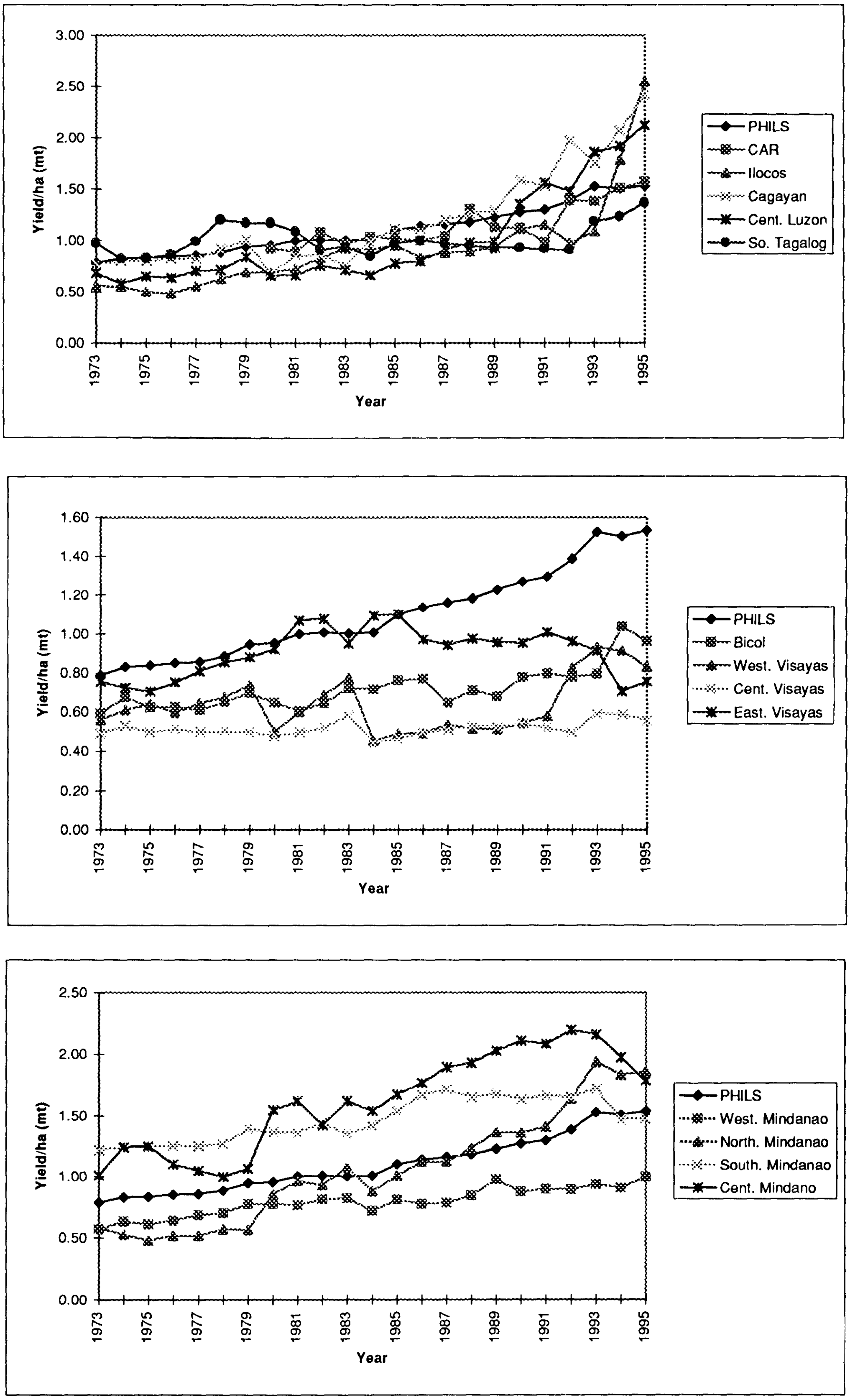



Figure 2.4 **Regional Trends in Corn Yield per Hectare**

sufficient for the large demand from the swine, poultry and the local feedmilling industries.

### 2.4.3 Prices

The annual average farmgate price of corn was stable from 1974 to 1978. It moved steadily upwards from 1979 to 1983. The highest growth rate was realized in 1988 to 1989. Prices were rising continuously from 1992 until 1995.

In general, corn farmgate and wholesale prices fluctuate depending on output levels. Farmgate prices fluctuated between 6.8 percent above and 8.7 percent below the yearly average price depending upon the time of the year. Wholesale prices rise up as high as 5.7 percent above the annual average price during the lean months of January to June and decrease to 6.4 percent below from July to September (DA, 1992).

In nominal terms, farmgate prices exhibited increasing trends. Increases were as much as 14 percent for yellow and 15 percent for white corn. In real terms, however, slight increases occured. For instance, annual increases were only 0.9 percent and 0.2 percent annually for yellow and white varieties respectively (DA, 1992).

Relative to world prices, domestic prices have been higher. The average CIF price of Thai corn in 1990 was only P3.49 per kg while the Metro Manila wholesale price of yellow corn was almost P5.69 per kg. The CIF price has been 35 percent lower than Philippine domestic wholesale prices in recent years (DA, 1992).

To stabilize prices, NFA also implements its grains stabilization program for corn. However, the agency's intervention in the corn market is more limited than its participation in the rice market. Corn trading is mainly undertaken by the private sector.

## 2.5 The Operation Land Transfer (OLT)

It has been recognized that the increased emphasis given to the productivity objective in recent land reform policy originated from the English experience and Marxian development theory. In addition, it has a strong empirical foundation in the economic environment faced by most underdeveloped countries in the 1960's. The social and political unrest associated with rising consumer food prices was as crucial as the instability created by the inequities in land distribution and income in rural areas. Hence, in countries characterized by low productivity and rapid population growth, the achievement of productivity objectives was a pre-requisite for both socio-political stability and social justice (Ruttan, 1964). The ability to overcome the above-mentioned problems provides a more pragmatic than philosophical basis for productivity objectives in land reform.

In the context of the Philippine reform policies, Operation Land Transfer (OLT) is the orderly and systematic transfer of privately owned tenanted rice and corn lands to actual tillers pursuant to Presidential Decree 27. This applies to areas measuring more than seven hectares and to areas below seven hectares not covered by the retention rights of small land-owners (Madronio, 1983).

OLT was instituted by President Marcos in October 1972 through Presidential Decree 27 (PD 27) promulgating the emancipation of tenants from the bondage of the soil and complementing the agricultural sector's efforts of enhancing production of rice and corn. The decree provided that all tenant-farmers, whether in land classified as landed estate or not, shall be deemed owners of a portion constituting a family-size farm of 5 hectares if not irrigated and 3 hectares if irrigated (DAR, 1988). Under this program, Emancipation Patents (EPs) are awarded to farmer-beneficiaries as proof of their ownership.

A basic limitation of the then PD 27 is its confinement to tenant-farmers or private agricultural lands in rice and corn areas. It excluded farmers of other agricultural lands and landless workers who are at least as equally worse-off as the rice and corn tenant farmers (Llanto and Dingcong, 1994).

OLT's land distribution suffered from implementation problems. Factors that affected its slow implementation in the past and its delayed completion included (i) lack of funds and (ii) inadequate policies (Llanto and Dingcong, 1994 from Cornista, 1987); (iii) the vacillating procedures for land valuation and (iv) lack of participation at the grassroots level (Ledesma, 1982); (v) technical problems in relation to coverage and acquisition; (vi) factors associated with bureaucratic procedures; and (vii) landowners' continued resistance which delayed almost every phase of implementation.

Along with the implementation problems was the unfavourable macroeconomic environment which discouraged the growth of the agricultural sector. This environment was characterized by (i) macroeconomic policies that were biased against agriculture such as an overvalued exchange rate, monopolies, and price controls; (ii) a "cheap credit" environment which resulted in the worsening of income distribution and the collapse of rural financial institutions; (iii) a highly regulated financial system which extracted high costs from the government and formal lenders (Llanto and Dingcong, 1994).

From the total land distribution scope of OLT, an accomplishment of 488,230 hectares had been achieved as of the end of 1995, leaving a balance of 94,610 hectares (DAR, 1996).

### 2.5.1 The OLT Land Distribution Process

The process of OLT was implemented in five stages which are discussed as follows (Madronio, 1983):

*1. Identification of farmers, landowners and landholdings.* This stage aimed at identifying all tenant-tillers, their landowners and areas cultivated as of October 21, 1972. This stage included data gathering on production, socio-economic conditions and landownership documents. There were different degrees of difficulty in the activities involved. For instance, identifying tenanted rice and corn lands and gathering other pertinent information proved to be relatively easier than locating landowners and gathering information about them.

The phase was undertaken mainly by the DAR field units with the assistance of tenant-tillers, local leaders and other government agencies. Landowners complied through sworn statements in accordance with Letters of Intent (LOIs) 41 and 45. It was completed in 1980 having identified 396,082 farmers covering an area of 730,734 ha (DAR, 1981). This comprised 11.95 percent of the total rice and corn area in 1980.

*2. Parcellary Map Sketching.* This stage was undertaken by the Bureau of Lands to delineate the actual areas tilled by tenants and areas for possible retention by the landowners. Sketching employed such documents as land titles, cadastral maps, aerial photographs and ground boundaries indicated by tenants and landowners.

