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101

PRICING BEHAVIOR IN PHILIPPINE CORN MARKETS: IMPLICATIONS FOR MARKET EFFICIENCY

Meyra Sebello Mendoza
Mark W. Rosegrant

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FOREWORD

Income-led growth in demand for meat is expected to provide the major stimulus for expansion in the Philippine corn sector. Traditionally eaten as a cheaper carbohydrate substitute for rice by many Filipinos, corn is now increasingly being used in the manufacturing of feeds for livestock production. More land is being used to grow corn, which has displaced rice as the most important crop in terms of cultivated area.

In recent years, the Philippine government has vigorously pursued a series of sectoral and economywide policy reforms to invigorate the corn sector and support the feed requirements of the livestock industry. These reforms include more liberal foreign exchange policies, lifting of control over domestic marketing operations, deregulation of the interisland transportation system, and production-augmenting programs. A major bottleneck in development of the livestock sector is the domestic pricing and marketing of corn. In this report, Meyra Sebello Mendoza and Mark W. Rosegrant examine the accuracy and timeliness of transmission of price information that is critical in the production and marketing decisionmaking of farmers and traders, and identify possible barriers to efficient pricing and distribution of corn across regional markets in the Philippines.

Establishing pertinent and enforceable corn grading and standardization, building roads and providing adequate transportation to connect rural production areas with urban consumption centers, and ensuring the transparency of prices through improved market knowledge are important policy challenges for the Philippine government to support the expected growth in the livestock sector.

Motivated by the need to understand possible constraints in growth in the corn sector, the research for this study started as part of a comprehensive USAID-funded project on the Philippine corn and livestock sector undertaken by IFPRI. Conducted in collaboration with the Philippine Department of Agriculture and the University of the Philippines at Los Baños, the project covered issues pertaining to production and incentives for increasing supply, comparative advantages in production and foreign trade, prospects for increasing meat consumption, and policy alternatives conducive to the development of the corn and livestock sectors.

Per Pinstrup-Andersen
Director General

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We wish to thank Howarth Bouis and Ousmane Badiane, research fellows, International Food Policy Research Institute; Merle Faminow, professor, Department of Agricultural Economics and Farm Management, University of Manitoba; and Ramon Clarete, professor, School of Economics, University of the Philippines in Diliman, for their helpful reviews. Their comments enriched the exposition made in the manuscript and helped bring out the policy implications of the study.

Our sincere appreciation is likewise expressed to Christopher Delgado, chairman of the Publications Review Committee at IFPRI, for coordinating the review of the report.

Meyra Sebello Mendoza
Mark W. Rosegrant

1

SUMMARY

Accurate, reliable, and prompt information is crucial to the efficiency of arbitrage in the discovery of commodity prices across differentiated markets, especially in the Philippines, where markets are allegedly inefficient because of imperfect knowledge. Although this assertion is pervasive in previous studies of agricultural market performance in the Philippines (Deomampo 1983; Habito 1983; Manuel and Maunahan 1982; Olgado, Abunyawan, and Domingo 1977), it has not been validated empirically. Little is known about the dynamics by which information is relayed across markets in price discovery. Much less is understood about the impact of newly transmitted information in commodity pricing and its implications for market performance.

This report examines the dynamics and efficiency of the Philippine corn market through analysis of a sample survey of farmers and corn traders, and through application of the autoregressive conditional heteroskedasticity (ARCH) model to time-series data of regional corn markets. Results of the 1990 IFPRI survey of 958 sample respondents, consisting of 840 corn farmers and 118 corn traders, provide the background information on the distribution of corn in the Philippines and the basis for the formulation of the ARCH model estimated. Survey findings disclose the presence of several constraints that could impede the efficiency of arbitrage in the local formation of corn prices in the Philippines.

Because Filipino farmers are small, semisubsistence farmers with relatively small landholdings, the volume of corn they dispose of at first sale is also small, limiting their ability to take advantage of better market prices. High costs of postharvest services further discourage farmers from employing locally available drying spaces and bonded warehouses. Very little drying and storage are done on-farm. Methods of grading and standards are undeveloped, resulting in imprecise market knowledge. Although standards of 14 percent moisture content and 98 percent purity exist, they are rarely enforced. Grading is done arbitrarily, assessed by ocular and "feel" methods. Because of improper on-farm drying and storage practices, the quality of grain sold on-farm is generally substandard. Incentives to supply better-quality corn are apparently small, because farmers are able to dispose of even the "most inferior" grains. Although opportunities to sell to many markets exist, accessibility to more market outlets is limited by considerable farm-to-market distance, poor infrastructure facilities, and inadequate inter- and intraisland transportation. Nevertheless, farmers typically have access to more than one trader and are knowledgeable about prices.

Monthly wholesale prices of yellow corn and white corn in major corn-producing regions—consisting of Cagayan Valley, Central Visayas, Southern Mindanao, and Northern Mindanao—during 1980-88 were used in the ARCH modeling. As the most important commercial port and major market center for corn, Manila was also included as a market. Because the heaviest volume of corn and most agricultural commodities are traded in Manila, it is postulated that the price of corn is first discovered locally in and centered around Manila, and that price changes that occur in Manila are transmitted to the other regions with lags. Statistical tests confirm the radial market configuration for Philippine corn, with Manila leading the pricing process and the other regional markets following Manila. Because of the dominance of Manila as the most important commercial market handling the largest volume of corn domestically and internationally traded, shocks from Manila exert a significant and large influence on changes in corn prices in the other regions.

Results indicate that a stable long-run relationship exists among the regional markets and that observed divergences from equilibrium prices, arising from market shocks, are short run and would eventually dissipate in time. Tests of cointegration also disclose that markets situated closer together tend to be better integrated, with estimates of the cointegrating parameters close to unitary, than those located farther apart.

However, estimates of the cross long-run multipliers disclose an imperfect spatial market integration for Philippine corn. These results are consistent with observations obtained from the 1990 IFPRI field survey. Results show that the regional markets take one month or more to respond to new information coming from Manila. Furthermore, periods of price adjustment confirm the findings of cointegration tests that regional markets in close proximity to Manila respond more quickly to shocks originating in Manila than markets situated considerably farther away. The survey results and time-series analysis taken together indicate that market integration is weakened by the presence of structural rigidities.

Findings of the study showing imperfect market integration for Philippine corn indicate that there may be substantial benefits in developing better infrastructure facilities to effectively link production centers to market centers and in improving market knowledge by providing more relevant, accurate, and timely public market information. Marketing costs could be significantly reduced if better roads and marketing facilities were built. Improvements in the methods of collecting and disseminating public market information could result in more transparent prices to all market agents. Better market information services would also enable market agents to read price signals more accurately and promptly, and therefore to make more reliable price forecasts that would aid them in making correct marketing decisions. This analysis does not, however, permit analysis of the relative returns to alternative investments in market infrastructure and services. Extensions of the time-series analysis to test the effect of structural variables such as density and quality of roads and bridges and penetration of extension and market services would help to identify the most productive investments.

2

INTRODUCTION

Prices contain information crucial to maximizing the returns to production and marketing investments. At planting time, a farmer's planting decision depends on expected profits, which invariably hinge on the anticipated prices of the crop or mix of crops that would prevail in the market at the time of sale and on the farmer's interpretation of those prices. A trader, in search of profitable arbitrage, reads and translates price signals in deciding on what crops to buy, where to buy, and when to sell. Apart from guiding production and marketing decisions, prices govern the optimal allocation of resources among competing uses. The accuracy, reliability, and promptness of market information is therefore critical in attaining pricing efficiency.

Market knowledge is particularly important for the Philippines, where attempts to improve publicly supported agricultural market information services have been undertaken in recent years. Yet the dynamics of the exchange of information and its effects on the pricing process are not well understood.

During the past two decades, corn has become a very important crop in the Philippines. It is increasingly used as an ingredient in feed for poultry and livestock in the country, replacing its primary use as human food, a trend expected to continue in the coming years. With the Philippine economy undergoing recovery in the 1990s, the outlook for growth in the corn sector is very optimistic. Expected increases in per capita income are projected to provide the major stimulus in raising domestic consumption of poultry meat, pork, and beef. This income-led demand growth for meat will increase the volume of corn required for animal feeds, which in turn will lead to the rapid expansion of corn production locally. The accelerated growth in the livestock sector is, however, expected to put increased pressure on the existing local marketing system to absorb the higher levels of output and deliver corn to livestock producers efficiently and promptly. Understanding the operation of the existing system of distributing corn domestically and the channels through which corn flows could aid in identifying possible constraints in the efficient movement of corn from its production point, the farm unit, to its consumption points, the urban centers.

Although numerous previous studies have stressed the importance of information in the competitive performance of commodity markets in the Philippines, there has been no study conducted on the economics of market information. Because Philippine agricultural commodity markets beyond the farmgate are oligopsonistic (having few buyers), allegations exist that market knowledge is imperfect (Deomampo 1983; Manuel and Maunahan 1982; Olgado, Abunyawan, and Domingo 1977).

In commodity markets in developed economies, imperfect markets have been found to yield prices that are biased representations of actual supply and demand conditions, and the resulting price relationships among markets are weak. Prices have also been established to be rigid in markets characterized as monopolistic or oligopolistic (Boyd and Brorsen 1986; Bailey and Brorsen 1989; Kinnucan and Forker 1987; Ward 1982). Likewise, price adjustments to newly transmitted information tend to be more sluggish in concentrated markets than in less concentrated ones (Brorsen, Chavas, and Grant 1984; Kardasz and Stollery 1988).

Although similar claims prevail and are widely accepted in the Philippines, they have not been supported empirically. Perceived to exploit or take advantage of farmers, middlemen are generally distrusted (Deomampo 1983). Erratic price fluctuations have been popularly blamed on the oligopolistic behavior of traders and imperfect market information (Deomampo 1983; Olgado, Abunyawan, and Domingo 1977). In general, traders are perceived to be better informed than farmers, and assertions that opportunities for the knowledgeable to "exploit" the less knowledgeable have been made by numerous researchers (Olgado, Abunyawan, and Domingo 1977; Deomampo 1983; Manuel and Maunahan 1982). These studies argued that asymmetric information, coupled with farmers' heavy reliance on traders for information, provide traders with market power and enable unscrupulous traders to manipulate prices to the disadvantage of the farmers.[1]

Traders tend to possess better bargaining skills than farmers and thus are perceived to be able to maneuver prices to the disadvantage of less-skilled farmers. Additionally, the information advantage possessed by large traders over small traders may permit the former to abate the rigor of competition by deterring new market entrants (Perloff and Rausser 1983). If market knowledge in the Philippines is asymmetric, enabling the better-informed market agents to manipulate prices, observed prices may be inexact representations of true market conditions, and linkages among markets may be poor.

In general, market transactions for Philippine corn have been found to be conducted on-farm, via direct and individual negotiations, bypassing central terminal markets. For this reason, reported prices collected from major market centers may be incorrect, as these markets would tend to be "thin" and the information content of these prices misleading (Hayenga 1979). It has been argued that the common problems of high transportation costs, inadequate postharvest facilities, and undeveloped infrastructures cause poor market performance in the Philippines. In the presence of these frictions, the availability of and access to alternative markets are severely restricted, and the efficiency of transmission of information among markets is impaired, resulting in poorly integrated markets.

The Objectives of the Study

Poor market knowledge and other structural imperfections have been asserted to cause inefficiency in Philippine agricultural markets, but the role of information in pricing, the dynamic process of information transmission between markets in price discovery, and its implications for market efficiency are not well understood. There has been no empirical study that analyzes the lead and lag relationships in the formation of prices among differentiated markets in the Philippines. Even less is known of the impact of newly transmitted information on the pricing process and of the speed with which information is conveyed.

[1]Although these relationships are well established in price levels, they are not as clear in price changes.

The major objective of this study is to determine the dynamics and efficiency of arbitrage activities of market agents in transmitting information in price discovery between markets by investigating the lead and lag relationships among geographic corn markets in the Philippines. The extent to which the communication of information integrates spatial markets is assessed by calculating cross long-run multipliers. Estimates of cross long-run multipliers quantify the size of the impact of newly transmitted information on the formation of corn prices across geographic markets. The speed with which information is conveyed across spatial markets is ascertained using estimates of the period of adjustment.

Knowledge about the lead-lag price relationships among markets could provide a better understanding of the dynamics and efficiency of arbitrage in transmitting information and thereby in integrating spatially differentiated markets. It could be a valuable aid in evaluating the potential of the existing marketing system to provide correct, reliable, and prompt price signals to farmers and traders in making their production and marketing decisions. The identification of leading markets could indicate that information from the market leader is a sensitive and accurate indicator of market equilibrium value. Findings on leads and lags could also reveal the presence of structural rigidities that inhibit the efficient operations of market exchange. Delayed and incomplete transmission of price information could indicate that arbitrage is inefficient in relaying information across markets and in completely integrating markets.

The dynamics and efficiency of spatial arbitrage in integrating corn markets in the Philippines is investigated utilizing the autoregressive conditional heteroskedasticity (ARCH) model. The use of the ARCH allows the correction of two important least squares violations of the homoskedasticity and normality assumptions, typically ignored in classical time-series models such as the vector autoregressive (VAR) models that were employed in previous tests of the market-efficiency hypothesis. In the presence of heteroskedasticity, standard errors tend to be biased upward, increasing the probability of rejecting the null hypothesis when in fact it is true. Standard statistical tests typically used in hypothesis testing tend to be imprecise, rendering inferences in market performance drawn from these tests seriously flawed.

The use of the ARCH model circumvents many of the limitations of previous studies that employed the industrial organization paradigm of market structure, conduct and performance, and the methods of price spread analysis and bivariate price correlations that have been popularly utilized in evaluating market performance in the Philippines. The ARCH model is able to incorporate the dynamics inherent in real market exchanges that these static models are unable to capture and permits the modeling of these market dynamics without imposing a priori restrictions, typically made in structural models, by allowing the regularities in the data to manifest the appropriate lag structure.

3

THE PHILIPPINE CORN ECONOMY AND GOVERNMENT GRAIN POLICIES

The Philippine Economy: A General Overview

The Philippines is located off the southeast coast of Asia. It covers a total land area of 115,831 square miles, about the size of the state of Nevada, twice the size of Bangladesh, and one-tenth the size of India (Figure 1). The country is composed of 7,100 geographically dispersed islands that are divided into three major island groups, namely, Luzon, Visayas, and Mindanao. For administrative purposes, as of 1988, these islands were further subdivided into 13 regions: the National Capital Region (Metropolitan Manila, hereafter referred to simply as Manila); Ilocos Region (Region 1); Cagayan Valley Region (Region 2); Central Luzon Region (Region 3); Southern Tagalog Region (Region 4); Bicol Region (Region 5); Western Visayas Region (Region 6); Central Visayas Region (Region 7); Eastern Visayas Region (Region 8); Western Mindanao Region (Region 9); Northern Mindanao Region (Region 10); Southern Mindanao Region (Region 11); and Central Mindanao Region (Region 12).

An increasingly populous country in Southeast Asia, the Philippines had a population of 60.7 million in 1990 (Table 1), ranking third after Indonesia and Vietnam. The Philippines has one of the highest birth rates in Asia, at an annual growth rate of 3 percent (Agcaoli and Rosegrant 1992).

Of the total population in 1991, nearly two-thirds was in the labor force, which is nearly equally distributed between the urban and rural areas. Approximately 91 percent of the country's labor force was actively employed in 1991.