Like the identification phase, the sketching stage was highly constrained by the landowner's lack of cooperation. This obstacle translated into further technical problems. After 8 years, completion of this stage was realized in 1980.

*3. Generation and Issuance of Certificates of Land Transfer (CLTs).* CLTs were generated by the National Computer Center (NCC) based on the information gathered by the DAR field units and on the parcellary map sketches prepared by the Bureau of Lands. The CLTs were registered with the Land Registration Authority (then Commission), which after authentication were issued to the farmer-beneficiaries (FBs).

The CLT therefore was an intermediate document that declared a tenant as a deemed owner of the land he cultivated. It was a documentary proof pending the issuance of an Emancipation Patent (EP) that granted him legal rights over the land.

Like in the previous stages, landowners' resistance posed obstacles to CLT generation. Protests were filed regarding the inexistence of tenancy relations and claims of subdivision of lands prior to effectivity of P.D. 27. In addition, the introduction and development of Samahang Nayons (Village Associations), a prerequisite for CLT issuance which was progressing at a slower pace was overtaken by CLT generation. In December 1980, this stage was reported to be 93 percent completed (DAR, 1981).

*4. Land Valuation and Landowners Compensation.* Land valuation is based on average gross production of the land, a deviation from the conventional "market value system". As means to systematize land valuation, two schemes, namely Land Tenure Production Agreement (LTPA) and Barangay Committee on Land Production (BCLP) were employed. LTPA referred to the mutual establishment of the average gross production by the landowner and tenant subject to approval and review by the DAR Regional Director. BCLP referred to the composite team of village officials, non-cultivating owners, tenant representatives and a DAR technologist who together, established the average gross production.

Landowners compensation is done in six modes of payments, namely: (i) cash payment of ten percent and the balance in 25-year tax free, six percent Land Bank Bonds; (ii) payment of 30 percent in preferred shares of stock and the balance in 25-year tax free, six percent Land Bank Bonds; (iii) full guarantee on the payment of fifteen equal annual amortization to be made by tenants; (iv) payment through the establishment of annuities or pensions with insurance to satisfy small absentee landowners; (v) exhange arrangement for government stocks in government corporations or private corporations where the government has holdings; and (vi) through other modes of settlement further adopted by the Land Bank Board of Directors and approved by the President of the Philippines.

The land compensation phase in the OLT process is highly constrained by the absence of pertinent production information for years prior to the institution of P.D. 27. Where information is available, it is contested by landowners. This subsequently affects the land valuation phase. This process is continuing.

5. *Issuance of Emancipation Patents (EPs).* EPs are the ultimate titles to the rice and corn lands. These are issued to beneficiaries who have fully paid the land values and are members of recognized cooperatives and, recently, to those who have made at least two amortization payments with LBP. For the latter, EPs are annotated with the balances in land values.

### 2.5.2 OLT Scope and Accomplishment

In relation to total rice and corn lands, OLT constituted about 10.33 percent (Table 2.4). Central Luzon has the highest scope of OLT lands followed by Bicol and Cagayan Valley. For Central Luzon, nearly 38.64 percent of total rice and corn lands are covered by OLT. The percent share of OLT lands to total lands is however, higher in Bicol than in Cagayan Valley. Ilocos and Western Visayas have about the same proportion of OLT lands relative to total rice and corn lands. Western Mindanao has the lowest proportion of OLT. Ilocos Region had highest percentage of accomplishment as of the end of 1995 (Table 2.4), followed by Western Mindanao and Cagayan Valley. Bicol and Eastern Visayas had the lowest percentage of accomplishment. On average, Central Luzon had the highest ratio of land distributed per farmer beneficiary (1.53 ha per FB) while Cordillera had the smallest ratio (0.80 ha per FB).

Table 2.4 *Physical Area of Rice and Corn (1991) and OLT Scope, Accomplishment and Remaining Workload, As of 1995*

| REGION | PHYSICAL AREA | | | OLT SCOPE | | ACCOMPLISHMENT | | | BALANCE |
|---|---|---|---|---|---|---|---|---|---|
| | Rice | Corn | Total | Area | % Share | Area | FBs | Percent | |
| Cordillera Autonomous Region | 94.87 | 15.80 | 110.67 | 1.72 | 1.55 | 1.144 | 1.431 | 66.67 | 0.57 |
| Reg I - Ilocos | 285.54 | 5.77 | 291.31 | 34.03 | 11.68 | 33.626 | 36.224 | 98.80 | 0.41 |
| Reg II - Cagayan Valley | 315.85 | 160.25 | 476.10 | 79.12 | 16.62 | 74.978 | 69.369 | 94.76 | 4.14 |
| Reg III - Central Luzon | 495.91 | 5.28 | 501.18 | 193.63 | 38.64 | 171.771 | 112.441 | 88.71 | 21.86 |
| Reg IV - Southern Tagalog | 446.64 | 65.26 | 511.90 | 33.86 | 6.61 | 31.167 | 24.240 | 92.06 | 2.69 |
| Reg V - Bicol | 232.51 | 87.99 | 320.50 | 65.80 | 20.53 | 43.278 | 38.246 | 65.77 | 22.53 |
| Reg VI - Western Visayas | 410.91 | 74.29 | 485.20 | 44.66 | 9.20 | 30.973 | 24.736 | 69.35 | 13.69 |
| Reg VII - Central Visayas | 123.19 | 254.65 | 377.83 | 20.54 | 5.44 | 13.880 | 13.558 | 67.57 | 6.66 |
| Reg VIII - Eastern Visayas | 219.18 | 38.20 | 257.38 | 23.07 | 8.96 | 15.063 | 16.011 | 65.30 | 8.00 |
| Reg IX - Western Mindanao | 127.16 | 237.60 | 364.76 | 10.84 | 2.97 | 10.479 | 7.928 | 96.70 | 0.36 |
| Reg X - Northern Mindanao | 164.30 | 377.11 | 541.41 | 24.15 | 4.46 | 20.747 | 13.882 | 85.92 | 3.40 |
| Reg XI - Southern Mindanao | 170.39 | 417.74 | 588.14 | 25.69 | 4.37 | 20.735 | 12.553 | 80.70 | 4.96 |
| Reg XII - Central Mindanao | 330.91 | 453.01 | 783.92 | 25.74 | 3.28 | 20.390 | 18.973 | 79.23 | 5.35 |
| **Philippines** | **3,417.37** | **2,192.93** | **5,610.30** | **582.85** | **10.33** | **488.23** | **389.592** | **83.77** | **94.61** |

**Notes:**

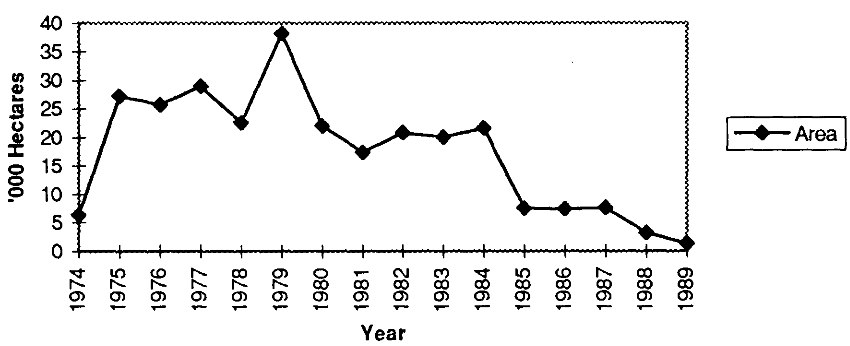
*Central Mindanao excludes Maguindanao for lack of figure on scope*
*It is presently under Autonomous Region of Muslim Mindanao (ARMM)*
*OLT Scope is scope adopted by the Field Operations and Support Services Office*
*All areas are expressed in ('000 ha.)*
*Percent (%) Share refers to share of regional OLT scope to total rice and corn area*
*FBs - Farmer Beneficiaries are expressed in '000 persons*

**Sources:**

PCARRD, CGPRT Crops in the Philippines, A Statistical Profile, 1960-1990
FOG-SSO, DAR, Status of Land Acquisition & Distribution as of 31 Dec. 1995
Planning Service, DAR
NSO, Census of Agriculture, 1991

In terms of balances in the OLT workload, Western Mindanao had the smallest as of the end of 1995 (360 ha), while Bicol (22,530 ha) and Central Luzon (21,860 ha) had the highest. The relatively large proportion of remaining workload in Bicol and Central Luzon reflects the relatively wide range of administrative and technical problems that have required additional resources and more effective strategies to the extent which other regions have not needed.

From the period 1974 to 1989, LBP's approval of landowners' claims for compensation had a fluctuating trend (Figure 2.5). The highest accomplishment in claims approval was recorded in 1979. A drastic decline ocurred from 1984 to 1985. From 1988, claims approved by LBP may have included other lands outside rice and corn which began to be valued in 1988.




Note: 1989 represents Jan-March only
Source: Balisacan (1990) and DAR

Figure 2.5 **Trend in Approval of Claims by LBP**

Though a peak was reached in 1979, the rate of approval has been rather slow. The revision of the valuation formula, which necessitated ammendments to previously issued Administrative Orders (A.O.s), contributed to the slow pace of valuation which further aggravated the landowners' resistance problem (DAR, 1995).