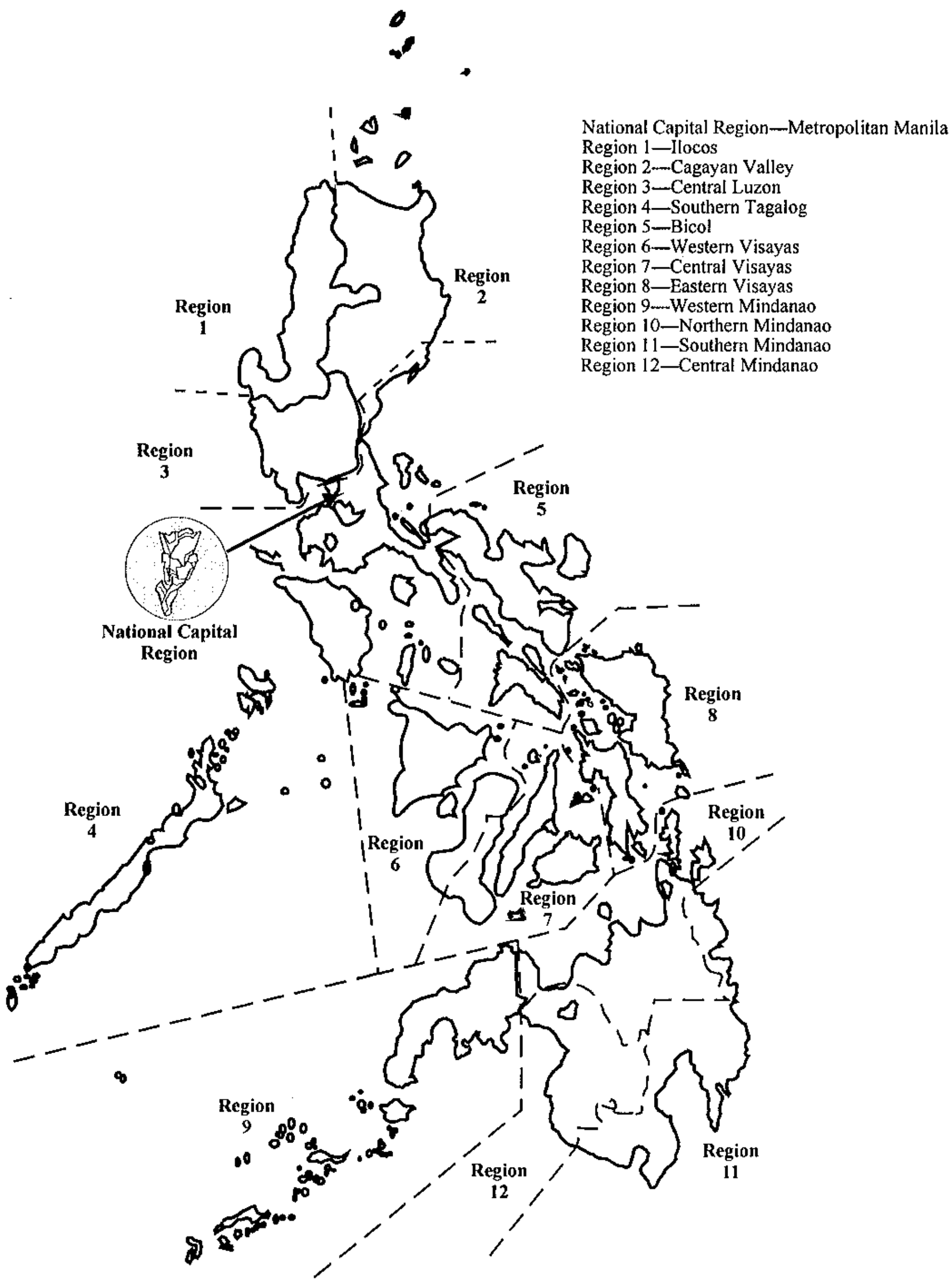
On average, per capita gross national product (GNP) has grown very slowly. Agcaoli and Rosegrant (1992) estimated that per capita GNP increased by only 3.0 percent over the 1965-88 period.

A large portion of family income is still spent on food, as food purchases constitute more than 50 percent of total household expenditures, falling only slightly from 53.8 percent in 1960 (Table 1). Of the total food bill, cereals and cereal preparation still account for the largest portion, though their share dropped from 20.2 percent in 1960 to less than 16 percent in 1991. Although purchases of meat and meat preparations, dairy products, and eggs climbed from 7.9 percent in 1960 to 10.3 in 1985 and held steady until 1991, they did not increase as sharply as the rise in family income.

Importance of Philippine Agriculture

Typical of most developing economies, the Philippines is still predominantly a farming economy. The importance of agriculture in the country's economic growth has, however, diminished over the years. In 1991 agriculture (including fishery and forestry) accounted for about 21 percent of the country's real GNP, down from 30

Figure 1— Regional map of the Philippine Islands



Source: NEDA 1988.

Table 1—Population, employment, and household income and expenditure statistics, selected years

Item	1960	1980	1985	1991
Sociodemographic traits				
Population (millions)	27.1	48.1	54.7	60.7[a]
Employment				
Labor force participation[b]	53.8	59.8	63.4	64.5
Percent employed	93.7	95.0	88.9	91.0
Percent unemployed	6.3	5.0	11.1	9.0
Household economic traits				
Household income (pesos)				
At current prices	1,804	3,736[c]	31,052[d]	40,408[e]
At 1985 constant prices	1,090	3,285	27,310	35,539
Household expenditures (percent)				
All food	53.8	53.7	51.9	50.7
Food consumed at home	51.6	51.0	48.8	47.3
Cereals and cereal preparation	20.2	19.6	18.5	15.9
Meat, meat preparations, dairy products, and eggs	7.9	9.7	10.3	10.3
Food consumed away from home	2.3	2.7	3.1	3.4
Nonfood[f]	46.2	46.3	48.1	49.3

Source: NEDA 1970, 1988, and 1992.
[a]This is the population as of May 1, 1990.
[b]This includes household members 15 years of age and over. Figures are based on the October rounds in each of the selected years of the Labor Force Survey of the Integrated Survey of Households.
[c]This figure is based on total family income of P 23.7 million of 6,347 families included in the 1971 Family Income and Expenditures Survey (FIES) of the National Statistics Office (NSO).
[d]This figure is based on total family income of P 305.8 million of 9,847 families included in the 1988 FIES survey of the NSO.
[e]This is an estimate for 1988, based on total family income of P 425.7 million of 10,533 families included in the 1988 FIES survey of the NSO.
[f]This includes expenditures on alcoholic beverages, tobacco, housing, fuel, light and water, household furnishings and equipment, clothing, footwear and other wear, personal care and effects, medical care, transportation and communication, recreation, education, taxes, special occasions, and others.

percent in 1960 (Table 2). Although the share of farming in total active labor declined from 61 percent in 1960 to 45.3 percent in 1991, agriculture remains the country's largest employer.

Dependence on agriculture as a major source of dollar earnings has also declined dramatically over the years. Earnings from agricultural sales abroad plummeted from 86.8 percent in 1960 to 15.8 percent in 1991. Agricultural crops constitute the bulk of total exports, accounting for over 75 percent during the last 30 years. Depressed world prices of traditional principal exports, including copra, sugar, and coconut oil, are the underlying factors behind the sharp drop in the share of agriculture in total dollar reserves. As income generated from sales abroad plunged, less was spent on agricultural imports, as indicated by the value of imports eroding from 15.9 percent in 1960 to 6.3 percent in 1991.

The Corn Economy: Importance to Philippine Agriculture

Philippine agriculture is heavily dependent on the production of four crops, rice, corn, sugarcane, and coconut, which accounted for approximately 80 percent of total agricultural area harvested and 60 percent of total crop production in 1991 (NEDA

Table 2—The role of agriculture in the Philippine economy, selected years

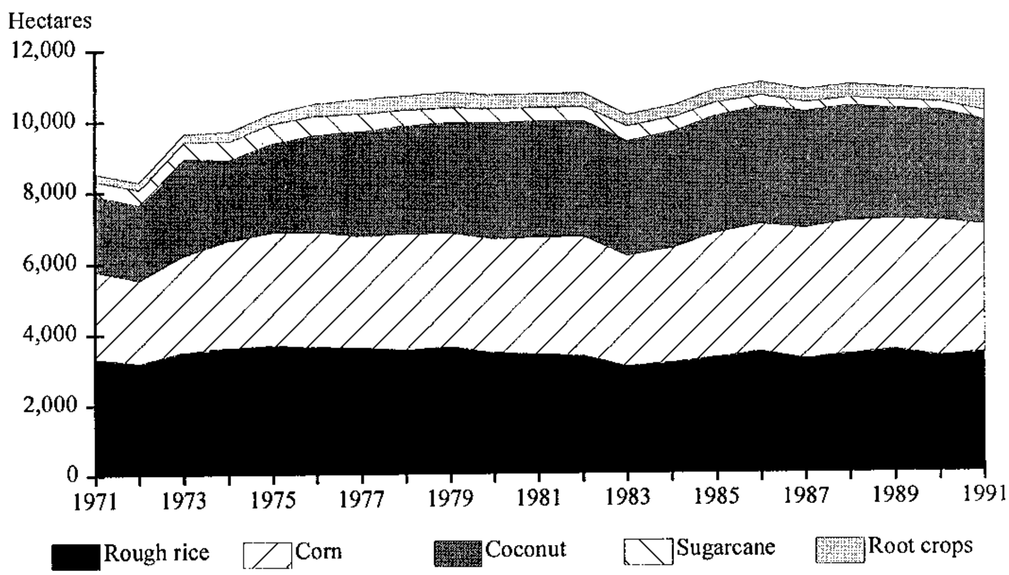
Year	Share of Agriculture				
	GNP	Employment	Volume of Exports[a]	Export Earnings[a]	Value of Imports[b]
			(percent)		
1960	30.0	61.1	89.2	86.8	15.9
1970	26.9	50.4[c]	75.9	59.6	10.7
1980	25.8	51.4	77.9	42.5	18.0
1985	25.3	48.9	84.9	28.2	7.3
1991	20.9	45.3	83.3	15.8	6.3

Source: NEDA 1970, 1988, and 1992.
[a]Figures include traditionally exported commodities, namely, copra, sugar, coconut oil, desiccated coconut, banana, logs and lumber, pineapple, and abaca, and exclude gold and copper concentrates.
[b]Before 1980, estimates include costs of importing consumer goods consisting of meat and meat preparations, dairy products, fish and fish preparations, fruits and vegetables, and other consumer goods. In the 1992 Philippine *Statistical Yearbook*, imports categorized as consumer goods, and capital goods and raw materials, were reclassified broadly into producer goods, including machinery, and equipment, unprocessed raw materials, semiprocessed raw materials, and supplies consisting of durables and nondurables. Estimates for 1985 and 1991 are only for nondurable consumer goods.
[c]This figure is an estimate for 1971.

1992). Of these major crops, rice and corn are the chief cereal grains, with sugarcane and coconut constituting the country's main agricultural crop exports.

Of the agricultural commodities grown in the Philippines, corn is the second most important grain crop after rice. Historically, rice was harvested in more agricultural lands than corn or any other crop (Figure 2). Since 1985, however, the largest

Figure 2—Harvested area of major crops, 1971-91



Source: NEDA 1992.
Note: 1991 figures are preliminary estimates only.

agricultural area has been in corn, and in 1991 harvested corn area accounted for 31.8 percent of total area (up from 25.1 percent in 1972). Rice area harvested declined from 32.6 percent in 1972 to 27.5 percent in 1991 (Table 3). The shift of more agricultural land to corn has the most pronounced effect on sugarcane. Because sugarcane competes with corn for land, the share of harvested sugarcane area dropped by more than half, from 4.2 percent in 1972 to 1.9 percent in 1991.

Of the agricultural commodities domestically grown, the share of rice in total production has been the largest of all agricultural crops (Figure 3). In 1987, rice production accounted for 27 percent of total crop production, a decrease from 31 percent in 1972 (Table 3). Over this period, the share of rice was more than twice as much as that of corn in 1991. On the other hand, the share of coconut production in total crop production declined slightly from 12 percent in 1972 to 10 percent in 1987. This may be partly due to the rapidly declining productivity of overmature coconut-bearing trees. Similarly, sugarcane experienced a slackening in production growth.

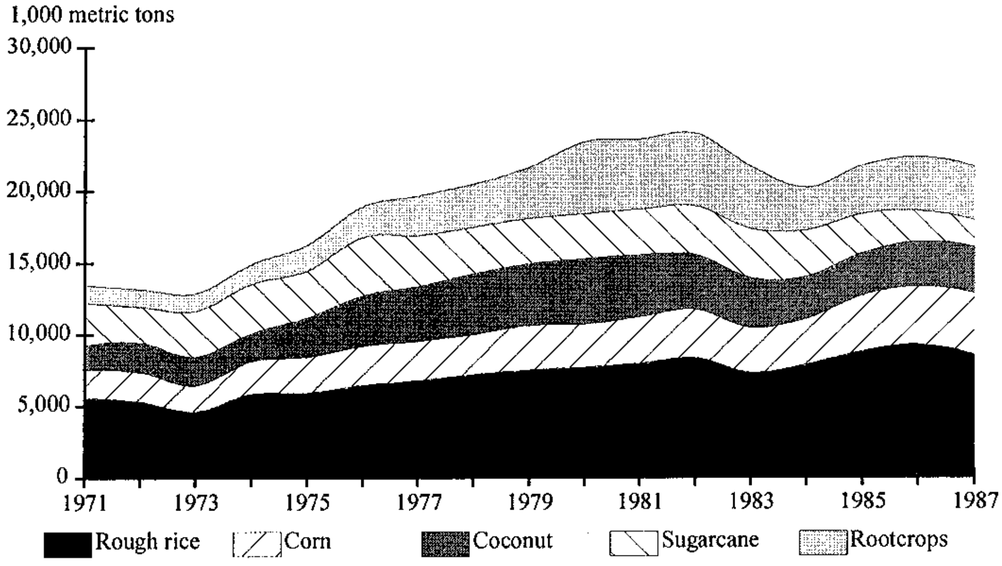
As also shown in Table 3, the largest portion of the total real gross value added in agriculture is ascribed to rice, though its share has deteriorated rapidly, from 24.2 percent in 1972 to 20.9 percent in 1991. Despite the decrease in its relative share, the contribution of rice to real gross value added in agriculture still surpasses that of corn, sugarcane, coconut, livestock, and poultry. Corn accounted for 8.6 percent in 1991, representing only a slight decline from the 8.9 percent share in 1972. From 10.2

Table 3—Importance of major crops and livestock to the Philippines, selected years

Item	1972	1980	1985	1991
Harvested area (1,000 hectares)[a]				
Rice	3,332 (32.6)	3,471 (29.2)	3,306 (27.5)	3,319 (27.5)
Corn	2,454 (25.1)	3,199 (26.9)	3,511 (29.2)	3,820 (31.8)
Coconut	2,126 (21.7)	3,277 (27.7)	3,310 (27.5)	3,112 (25.9)
Sugarcane	420 (4.2)	402 (3.4)	369 (3.1)	235 (1.9)
Production (1,000 metric tons)[b]				
Rice	5,100 (31.0)	7,646 (24.0)	8,806 (28.5)	8,539 (27.0)
Corn	2,013 (12.0)	3,050 (9.5)	3,863 (12.5)	4,278 (13.8)
Coconut	2,040 (12.0)	4,570 (14.2)	2,965 (9.6)	3,262 (10.5)
Sugarcane	2,554 (15.5)	3,120 (9.7)	2,748 (8.9)	1,861 (6.0)
Gross value added (million pesos)[c]				
Rice	2,767 (24.2)	19,405 (18.8)	22,476 (21.5)	25,821 (20.9)
Corn	1,019 (8.9)	7,855 (7.6)	9,491 (9.0)	10,567 (8.6)
Coconut	1,162 (10.2)	11,956 (11.5)	11,307 (10.8)	6,782 (5.5)
Sugarcane	1,070 (9.4)	5,184 (5.0)	3,791 (3.6)	4,141 (3.4)
Livestock	1,766 (15.4)	9,748 (9.4)	10,972 (10.5)	17,043 (13.8)
Poultry	728 (6.4)	6,910 (6.6)	6,771 (6.5)	12,467 (10.1)

Sources: NEDA, various years; calculation of harvested area is based on Gonzales, Dimaranan, and Manzo 1992, 21.
Note: Figures in parentheses are percentages.
[a]The percentage is calculated as the share of harvested area of each crop in total area harvested. Figures in 1991 column are for 1990 only.
[b]The percentage is calculated as the share of production of each crop in total agricultural production; the figures may not add up to 100 percent because banana, root crops, fruits, vegetables, and other crops are excluded. Figures in 1991 column are for 1987 only. Changes in reporting of production statistics in the 1992 Philippine *Statistical Yearbook* cannot be reconciled with previously published statistics and therefore are not included.
[c]Gross value added in agriculture is in millions of pesos at 1985 constant prices. The percentage is calculated as the share of gross value added of each crop in agricultural crops, including paddy rice, corn, coconut and copra, livestock, and poultry.

Figure 3—Total production of major crops, 1971-87



Source: NEDA 1988.
Note: Figures for 1981-87 in the 1992 Philippine *Statistical Yearbook* cannot be reconciled with those available in the 1988 Philippine *Statistical Yearbook*. Therefore, the production figures were not updated to 1991.

percent in 1972, the contribution of coconut fell to 5.5 percent in 1991, while the share of sugarcane declined from 9.4 percent to 3.4 percent, and livestock from 15.4 percent to 13.8 percent over the same years. Only the poultry sector exhibited an increase in share from 6.4 percent to 10.1 percent during the same period.

Growth in the agricultural crops sector is expected to come from corn (Table 4). Of the major agricultural commodities in the country, corn enjoyed the largest growth in real gross value added in agriculture during 1970-91, an average annual growth rate of 3.94 percent, exceeding that of rice, which was 3.3 percent for the same period. The real gross value added of livestock registered an annual increase of 2.35 percent, and poultry an annual 10.53 percent during 1970-91.

Trends in Corn Production and Area Harvested

Harvested corn area has been expanding since the 1970s, increasing at an annual rate of 1.48 percent over the 1973/74-1988/89 crop year (Table 5). Although total corn area continued to grow during that period, the size of corn farms in the Philippines remained relatively small, about 2.6 hectares on average (NEDA 1988).[2]

Yellow and white corn are the two varieties of corn popularly grown in the Philippines. The growth in corn area, however, came largely from yellow corn, which

[2]In comparison, paddy rice farms are 2.33 hectares on average. Tobacco farms average 1.5 hectares; coconut farms, 4.0 hectares; abaca farms, 3.76 hectares; poultry and livestock farms, 4.3 hectares; and sugarcane farms, 9.0 hectares (NEDA 1988).

Table 4—Trends in growth of real gross value added of major commodities as share of total agriculture, 1972-91

Commodity	1970-75	1976-80	1981-85	1986-91	1970-91
			(percent)		
Agricultural crops					
Rice	3.58	4.51	1.21	2.65	3.30
Corn	6.45	3.27	2.24	1.68	3.94
Coconut	3.05	−2.24	−2.71	−8.19	2.24
Sugarcane	5.56	−4.15	−10.90	5.32	−2.24
Banana	−5.56	16.77	5.08	−7.52	1.15
Other crops	15.92	9.86	3.22	4.54	7.38
Livestock	0.62	1.99	2.58	6.33	2.35
Poultry	5.28	14.08	7.45	13.31	10.53
Fishery	3.62	3.72	1.54	0.68	3.07
Forestry	−6.77	−2.19	−14.35	−13.91	−8.21
Total agriculture, forestry, and fishery	4.32	4.59	1.31	2.34	3.96

Source: NEDA, various years.
Notes: Estimates for 1970-75 are from NEDA 1983; figures for 1976-87 are from NEDA 1988; and figures for 1988-91 are from NEDA 1992. Estimates for 1970-87 were based on 1972 constant prices and figures for 1988-91 on 1985 constant prices. For consistency, 1988-91 figures at 1985 constant prices were converted to 1972 constant prices by splicing.

grew at an average rate of 8.83 percent yearly over 1973/74-1988/89 (Table 5). Due to the sustained growth in yellow corn, the relative share of harvested area of yellow corn rose from 10 percent in 1974 to 27 percent in 1991 (BAS 1990). White corn area showed a meager increase of 0.05 percent per year during 1973/74-1988/89.

Domestic production of corn increased at more than 4 percent a year during 1973/74-1988/89 (Table 5). Although the growth in corn production may be attributed to more land having been brought into growing corn, improvements in yields arising from the adoption of improved open-pollinated and hybrid corn varieties provided the major stimulus. On average, the annual growth rate of corn yields was 2.51 percent during 1973/74-1988/89. Most of that growth came from yellow corn, which increased at 5.92 percent annually, compared with 1.57 percent for white corn.

Table 5—Trends in growth of corn production and area harvested, by type of corn, 1973/74-1988/89

Crop Year	White Corn			Yellow Corn			All Corn		
	Production	Area	Yield	Production	Area	Yield	Production	Area	Yield
					(percent)				
1973/74-1981/82	3.21	0.83	2.41	12.90	8.61	3.94	4.31	1.79	2.44
1981/82-1988/89	1.99	0.39	1.59	16.48	9.97	6.11	5.62	2.35	3.23
1973/74-1988/89	1.57	0.05	1.57	15.28	8.83	5.92	4.04	1.48	2.51

Source: BAS 1990.
Note: Growth rates were calculated using the mathematical formula $y = e^{bt}$, where the base of the natural logarithm, e, is approximately equal to 2.71828, y is production and area harvested, t is year, and b is the estimated growth rate.

Compared with other countries in Southeast Asia, however, the Philippine national average yield of 1.2 metric tons per hectare is the lowest.[3]

Uses of Corn and Trends in Growth of Corn Uses

Corn has two major uses: human food and animal feed. As a cheaper source of calories than rice, corn is eaten by approximately 20 percent of Filipinos, most of them concentrated in the Visayas and Mindanao regions. The most recently available statistics reveal that rural Filipinos consumed nearly 10 kilograms of corn per person in 1987, more than twice the 4.30 kilograms eaten by urban Filipinos (Bouis 1992). Corn purchases account for only 0.01 percent of the food budget in urban households and 0.24 in rural households.

Corn is an excellent energy source in the production of hogs, cattle, and poultry feed because of its high metabolizable energy content and crude protein content. Corn accounts for 35 percent and 30 percent, respectively, of the total cost of hog and poultry feed mix (Rosegrant et al. 1987). Setboonsarng and Rosegrant (1992) estimated that corn production in the Philippines is 30 percent higher than in Thailand, and the cost of moving corn from the farm to retail in the Philippines is about 70 percent higher than in Thailand. The high costs of producing and distributing corn, together with barriers to the importation of corn, explain the high prices of locally available feeds.

The demand for corn as food and feed has undergone some major transformations. Over the years, more and more corn has been used in feed manufacturing, displacing its primary use as human food. The relative share of corn used in the manufacturing of poultry and livestock feed increased to 67 percent in 1989 from 60 percent in 1978. Corn consumed as food accounted for almost 27 percent of domestically available corn supply in 1989, down from 33 percent in 1978. The relative share of nonfood corn uses, excluding wastage and seeds, remained relatively stable at 5.0 percent in 1978 and 4.5 percent in 1989 (Figure 4).

The major impetus in growth in yellow corn stems from the development in the country's poultry and livestock sectors during the 1970s. Between 1971 and 1989, total production of pork meat rose at an annual rate of 3.30 percent (Table 6). Improvements in pork production came largely from a vibrant commercial hog sector, which grew annually at the rate of 5.54 percent during 1971-89. Small-scale backyard hog-raising rose by 3.23 annually in the same period.

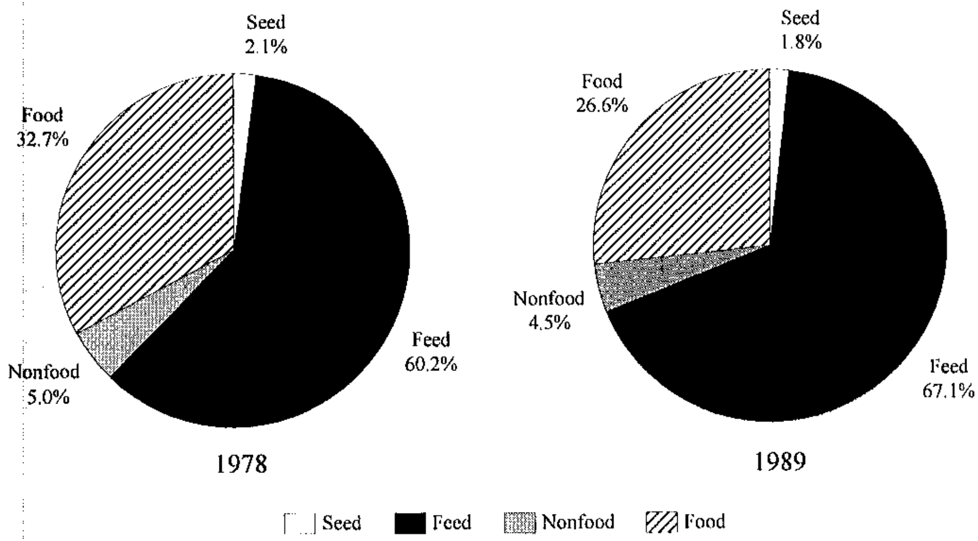
Total production of poultry meat has likewise grown, expanding at 4.99 percent per year during 1971-89. The boost in poultry production also came from substantial growth in the commercial sector, which displayed a remarkable 14.11 percent yearly increase during this period. Backyard poultry husbandry rose at 1.85 percent per year.

Government Corn Programs and Policies

Due to the increasing importance of corn to the economy and its critical role in the development of the poultry and livestock sector, the Philippine government has vigorously pursued sectoral and economy-wide policies that have directly and indirectly affected the corn industry.

[3]All tons referred to in this report are metric tons.

Figure 4—Share of total corn locally produced, by type of use, 1978 and 1989



Source: BAS 1990.

Price Stabilization Policy and Related Market-Intervention Programs

Price control, via a series of support and ceiling price schemes, has played a major role in regulating the domestic corn sector beginning in the 1970s. The task of administering the local and international marketing of corn is undertaken by the National Food Authority (NFA). Between 1970 and 1990, the government raised its support price for corn grains from 0.24 pesos (P) per kilogram to P 4.50 per kilogram (BAS 1990).

Corn is planted in the beginning of the second quarter of the year, and the government discloses its support price for corn later in the cropping period. The

Table 6—Growth in the pork and poultry sectors, by scale of operation, 1971-89

Item	1971-79	1980-89	1971-89
		(percent)	
Pork meat			
Commercial scale	10.69	0.90	5.54
Backyard scale	4.67	1.93	3.23
Total pork production	5.44	1.37	3.30
Poultry meat			
Commercial scale	5.20	22.14	14.11
Backyard scale	1.18	2.44	1.85
Total poultry production	1.66	7.98	4.99

Source: BAS 1990.
Note: Growth rates were calculated using the mathematical formula $y = e^{bt}$, where the base of the natural logarithm, e, is approximately equal to 2.71828, y is production (in 1,000 head), t is year, and b is the estimated growth rate.

timely release of the government support price is particularly critical in providing accurate price signals to farmers. Price announcements circulated toward the third and the fourth quarters are no longer pertinent, since production decisions have been made and resources committed earlier in the cropping season.

To maintain its domestic price policy, the NFA regulates the local supply of corn by purchasing directly in the open market and managing the disbursement of buffer stocks. It likewise monitors the importation of corn. Overall, these programs are very costly for the already financially strapped Philippine government and are relatively ineffective in stabilizing domestic prices.

Due to the increasing burden on the treasury, the NFA surrendered its monopoly control of the import market in 1985 and opened the foreign market to the private sector. However, the NFA retained its control by regulating the importation of corn via some form of import licensing (Pabuayon 1985). Under the import licensing scheme, the NFA determines the volume of corn imports as the gap between the amount of corn locally produced and the volume required to meet local demand. Then the quantity of corn imported by the NFA, which comes largely from the United States, is allocated among qualified, licensed local corn processors and livestock and poultry raisers. Costs of importation plus a (fixed) service fee are paid to the NFA by the processors and livestock raisers.

Import permits are renewable every 60 days, and the NFA reserves the right to cancel permits any time. The NFA determines the timing of importation, with imports of corn restricted during the lean months of February to May, which presents problems to processors because the corn supply is uncertain at other times of the year. In many instances, processors have complained that the NFA has misused its authority to severely limit corn imports, resulting in local prices rising well above competitive levels (Pabuayon 1985).

Exchange Rate Policy and Taxation

The competitiveness of Philippine corn in the world market has been further reduced by an overvalued peso. The overvaluation of the peso, with a simultaneous artificially supported rise in domestic prices, has heavily taxed agricultural tradables and biased the terms of trade against agriculture.

Tariffs on feed ingredients and mixed feeds, and nontariff barriers such as the import quotas on corn, poultry, and eggs, have resulted in a rapid rise in domestic prices for these commodities. Rosegrant et al. (1992) calculated that the nominal rates of protection for corn, poultry, and eggs have amounted to 40-50 percent in recent years.

Transportation Policy

Insular in nature, the distribution system in the Philippines is highly dependent on interisland shipping. Interisland transportation is regulated through tariffs on the importation of replacement parts and restriction of shipping routes.

Most of the cargo vessels for interisland transportation are very old. Because of the high cost of acquiring new vessels and purchasing replacement parts, in addition to high interest on credit, local shipping companies have no immediate plans to replace old vessels, which are increasingly unreliable due to frequent breakdowns.

The regulation of interisland shipping and port facilities has fostered monopolization of these services by only a few firms and increased the costs of shipping cargoes between islands (Rosegrant et al. 1992). This has restricted the domestic flow of corn and distorted domestic corn prices.

The recent elevation of corn from the lowest-priority cargo classification to Class C cargo category and other shipping reform policies are, however, expected to alleviate the ailing condition of the Philippine shipping industry.

Public Market Information Services and Transparency of Prices

For two decades after the inception in 1957 of the Bureau of Agricultural Economics (BAEcon), now the Bureau of Agricultural Statistics (BAS), price information was collected primarily for monitoring the government's price-control schemes. Created under the Department of Agriculture, the BAS has redirected its public information services to benefit the Filipino farmers.

Large budget cutbacks in the 1980s resulted in several changes within the BAS. The frequency of reporting of wholesale and retail prices was reduced from daily to three times weekly beginning in 1980. Because of a smaller number of personnel available for conducting the farm and market survey, fewer agricultural commodities from a narrower pool of samples are currently covered.

The revised *Farm Prices Survey Manual of Operations* (BAS 1987) outlines methods of collecting and disseminating public market information in the Philippines to ensure more reliable market news to a greater number of farmers. A four-stage stratified sampling procedure is currently used by the BAS in gathering prices received by farmers to secure more representative samples of prevailing market conditions. This replaced the customary random sampling previously employed in data collection. Because more realistic product grades are defined in collecting and reporting prices, price quotations relayed about the commodities traded are more accurate and more pertinent in pricing. Opportunities for price manipulation and errors in pricing are also substantially reduced. Through extensive use of locally available print and audiovisual media, the BAS provides price information services that are more accessible and ensures that information is delivered more promptly than in earlier years to many farmers located in the hinterlands.