The overall trend in OLT land distribution shows that from 1986 to 1988, the average national rate of accomplishment increased at an increasing rate until 1989 and began to decline thereafter, until 1991. Lower increase rates were realized until 1993 then declined again until 1995 (Figure 2.6).

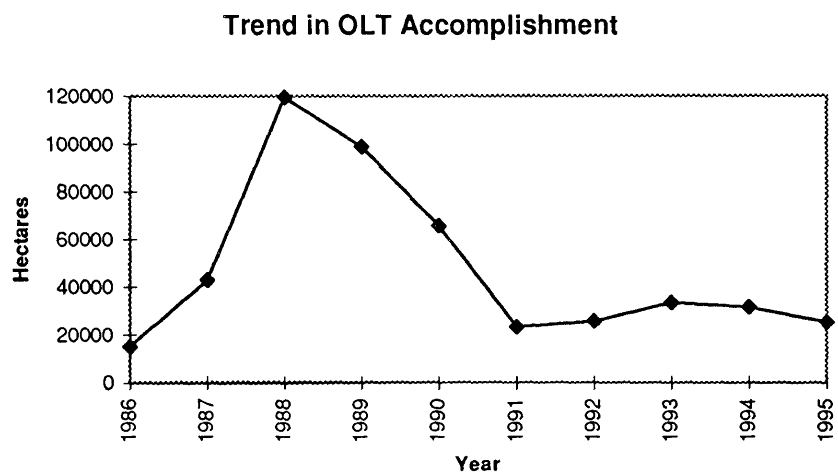
As the coverage of the land reform was expanded in 1987 through the Comprehensive Agrarian Reform Program (CARP), systematic scheduling of all types of land was undertaken and modes of acquisition were further defined. One reason for the decline in national average accomplishment after 1988 was the emphasis given to other land types under Phase I of CARP which were programmed to be finished four years after CARP was enacted. These other land types include Government-Owned Lands (GOL) and lands owned by Government Financial Instruments (GFIs), other private agricultural lands acquired through the Voluntary Offered to Sell (VOS) scheme and other non-OLT lands acquired through the Voluntary Land Transfer (VLT) scheme. These latter schemes required lesser time and resources and did not involve considerable landowners' resistance.

The perennial delay in OLT completion required the employment of innovative strategies. This included, among others, the adoption of an automatic trust deposit for landowners and issuance by LBP of collective certificates of full payment of trust deposits to hasten the subsequent activities such as title registration (Madronio, 1993).

As of the end of 1995, approximately 84 percent of OLT scope had been distributed. There were variations in the extent of accomplishment among regions due, among others, to the differences in the nature of problems encountered in the course of the program's implementation. The distribution of such magnitude of lands must have caused structural changes in the rice and corn sector which are necessary for enhancing productivity.

### 2.5.3 The OLT Support Services

As a component of CARP, the OLT beneficiaries are entitled to support services such as training, extension, credit, farm to market roads and irrigation services. These services are extended by the CARP implementing agencies through a coordinative body within DAR. For physical infrastructure projects an appraisal system was implemented to ensure that projects identified are capable of serving a large number of CARP beneficiaries relative to the total. However, the number of strictly OLT beneficiaries could not be isolated from the existing database.




Note: 1986 Figure represents accomplishment from 1972-1986

Figure 2.6 **Trend in OLT Accomplishment (1972-1995)**

A regional breakdown (Table 2.5) of distributed OLT lands for 1991 and newly completed irrigation and small water impounding projects (SWIPs) shows that, for 1991 alone, 55 irrigation projects and 82 SWIP projects were operationalized. However, the proportion of project beneficiaries was small relative to the land distribution beneficiaries. Irrigation projects' service areas were high for Ilocos and Southern Mindanao. Bicol and Western Visayas, on the other hand, were more benefited by newly completed SWIP projects for the same year. There was no clear proportionality between OLT lands distributed as of 1991 and the service areas of newly operationalized projects. For instance, Cagayan Valley had a large amount of redistributed rice and corn lands for the year but its share to irrigation and SWIP service areas and beneficiaries was marginal. The same is true for Central Luzon. One implication of this is that the OLT lands distributed for 1991 may include irrigated lands, which do not need further irrigation assistance, but which cannot be verified from the data.

**Table 2.5** ***OLT lands in 1991 and Completed Irrigation and Small Water Impounding Projects (SWIPs) under CARP, As of 1991***

| REGION | OLT | | Irrigation Projects | | | | | SWIPs | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area | FBs | No. | FBs | Service Area | % Share | | No. | FBs | Service Area | % Share | |
| | | | | | | Area | FBs | | | | Area | FBs |
| Cordillera | 111 | 59 | 3 | 203 | 139.89 | 0.06 | 14.839 | 1 | 15 | 20.00 | 0.09 | 1.096 |
| Ilocos | 2,764 | 4,532 | 11 | 2,204 | 2,107.00 | 2.48 | 8.005 | 7 | 1,312 | 142.00 | 0.17 | 4.765 |
| Cagayan Valley | 4,501 | 4,640 | 4 | 181 | 827.00 | 0.59 | 0.312 | 12 | 485 | 415.00 | 0.29 | 0.836 |
| Central Luzon | 7,284 | 6,635 | 5 | 422 | 669.37 | 0.27 | 0.696 | 7 | 232 | 381.00 | 0.16 | 0.383 |
| Southern Tagalog | 2,634 | 2,574 | 8 | 338 | 182.27 | 0.26 | 1.572 | 10 | 137 | 326.00 | 0.48 | 0.637 |
| Bicol | 283 | 187 | 2 | 548 | 560.00 | 1.83 | 1.571 | 17 | 768 | 868.00 | 2.83 | 2.202 |
| Western Visayas | 2,346 | 2,243 | 1 | 339 | 300.00 | 0.35 | 1.742 | 14 | 327 | 955.68 | 1.14 | 1.681 |
| Central Visayas | 930 | 1,145 | 5 | 469 | 425.00 | 4.26 | 5.586 | 1 | 65 | 36.00 | 0.15 | 0.774 |
| Eastern Visayas | 230 | 189 | 2 | 103 | 368.53 | 2.90 | 0.671 | 0 | 0 | 0.00 | 0.00 | 0.000 |
| Western Mindanao | 305 | 200 | 2 | 100 | 123.00 | 0.53 | 1.376 | 5 | 79 | 205.00 | 0.88 | 1.087 |
| Northern Mindanao | 152 | 109 | 2 | 83 | 144.00 | 0.39 | 0.644 | 7 | 123 | 81.00 | 0.22 | 0.954 |
| Southern Mindanao | 478 | 301 | 1 | 200 | 2,000.00 | 2.43 | 1.822 | 1 | 250 | 180.00 | 0.21 | 2.277 |
| Central Mindanao | 1,460 | 1,008 | 9 | 794 | 859.00 | 1.52 | 4.956 | 0 | 0 | 0.00 | 0.00 | 0.000 |
| **Philippines** | 23,478 | 23,822 | 55 | 5,984 | 8,705.06 | 1.37 | 3.37 | 82 | 3,793 | 3,609.68 | 0.51 | 1.28 |

*Notes: FB denotes farmer-beneficiaries*
*Service area denotes areas under CARP served by the projects (in hectares)*
*% Share area refers to percentage share of projects' service areas to total regional irrigated area*
*% Share FBs refers to percentage share of project beneficiaries to total OLT FBs as of 1991*

*Source: Consolidated Regional Monitoring Reports, FOG-SSO, DAR, As of December 1992*

## 2.6 Comments and Conclusion

This Chapter has shown some initial differences among regions such as regional attributes, different yield levels for the crops under study, consumption patterns and prices, and different accomplishment rates with respect to the OLT program. Although the program covered only 10.33 percent of the total rice and corn area, its contribution to overall productivity in the two crops is to be explored in this study.

There are differences in the yield rates per hectare among regions for rice and corn. Presumably, differences also exist in the TFPs of rice and corn among regions.

# Chapter 3
# Review of Related Studies

## 3.1 Introduction

The focus of this Chapter is the collation of related studies in relation to the objectives and methods of this study. These include such studies dealing with output growth in general using the total factor productivity (TFP) approach; regional productivity differences; land reform and output growth; land reform and regional productivity; and effects of a government program on productivity. In addition, a study dealing with transitive indices is also reviewed. In general, the review is carried out by discussing the major findings in relation to the major output, input and productivity related objectives.

## 3.2 Productivity and Output Growth Over Time

Although this study is unable to trace the growth of productivity in rice and corn across regions in the more recent years due to the limitations imposed by input data, a review of previous literature on productivity growth over time was deemed necessary to establish an adequate background on the nature of productivity growth in Philippine agriculture, in which rice and corn is an integral part.

Lawas' (1965) estimation of productivity in the post-war period (1948-1960), employing a Cobb-Douglas production function, found that only around 11 percent of total output growth was accounted for by increased productivity. He attributed the greater portion to increased fertilizer use and concluded that the reason for low increases in productivity were the lack of institutional support services, such as extension, and adequate marketing and distribution facilities (Antonio, 1979).