4

CORN MARKETING AND THE PRICING PROCESS

The structure of the corn farming and marketing system in the Philippines will be discussed in this chapter. Possible constraints on attainment of self-sufficiency in domestic production of corn and the efficiency of existing markets in moving anticipated increases in corn production across markets are presented. The dynamics of the price formation process for corn and factors that influence local pricing are discussed, and bottlenecks to the potential of local markets to provide correct, reliable, and prompt price signals to market participants are identified.

The discussion draws heavily from a field survey of randomly selected samples of corn farmers and traders in major corn-producing provinces in selected regions in the Philippines, conducted by the International Food Policy Research Institute (IFPRI) from March 1990 to July 1990. Information on general sociodemographic characteristics, production, marketing, and pricing aspects of corn farming are from this corn/livestock survey. Appendix 1 describes the sampling framework used and representative samples included in the survey.

Results of the survey in the five selected sample provinces in three major corn-producing regions are presented here: Isabela and Nueva Viscaya in Cagayan Valley (Region 2); Bukidnon in Northern Mindanao (Region 10); and Davao and South Cotabato in Southern Mindanao (Region 11). Survey findings for traders are from the primary information collected in the four provinces of Isabela, Bukidnon, Davao, and South Cotabato, excluding Nueva Viscaya, where no traders were present during the period of the survey.

Structure of Corn Farms and the Corn-Production System

Corn-growing is most suitable in upland conditions with well-drained sandy loam or clay loam soil in flat to slightly rolling topography and in areas where rainfall is distributed evenly throughout the year. Although corn can be planted in most farms in the countryside, the agroclimatic conditions in the Visayas and Mindanao regions are best-suited for growing corn.

Sociodemographic Profile of Filipino Corn Farmers

On average, a typical Filipino corn household consists of six members (Table 7). Most Filipino farmers interviewed have been engaged in corn farming for an average of 19 years. Among provincial samples, Bukidnon farmers have been in corn farming the longest, 26 years, while farmer respondents from Davao, Isabela, Nueva Viscaya, and South Cotabato have been growing corn for 16-18 years.

Table 7—General characteristics of corn-farmer respondents in five selected major corn provinces

Item	Bukidnon	Davao	Isabela	Nueva Viscaya	South Cotabato	Total
	Sample Provinces					
Size of household (persons)	6	6	5	6	6	6
Years in farming	26	16	16	18	17	19
Farm size (hectares)	5.82	2.82	2.29	3.30	2.90	3.37
	(percent of farmers reporting)					
Tenure status						
Owner	58	50	57	57	53	55
Tenant	24	50	48	28	33	32
Others	18	. . .	11	3	11	12
Total	100	100	100	100	100	100
	(number of farmers reporting)					
Involvement in nonfarm activity						
Involved	65 (40)	29 (100)	50 (20)	63 (22)	21 (33)	228 (29)
Not involved	95 (60)	. . . . . .	198 (80)	229 (78)	43 (67)	565 (71)
Total number reporting	160 (100)	29 (100)	248 (100)	292 (100)	64 (100)	793 (100)
Purpose of growing crops other than corn						
Home consumption	110 (62)	1 (11)	91 (56)	37 (24)	32 (76)	271 (50)
Commercial sale	42 (24)	7 (78)	38 (23)	47 (31)	2 (5)	136 (25)
Both home consumption and commercial sale	26 (14)	1 (11)	34 (21)	70 (45)	9 (19)	140 (25)
Total number reporting	178 (100)	9 (100)	163 (100)	154 (100)	43 (100)	547 (100)
Involvement in livestock raising						
Involved	161 (100)	17 (100)	276 (99)	249 (96)	64 (100)	767 (98)
Not involved	. . . . . .	. . . . . .	2 (1)	10 (4)	. . . . . .	12 (2)
Total number reporting	161 (100)	17 (100)	278 (100)	259 (100)	64 (100)	779 (100)
Purpose of raising livestock						
Home consumption	53 (49)	4 (40)	56 (33)	47 (31)	6 (33)	166 (36)
Commercial sale	25 (23)	6 (60)	49 (28)	41 (27)	4 (22)	125 (27)
Both home consumption and commercial sale	30 (28)	. . . . . .	67 (39)	66 (42)	8 (45)	171 (37)
Total number reporting	108 (100)	10 (100)	172 (100)	154 (100)	18 (100)	462 (100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: The figures in parentheses are the percentage of total farmers reporting. Leaders (. . .) indicate no farmers reporting.

Filipino corn farmers are predominantly small, semisubsistence farmers. Results of the survey showed that sample corn farmers in Isabela, Nueva Viscaya, Davao, and South Cotabato cultivate about 3 hectares, on average. Bukidnon farmers grow corn on relatively larger farms, nearly 6 hectares.

About 55 percent of corn farmers own the land they till. Of the remaining sample farmers, 32 percent are tenants, and 12 percent are in other forms of tenure arrangements (Table 7). These other arrangements, as cited by the farmers, include sharecropping, landownership obtained through certificates of land transfer, and inheritance.

Corn farming is the primary source of livelihood for most rural farmers. Only 26 percent reported employment in nonfarm activities. Planting crops other than corn, which are largely used for home consumption, is common. About half of the farmer respondents indicated that they grow root crops and vegetables in the backyard for food use.

Many corn farmers also are engaged in animal husbandry. About 98 percent of the sample corn farmers raise livestock and poultry, although this is predominantly on a small-scale basis. Across sample provinces, the average number of hogs raised per farmer is 2.4; cattle, 2.8; and poultry, 17.7. Livestock and poultry are produced for both home use and commercial sale.

Production and Harvesting

As reported by over half of the sample corn farmers, corn is commonly grown twice a year (Table 8). Less than 40 percent of the farmers in the survey planted corn only once a year, and only 7 percent indicated planting corn three times a year.

The relatively small size of corn farmholdings, growing scarcity of frontier lands for cultivation, and rising land rents strongly suggest that the increments in corn production required to sustain the projected rise in corn demand will have to come from either increased intensity in cultivation or shifts in land use. Both solutions hinge on a price-incentive package attractive enough for corn farmers to modify current production practices.

Table 8—Production and related farm characteristics of corn-farmer respondents in five selected major corn provinces

Item	Sample Provinces										Total	
	Bukidnon		Davao		Isabela		Nueva Viscaya		South Cotabato			
	(number of farmers reporting)											
Number of croppings												
One	36	(20)	2	(10)	234	(79)	22	(42)	29	(10)	323	(39)
Two	144	(80)	18	(86)	46	(16)	24	(46)	210	(75)	442	(54)
Three	1	a	1	(4)	15	(5)	6	(12)	40	(15)	63	(7)
Total number reporting	181	(100)	21	(100)	295	(100)	52	(100)	279	(100)	828	(100)
Planting season[b]												
First quarter	60	(18)	27	(53)	11	(2)	112	(17)	6	(4)	216	(12)
Second quarter	103	(31)	3	(6)	297	(49)	202	(30)	78	(49)	683	(37)
Third quarter	141	(42)	18	(35)	11	(2)	272	(40)	...	...	442	(24)
Fourth quarter	29	(9)	3	(6)	287	(47)	88	(13)	74	(47)	481	(27)
Total number reporting	333	(100)	51	(100)	606	(100)	674	(100)	158	(100)	1,822	(100)
Harvesting season[b]												
First quarter	49	(15)	2	(6)	224	(37)	88	(13)	53	(32)	416	(23)
Second quarter	23	(7)	9	(27)	80	(13)	92	(14)	29	(18)	233	(13)
Third quarter	133	(41)	4	(12)	269	(44)	222	(33)	76	(46)	704	(39)
Fourth quarter	122	(37)	18	(55)	34	(6)	267	(40)	6	(4)	447	(25)
Total number reporting	327	(100)	33	(100)	607	(100)	669	(100)	164	(100)	1,800	(100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.

Notes: Figures in parentheses are the percentage of total sample corn farmers reporting. Leaders (. . .) indicate no farmers reporting.

[a]Less than 1 percent.

[b]Because of multiple responses, totals may not add up to the total number of samples included in the IFPRI survey.

Production of corn is highly seasonal. Due to pronounced contrasts in agro-climatic conditions and rainfall distributions across regions, there are regional differences in seasonality in corn production. For example, as shown in Table 8, many farmer respondents in the provinces of Bukidnon and Nueva Viscaya plant corn in the second and third quarters, when water is plentiful. In Isabela, many farmers indicated planting corn in the second and fourth quarters, and in Davao, in the first and third.

Most of the corn varieties locally grown are harvested over a six-month period.[4] In Bukidnon and Nueva Viscaya, most of the corn is harvested during the third and fourth quarters. Corn produced in Isabela and South Cotabato is harvested mainly in the first and third quarters. In Davao, corn harvesting is done mainly in the second and fourth quarters.

For corn consumed as food, seasonality in corn production is not critical, as dietary substitutes such as rice and root crops are available year-round. Nor is seasonality a serious concern among backyard livestock and poultry raisers. Alternative feeds such as table scraps, tubers, and other cheap sources may be fed to livestock and chickens.

In contrast, a regular supply of corn all year is crucial for feed millers, large-scale poultry and livestock raisers, and other commercial corn processors who are heavily dependent on corn for economical plant operation. Due to seasonality in corn production and unavailability of reliable and cheaper energy feed substitutes for corn, storage and imports are critical. Adequate availability of storage facilities and proper timing of importation of corn equalize intertemporal variations in supply and demand for corn by allocating and extending the availability of corn, particularly during the lean months of February, March, April, and May.

On-Farm Postharvest Practices

Prior to marketing corn, some postharvest preparation is done by farmers on-farm. The customary postharvest activities of drying, shelling, and storage are described in this section.

Marketable Surplus for Corn

Excluding the volume of corn set aside for home consumption, seed, and feed, the marketable corn surplus sold at the farmgate is moderately small. On average, of the total sample farmers reporting, 67 percent sold 0.30 ton of corn or less to the market and only 19 percent marketed more than 5 tons (Table 9). These findings suggest a large potential for growth in corn production through continued adoption of high-yielding varieties, supplemented with appropriate support-services packages in the form of farm inputs, credit, and adequate marketing services.

On-Farm Differentiation of Corn Grains

Corn is generally sold at first sale[5] as an undifferentiated product. Although some farmer respondents practiced some form of product differentiation, it was done rather

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[4]Popularly grown varieties include San Miguel, white open-pollinated, Pioneer, and Cargill.

[5]The point of first sale refers to the node in the vertical marketing channel where a transaction between a farmer and a local assembler is negotiated.

Table 9—Range of quantity of marketable corn surplus per farm in five selected major corn provinces

Marketable Surplus	Sample Provinces										Total	
	Bukidnon		Davao		Isabela		Nueva Viscaya		South Cotabato			
(metric tons)	(number of farmers reporting)											
≤ 0.30	117	(39)	24	(69)	283	(100)	42	(52)	298	(67)	764	(67)
0.31-5.0	31	(10)	. . .	. . .	. . .	. . .	39	(48)	93	(21)	163	(14)
> 5.1	153	(51)	11	(31)	. . .	. . .	. . .	. . .	53	(12)	217	(19)
Total[a]	301	(100)	35	(100)	283	(100)	81	(100)	444	(100)	1,144	(100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Notes: Leaders (. . .) indicate no farmers reporting. Figures in parentheses are the percentage of total sample corn farmers reporting. Because of numerous occurrences of nonresponses, no relevant averages could be obtained; therefore, the volume of marketable surpluses reported here is expressed in ranges per farm.
[a]Total number reporting may not add up to total number of farmers included in the IFPRI survey due to multiple responses. Frequency counts represent the number of farmers reporting for all cropping seasons.

arbitrarily. Sorting of corn is typically based on quality characteristics that are often unrelated to existing government grades and standards. The required grain standard of 14 percent moisture content and 98 percent purity is rarely followed or strictly enforced because it is difficult to follow. In Cagayan de Oro, for example, corn harvested during the rainy season is sold as "wet corn." Poor-quality corn from South Cotabato is differentiated as "dirty corn" from better-quality corn produced in other areas. Typically, corn is sold by farmers either as green, fresh, and unhusked corn or as dried, shelled corn.

Although government-regulated moisture meters are cheaply available, grading is commonly done by visual inspection or "feel" method. Additionally, no standard weights or measures are used, as these generally differ by type of corn product being sold. For example, green, unhusked corn (young corn) is typically marketed on a per ear basis, although the volume of corn sold in this form is relatively small. Most corn is disposed of in shelled form (grains) and is commonly sold on a per kilogram or per sack basis. A sack of shelled corn is equivalent to 50 kilograms.

Corn Shelling and Drying

Although mechanical dryers are locally available, corn is typically solar-dried. Solar drying of corn is done by tying together several ears of corn by the husk in bunches of five or more and hanging these bunches in makeshift bamboo posts, trees, or clotheslines. Some corn is placed on mats, locally termed *banig*, and then solar-dried on concrete floors adjacent to the farmer's residence, in the farmer's backyard, or on any available publicly owned cement or concrete floors, that is, village halls, basketball courts, or the side streets or public highways, where foreign materials can easily mix with the grains.

Losses due to grain damage from kernel breakage or cracking, largely from passing traffic and improper handling, are reportedly high during drying. Moisture reduction by sun-drying corn on the cob is also generally slower and less efficient than drying corn in shelled form. Due to substandard drying conditions, most of the corn sold on-farm is of poor quality. The monsoon rains during some harvest months also make drying corn cobs even more difficult. Marketing corn as wet corn during the monsoon months is common.

After drying, corn is generally shelled manually, although some farmer respondents indicated that they use rented shellers, which are frequently provided by traders. Family labor is usually employed in corn-drying and the manual shelling of corn. Hired labor is seldom engaged.

Corn Storage

After harvesting, most corn is immediately marketed. Survey results disclosed that only 37 percent (311 farmers) of the total 840 farmer respondents reported storing corn.

Various reasons were cited by farmer respondents for setting aside corn in storage. As shown in Table 10, of the 124 sample farmers reporting in Bukidnon, more than 71 percent (88 farmers) set aside corn for later consumption. In Isabela, 46 percent (49 farmers) stored corn for the purpose of later sale, and more than 50 percent (55 farmers), who are engaged in poultry or hog raising, set aside less than 20 kilograms of corn for feed use. Nearly 50 percent of the South Cotabato farmers stored corn for feed.

On-farm storage is common, although bonded warehouses are locally available. Typically, the basement or other dry portions, such as the kitchen hearth, of the farmer's dwelling are used as storage spaces.

Due to insufficient on-farm storage, the volume of corn stored is generally small, ranging from 2 to 500 kilograms. About 50 kilograms is the modal volume of corn stored. The largest volume stored was 1,000 kilograms, as reported by one respondent who rented space in a commercial warehouse.

Table 10—Volume of corn set aside by corn farmers in five selected major corn provinces, by purpose of storage

	Sample Provinces				
Purpose of Storage	Bukidnon	Davao	Isabela	Nueva Viscaya	South Cotabato
Food consumption (kilograms)[a]	2-200	10-20	2-3	. . .	2-30
Number of farmers reporting	88	5	3	. . .	19
Later sale (kilograms)[a]	5-350	. . .	5-1,000	. . .	10-500
Number of farmers reporting	17	. . .	49	. . .	16
Feed use (kilograms)[b]	1-10	3	1-20	1-21	2-70
Number of farmers reporting	19	1	55	7	32
Range of storage time	1 day-5 months	2 days-4 months	4 days-7 months	1 day-4 months	1 day-5 months
Total number of corn farmers reporting[c]	124 (45)[d]	6 (2)[d]	107 (39)[d]	7 (3)[d]	67 (11)[d]

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Due to a large number of nonreporting sample corn farmers, pertinent averages cannot be calculated. Of the total 840 sample corn farmers interviewed, only 311 reported storing corn. Therefore, figures are expressed as ranges of the volume of corn reported set aside by the farmers. Leaders (. . .) indicate no farmers reporting.
[a]This corn is generally stored in cob form.
[b]This corn is generally stored in shelled form.
[c]The number of farmers reporting that they set aside corn for storage.
[d]Figures in parentheses are the percentage of farmers who reported storing corn in each province to total number, 311.