Hooley (1968) studied the long-term growth of the Philippine economy from 1902-1961. To measure changes in agricultural output, a long-term series on value of crop and livestock production at constant prices was computed. Likewise, inputs were combined to determine whether total farm efficiency increased. Partial and total productivity indices indicated that, over the period, labour use grew more slowly than any other input. Output grew at a compounded annual rate of 2.9 percent between

1902 and 1961. Agricultural output growth was attributed to expansion in input use rather than to the increases in the efficiency of inputs used. A substitution effect of land for labour was observed.

Oña and Hsieh (1968) analyzed the output growth of rice and corn in the Philippines from 1946 to 1966. They found that all the then nine regions exhibited positive trends in production though the rate of increase varied across regions. For rice, the regions with relatively rapid increase in output were also those that manifested a higher percentage in area expansion. Similarly, for corn, the trend in acreage in different regions almost followed the production pattern. Production of both crops increased significantly due to area expansion which characterizes the development stage of the Philippine agriculture, then an expansion oriented and not a productivity oriented agricultural economy.

Antonio (1976 in Antonio, 1979) pointed out the seeming contradiction between Lawas' and Hooley's studies. An explanation offered by Hooley and Ruttan (1969) regarding the differences was that they might have been due to the different weights assigned to irrigated and non-irrigated lands. Hooley and Ruttan's explanation for agricultural productivity decline was the deterioration in land quality.

There were similarities for the subject years in the succeeding long term studies. For instance, Paris (1971), studied the growth of the agricultural sector for the postwar period 1948 to 1967 by constructing. annual indices of output, input and partial and total productivities. His results revealed that total productivity increased by only 8.8 percent over the subject period, while labour productivity increased by 24.6 and land productivity by 19.7 percent. Conversely, the productivity of fixed and operating capital declined (Antonio, 1979).

Using almost the same subject period, Crisostomo and Barker (1973), estimated the growth rates in Philippine agriculture from 1948 to 1971, they found that Philippine agricultural output grew at an average annual rate of 4.0 percent. Total inputs increased by 3.3 percent per year and total productivity by 0.7 percent per year. Based on the results, Antonio (1979) suggested that total productivity must have declined from 1969 to 1971 based on the estimated annual growth rates in the two periods, those covered by Paris' study (1948-1967) and those by Crisostomo's (1972) study for 1948 to 1969.

A further extension of Crisostomo and Barker's (1973) study was done by David, Barker and Palacpac (1984) dealing with the nature of productivity growth in Philippine agriculture (1948-1982). In order to understand the nature of productivity growth in agriculture, the trends in partial productivities of labour and land in relation to changes in relative resource use were examined. Results showed that growth and productivity change were functions of many other factors aside from the efficiency of resource use within the agricultural sector. Rather, the performance of the industrial and public sectors was not good enough to effect a better performance for the agricultural sector. Nonetheless, the latter's performance was considerably good enough especially with respect to the provision of cheap wages for the entire economy.

Table 3.1 **Summary of Annual Growth Rates in Outputs, Inputs and Productivity, Philippine Agriculture, Selected Periods**

| Authors/ Year | Period | Annual Growth Rates | | |
|---|---|---|---|---|
| | | Output | Inputs | Productivity |
| Paris (1971) | 1948-1955 | 6.90 | 4.30 | 2.50 |
| | 1955-1960 | 2.00 | 3.80 | (1.70) |
| | 1960-1967 | 3.00 | 3.10 | (0.10) |
| | 1948-1960 | 4.90 | 4.10 | 0.70 |
| | 1948-1967 | 4.20 | 3.70 | 0.40 |
| David, Barker and Palacpac (1984) | 1965-1970 | 4.00 | 3.30 | 0.70 |
| | 1970-1975 | 6.60 | 3.50 | 3.00 |
| | 1975-1980 | 6.00 | 3.60 | 2.30 |
| | 1950-1960 | 5.00 | 3.10 | 1.80 |
| | 1960-1970 | 3.20 | 2.80 | 0.40 |
| | 1970-1980 | 6.30 | 3.60 | 2.70 |
| | 1950-1980 | 4.90 | 3.20 | 1.60 |

Note : *Paris' s estimates were based on average of 1955, 1960 and 1965 prices*

Table 3.1 provides a summary of various estimates of annual growth rates in outputs, inputs and productivity in Philippine agriculture. There was an apparent closeness in the estimates of output and input growth in different time periods but variations existed in the case of productivity growth.

The foregoing review has shown that there has been a substantial body of studies conducted to analyze the nature of output, inputs and productivity growth for the entire agricultural sector; of those, the rice and corn subsectors were studied only by Oña and Hsieh (1968).

## 3.3 Regional Productivity Differences

Oña and Hsieh's (1968) study was, apart from being a long-term output growth study, also a regional comparative study. The authors found out that all the then nine regions exhibited positive trends in production. For rice and corn, the trend in acreage in different regions almost followed the production pattern. The subject period of the study (1946 to 1966) were years when Operation Land Transfer (OLT) was not yet implemented.

Easter, Abel and Norton (1977) conducted a study on the regional differences in productivity between the wheat and rice regions of India. For their study, it was not possible to utilize the envisaged ten-year time series of cross section data, as observations for the whole period were not available for all variables. Interpolation and extrapolation was not undertaken because variables did not behave in a trend and to avoid problems of multicollinearity. Results indicated that for the wheat region, output increases were attributed to the introduction of new varieties, irrigation expansion and quality improvement and increased fertilizer use. For the rice region, it appeared that output increases were not comparable to those of wheat. Hence, it was suggested that efforts should be geared towards development of adaptable rice HYVs and improvement in market -related structures.

Antonio's (1979) study was a fact-finding analysis of agricultural productivity in the Philippines at the regional and national levels. To construct and analyze total factor productivity indices, the Chain-linked Geometric Index (CLGI) was used. The study found that the relative contribution of total input growth was higher (55.6 percent) than the relative contribution of total factor productivity growth (44.4 percent) to total output growth in 1948 to 1975. This highlighted the continuous dependence of agricultural growth on increased input use.

From a regional perspective, wide variations existed in the factor proportions and the composition of agricultural production. There were also wide income inequalities across regions. For instance, Ilocos, Bicol and Eastern Visayas had incomes below the national median income. It was inferred that the uneven nature of growth across region was a function of differences in resource allocations per region. Central Luzon and Southern Tagalog were beneficiaries of irrigation, credit and transportation enhancement, while the same services have been wanting in most Visayas and Mindanao regions.

At both national and regional levels, there were positive correlations between total factor productivity and labour and land productivities, although total factor productivity was more correlated with the change in labour productivity than with the growth in land productivity.

Chen (1996) studied the impact of regional factors on productivity in China. The regional production environment of China was decomposed into five regional factors such as education endowment, direct foreign investment, agglomeration, producers' market accessibility and consumers' market accessibility. The impacts of the regional factors on the Chinese machinery building and food manufacturing industry were estimated across regions. Results revealed highly significant estimates showing that regional factors substantially affect regional productivity. Total regional factor impact was positive and highest at the east coast regions, and was low or even negative in the western and mountain regions. Also, the capital return rate was positively related to the ratio of the total regional factor impact to the wage rate.

Moomaw and Williams (1991) analyzed the sources of growth for the manufacturing sector of 48 states in the US using cross-sectional data to estimate the determinants of TFP growth variations. Findings indicated that there was little association between TFP growth differentials and output growth differentials for census regions. A positive association between TFP growth and output growth was found at the State but not at the regional level. Results also revealed that State investments in education and transportation infrastructure may have affected TFP growth, while energy price increases in the early 1970's had no differential effects on productivity growth across states.

It can be observed that regional-oriented productivity studies are limited but, where they exist, they are valuable references for regional planners and agricultural agencies for further exploring the agricultural productivity and development potential of each region. These studies have also showed that the application of TFP approach in regional analysis is highly appropriate.

## 3.4 Internal Consistency of Index Numbers

In relation to the objective of exploring transitive index numbers, the study of Hill (1997) was reviewed. Kravis, Heston and Summers (1982) earlier work on spanning trees, one method adopted in this study was also reviewed.

Kravis, Heston and Summers (1982 in Hill, 1997) explored but rejected the concept of linking bilateral comparisons across countries using a variant on the star spanning tree. Using cluster analysis, the authors suggested that a set of countries could be divided into homogeneous subsets. To measure similarity across countries enabling cluster formation, they developed such criteria as geographical propinquity, price correlation coefficients and Paasche-Laspeyres spreads. However, such approach proved to impose arbitrary constraints on the Minimum Spanning Tree (MST). For instance, the center country for each cluster and the link countries between clusters were both chosen arbitrarily. This work was extended by Hill (1997) who obtained a spanning tree directly from the data without imposing arbitrary restrictions.

Hill (1997) compared price levels accross countries by chaining them across a minimum spanning tree (MST). Through the tree, he linked bilateral comparisons in such a way that all the countries in the set were connected but, without creating any cycle. He computed multilateral price indices by chaining them across an MST, which ensures consistency between price and quantity indices.

Hill's results indicated that for 1980 and 1985 the spanning trees constructed had common edges and generated similar clusters of countries. For instance, eight countries formed a cluster, as did the three Eastern European and five Latin European countries included in the study. In both MSTs, France was linked to Northern, Southern and Eastern Europe while the U.S. and Canada were linked to Europe through Germany. Asian and Northern European countries formed separate clusters. In general, the MSTs were stable over time.