The period of storage for corn is generally brief. Most of the farmer respondents indicated that they disposed of their corn within two to six days after harvest. The decision by farmers to sell corn immediately seems to be motivated by the need for cash to repay credit and by the high cost or unavailability of local bonded warehouses to store corn.

Because of poor drying conditions and inadequate drying spaces, storing corn over an extended period of time is infeasible, even if desired. Improperly dried corn is highly susceptible to molding and weevil infestation and therefore cannot be stored for a long period. Additionally, good ventilation, which is highly critical for prolonged storage, is often lacking, especially for corn stored in-house.

If properly dried to 14 percent moisture content and kept in well-managed and well-maintained warehouses, corn may be stored from two to three months or even longer. Poor storage conditions can result in losses from molding of improperly dried grains, grain shrinkage, pilferage, and rat and weevil infestation. According to a few farmer respondents, these losses could amount to 5-25 percent.

The Corn Distribution System

Corn marketing in the Philippines is a dynamic and complicated process of interaction among numerous market agents in various channels of the marketing system as corn flows from the farm to consumers in urban market centers. This section reports the various postharvest activities done on-farm prior to marketing corn. The channels through which corn flows and the dynamics of the interaction among market participants in discovering corn as it moves through the markets are described. Factors considered by farmers and traders as important in the pricing process are also discussed.

Market Opportunities for Farmers

Generally, Filipino corn farmers and traders have access to several market outlets. According to 72 percent of farmer respondents, there are about 5 to 10 local traders buying corn within their area, including those located within their villages or from adjacent villages or towns (Table 11). Of these local merchants, farmers contact more than one before deciding to whom to sell, as indicated by 87 percent of the farmer respondents interviewed.

Contact with farmers is generally initiated by traders through several unscheduled farm visits. When asked whether they are approached by traders, 87 percent of the farmers responded that traders come to them, typically around harvest time (Table 12). Only 13 percent of the farmer respondents mentioned that they look for buyers as an initial step in deciding to whom to sell the corn they harvest.

Although farmers seek local corn millers as alternative buyers, very few farmers actually close sales with them. Only about 26 percent of farmer respondents disposed of corn to local millers (Table 13). A reason commonly cited by these respondents is that prices offered by the millers tend to be lower than those tendered by other local traders. Another reason mentioned is that millers enforce stricter standards of grading, preferring to buy corn grains with low moisture content, a requirement that many farmers find difficult to satisfy. In a few reported cases, additional purchases from

Table 11—Number of corn buyers contacted by farmers before their first sale and number of buyers buying and selling in five selected major corn provinces

Item	Bukidnon		Davao		Isabela		Nueva Viscaya		South Cotabato		Total	
	Sample Provinces											
	(number of farmers reporting)											
Number of buyers contacted prior to sale												
1	18	(22)	. . .		8	(7)	. . .		19	(16)	45	(13)
2-4	48	(59)	2	(100)	86	(80)	21	(91)	88	(73)	245	(74)
5-10	16	(19)	. . .		13	(13)	2	(9)	14	(11)	45	(13)
Total number of farmers reporting	82	(100)	2	(100)	107	(100)	23	(100)	121	(100)	335	(100)
Number of buyers in the area												
1	4	(6)	. . .		6	(7)	. . .		7	(7)	17	(6)
2-4	16	(23)	. . .		26	(31)	2	(11)	19	(18)	63	(22)
5-10	50	(71)	2	(100)	53	(62)	17	(89)	80	(75)	202	(72)
Total number of farmers reporting	70	(100)	2	(100)	85	(100)	19	(100)	106	(100)	282	(100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Leaders (. . .) indicate no farmers reporting. Figures in parentheses are the percentage of total sample farmers reporting.

other farmers were unnecessary because many millers had contracts with a specific number of farmers to meet the volume required for milling.

Increasingly important buyers of corn are the *viajeros*, traders from other towns or cities passing through the farm villages on their way to the city. Many of these itinerant traders operate on a full-time basis, driving through several farm villages in large, four-wheel trucks, buying large volumes of corn along the way. Others purchase corn irregularly, buying corn only if transport space allows.

Many of the *viajeros* act as commission agents or brokers for other urban corn buyers or large corn processors, and their presence in farm villages has escalated competition locally. As found by Manalaysay et al. (n.d.), the *viajeros* tend to offer a price higher by P 0.05-P 0.10 per kilogram than those extended by local traders.

Table 12—Methods by which farmers contact traders to sell their corn in five selected major corn provinces

Method	Bukidnon		Davao		Isabela		Nueva Viscaya		South Cotabato		Total	
	Sample Provinces											
	(number of farmers reporting)											
Farmers look for buyers	13	(8)	5	(25)	58	(23)	23	(8)	. . .		99	(13)
Buyers come to farmers	152	(92)	15	(75)	190	(77)	278	(92)	62	(100)	694	(87)
Total number of farmers reporting	165	(100)	20	(100)	248	(100)	301	(100)	62	(100)	793	(100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Leaders (. . .) indicate no farmers reporting. Figures in parentheses are the percentage of total sample farmers reporting.

Table 13—Viability of local corn millers as market outlets for corn farmers in five selected major corn provinces

Easy to Sell to Millers?[a]	Sample Provinces										Total	
	Bukidnon		Davao		Isabela		Nueva Viscaya		South Cotabato			
	(number of farmers reporting)											
No	73	(56)	8	(62)	224	(97)	. . .		127	(60)	432	(74)
Yes	57	(44)	5	(38)	8	(3)	. . .		85	(40)	155	(26)
Total number of farmers reporting	130	(100)	13	(100)	232	(100)	. . .		212	(100)	587	(100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Leaders (. . .) indicate no farmers reporting. Figures in parentheses are the percentage of total sample farmers reporting.
[a]Direct quotation from the farmer questionnaire used in the survey.

Confronted with increased competition, local traders are compelled to match the offering price of the *viajeros* to secure their own market share.

From among the numerous traders, the farmers sell to the trader who extends the highest price bid.[6] However, there are also nonprice factors that are equally considered by the farmers in their choice of traders. Since traders are the chief source of credit for nearly 68 percent of the sample farmers (Table 14), the trader with the best credit package or farm-input deal is most preferred by farmers. A credit offer considered sufficiently appealing by farmers to accept the price bid of a trader would include a noncollateral loan and an extended maturity date or flexible terms of payment. Credit may be in the form of cash or farm inputs, depending on the farmer's preference.

Table 14—Sources of credit used by corn farmers in five selected major corn provinces

Source of Credit	Sample Provinces										Total	
	Bukidnon		Davao		Isabela		Nueva Viscaya		South Cotabato			
	(number of farmers reporting)											
Personal savings	76	(48)	13	(76)	17	(6)	14	(22)	97	(33)	217	(27)
Informal sources[a]	65	(41)	4	(24)	254	(92)	48	(76)	178	(61)	549	(68)
Rural banks	16	(11)	. . .		6	(2)	1	(2)	16	(6)	39	(5)
Total number of farmers reporting	157	(100)	17	(100)	277	(100)	63	(100)	291	(100)	805	(100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Leaders (. . .) indicate no farmers reporting. Figures in parentheses are the percentage of total sample farmers reporting.
[a]Informal sources of credit are mainly traders. Other sources include landowners and relatives.

[6]The closing of a sale transaction by a farmer with the trader who offered the highest bid for his crop is referred to as bid acceptance.

A trader's character or reputation, good standing or leadership, and status within the community are likewise weighed heavily by farmers. Through word of mouth or direct contact with a trader, a farmer forms his subjective assessment of the trader's trustworthiness and good faith. Words about a trader's involvement in unfair pricing, scale tampering, or other fraudulent practices are often sufficient to discourage farmers from dealing with the trader.

Access to Markets

Although there are several traders among whom farmers may peddle their corn, a farmer's choice of traders is narrowed by the accessibility of a trader's buying station from his farm. About 73 percent of the farmer respondents are within 1 to 11 kilometers of the closest market center, 11 percent are situated within 12 to 30 kilometers, and 16 percent are located farther than 31 kilometers away (Table 15). The average farm-to-market distance across sample provinces is 8 kilometers.

There are apparent differences in relative access to market centers across sample provinces. For Bukidnon and South Cotabato farmer respondents, the closest market center is situated 12 kilometers and 10 kilometers away, respectively. Respondents from Isabela, Nueva Viscaya, and Davao are approximately 5-8 kilometers from the nearest market center. Roads between farms and market outlets vary from dirt to concrete. Transportation facilities are also reported to be very poor and infrequent, which could further limit the number of a farmer's market outlets.

A General Profile of the Corn Traders

Of the trader respondents interviewed, 87 percent own and operate their businesses independently, 7 percent are family owned, and 6 percent are corporately owned (Table 16). Most traders buy and sell corn all year round.

Due to the seasonal nature of corn production, however, 89 percent of these traders engage in buying corn on a part-time basis. Most of them supplement their income by trading other agricultural crops such as rice, coffee, and peanuts. Others are involved

Table 15—Accessibility of markets to farmers, measured by farm-to-market distance in five selected major corn provinces

Distance	Sample Provinces					
	Bukidnon	Davao	Isabela	Nueva Viscaya	South Cotabato	Total
(kilometers)	(number of farmers reporting)					
≤ 11	123 (78)	18 (100)	187 (76)	47 (87)	212 (63)	587 (73)
12-30	15 (10)	. . .	49 (20)	6 (13)	15 (5)	85 (11)
≥ 31	19 (12)	. . .	5 (4)	. . .	108 (32)	132 (16)
Total number of farmers reporting	157 (100)	18 (100)	241 (100)	53 (100)	335 (100)	804 (100)
	(kilometers)					
Average distance	12	5	8	7	10	8

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Leaders (. . .) indicate no farmers reporting. Figures in parentheses are the percentage of total sample farmers reporting.

Table 16—General characteristics of sample corn traders in four selected major corn provinces

Item	Sample Provinces								Total	
	Bukidnon		Davao		Isabela		South Cotabato			
	(number of traders reporting)									
Type of business ownership										
Single proprietorship	5	(100)	13	(68)	20	(87)	37	(95)	75	(87)
Family business	...	...	1	(5)	3	(13)	2	(5)	6	(7)
Corporation	...	...	5	(27)	...	...	...	...	5	(6)
Total number of traders reporting	5	(100)	19	(100)	23	(100)	39	(100)	86	(100)
Time involved in buying and selling corn										
Full time	2	(33)	3	(17)	4	(18)	...		9	(11)
Part time	4	(67)	15	(83)	18	(82)	36	(100)	73	(89)
Total number of traders reporting	6	(100)	18	(100)	22	(100)	36	(100)	82	(100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Leaders (. . .) indicate no traders reporting. Figures in parentheses are the percentage of total sample traders reporting.

in the retailing of farm chemicals and fertilizers and general consumer goods and in operating corn mills. Many own and operate moderate-sized transportation facilities as well as drying and storage spaces, which are often rented to fellow traders or farmers. In other instances, some traders practice a profession, such as dentistry or medicine, to augment income derived from corn trading. The buying and selling of corn is the sole source of income of only 11 percent of the trader respondents.

The Vertical Marketing Channels

On-Farm: The Point of First Sale. On-farm, corn is purchased by the village or local traders who dwell within the farming village. Although some act as commission agents or brokers for larger town buyers or wholesalers, these local traders operate on a small basis and tend to limit their procurement operations to the village they reside in.

Most corn sold on-farm is picked up by local traders, either directly from the field immediately after harvest or from the farmer's house if corn was stored. Transport vehicles and labor to haul corn are usually provided by the traders. Due to unavailability or inconvenience of using local transportation to move corn, as well as the high cost of renting public vehicles, farmers seem to prefer this type of arrangement. Only a very small number of farmer respondents delivered corn directly to traders via public transportation vehicles.

Farmers are typically paid by the traders, on the spot. Payment is generally made in cash regardless of whether corn is delivered by the farmers or picked up by traders. In making payments, traders have been known to adjust prices by discounting for transportation costs, handling costs, and other costs they incurred in obtaining corn from the farm. Although it would be useful, pertinent information on the magnitude of the price adjustments and the manner in which they are applied to prices offered by traders to farmers cannot be obtained from the IFPRI survey. Because these discounts are, in general, concealed in many forms, they are not easily verifiable.

The Wholesaler/Assembler Level. Beyond the point of first sale, corn flows through the second level in the vertical distribution channel via wholesalers or assemblers. These second-level corn buyers procure larger volumes of corn than their municipal counterparts and generally have marketing bases located in a nearby town.

In contrast to village traders, wholesalers/assemblers handle a larger volume of corn. Generally based in town, a wholesaler buys corn from two or three villages or towns, as allowed by transportation vehicles, which many wholesalers own.

For most wholesalers, buying corn spans market boundaries where other wholesalers/assemblers from adjacent villages or towns also procure corn. The narrowing and overlapping of market boundaries sharpens competition among the wholesalers/assemblers, and many are forced to operate on a very narrow margin (Quero et al. n.d.).

To offset a further squeeze in margins, the majority of the wholesalers/assemblers (63 percent) interviewed openly admitted to mixing poor-quality and cheaper grains with better-quality and relatively high-priced grains (Table 17). The proportions in which traders blended different qualities of grains cannot be determined from results of the survey.

Extra postharvest services, including drying, cleaning, and storage, are performed by wholesalers/assemblers, and hired labor is commonly employed. The extra drying is done by either solar radiation or mechanical dryers. For small to medium amounts, corn is solar dried, whereas mechanical dryers are rented for large-volume drying and are used particularly during the monsoon months.

This additional drying reduces the moisture content of wet corn purchased from farmers and minimizes grain losses from molding and decay of improperly dried grains, thus extending the storage life of the corn over a longer period of time than farmers can normally do on-farm.

The extra cleaning of grains or straining of foreign matter is done at this level, because according to sample traders, these supplementary services enable them to exact a higher price for better-quality grains. Although it cannot be determined from the survey results, it is conjectured that the economic incentives do not appear adequate to maintain better-quality standards for grains. Because of limited availability of proper drying facilities, well-ventilated storage, and appropriate equipment for filtering grains, poor-quality corn is still sold at the retail level. And even if better-quality grains are preferred by some segments of the market, there could also

Table 17—Number of traders who admitted mixing different qualities of corn in four selected major corn provinces

Do Traders Mix Different Quality Corn?[a]	Sample Provinces: Bukidnon		Davao		Isabela		South Cotabato		Total	
	(number of traders reporting)									
No	7	(30)	6	(40)	13	(56)	12	(29)	38	(37)
Yes	16	(70)	9	(60)	10	(44)	29	(71)	64	(63)
Total number of traders reporting	23	(100)	15	(100)	23	(100)	41	(100)	102	(100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Figures in parentheses are the percentage of total sample traders reporting.
[a]Direct quotation from the trader questionnaire used in the survey.

be sufficient and distinct demand for lower-quality corn in other segments of the urban markets, given appropriate price discounts.

Higher Levels of the Vertical Distribution Channel. From the town wholesalers/assemblers, corn flows to other wholesalers with marketing bases at terminal markets in the urban areas at the provincial or regional levels. Compared with the local wholesalers/assemblers, the provincial and regional wholesalers are fewer and tend to handle sizable volumes of corn. Many have forged contracts with livestock and poultry raisers, feed manufacturers, and other similar corn processors to deliver a specified volume of corn at a designated time. Acting as commission agents or brokers to these major corn users, the provincial and regional wholesalers/assemblers employ a regular number of traders from several corn-producing areas to meet the volume required in their contracts. Periodic contacts with numerous local traders enable the provincial and regional wholesalers/assemblers to extend their buying operations over several provinces or regions. Many, however, maintain primary marketing bases in major cities all over the country, mainly in Manila, Cebu, and Davao.