Coelli and Rao (1995) present another method to impose internal consistency of index numbers, the Elteto-Köves-Szulc (EKS) method. This method converts non-transitive into transitive indices. A similar transformation using non-transitive Fisher indices which was used in this study is given in Chapter 4.

## 3.5 Land Reform and Productivity

Ruttan (1964) expressed the view that land reform by itself does not directly affect the growth of agricultural output. Changes in agricultural output are derived from changes in inputs and changes in the efficiency of input and output linkages. Hence, the policy instruments and constraints must be evaluated in terms of the effectiveness with which they facilitate such changes.

Berry and Cline (1979) conducted intensive hypotheses tests on the influence of agrarian structure on agricultural productivity and employment for selected developing countries such as Brazil, Colombia, Philippines, Pakistan, India and Malaysia. The study examined the differences among countries in their scope for increasing agricultural production and employment through land reform, and through programs focused upon small farm development. The study concluded that small farms exhibit higher land productivity and total social factor productivity.

The same study indicated that there is no aggregate evidence on relative factor productivity by farm size for 1960s to early 1970s. This suggest that new varieties introduced in the 1970s brought no lasting changes in the usual relationship between yield and farm size of rice. This implies that other factors might have affected the productivity of rice and corn during the study period. In relation to Ruttan's (1963) assertion, Berry and Cline (1979) suggest that for rice and corn, the growth in past output was not due to land reform alone but to a host of other factors.

The Department of Agrarian Reform (DAR) conducted a study in 1983 on the process and impacts of OLT, considering the period the program had been implemented (1972-1981). Using a sample of one (1) percent of the OLT beneficiaries in 1982, the study explored, among other factors, the changes in tenurial status of rice and corn farmers in OLT areas. Some insights on the productivity aspects were generated. For instance, a favourable change in cropping pattern from corn to rice, and an increase in the cropping index[2] for rice and a decrease for corn were observed. The cropping index for rice increased from 106.5 to 124.2 percent of the area, while for corn, it declined from 34.4 to 29.6 percent. Increases in rice output and decreases in corn output per hectare were generally observed in OLT areas, but showed no clear trend among the various types of farmer beneficiaries for the given period.

Sandoval (1983) reviewed studies relating farm size and land reform to farm productivity. Studies showed both neutral and positive effects on farm productivity (Table 3.2). Harkin (1976) qualified his neutral position stating that OLT would have no effect without the provision of institutional services such as credit and extension. In the same vein, Sodusta (1977) indicated that productivity increases were due to intensive input usage. Sandoval himself observed that there had been no time series studies that carefully isolated the effect of OLT from technological change in determining the growth of farm productivity (Mangahas, 1985).

Table 3.2 **Summary of Previous Studies on Effects of OLT/ Land Reform on Farm Productivity**

| Authors | Year | Findings |
|---|---|---|
| Sandoval and Gaon | 1972 | no effect |
| Zarsa | 1974 | positive |
| Nicolas | 1974 | positive |
| Harkin | 1976 | no change without institutional services |
| Mangahas, Miralao and de los Reyes | 1976 | neutral |
| Sodusta | 1977 | neutral |
| Angsico | 1978 | positive |
| San Andres and Illo | 1978 | positive |

Note : *Based on review by Sandoval (1983), Economic Aspects of Agrarian Reform: Lessons from Experience*

[2] Cropping index or 'intensity' index refers to the total cultivated area on a farm divided by total cropland. If multiple cropping exists, the cropping intensity may be greater than 1 which can be expressed in percentage terms (Gittinger, 1982).

Mangahas (1985) expressed the view that agricultural productivity is unaffected by farm tenure structure, reiterating his earlier position that land reform would not have any significant effect on yield. This was based on surveys of different tenure groups in Nueva Ecija, one of Central Luzon's provinces. The survey results showed no significant differences, cross sectionally among the different tenure groups, in terms of productivity or agronomic modernization. In addition, it was pointed out that neither did there appear to be any tenure-related differences in productivity in other studies then available.

Using a comparative analysis of five rice-dependent Philippine villages, Otsuka (1987), studied the relationship between technical change and land reform implementation. The study found that the success of land reform for the Philippine rice sector was linked to technical change represented by the adoption of modern seed and fertilizer technology. However, the substantial income redistribution from landlords to tenants occurred only in areas where yields grew significantly since land reform was implemented. It was inferred that, if technical change were absent, the distributional impact of land reform would not be as broad. In short, technical change was a major contributory factor to the perceived early successes of land reform.

Heath (1992) evaluated the impact of Mexico's land reform program on agricultural productivity. Studies comparing the productivity of individual 'ejido' parcels and small private landholdings were analyzed. The results revealed no significant difference between the two sectors. The evaluation further showed that between tenure categories, there was 'de jure' but not a 'de facto' difference in small farmers' control over resources, partly because farmers circumvented the implicit restrictions within land reform.

Pingali and Xuan (1992) studied the link between Vietnam's decollectivization efforts and rice productivity growth. Decollectivization included such reforms as land reform completion prior to reunification, widespread adoption of modern rice technology and the existence of a flourishing private enterprise economy until 1975. Completion of the land reform and land redistribution program allowed the small farmers to bring back into cultivation lands that were abandoned by landlords during the war. This was instrumental for expanding rice area and, hence, enhancing aggregate output during the decade 1966 to 1975.

## 3.6 Induced Innovation and Aggregate Productivity

For this study, OLT is treated as a government program, similar to investment in research and human capital which belongs to a general classification of 'induced innovation'. Using the total factor productivity index, effects of factors such as credit, infrastructure support and other services extended to complement OLT which were extended under CARP; other services outside CARP; and natural factors on productivity are determined highlighting the differences across the thirteen geographical regions. The following literature were found to be closely related and able to provide guidance for the second stage of this study, that is, relating OLT to aggregate and regional productivity in rice and corn.

Hayami and Ruttan (1971), as cited by Antle (1983) made an important contribution to the study of international agricultural productivity by showing that an aggregate agricultural production function, that accounts for intercountry differences in resource endowments, technical inputs, and human capital can explain a large proportion of the variation in aggregate agricultural output across more and less developed agricultures. The study hypothesized that there existed only one aggregate agricultural production function across the more and less developed agriculture but this assumption was not tested because their sample was very small. The findings of the study were not cited in Antle's review but the hypothesis was not rejected.

Antle (1983) conducted a study continuing on the model that Hayami and Ruttan (1971) adopted, by incorporating an 'infrastructure' variable to measure each country's transportation and communication services. He used a separate sample of LDCs and a combined sample of DCs and LDCs. In addition, he used Evenson and Kislev's (1985 in Antle, 1983) 'research' variable that measures a country's investment in agricultural research. In short, in Antle's study each country's Hicks-neutral productivity level is a function of education, research and infrastructure variables. The study found that infrastructure contributes significantly to the LDC model supporting the hypothesis that infrastructure investment contribute to agricultural productivity in developing countries.

Evenson (1988) decomposed U.S. agricultural productivity into research and extension. A two-stage analysis was employed: first, analyzing the combined time-shape and contiguity pattern of applied agricultural research and, second, doing a more complete decomposition analysis. His specification was composed of TFP as the dependent variable and the independent variables were: ED which was an index of years of school completed by farm operators; an extension variable based on extension, production-oriented and applied engineering research expenditures; an index of level II (pre-technology) research conducted with different time-shape weights for different states; a productivity scaling factor for states; a business cycle index capturing the productivity index of the business cycle; and region and time dummies.

Different specifications showed the effects of each variable on TFP. Level II research showed productive effects. The business variable indicated that, as farm income falls in a cycle TFP rises and, as farm income cycle reaches a boom phase TFP slows down. There were marginal returns to investment in schooling, extension and economic research, applied research and pretechnology research.

## 3.7 Comments and Conclusion

The long-term studies on productivity growth were subjected to data limitations. Estimations using interpolation and extrapolation were almost always necessary to complete certain series. Nonetheless, the studies were able to arrive at relatively consistent estimates of factor shares and rates of growth.

The earlier long-term studies were conducted during the time when structural reforms for rice and corn were fragmented and OLT was not yet implemented. David, Barker and Palacpac's study covered the early years of OLT implementation but analysis did not touch on the possible effects of the program in the later years of the 1970s. Similarly, there are studies not covered in this review that have dealt with technological change alone. None of the cited literature has included OLT in its analytical framework or considered testing the changes, at least highlights of Hill's (1997) results and insights on Kravis, Heston and Summers (1982) exploration on the use of MSTs were presented. Most of the discussion on internal consistency or transitivity; MST; and Paasche-Laspeyres Spread (PLS) is presented in Chapter 4.

Evenson's (1984) study provides the closest example of the way in which TFP indices were treated in this study, that is, regressing them against OLT and regional factors. However, this study did not go as far as Evenson's decomposition.

# Chapter 4
# Research Framework and Methods

## 4.1 Introduction

Hicks' induced innovation theory has provided a theoretical framework for the explanation of agricultural productivity differences across regions and over time. Agricultural productivity has also been explained in terms of investment in agricultural research, extension and human capital (Capalbo and Antle, 1988). Explanation of agricultural productivity changes or differences in terms of such interventions requires a careful consideration of relevant variables and appropriate analytical approaches.

In this chapter, the framework through which regional productivity differences in rice and corn were studied is presented. Various index number methods used in this study are discussed in detail. Likewise, the framework for analysing the relationship between OLT and regional productivity of rice and corn is discussed.

## 4.2 Total Factor Productivity (TFP) Measurement

### 4.2.1 The TFP Theory and Measurement

Four approaches to the measurement of Total Factor Productivity (TFP) were categorised by Diewert (1990). These include the econometric approach involving joint cost functions, the Divisia approach, the exact index number approach and the non-parametric approach. The econometric index number approaches have been widely used in economic research due to the inadmissibility of a negative technical change in the non-parametric approach (Francisco, 1993).

Total Factor Productivity (TFP) measures the index of total output relative to an index of total inputs. It considers the use of most or all inputs including seeds, water, labour, tractors, fertilisers and others. Construction of an index of TFP permits an objective assessment of the productive performance of a system over time (Barnett, 1995). Similarly, it provides an objective assessment of the system's productive performance across regions. For instance, the ratio of TFP between two given regions can be denoted by:

$$\frac{TFP_s}{TFP_r} = \frac{Q_s/X_s}{Q_r/X_r} \quad (4.1)$$

where: $Q_t$ is an index of aggregate output in region t; and

$X_t$ is an index of aggregate input in region t

The aggregator functions Q and X can be written as:

$$Q_t = f(Q_{1t}, \ldots Q_{mt}, u_1 \ldots u_m) \quad (4.2)$$

$$X_t = f(X_{1t}, \ldots X_{nt}, v_1 \ldots v_n) \text{ for } t = r,s \quad (4.3)$$

where $m$ individual outputs are produced from $n$ individual inputs and the weights $u_j$ and $v_i$ ($j = 1...m$, $i = 1...n$) used in the aggregator functions are held constant between t = r and t = s. The simplest aggregator function is a weighted mean, or could be a weighted sum, or an aggregate derived using prices where:

$$Q_t = f(Q_{1t}, \ldots Q_{mt}, u_1 \ldots u_m) = \sum_{j=1}^{m} u_i Q_{jt} \quad (4.4)$$

This can be used for aggregation if the algebraic form of the production function is known.

The relationship between TFP measurement and specific functional forms for the production function may be presented for a single-output or two-input linearly homogeneous production function exhibiting Hicks neutral technical change (Barnett, 1995). The linearly homogeneous production function exhibits constant returns to scale (i.e., a proportionate expansion of all inputs leads to the same proportionate expansion of output).

Output at time t can be expressed as:

$$Q_t = A(t)\, f(X_{1t}, X_{2t}) \text{ for } t = r,s \quad (4.5)$$

where A(t) is a shift factor dependent only on the passage of time and reflecting technological change, and $f(X_{1t}, X_{2t})$ is a linearly homogenous production function in inputs $X_1$ and $X_2$. The above expression can be used to form a ratio of TFP between the two regions s and r with the aggregator function $f(X_{1t}, X_{2t})$ used to form the input index. This gives:

$$\left(\frac{TFP_s}{TFP_r}\right) = \left(\frac{A_s}{A_r}\right) = \frac{Q_s/[f(X_{1s},X_{2s})]}{Q_r/[f(X_{1r},X_{2r})]} \quad (4.6)$$

Construction of the index of TFP requires knowledge of the form f $(X_1, X_2)$ in order to generate the aggregate index of the two inputs. Furthermore, assuming both a specific form of the production function and competitive equilibrium in production leads to a specific aggregator function expressed in terms of input prices and quantities (Barnett, 1995).

### 4.2.2 The TFP Indices

TFP differs from partial factor productivity because it measures the effect of all the inputs while the latter often measures only those due to labour or capital. TFP is often referred also as the 'residual' or the index of 'technical progress' (Nadiri, 1970). The early measures of TFP in empirical research include the Kendrick's arithmetic measure and Solow's geometric index. Kendrick's measurement approach uses a distribution equation and implicitly assumes a homogeneous production function. Solow's measure is based on the Cobb-Douglas production function with constant returns to scale and autonomous and neutral technological change (Nadiri, 1970).

TFP indices may be derived using the Hicks-Moorstein (H-M) approach or defined using the Malmquist productivity indices. These approaches are discussed in Diewert (1992). Under the H-M approach, the TFP index is defined as the ratio of output index to the input index defined as:

$$TFP_{jk} = \frac{\text{Output index}_{jk}}{\text{Input index}_{jk}} \tag{4.7}$$

where j and k represent countries or regions j and k. In applying the H-M approach; it is necessary to measure the input and output quantity index numbers. Many alternative index number formulae are available, most important of which are discussed below.

#### Paasche and Laspeyres Indices

Paasche and Laspeyres index numbers are used in the general area of economics particularly in deriving consumer price indices. The Laspeyres price index uses the base period quantities as weights whereas the Paasche index uses the current period weights to define the price index. The former is the ratio of two value aggregates resulting from the valuation of the base period quantities at current and base period prices. The latter makes use of current period quantities and current period value share weights. However, the two formulae are said to be extremes, each placing emphasis on quantities from a different time period but they provide bounds for the unknown 'true index' (Coelli and Rao, 1995). The indices tend to diverge when there exists a large variation in the price relatives. In addition, the extent of divergence depends on quantity relatives and statistical correlation between price and quantity relatives. The Paasche and Laspeyres indices are defined as:

$$\text{Paasche Index} = Q_{st}^{P} = \frac{\sum_{i=1}^{N} p_{it} q_{it}}{\sum_{i=1}^{N} p_{it} q_{is}} \tag{4.8}$$

and

$$\text{Laspeyres Index} = Q_{st}^{L} = \frac{\sum_{i=1}^{N} p_{is} q_{it}}{\sum_{i=1}^{N} p_{is} q_{is}} \tag{4.9}$$

from Coelli and Rao, 1995.

### Fisher Index

In between the Paasche and Laspeyres indices, the Fisher Index represents a geometric mean of the two indices as a possible index number formula. It is given as:

$$\text{Fisher Index} = Q_{st}^{F} = \sqrt{Q_{st}^{L} \bullet Q_{st}^{P}} \tag{4.10}$$

The Fisher index possesses a number of statistical and economic theoretic properties. It is also known as the Fisher Ideal Index because it satisfies such criteria as: (a) positivity; (b) continuity in prices and quantities; (c) invariance to changes in units of measurement; (d) time reversal test, where for two periods s and t: $Q_{st} = 1/Q_{ts}$ ; (e) mean value test, where the price or quantity index must lie between the respective minimum changes at the commodity level; and (f) factor reversal, where if the same formula is used for price and quantity indices, their product is equal to the value ratio. However, it does not satisfy the transitivity requirement where for any three regions s, t and t', $Q_{st} = Q_{st'} \times Q_{t't}$, where a direct comparison between two regions s and t yields the same index as an indirect comparison through t'. In the case of regional comparisons, the reversal test is given more importance (Köves, 1983).

#### Theil-Tornqvist (TT) and Divisia Indices

The Theil-Tornqvist (TT) Index is a weighted geometric average of the quantity relatives, with weights given by the simple average of the value shares in regions s and t. The index is usually applied in its log-change form which offers a convenient computational form. It is considered a nearly exact approximation to the Divisia index (Coelli and Rao, 1995).

The Divisia Index approach assumes that data are available at a continuous time interval t. Under certain conditions, the Divisia index of factor inputs is held as the appropriate index of inputs for the measurement of TFP (Francisco, 1993 in Star and Hall, 1976).

## 4.3 Interspatial Total Factor Productivity (TFP)

Intertemporal productivity differences are attributable to technological change on the assumption that efficient production exists. Interspatial productivity differences arise from differences in the efficient production functions in each region (Capalbo and Antle, 1988). It is defined as the logarithmic difference in an index of outputs between two producing regions divided by the log difference of an index of inputs. Alternatively, it can be interpreted as the exponentiation of the log difference in an index of outputs minus the log difference in production costs minus the log difference in an index of input prices. Consistent with Capalbo and Antle, interspatial productivity differences arise not due to the dynamic forces of technological change but from static technological differences across producing regions (Hazilla and Kopp, 1988). Qualitative and quantitative differences in resource endowments among regions dictate different types of technological development as well as different development strategies (Easter, Abel and Norton, 1988).

To analyse productivity differences across different regions and time periods, a production function:

$$\ln Q = f(\ln X_1, \ldots, \ln X_n, T, D) \quad (4.11)$$

where T is a technological change variable while D denotes a vector of regional variables, may be specified. A growth accounting method is employed for time-series studies. A logarithmic expression of the changes in Q is written as:

$$\Delta \ln Q = 1/2 \ (f_i^r + f_j^s)(\ln X_i^s - \ln X_i^r) + \rho_{sr} + \tau_{sr} \qquad (4.12)$$

where the interspatial effect is given as:

$$\rho_{sr} = 1/2 \ (f_D^r + f_D^s)(D^r - D^s) \qquad (4.13)$$

For this study, which is cross-sectional in nature, technological change variables were not incorporated, but regional variables capturing technological differences were considered. It is assumed that there are variations and similarities in irrigated area, HYV utilisation, extent of fertiliser use, and in the general adoption of improved technologies. The levels of factor use indicated by the relative factor shares was expected to provide a basis for classifying regions of similar characteristics. A comparison of the relative position of each region in terms of TFP provides a valuable tool for assessing each region's agricultural sectors from economic and technological perspectives. The differences in TFP across regions should provide a basis for determining the relative effectiveness of government programs such as the OLT Program where land distribution is supported by complementary services aimed at increasing productivity and farmers' income, particularly in the rice and corn sectors.