Provincial and regional corn wholesalers are also better equipped and better financed than their local counterparts. Many own large-sized trucks and several medium-sized vehicles that facilitate the long-distance trips, even to remote localities. Being well financed, they are able to hire numerous local assemblers as commission agents from a wider geographic boundary that often spans more than one island.

Better organized in managing their business, the provincial and regional traders possess their own communication system and are connected to market intelligence centers located all over the country. Via a radio dispatch system or telephone, they are able to periodically monitor prices in major trading centers.

Though more mobile than their local counterparts, the scope of arbitrage activities of the provincial and regional traders is limited by the public transportation system. Because of highly irregular schedules, the buying and selling activities of traders have been confined to areas reachable by public transportation. The high cost of renting has further dissuaded traders from using public vehicles in their buying operations. For these reasons, many traders purchase corn from farms conveniently close to a highway or a major road. Corn from farms situated in more distant locations is seldom sought.

Substandard roads and the poor condition of other physical infrastructure that links market centers to farm centers have likewise confined purchasing operations within narrow and serviceable areas. Thus, the market boundaries at the provincial and regional wholesalers level, like those of their local counterparts, tend to overlap, opening the market to the working of more competitive forces.

The Price Discovery Process for Corn and Market Information

Price discovery refers to the process of interaction among market agents, via various pricing mechanisms, in arriving at a transaction price (Kohls and Uhl 1980).[7] The mechanisms by which commodity prices are discovered are broadly classified

[7] In the marketing literature, price discovery has been used synonymously with price formation, and hereafter these terms are used interchangeably.

into organized exchanges or auction arrangements, private treaty or individual bargaining, administered pricing (government regulation of prices), and formula pricing (Marion 1986). Each of these pricing arrangements has different impacts on pricing behavior and market performance.

In this section, the pricing arrangements for corn in the Philippines and the dynamics by which prices are discovered, via the interaction of Filipino farmers and traders, are described. Sources of market news used in corn pricing and factors affecting the price discovery process are also discussed, and then some implications for the extent of market integration of Philippine corn are drawn.

Sources of Market News

As in other developing economies, market information in the Philippines is typically relayed and transmitted across markets inexpensively, by word of mouth. News about price changes and relevant price-making forces in pertinent terminal markets are generally obtained from informal sources.

As presented in Table 18, 83 percent of the farmer respondents relied on local traders (74 percent) or traders from adjacent towns (9 percent) for market news. Some farmer respondents (14 percent) relied on neighboring farmers for market information. Publicly available market-information services are rarely used. Less than 5 percent of the farmers consulted the print or audio media, prices posted at the National Food Authority (NFA) warehouses, or buying stations for price news. Similarly, traders were also found to use fellow traders from their locality or those from out of town as price sources.

As asserted by many previous researchers (Olgado, Abunyawan, and Domingo 1977; Deomampo 1983; Habito 1983; Manuel and Maunahan 1982, to cite a few), the heavy reliance on informal sources exposes farmers to possible price manipulation and exploitation. There are other factors, however, that limit the possibility of price manipulation. The first is the access of farmers to multiple traders, as noted above.

Table 18—Formal and informal sources of price information used by farmers in five selected major corn provinces

Source	Sample Provinces					
	Bukidnon	Davao	Isabela	Nueva Viscaya	South Cotabato	Total
	(number of farmers reporting)[a]					
Informal						
Local trader	98 (52)	9 (90)	252 (98)	55 (75)	215 (66)	629 (74)
Out-of-town buyer	36 (18)	. . .	. . .	. . .	37 (11)	73 (9)
Other farmers	39 (21)	. . .	1 (b)	16 (25)	61 (19)	117 (14)
Formal						
Print/audio media	13 (7)	1 (10)	3 (2)	. . .	6 (2)	23 (3)
National Food Authority posted price	4 (2)	. . .	. . .	. . .	7 (2)	11 (b)
Total	190 (100)	10 (100)	256 (100)	71 (100)	326 (100)	853 (100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Notes: Leaders (. . .) indicate no farmers reporting. Figures in parentheses are the percentage of total sample farmers reporting.
[a]Multiple responses recorded.
[b]Less than 1 percent.

Table 19—Number of farmers who reported conducting a price search before closing a sales transaction with a particular trader, five selected major corn provinces

Do Farmers Search for "Better" Price Prior to Sale?[a]	Sample Provinces					
	Bukidnon	Davao	Isabela	Nueva Viscaya	South Cotabato	Total
	(number of farmers reporting)					
No	77 (48)	16 (89)	188 (69)	39 (61)	201 (53)	521 (63)
Yes	84 (52)	2 (11)	85 (31)	25 (39)	112 (47)	308 (37)
Total reporting	161 (100)	18 (100)	273 (100)	64 (100)	313 (100)	829 (100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Figures in parentheses are the percentage of total sample farmers reporting.
[a]Direct quotation from the farmer questionnaire used in the survey.

Second is the narrow and overlapping geographic boundaries faced by traders. These factors, coupled with the moderate corn surplus available on-farm, reduce the chances for traders to manipulate prices. The importance of a trader's reputation in forging long-standing and regular business relationships with farmers may also be an effective deterrent to exploitation of the farmers. Knowledge about the market, via regular consultation with other sources, also enables farmers and traders to validate the veracity of the price information they receive from one another.

The frequent and active involvement of farmers and traders in trading also enables them to correctly read and interpret market signals and to translate them into price expectations. Thus, even if 63 percent of the farmer respondents indicated that they had not solicited information from traders other than those who contacted them, it could be surmised that these farmers received price information that converged to competitive levels (Table 19).

Due to their mobility, traders are able to easily conduct a search for markets with a better price, as indicated by about 66 percent of those interviewed (Table 20). Additionally, through their regular monitoring of prices, traders develop a sense of the prevailing conditions in the market and thereby are able to discern whether the

Table 20—Number of traders who reported conducting a price search before selling to other corn buyers, four selected major corn provinces

Do Traders Search for a Better Offering Price Prior to Sale?[a]	Sample Provinces				
	Bukidnon	Davao	Isabela	South Cotabato	Total
	(number of traders reporting)				
No	9 (36)	8 (47)	11 (55)	6 (16)	34 (34)
Yes	16 (64)	9 (53)	9 (45)	31 (84)	65 (66)
Total reporting	25 (100)	17 (100)	20 (100)	37 (100)	99 (100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Figures in parentheses are the percentage of total traders reporting.
[a]Direct quotation from the trader questionnaire used in the survey.

market is active or slow. About 34 percent do not corroborate the price information they obtain from their regular sources.

Market Mechanism for Price Discovery and Factors Affecting Corn Pricing

Generally, corn prices along the vertical channels of the market exchange are settled through private (individual), on-the-spot negotiations between farmers and traders. In negotiating prices, 92 percent of the farmer respondents indicated that prices were set by the traders, and 7 percent reported that they negotiated the price with the traders (Table 21). In the former situation, a trader tendered an offer price readily acceptable to the farmer, while the latter involved bargaining until a price acceptable to both parties was reached. There are no formal rules governing the individual negotiation between farmer and trader.

In establishing corn price, the majority of farmer respondents (79 percent) indicated that the price prevailing in the market is the most important determinant (Table 22). An offer price that nearly equals the market price, given appropriate discounts, is considered an acceptable bid. Although credit obligations with traders and grain quality are considered in pricing, they are of minor importance, as reported by 9 percent and 8 percent, respectively, of sample farmers. Long-standing goodwill relations with traders (or the *suki* system, in the vernacular) established through mutual personal trust over an extended period of time is seen as important by only 2 percent of the farmer respondents. The price of corn posted at NFA-licensed warehouses is considered important by only 1 percent of these respondents, indicating the weakness of formal market information.

Survey results revealed comparable findings for traders. The prevailing market price is regarded as important in corn pricing by 71 percent of trader respondents (Table 23). The quality of grains influenced pricing for 18 percent of the traders. Factors considered of minor importance included historical prices, goodwill relationships, credit obligations, and the NFA posted price.

Table 21— Methods of price setting cited by farmer respondents in five selected major corn provinces

Price Setter	Sample Provinces					
	Bukidnon	Davao	Isabela	Nueva Viscaya	South Cotabato	Total
	(number of farmers reporting)					
Trader	152 (92)	20 (100)	217 (86)	46 (99)	288 (98)	723 (92)
Farmer	1 (1)	... ...	2 (1)	... ...	... ...	3 (1)
Price is negotiated between traders and farmers	13 (7)	... ...	32 (13)	4 (1)	7 (2)	56 (7)
Total number of farmers reporting	166 (100)	20 (100)	251 (100)	50 (100)	295 (100)	782 (100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Leaders (. . .) indicate no response recorded. Figures in parentheses are the percentage of total sample farmers reporting.

Table 22—Factors considered important by farmers in corn pricing in five selected major corn provinces

Factor	Sample Provinces										Total	
	Bukidnon		Davao		Isabela		Nueva Viscaya		South Cotabato			
	(number of farmers reporting)[a]											
Prevailing market price	130	(75)	8	(40)	249	(89)	64	(100)	187	(71)	638	(79)
Grain quality	16	(9)	7	(35)	13	(5)	. . .		27	(10)	63	(8)
Goodwill relations between farmer and traders	10	(6)	3	(15)	. . .		. . .		3	(1)	16	(2)
Outstanding credit obligation of farmer with traders	14	(8)	. . .		17	(6)	. . .		42	(17)	73	(9)
National Food Authority posted price	1	(b)	. . .		1	(b)	. . .		3	(1)	5	(1)
Transportation cost	3	(2)	2	(10)	1	(b)	. . .		3	(1)	9	(1)
Total	174	(100)	20	(100)	281	(100)	64	(100)	265	(100)	804	(100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Notes: Figures in parentheses are the percentage of total sample farmers reporting. Leaders (. . .) indicate no response recorded.
[a]Multiple responses recorded.
[b]Less than 1 percent.

Summary

Findings obtained from the IFPRI survey indicate that information about price changes and price-making forces in relevant trading centers is continuously communicated across markets. This important survey finding suggests that Philippine corn markets are integrated to a certain degree.

Farmers are able to obtain market information rather quickly. Regular contacts with several traders and neighboring farmers enable the farmers to verify the accuracy of information they receive, thereby reducing the opportunities for traders to manipulate prices.

Typically, the price of corn in rural areas of the Philippines is established on-farm via on-the-spot bargaining between farmers and local traders. Although farmers seldom sell directly in terminal markets, the survey findings reveal that the prevailing prices in these markets are heavily considered by both farmer and trader respondents in establishing corn prices. Moisture content and grain purity, long-established goodwill relations and outstanding credit obligations with traders, and the NFA listed price are also important.

The presence of several traders within a narrow and overlapping market boundary of two or three villages or towns suggests that corn pricing is discovered competitively in the Philippines. Results of the survey, however, disclosed the existence of some potential constraints that could hamper the efficient discovery of prices and the perfect integration of the Philippine corn markets. Price information from informal sources, although easily verifiable, could be distorted, as it is transmitted from one market agent to another by word of mouth. Marketing problems relating to poor physical farm-to-market linkages, inadequate and costly postharvest services (including storage

Table 23—Factors considered important by traders in corn pricing in four selected major corn provinces

Factor	Sample Provinces								Total	
	Bukidnon		Davao		Isabela		South Cotabato			
	(number of traders reporting)									
Prevailing price	15	(63)	12	(86)	17	(77)	25	(68)	69	(71)
Past price	. . .		. . .		1	(5)	1	(3)	2	(2)
Grain quality	6	(25)	1	(7)	2	(9)	8	(22)	17	(18)
Goodwill relationship with buyer	. . .		1	(7)	2	(9)	2	(5)	5	(5)
National Food Authority posted price	1	(4)	. . .		. . .		. . .		1	(1)
Credit obligation with buyer	2	(8)	. . .		. . .		1	(3)	3	(3)
Total	24	(100)	14	(100)	22	(100)	37	(100)	97	(100)

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Notes: Leaders (. . .) indicate no traders reporting. Figures in parentheses are the percentage of total sample traders reporting. Numbers may not add to totals because of rounding.

and drying), and insufficient intraisland shipping could impede the rapid and full transmission of information across markets, resulting in poorly integrated markets. Misinformation could likewise result from arbitrary methods employed in product grading and measuring, thus increasing pricing efforts. The application of price discounting to account for costs incurred in transportation, handling, and other pertinent marketing costs may also result in the incomplete transmission of price changes across markets. The hypothesis of market integration for Philippine corn is rigorously tested in Chapter 7.

5

THE GEOGRAPHICAL FLOW OF PHILIPPINE CORN

This chapter describes the spatial movement of corn from major production centers to principal consumption centers. Testable hypotheses are established on the dynamic relationships among the major regional markets in corn pricing and efficiency by which information about price changes is transmitted across regions. The discussion in this chapter provides the essential background for the time-series modeling procedure employed in Chapter 6.[8]

Regional Concentration of Corn Production

Historically, corn farming has been concentrated in the Mindanao islands, which comprise the Southern Mindanao, Northern Mindanao, and Central Mindanao regions. Approximately two-thirds of corn domestically produced is grown in these regions, accounting for two-fifths of total agricultural area harvested (BAS 1990). Other principal corn-producing areas include the Cagayan Valley and Southern Tagalog regions in Luzon, which together account for 17 percent of local corn production and 17 percent of total agricultural area harvested. More than 8 percent of the domestic corn supply and 15 percent of the total harvested area are registered to the Central Visayas region. Altogether, these six regions accounted for more than 80 percent of corn locally produced and 75 percent of total agricultural area harvested in the 1970-89 period.

Geographical Flow of Corn and Hypothesized Spatial Price Relationship

Rosegrant et al. (1987) identified as surplus areas the regions of Ilocos and Cagayan Valley on the island of Luzon; Western Visayas in the Visayas; and the principal corn-producing Mindanao regions. Central Luzon, Southern Tagalog, Bicol, and Manila as well as Central Visayas and Eastern Visayas were identified as deficit areas. Filipino traders, seeking profitable arbitrage, buy corn from the surplus regions, where corn prices are low, and then sell it in terminal markets in deficit regions, where prices are high. Low-price corn produced in the Ilocos and Cagayan Valley regions is moved to the relatively high price Divisoria market, located in Manila, by land transportation via the terminal market in Tuguegarao City. Corn

[8]An excellent discussion of the spatial pricing theory can be found in Faminow and Benson 1990.

from Western Visayas and Western Mindanao en route to its final destination to Manila, and then to other demand areas, is shipped through Cebu City by way of the port in Zamboanga City. Corn harvested from Mindanao passes through General Santos City and Davao City on its way to Cebu City and then to Divisoria. Thus, although corn prices are discovered by the interaction of numerous market agents trading in several satellite markets dispersed all over the country, it is arbitrage in the principal terminal markets in the Southern Tagalog, Cagayan Valley, Central Visayas, Northern Mindanao, Southern Mindanao, and Central Mindanao regions that will exert considerable influence in the local formation of corn price.

Of the many ports in these regions, Manila and Cebu are the most vital commercial ports. The heaviest volume of corn (and agricultural commodities in general) traded domestically and internationally goes through Manila and Cebu. Most of the corn harvested on farms located in Luzon is moved to market centers in Manila. Corn grown in the Visayas and Mindanao regions is transported by means of interisland shipping, via Cebu, to Manila and other shortage areas around the archipelago. Manila and Cebu are also the major ports for unloading of corn originating abroad.