## 4.4 TFP Indices for Cross-Regional Comparisons

In view of the very limited data available for purposes of this study (see Chapter 5 for details), which includes only a single cross-section covering all the thirteen regions in the year 1991, the index number approach is used in measuring total factor productivity across the regions. Neither econometric estimation of the underlying production function nor the application of non-parametric techniques such as the Data Envelopment Analysis (DEA) were feasible. So the main emphasis of the dissertation is on the derivation of suitable measures of TFP using index numbers that satisfy the transitivity property.

Most of the studies in the literature on transitive index numbers make use of the approach suggested in Caves, Christensen and Diewert or CCD (1982a). The CCD approach, which is based on the Elteto-Köves-Szulc (EKS) method works on the premise that any set of transitive multilateral index numbers should preserve the direct binary comparisons derived using Fisher or Tornqvist index numbers. The EKS-CCD approach seeks to preserve the characteristics of binary comparisons in the process of constructing transitive multilateral indices.

However, some recent work by Hill (1997) points towards the idea that a direct binary comparison between two regions or countries may not always be ideal. For example, a direct comparison between two countries at a similar stage of development such as the US and Germany may be quite satisfactory and reliable, whereas a direct comparison between two dissimilar countries like the US and India may not be reliable. Hill suggested an alternative to the EKS-CCD approach using an intuitive "chaining procedure" where countries are chained using links between pairs of countries that are fairly similar.

In order to use Hill's chaining procedure it is necessary to have a measure of reliability of a given binary comparison. Hill (1997) suggested the use of the concept of distance defined as the Paasche-Laspeyres Spread (PLS). The matrix of distances between all pairs of regions/countries, involved in the multilateral measurement, are used in identifying the minimum spanning tree (MST) and the associated transitive comparisons derived using the chains indicated by the minimum spanning tree.

In this dissertation, the standard EKS-CCD approach as well as Hill's minimum spanning tree approach are applied to output, input and TFP index numbers. These approaches are discussed below.

### 4.4.1 Transitivity

The transitivity criterion refers to the test of assuring the internal consistency of index numbers constructed for pairs of regions. Output and productivity levels across a number of regions could be compared by examining all combinations of regions. A matrix of all binary comparison can be represented as:

$$\begin{bmatrix} \mathbf{I}_{11} & \mathbf{I}_{12} & \cdots & \mathbf{I}_{1m} \\ \mathbf{I}_{21} & \mathbf{I}_{22} & \cdots & \mathbf{I}_{2m} \\ \vdots & & & \\ \mathbf{I}_{m1} & \mathbf{I}_{m2} & \cdots & \mathbf{I}_{mm} \end{bmatrix} \tag{4.14}$$

which shows all the multilateral comparison involving m regions. When indices are internally consistent, a direct comparison between any two regions s and t is the same as an indirect comparison between s and t through r, a third region. Hence, for any three regions, r, s and t, transitivity requires that:

$$I_{st} = I_{sr} \times I_{rt} \qquad (4.15)$$

Transitivity is a requirement for spatial comparisons but not a necessary requisite for temporal comparisons where the observations are in an ordered sequence (Coelli and Rao, 1995). It is easy to check that the widely used index number formulae like the Fisher and Tornqvist do not satisfy the transitivity criteria although they pass the time or country/region-reversal test.

### 4.4.2 Choice of Binary Index Form

Fisher index formula was chosen for all index calculations in the study. The choice of Fisher as the appropriate index number is worth explaining. The properties mentioned in Section 4.2.2 are enough reasons for choosing Fisher index. Diewert's (1992) review of Fisher index revealed that the index satisfies 21 tests including the ones mentioned in 4.2.2. Compared to a translog index (Tornqvist index) which fails nine tests, Fisher is considered superior. In a time-series study, the Fisher productivity index is exact for the theoretical productivity indices $Pr^0$ and $Pr^1$, hence it is a superlative index. In short, the Fisher index satisfies various tests and properties associated with economic approaches.

### 4.4.3 EKS - CCD Approach

A system for generating transitive indices from non-transitive indices exists and it is known as the Elteto-Köves-Szulc (EKS) method. The EKS method which uses a set of non-transitive multilateral comparisons and derives a set of transitive multilateral comparison (Coelli and Rao, 1995). This method was used by Caves, Christensen and Diewert (1982a in Coelli and Rao, 1995) for deriving transitive T-T indices.

#### Formula

Non-transitive TFP indices can be converted to transitive indices through the following transformation:

$$\mathrm{TFP}_{st} = \left[ \prod_{j=1}^{n} (\mathrm{I}_{sj} \times \mathrm{I}_{jt}) \right]^{1/n} \tag{4.16}$$

where $I_{sj}$ and $I_{jt}$ are TFP indices for pairs of regions (s,j) and (j,t), respectively.

### Properties

The TFP indices defined in (4.16) possess the following properties:

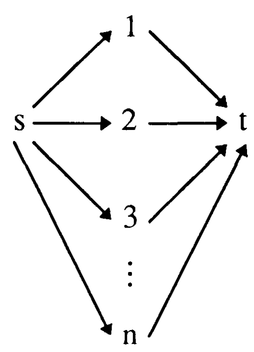
(i) $TFP_{st}$ for s,t = 1...n are transitive;

(ii) The CCD index deviates least from the original binary TFP indices;

(iii) Though the CCD method used binary Tornqvist index numbers, for purposes of this study, Fisher indices are used as the basic binary indices.

### Interpretation

The EKS-CCD formula in 94.16) can be interpreted using the illustration below. The EKS-CCD index for two regions s and t is a geometric average of all indirect comparisons derived through various middle counts through 1 to n.




(4.17)

### Computational Aspects

Transitive multilateral indices were constructed using the original Fisher index matrices and calculating the geometric means using the MatLab computer program (The Mathworks Inc., 1995). This concretized the application of the transformation illustrated in 4.16 which was applied to the individual rice and corn input indices, aggregate input and aggregate input indices. The individual rice and corn output indices were no longer subjected as they were assumed to be already transitive.

### 4.4.4 Paasche - Laspeyres Spread (PLS): A Distance Measure of Reliability

In the index number literature, the Laspeyres and Paasche index numbers are considered to be polar opposites, respectively using base and current period weights. Both statistically and from economic theory these indices are often considered as bounds for numerical values obtained using alternative index number formulae. The gap between the two indices was analysed and decomposed by Von Bortiewicz (1924). The spread depends upon the shifts in the structure of relative prices and quantities across countries and over time.

Hill (1997) suggests a measure of distance associated with comparisons across two regions or over time based on the extent of the gap between the Laspeyres and Paasche indices. The distance between Laspeyres and Paasche indices between two regions j and k is given as:

$$D(j,k) = \left| \ln \frac{P(j,k)}{L(j,k)} \right| \qquad (4.18).$$

The distance measure in (4.18) has the following properties:

(i) D (j,k) $\geq$ 0 for all j and k;

(ii) D (j,k) = D (k,j) for all j and k;

(iii) D (j,k) (price) = D (j,k) (quantity).

The spread between corresponding Paasche and Laspeyres indices may be interpreted as a measure of the sensitivity of the index to the choice of index number formula. Conceptually, most bilateral formulae lie between Paasche and Laspeyres. The PLS value becomes zero if all bilateral formulae give the same results, while it rises as results from formulae diverge from each other (Hill, 1997).

A distance matrix contains the values of PLS or distances as defined in (4.18) for all pairs of regions. It is a matrix of the absolute values of the natural log of the ratio between the Paasche and Laspeyres indices. For this study, a matrix of the distances on input indices is called an 'input distance matrix' whereas for output indices, the relevant distance matrix is called 'output distance matrix'. The matrix suggests the reliability of index estimates such that a small distance value for an index implies greater reliability.

Since the distance matrix shows the spread between the Paasche and Laspeyres indices, the values contained in the matrix are termed the Paasche Laspeyres Spread (PLS). A bilateral comparison between regions with a small PLS approximates closely the true value of the index under study.

The distance measure is the same for price and quantity indices. The distance matrices are presented in Chapter 6 and in the Appendix.

### 4.4.5 Minimum Spanning Tree (MST)

Spanning trees provide a means of generating chained comparisons using the links shown in the tree. A spanning tree is a scheme that provides a unique chain between any two regions.

#### Example

A spanning tree links together vertices in such a way that there is one and only one path between any pair of vertices (Hill, 1997). Figure 4.1 below provides two spanning trees involving 4 countries which shows index number comparisons between the countries. An edge connecting two countries in a spanning tree denotes a bilateral index number comparison between those two countries. In the first tree, a comparison between 1 and 2, and 3 are direct; and comparison between 2 and 4 is linked through 1 and 3. In the second spanning tree, country 1 is the star country and all comparisons are linked through 1.