Between Manila and Cebu, however, Manila is expected to exert the most significant influence in discovering corn prices. In negotiating prices in forward contracts with farmers and larger traders at the provincial or municipal levels, Manila prices have been used as reference prices. It is thus postulated that the formation of local corn prices is centered around Manila, meaning that Manila is expected to lead the local formation of corn prices, and after some time lags, prices in Cebu and the other regions will be discovered.

Manila is also the major commercial port for loading and unloading corn and other agricultural products in the country, with Cebu placing second. Of the total volume of domestically traded commodities in 1990, 21 percent went through Manila, 16 percent through Cebu, 7 percent through Iloilo, and 1 percent through Zamboanga. Manila is also the major port for unloading imported goods. In 1990, approximately 33 percent of the total volume of goods purchased from foreign ports was unloaded in Manila, whereas only 5 percent entered the Philippines through the port of Cebu (NEDA 1992). Because the volume of commodities landed in Manila is substantial compared with other ports, Manila is expected to influence the pricing behavior in all the other local markets, while the impact of local markets on corn prices in Manila may not be as significant.

As the center of commerce and government, infrastructure support is more developed in Manila than elsewhere in the country. Facilities for transportation, storage, and related postharvest services are more adequately available in Manila than in other regions. Most of the processing plants of feed millers and livestock and poultry raisers are concentrated in and around Manila. According to estimates of Costales (1989), commercial feed mills in Manila and adjacent provinces accounted for approximately 84 percent of the country's total rated milling capacity in 1987. Furthermore, two-thirds of the 123 feed mills in the country in 1985 were in Luzon, of which 17 were operating in Manila, 22 in Central Luzon, and 42 in Southern Tagalog. Most of these feed millers and livestock and poultry producers likewise have their principal marketing bases situated around Manila, with several buying stations dispersed nationwide. In their study of the corn-marketing system in Southern Mindanao, Manalaysay et al. (n.d.) found that 43 percent of the white and 92 percent of the yellow corn grain produced in General Santos City in 1985-86 was procured by traders with major marketing bases in Manila. Because the volume of their purchases is large, the buying and selling activities of dealers in Manila should exert a sizable effect on domestic corn prices.

Communications and market intelligence are also more developed in Manila than in other areas of the country. In 1990, 68 percent of the nation's telephone communication system was in Manila, and 43 percent of the radio broadcasting stations operating in the same year were located there (NEDA 1992). The main headquarters of the Bureau of Agricultural Statistics (BAS), the nation's public information agency for market news reporting and dissemination, is also situated in Manila. Because of the accessibility of market intelligence, Manila corn traders are able to receive, transmit, and process information more quickly than corn traders from other regions. Therefore, Manila traders are expected to respond to value-relevant information with smaller time lags than their regional counterparts.

As a separate market, the marketing flow of yellow corn, which is largely used for feed processing, differs from that of white corn, which is predominantly used for direct human consumption. Although the production of both yellow corn and white corn is concentrated in the Mindanao regions, trading of white corn is limited to the Mindanao and Visayas regions, where most of the Filipino corn-eating population is located. Very little white corn is sold in the urban centers in northern Luzon. Thus, the market centers in the Visayas and Mindanao regions are anticipated to be better integrated than market centers in the distant markets of Luzon. On the other hand, most of the yellow corn grown in Mindanao flows to Luzon, where the majority of feed millers and poultry and livestock raisers have their plants of operation. Heavily dependent on yellow corn as a major ingredient in processing, most of these feed millers and poultry and livestock raisers purchase large volumes of yellow corn from Mindanao; therefore, Luzon and Mindanao are expected to be better connected.

6

TIME-SERIES MODEL OF SPATIAL MARKET INTEGRATION: PROCEDURES AND METHODOLOGY

The empirical use of time-series modeling is well established in the economics literature and has been widely applied in studies of pricing efficiency in commodity markets in developed economies (Brandt and Bessler 1984 on U.S. hogs; Brorsen 1983 on U.S. rice; Gupta and Mueller 1982 on West German hogs; Boyd and Brorsen 1986 on U.S. and European Community corn gluten and related markets). A bivariate time-series model is employed in analyzing the dynamics and efficiency of information in the spatial integration of Philippine corn markets. The merits of its use for the Philippine case are reviewed in this chapter.

Based on the conceptual framework discussed in Chapter 5, the dynamics of arbitrage activities of Filipino traders discovering corn prices in the large-volume markets of the Manila, Cagayan Valley, Central Visayas, Northern Mindanao, Southern Mindanao, and Central Mindanao regions are highlighted in the time-series model employed for analysis. The postulated spatial price relationships among these regions established in the previous chapter are then rigorously tested utilizing appropriate statistical techniques that are presented in a later section of this chapter.

The representation of corn pricing behavior in spatial markets in the Philippines, using the autoregressive conditional heteroskedasticity (ARCH) model developed by Engle (1982), with refinements, represents an extension of the classical time-series modeling efforts employed in similar previous studies. The motivation of the ARCH modeling exercise is highlighted by exploring the properties of normality and homoskedasticity that have been empirically found to be invalid but are ignored in classical time-series modeling of commodity markets. The ARCH representation of the spatial pricing process in the study exemplifies the dynamics inherent in real market exchange, which static models widely used in studies of market performance in developing countries—such as bivariate spot price correlations and the industrial organization paradigm—are unable to capture.

Motivation for the Time-Series Modeling Effort

A practical appeal of time-series modeling over structural econometric models is the minimal data required in model specification. This is a particularly attractive feature of time-series models in developing countries, where publicly supported information services remain relatively undeveloped. Typically, data on relevant structural variables required in econometric modeling are incomplete and fragmentary, even if available. In the bivariate autoregressive model used for analysis here, readily available and easily obtainable price series from secondary sources are required.

As reduced-form equations, time-series models are parsimonious representations of structural models (Ford 1986; Brorsen 1983).[9] Because they are derived from structural models formulated on the basis of sound economic theory, the specification of time-series models is strongly grounded in theory and is not ad hoc, as many believe. Researchers exercise less subjectivity in the formulation of a time-series model than for a structural econometric model. As economic theory is most often ambiguous about the classification of variables in the formation of expectations by market agents and the explicit dynamic relationships between variables, time-series models reduce the amount of "guesswork" by allowing "every variable in the system to affect every other variable" (Bessler 1984, 111) and permitting the data to specify the dynamics between them. Since market integration is concerned about the behavior of prices across spatially differentiated markets over time, the use of a time-series model in the study is most pertinent.

Time-Series Properties of Price Series

Nonstationarity and Cointegration

Stationarity is a time-series property commonly overlooked in previous work on commodity markets. A stationary series is often inferred by tests of unit roots. Findings of unit roots would imply nonstationarity in the series, indicating that the variances are infinite and thus explode with time, so the series would tend to drift farther and farther apart from equilibrium if shocks are introduced. Ignoring unit roots has serious statistical consequences because it renders conventional least squares estimation procedure invalid and inferences derived from their results highly suspect.

The Concept of Cointegration. Economic variables such as prices, interest rates, and income may drift from their equilibrium levels when stochastic shocks enter the system. Such shocks could arise from policy reforms or structural changes occurring within the market. According to theory, such patterns of divergence from the steady state are only a short-run phenomenon, because economic forces will bring the series back to equilibrium whenever they depart from it.

Ordinarily, stationarity has been imposed by obtaining the first-order differences or, when necessary, higher-order differences in the variable being analyzed. Differencing of any order, however, significantly alters the economic relationships between series.

Tests of cointegration reconcile the presence of unit root in individual series by testing the stationarity of their linear combinations (Granger and Newbold 1974). In simpler terms, cointegration allows the verification of the presence of a long-run equilibrium relationship between nonstationary series, without a priori imposing short-run dynamic behavior, as in Ravallion 1986 and later in Timmer 1987, Heytens 1986, and Webb, von Braun, and Yohannes 1992.

Cointegration tests permit the empirical testing of the persistence of deviations of prices across differentiated markets and are used here. Results of cointegration tests

[9]The mathematical derivation of the relationship between the structural model and the time-series model of pricing behavior in commodity markets can be found in Brorsen 1983.

provide the preliminary groundwork for the further testing of market integration, which is formally tested using the multivariate ARCH model discussed in a later section.

In the study, cointegration tests are conducted between pairs of regional markets for Philippine yellow corn and white corn markets. The procedure for conducting the cointegration tests is discussed in the following section.

The price series used in the analysis as described in this chapter is discussed in detail in Appendix 2.

Cointegrating Regression and Testing. Consider the equilibrium relationship for a vector of prices, P_t, of homogeneously produced commodities across n differentiated markets[10] as $z_t = \sum \alpha_t P_{nt}$, where z_t measures the divergence of prices from the equilibrium level. If z_t equals zero, the market is said to be in a steady state, even if prices in the individual markets are nonstationary, $I(1)$. Markets are cointegrated if $z_t = I(0)$. A non-zero z_t, $z_t = I(1)$ would indicate non-cointegrated markets and that prices deviate from their equilibrium levels.

The estimated bivariate cointegration regression is written mathematically as

$$P_t^k = \beta P_t^j + \mu_t, \tag{1}$$

where

- P_t^k = monthly wholesale prices in rural market k,
- k = 1, 2, 3 during month t, where 1 is Cagayan Valley, 2 is Nothern Mindanao, and 3 is Southern Mindanao,
- P_t^j = monthly wholesale prices in urban market j,
- j = Manila for yellow corn and Central Visayas for white corn, and
- μ_t = magnitude of divergence between the regional prices at each time period t.

For cointegration to exist, it follows from equation (1) that μ_t should be equal to zero. The coefficient, β, is the cointegrating parameter between contemporaneous pairs of prices, which measures the proportionality of the relationship between series.

The null hypothesis of non-cointegration, $I(1)$, was tested separately for pairs of wholesale prices of yellow corn grains and pairs of wholesale prices of white corn grains, using equation (1) against the alternative hypothesis of cointegration, $I(0)$. From equation (1), P^k and P^j would refer to price levels in market k and price levels in market j, respectively, where k is not equal to j.

For yellow corn, the cointegration regression in equation (1) was estimated using Manila, Cagayan Valley, Northern Mindanao, and Southern Mindanao monthly wholesale prices. For white corn, the tests were done for the regions of Cagayan Valley, Northern Mindanao, and Southern Mindanao. Because the price of white corn is not quoted for Manila, the price in Central Visayas, the region with the second most important commercial port of Cebu, was used as a replacement for the missing Manila series.

[10]Although the analysis in this study is on spatially differentiated markets, the concept can be easily applied to markets differentiated by form as in Ardeni 1989 and by time.

The estimation of the cointegrating regression in equation (1) proceeded in two stages. The first stage involved estimating equation (1) for market pairs via ordinary least squares (OLS). In the case of wholesale prices for yellow corn grain, equation (1) was estimated in pairs with Manila as the exogenous variable and Cagayan Valley, Southern Mindanao, and Northern Mindanao prices, in turn, as the endogenous variable. Then equation (1) was again calculated, but with the above relationship reversed. For white corn, equation (1) was estimated for the wholesale price of white corn grain with Central Visayas as the exogenous variable, and wholesale prices in Cagayan Valley, Southern Mindanao, and Northern Mindanao, in turn, as endogenous. Similarly, reestimation on the reverse relationship was conducted.

The second stage of the cointegration test consists of a series of tests on the residuals, obtained from each of the regression estimations done in equation (1).[11] Three cointegration tests are performed in the study: the cointegrating regression Durbin-Watson (CRDW), Dickey-Fuller tests (D-F), and the Augmented Dickey-Fuller (ADF), all of which follow Nachane, Nadkarni, and Karnik (1988).[12]

The CRDW is a quick and rough approximation of the cointegration relation between prices, and is conducted by obtaining the D-W statistics on the residuals of OLS estimation of equation (1) for each of the different pairs of price combination. A statistically significant and non-zero CRDW would reject the null hypothesis of non-cointegration between spatial markets. Cointegration is established by a statistically nonsignificant CRDW.

The D-F cointegration test is calculated by

$$\Delta\mu_t = \phi\mu_{t-1} + \varepsilon_t\,, \tag{2}$$

where μ_t is the residuals obtained from equation (1), $\Delta\mu_t$ is their first differences, and μ_{t-1} is previous residuals. The hypothesis of non-cointegration is rejected if the calculated D-F test statistic on ϕ, denoted as t^{ϕ}, exceeds the critical value at conventional levels of significance.

The third cointegration test, the ADF test, is estimated by

$$\Delta\mu_t = \phi\mu_{t-1} + \sum_{i=1}^{p} b_i \Delta\,\mu_{t-1} + \varepsilon_t\,, \tag{3}$$

[11]Because cointegration testing involves residuals, it has been referred to as a "residual-based test" (Phillips and Oularis 1990).

[12]In addition to the three cointegration tests conducted in the study, Engle and Granger (1987) proposed other tests including the restricted vector autoregression test (RVAR), the augmented RVAR (ARVAR), the unrestricted VAR (UVAR), and the augmented UVAR (AUVAR), which adds up to seven cointegration tests. The latter four tests are highly applicable to higher-order testing. However, because there is no strong a priori knowledge that higher orders of serial correlation exist in the price series used, further testing using those suggested by Engle and Granger (1987) are not necessary and do not alter the results of the study. Testing for cointegration using the ADF was terminated at the fourth order when the second stage residuals, ε_t, in equation (3) are serially uncorrelated.

where p represents the lag structure in the series. The ADF test statistic used is the t-statistic of ϕ, denoted as t_ϕ^A, from equation (3) at p lags. Lag lengths of 1 and 4 were chosen so that the residuals, ε_t, in equation (3) are white noise. Cointegration is established if the t_ϕ^A statistic is greater than the critical value.

Among the three cointegration tests, ADF has been verified to be the most powerful. However, results of all three tests are presented in the analysis.[13]

Estimated Bivariate Exponential Autoregressive Conditional Heteroskedasticity Model

Results of cointegration tests are supplemented with the bivariate exponential autoregressive conditional heteroskedasticity (E-ARCH) model, which extends the conventional vector autoregressive modeling commonly used in previous studies of market integration.[14] The E-ARCH model utilized for analysis provides the quantification of the size of the impact of exogenous shocks on price adjustments and the length of time by which equilibrium is achieved, which tests of cointegration are unable to ascertain.

Recent work on conditional heteroskedasticity models has been shown to reduce leptokurticity and the time dependence of variances (Baillie and Bollerslev 1989; Mendoza 1992; Taylor 1986; Yang 1989). Compared with conventional and often ad hoc methods, conditional heteroskedasticity models allow the correction of the time dependence of the variance without a priori restricting the specification of the conditional variance equation. Economic theory is often deficient for enabling the identification of factors that could cause variances to change over time.

Empirical findings of leptokurtic distribution, that is, more observations around the mean and a more extreme tail than normal, have been presented (Mendoza 1992; Taylor 1986; Yang 1989). Neither is the least squares assumption of homoskedasticity valid. Engle (1982), Taylor (1986), and Yang (1989) found that variances are not constant but change over time, following some pattern. This serial dependence in the second moment has also been found to partly explain leptokurticity, which if correctly modeled could reduce fat-tailed distributions (Hsieh 1989; Mendoza 1992; Yang 1989). If ignored, leptokurticity results in biased statistical tests and weakens the validity of inferences derived from them.

Thus, before estimating an ARCH model, several diagnostic checks on the presence of nonnormality and heteroskedasticity were performed. These are recounted in Appendix 3.

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[13]The CRDW is highly fragile and inconsistent, being dependent on the specification of the regression equation used in conducting the test (Engle and Yoo 1987).

[14]Although the generalized autoregressive conditional heteroskedasticity model, GARCH (p, q), associated with Bollerslev (1986) is a more parsimonious representation than the ARCH (p) model of Engle (1982), the GARCH (p, q) process, like the conventional autoregressive moving average model (ARMA), cannot be uniquely identified. The ARCH (p) model allows greater flexibility in incorporating more lag structure for series exhibiting a longer memory process than the popularly used GARCH (1, 1) process.