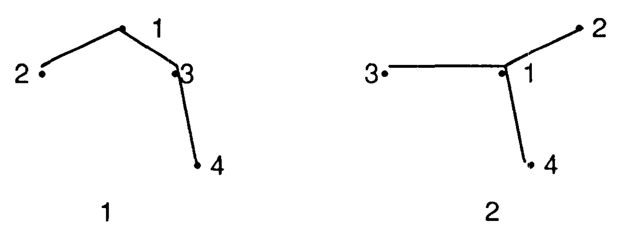



Figure 4.1 Some Simple Spanning Trees

#### The Minimum Spanning Tree

A Minimum Spanning Tree (MST) is a tree, or flowchart, that contains the route of connections between all points of a network which minimises the total length of such connections (Moore, Lee and Taylor, 1993). The construction of an MST involves the use of network branches, or arcs, to reach all nodes in such a fashion that the total length of all branches is minimal (Anderson, Sweeney and Williams, 1988).

### MST Algorithm

An algorithm or a flowchart is a scheme that leads to the identification of the minimum spanning tree. There are many algorithms available for this purpose. The algorithm used in the study is often called the 'greedy algorithm' because it utilises the best available choices at each step of the flowchart. To construct an MST, an arbitrary starting point is selected at any node connecting it to the closest node, then selecting the node closest to either of the two nodes already connected. Moore, Lee and Taylor (1993) described the procedures as (1) arbitrary selection of any node on the network and connecting it to the closest node which may be nearest in terms of distance, time or cost; (2) identifying the unconnected node that is nearest to a connected node, and connecting those two nodes; and (3) repetition of step 2 until all nodes have been connected resulting in a spanning tree of minimum total branch length.

### Properties

According to Hill (1997), the sum of the PLS is taken by selecting a tree with the smallest summed PLS indices technically denoted as K-1. The smallest sum property provides the MST with the advantage of minimising the sensitivity of multilateral indices to the choice of a bilateral formula. Hence, a symmetric distance matrix subjected to the MST method should theoretically have column vectors of equal total distances between the nodes.

### Methods

For this study, MSTs are constructed from any column in a symmetric distance matrix. An MST begins at a base node which contains the index for the base region. Connected nodes represent the regions whose index numbers are used for succeeding multiplication or comparison.

Multilateral Indices are generated from an MST by multiplication of one index number to another along the MST connecters. Since the Paasche and Laspeyres indices serve as bounds for the relevant index, the gap between the multilateral index and the index under study is minimised if the spanning tree with the smallest total PLS spread is applied. The Fisher index was used in multilateral comparisons in this study since it lies between the Paasche and Laspeyres Indices (Hill, 1997).

From the distance matrices, MSTs were created. The sum of the distances between the nodes represent a minimum distance for the whole matrix. The MSTs estimated for the aggregate output, input and TFP are presented in Chapter 6.

To generate transitive indices, bilateral and multilateral comparisons were undertaken using the network of nodes created from the MSTs. A set of transitive indices were constructed for input, output and TFP for rice, corn and their aggregates.

### MST and Productivity Measures: A Problem of Non-Uniqueness

The process of generating transitive multilateral measures of total factor productivity using the minimum spanning trees has the potential to lead to two sets of distinct answers. The problem arises as the Hicks-Moorstein approach to productivity measurement is used as defined in (4.7).

In such cases, it is possible that MST approach is applied to output indices and input indices separately, which in turn implies that the MST for outputs and inputs could be quite different. Different linking processes are applied in deriving chained transitive output and input index numbers. An alternative to this approach is to derive binary TFP indices and define a distance measure for the TFP indices, and then use the distances obtained to define a transitive TFP index directly. These two approaches are likely to result in different numerical measures of TFP. Results from the two approaches are presented in Chapter 6.

In the study, an attempt is made to examine the effect of aggregation on the TFP indices. Indices for the thirteen regions are first derived for rice production, then for corn production and finally, TFP measures are derived for the activity of combined rice and corn production. Results are presented in Chapter 6.

## 4.4.6 Regional Contiguity and TFP Indices

The closeness of index values were analysed by looking at contiguity or proximity effects, or the nearness of a regional index value to an adjacent region's index value. Figure 4.1 can be used as a base diagram for analysing contiguity or proximity effects.

The connections between nodes represent the proximity of two regions. The diagram represents the actual geographical proximity of Philippine regions. The proximity or contiguity analogy was applied to most discussions of input, output and TFP indices; and chaining.

The effect of aggregation was determined from the input, output and TFP indices for rice, corn, and rice and corn.

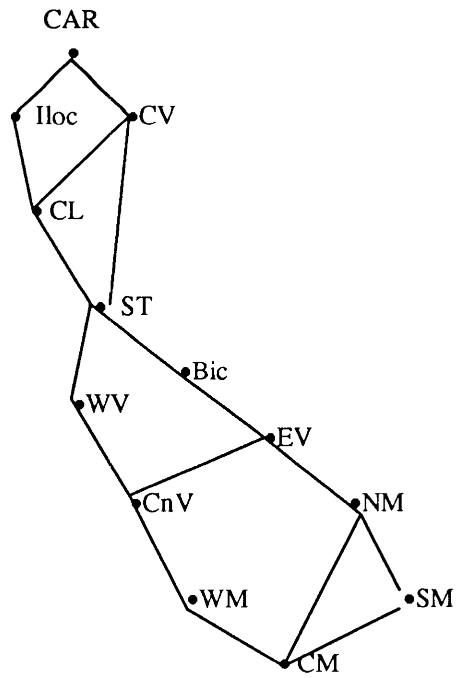



Figure 4.2 **A Contiguity/Proximity Diagram for Philippine Regions**

## 4.5 Regression Analysis of OLT and Other Variables

Studies measuring productivity differences have used either a benefit-cost method or decomposition models (Evenson, 1988). Productivity decomposition models could be carried out through an aggregate production framework or through a two-stage procedure involving index computations and subsequently relating them to certain explanatory variables. For instance, after computing a total, or multifactor productivity index for different regions and time periods, regression analysis is employed to decompose the causes of productivity differences into research, extension schooling and others (Evenson, 1988). Evenson's analysis of U.S. agricultural productivity made use of such approach and obtained estimates indicating the proportion of TFP differences attributable to research and extension.

The applicability of such approach, using Philippine regional data was tested in this study. The TFP indices derived using the methods discussed in earlier sections are related to various factors such as regional OLT area, regional proportion of irrigated area and regional proportion to credit extended for rice and corn as explanatory variables.

### 4.5.1 Regional TFP Indices, OLT and Other Variables

After constructing a fairly reliable body of TFP index numbers, the regional indices are assumed to have a functional relationship with OLT and other explanatory variables which are important factors influencing/determining productivity levels. The nature and extent of technologies in different regions, as reflected in the TFP indices, are affected by exogenous variables which are important determinants of productivity.

Following Evenson's approach, the multilateral TFP indices generated in this study are regressed against OLT and support services variables. These include OLT lands distributed until t-1 which represents land distribution and support services; the proportion of irrigated land to total area planted to rice and corn; the regional share to total credit extended to rice and corn production; and the regional amount of rainfall for the subject year. An extended set of explanatory variables could be identified for analysis. However, due to limited degrees of freedom, only these four explanatory variables are considered. Regression coefficients provide an estimate of the effects of such variables on regional rice and corn productivity for the subject period. They suggest the responsiveness of regional TFP differences to differences in the explanatory variables.

A functional relationship between regional TFP indices and the identified explanatory variables is expressed as:

$$TFP = f\,(OLT, IA, Cr, Rf); \qquad (4.19)$$

In regression form, it is expressed as:

$$\mathbf{TFP_{rc} = \beta_1 + \beta_2\,logOLT + \beta_3\,logIA + \beta_4 logCr + \beta_5 logRf + e_t} \qquad (4.20)$$

where $TFP_{rc}$ is the regional index of TFP for rice and corn;

OLT represents OLT program expressed in area terms until t-1

IA is the proportion of irrigated area to total rice and corn area;

Cr is regional share to total credit extended for rice and corn;

Rf is regional rainfall considered to represent weather and climatic variations;

It is assumed that a positive relationship exists between TFP and the first three explanatory variables, whereas either a positive or negative coefficient for the weather variable is acceptable since some regions' rainfall endowments maybe sufficient for rice but excessive for corn, leading to decreased productivity for corn on a per hectare basis.

The regression equation (4.20) was run in three forms namely, using rice, corn and TFP for aggregate output (rice and corn) as dependent variable. Two alternative specifications with and without the credit variable were tested for each equation which were defined in two models, namely 1 and 2. This was done on the assumption that the effect of credit is already captured in the variation in input usage, particularly fertiliser and chemicals, thereby affecting the variation in the computed input indices and hence the regional TFPs.

For the corn equations in both models, the irrigation variable was excluded because no data on irrigated corn lands exist and irrigation is not considered a major factor input for corn. The BAS survey did not capture irrigation as an input for corn.

The TFP indices of the 1st Region (CAR) were used as base values for the TFP dependent variables. It was not considered necessary to run individual regressions for each region because regional TFP values are already transitive and internally consistent.

The model was run using the OLS commands in the Shazam econometrics package (White, 1993). In addition to OLS commands, correlation commands were used to explore the possible correlation between the explanatory variables specially OLT, irrigation proportion and credit because the former includes lands already provided with irrigation and credit under the CARP and from other government programs.