Equation (5) can easily be extended to a GARCH (1, 1) model by including last month's value of the conditional variance, h^2_{t-1}, in addition to last month's residuals, ε^2_{t-1}.

A modification of Engle's (1982) ARCH (p) model is used in the study and is specified separately for pairs of wholesale markets for yellow corn grains and pairs of wholesale markets for white corn grains for selected major corn-producing regions. The ARCH model estimated for Philippine regional markets is represented as

$$\begin{bmatrix} \ln\Delta P_{tk} \\ \ln\Delta P_{tj} \end{bmatrix} = \begin{bmatrix} \alpha_1\ \alpha_2 \ldots \alpha_i\ \beta_1\ \beta_2 \ldots \beta_i \\ \gamma_1\ \gamma_2 \ldots \gamma_i\ \lambda_1\ \lambda_2 \ldots \lambda_i \end{bmatrix} \begin{bmatrix} \ln\Delta P_{tk-1} \\ \ln\Delta P_{tk-2} \\ \vdots \\ \ln\Delta P_{tk-i} \\ \ln\Delta P_{tj-1} \\ \ln\Delta P_{tj-2} \\ \vdots \\ \ln\Delta P_{tj-i} \end{bmatrix} + \begin{bmatrix} \omega_1\ \omega_2 \ldots \omega_{11} \\ \phi_1\ \phi_2 \ldots \phi_{11} \end{bmatrix} \begin{bmatrix} Jan \\ Feb \\ Mar \\ Apr \\ May \\ June \\ July \\ Aug \\ Sept \\ Oct \\ Nov \end{bmatrix} + \begin{bmatrix} \varepsilon_{tk} \\ \varepsilon_{tj} \end{bmatrix}, \quad (4)$$

where

$\ln\Delta P_{tk}$ = natural logarithm of the first differences in monthly wholesale prices in market k;

$\ln\Delta P_{tj}$ = natural logarithm of the first differences in monthly wholesale prices in market j, k not equal to j;

$\ln\Delta P_{tk-i}$ and $\ln\Delta P_{tj-i}$ = lagged monthly natural logarithms of the wholesale price changes in each market k and j, respectively; and

i = Akaike Information Criterion (AIC) identified autoregressive process.

The natural logarithm of the first differences in prices represents intertemporal percentage changes in prices or returns to storage and is referred to hereafter as price changes. Equation (4) is a valid short-run approximation when prices are cointegrated.

For consistency with their importance in the domestic corn production and marketing system, as discussed in Chapter 5, equation (4) is empirically estimated for the major producing regions of Cagayan Valley, Northern Mindanao, and Southern Mindanao and major urban consuming regions of Central Visayas and Manila.

The random shocks in each market k and j, ε_{tk} and ε_{tj}, respectively, conditional on all historical information contained in the information set θ_{t-1}, is normally distributed with zero mean and follows an ARCH process with conditional variances, H_t^2:

$$(\varepsilon_t | \theta_{t-1}) \cong N(O, H_t^2),$$

$$\begin{bmatrix} h_{tk}^2 \\ h_{tj}^2 \end{bmatrix} = \begin{bmatrix} \sigma_1\ \sigma_2 \ldots \sigma_p\ \rho_1\ \rho_2 \ldots \rho_p \\ \upsilon_1\ \upsilon_2 \ldots \upsilon_p\ \kappa_1\ \kappa_2 \ldots \kappa_p \end{bmatrix} \begin{bmatrix} \varepsilon_{tk-1}^2 \\ \varepsilon_{tk-2}^2 \\ \cdot \\ \cdot \\ \cdot \\ \varepsilon_{tk-p}^2 \\ \varepsilon_{tj-1}^2 \\ \varepsilon_{tj-2}^2 \\ \cdot \\ \cdot \\ \cdot \\ \varepsilon_{tj-p}^2 \end{bmatrix} + \begin{bmatrix} \eta_1\ \eta_2 \ldots \eta_{11} \\ \omega_1\ \omega_2 \ldots \omega_{11} \end{bmatrix} \begin{bmatrix} Jan \\ Feb \\ Mar \\ Apr \\ May \\ June \\ July \\ Aug \\ Sept \\ Oct \\ Nov \end{bmatrix}, \qquad (5)$$

where H_t^2 is equal to the conditional variance in market k, h_{tk}^2, and the conditional variance in market j, h_{tj}^2. Equation (5) denotes a moving-average representation of the conditional variances in markets k and j, which are linear functions of past realizations of squared residuals or shocks within the local market k, ε_{tk-p}^2 and in the other market j, ε_{tj-p}^2. Nonnegativity in the predicted variances is imposed by obtaining their exponential values, thus equation (5) is an exponential ARCH model (E-ARCH).

Equation (5) formulation captures the shocks arising from new information originating locally and shocks from the other market where regular trading has been established. It also enables the modeling of the volatility clustering characteristic of series that exhibit an ARCH effect, so that large errors occurring in the past increase the possibility of large errors occurring in the future. The lag structure p is the Akaike Information Criterion (AIC) identified order of the ARCH process. If the ARCH (p) process is zero, p=0, then the variances are time-invariant and H_t^2 equals H^2 for all t.

Seasonality in corn production is incorporated using binary monthly variables. Anderson (1985) claimed that price instability tends to be higher during periods of supply uncertainty than during periods of abundance. Kenyon et al. (1987) confirmed that the volatility in the future prices for grains tends to vary seasonally. Yang (1989) found that seasonality exerts a significant effect on the mean returns as well as on volatility. In this study, seasonality is included in both the conditional variance equation, equation (5), and in the mean equation, equation (4), using 11 monthly dummy variables. Estimates obtained in the study, therefore, should be more precise than previous research where seasonal price movements are ignored.

The procedure for estimating the E-ARCH (p) model employed in the study is discussed in detail in Appendix 4.

Determining the Dynamics of Spatial Discovery of Prices

The concept of Granger causality is used to determine the lead-lag relationships among the geographic corn markets in discovering prices (Granger 1969).[15] For this

[15] Prior to Granger causality testing and subsequent calculation, the estimated E-ARCH models are validated using the Lagrange multiplier described in Appendix 3. A statistically nonsignificant chi-square value would indicate homoskedastic variances, and the estimation is terminated.

study, the definition of Pierce and Haugh (1977) is pertinent. Defining causality in terms of predictability, a series X "causes" a series Y if Y can be better predicted using historical values of X than if information contained in X is not used. By this definition unidirectional causality is indicated if X causes Y, but Y does not cause X. Bidirectional causality is established if X causes Y and the reverse. If X does not cause Y, nor does Y cause X, then X is independent of Y and vice versa.

Granger causality testing is conducted separately for yellow corn grain and white corn grain markets. Using the EGLS estimated mean equation (4), the Granger causality test is conducted by testing the statistical significance of the lagged values of the price changes in market i on contemporaneous price changes in market j, i not equal to j.

Distributed as an F statistic, the Granger test statistic has degrees of freedom (i, T-i-1), where i denotes the AIC identified autoregressive process and T is the number of observations. At conventional significance levels, a statistically significant F statistic obtained in both directions of causation would indicate a feedback relationship between markets, meaning that shocks originating from the postulated central market influence pricing in the other markets, and that shocks coming from the other markets also affect the central market. Thus, a feedback relationship indicates that prices are discovered simultaneously at the appropriate time lag. A unidirectional Granger causality would be indicated if the F statistic is significant in one direction but not the reverse. This would suggest market leadership, such that prices are first discovered in one market (the lead market) and then in other markets, after some elapsed time. An instantaneous relationship is said to exist between markets k and j if the calculated F statistic on contemporaneous values of price changes in market j is significant at no lags, k not equal to j. The hypothesis of the centrality of Manila in domestic corn pricing is confirmed if a statistically significant unidirectional causality from Manila to the other markets is found, with the reverse causality being nonsignificant.

Long-Run Multiplier and Market Integration

After establishing the dynamic relationship between spatial markets in discovering prices, the impact of shocks stemming from one market to another is quantified by calculating the long-run multipliers (LRMs). Estimates of the LRMs provide a measure of the magnitude of the effect of newly transmitted information from one market on price responses in the other market, and thus provide a quantification of the degree of proportionality of price interdependence between markets. The LRMs were calculated as (Chow 1975)

$$LRM_{kj} = \lim_{h \to \infty} \frac{\partial E\,[P_k(t+h)]}{\partial P_j(t)}. \qquad (6)$$

Estimating equation (6) yields estimates of own LRMs, the impact of historical values of prices in market j on contemporaneous prices in the same market, market j, and cross LRMs, the impact of past prices in market j on contemporaneous prices in market k, j not equal to k. Of most interest in the study are the numerical values of the cross LRMs.

Empirically, arbitrage has been found to be rarely perfect in fully and rapidly communicating new information between markets. Because of structural rigidities inherent in commodity markets, expectations of complete and instantaneous market responses are unrealistic and therefore rarely verifiable. The transmission of prices across markets is most commonly fragmentary and sluggish, and estimates of cross LRMs are prevalently less than unitary. However, the condition of unitary LRMs has been consistently imposed.

In this study, this criteria is relaxed. Spatial integration between geographic markets is verified if the cross LRM is positive and significantly different from zero. Based on the following yardstick,[16] the degree of integration is classified as weakly integrated if LRMs are 0.1-0.39; moderately integrated if LRMs are 0.4-0.79; and well integrated if LRMs are 0.8-0.99. At the extremes, markets are perfectly integrated if LRMs are unitary, and markets are not integrated or segmented if the calculated cross LRM is zero.

Since all variables on the left-hand side are lagged endogenous variables, the LRMs were calculated assuming a one-time shock occurs through the error terms, ε_{tk} and ε_{tj}, in equation (4). The shock could arise from local crop failure, which would shift supply, or any market anomalies, which would affect demand. The shifts in supply and demand result in changes that would affect current prices in market j, $P_j(t)$, and also affect price forecasts in market k, $P_k(t+h)$. With the shocks ultimately expressed in shifts in the exogenous variables, the sources of the shocks, whether from changes in supply or changes in demand, cannot be determined.

Period of Market Adjustments

Although it gives a parsimonious representation of the dynamics of the pricing relationship between markets, the order of the autoregressive process in the E-ARCH modeling tends to underestimate the length of time it actually takes for markets to attain full adjustments. Therefore, the period of market adjustment was calculated. Ngenge (1983) provided two approaches for measurement: Adjustment Period I refers to the length of time it takes for all but 5 percent of the impact from a shock to be reflected in prices, and Adjustment Period II refers to the length of time it takes for the full impact of the shock to dissipate. The minimum time of the two measures was utilized.

Price responses achieved within the shortest possible time would suggest markets are efficient in processing new information relayed from other markets. An extended

[16]Because of inherent structural rigidities and market inertia due to storage, product processing, and transportation, real commodity markets are seldom perfectly integrated through arbitrage activities of traders. Thus, using the criteria of LRM equal to unitary to verify that markets are integrated is too rigid because one is most likely to reject it. Alternatively, three more flexible groupings are used in the study to allow the classification of the extent to which spatially differentiated markets are integrated, from weakly integrated to well integrated.

response period would indicate a sluggish market and the presence of impediments that naturally exist.

The LRMs quantify the impact of exogenous market shocks in the local pricing of corn, whereas the period of market adjustment measures the length of time it takes for these shocks to affect corn prices across regional markets and be reflected as price changes. By this definition, lags quantify the speed in price responses to shocks or information transmitted between trading markets, and the LRMs measure the size of the effect of a shock. Together, however, the LRMs and the period of market adjustment are utilized in this study to quantify the degree of integration in Philippine corn markets.

7

THE DYNAMICS AND EFFICIENCY OF SPATIAL INTEGRATION OF CORN MARKETS

Results of the cointegration tests confirm the existence of market equilibrium for Philippine corn. Granger causality tests of the causal dependence between spatial markets validate the centrality of the Manila wholesale market in discovering yellow corn prices in the domestic markets. As expected, spatial integration is seldom complete or rapid, given constraints that intrinsically exist in the Philippine corn-distribution system.

Cointegration Tests of Spatial Price Relationships

The estimated bivariate cointegrating regression and relevant statistics are presented in Table 24. Using results of the Augmented Dickey-Fuller (ADF) test, the maintained hypothesis of cointegration cannot be rejected for the Philippine corn markets.[17] The overall results of cointegration are consistent with expectations. Cointegrating parameters are generally positive and statistically significant at conventional levels, suggesting that any deviations from the long-run equilibrium observed between the urban market centers and the regional markets are only transitory, and that markets eventually converge to equilibrium after the effects of a shock dissipate.

The values of the cointegrating parameters, β, although mostly close to unitary, differ between cointegrating market pairs.[18] For the first cointegrating regression for yellow corn estimated with Manila as the exogenous variable and each of the regional markets as the endogenous variables, the highest cointegrating parameter of 0.90 was obtained between Manila and Cagayan Valley, the region closest to Manila. However, the extent of cointegration tends to diminish as the distance from Manila increases, as in the case of Northern Mindanao. Farthest away from Manila, Southern Mindanao is not cointegrated with Manila. In the reverse direction of causation,

[17]Compared with CRDW and D-F tests, the ADF has been deemed most powerful and thus is considered in the preliminary investigation of integration between markets. The spurious regressions are evident in the third to the fifth columns of Table 24, where the CRDW statistics are low and less than one, suggesting non-cointegrated markets. No explanation could be forwarded to resolve these aberrations, but similar findings were obtained by Ardeni (1989) and Goodwin and Schroeder (1991).

[18]Cointegrating parameters exceeding one were also obtained. This may be caused by spurious correlations between the cointegrating variables, which are even more pronounced when the direction of causation between markets is reversed, that is, causality originating from the regional markets to the postulated central markets of Manila in the case of yellow corn and Central Visayas in the case of white corn.

Table 24—Results of cointegration tests of monthly wholesale price changes of yellow and white corn between selected major market pairs, January 1, 1980 - December 31, 1989

Spatial Market	β^a	CRDW	Dickey-Fuller $\hat{t}_\phi$	Augmented Dickey-Fuller $(\hat{t}_\phi^A)$ $p=1$	$p=4$
Yellow corn					
$P_i^{yc} = \alpha^{yc}/ + \beta^{yc}/ P_{Manila}$ [b]					
Cagayan Valley	0.90	0.54	−4.27*	−4.90*	−2.52
Northern Mindanao	0.64	0.41	−3.46*	−3.86*	−3.15*
Southern Mindanao	0.69	1.21*	−7.08*	−5.39*	−3.20*
$P_{Manila}^{yc} = \alpha^{yc}// + \beta^{yc}// P_i$ [c]					
Cagayan Valley	0.99	0.55	−4.29*	−4.97*	−2.50
Northern Mindanao	1.29	0.39	−3.55*	−3.92*	−2.93*
Southern Mindanao	1.20	1.07*	−6.55*	−5.10*	−3.20*
White corn					
$P_i^{wc} = \alpha^{wc}/ + \beta^{wc}/ P_{Central\ Visayas}$ [d]					
Cagayan Valley	0.75	0.29	−3.01*	−3.26*	−2.24
Northern Mindanao	0.66	1.10*	−6.68*	−5.63*	−4.13*
Southern Mindanao	0.65	0.42	−3.41*	−2.70	−2.16
$P_{Central\ Visayas}^{wc} = \alpha^{wc}// + \beta^{wc}// P_i$ [e]					
Cagayan Valley	0.90	0.25	−2.67	−3.03*	−2.20
Northern Mindanao	1.35	1.04	−6.36*	−5.24*	−3.58*
Southern Mindanao	1.33	0.41	−3.58*	−2.94*	−2.35

Source: Basic data are from BAS 1990.

Notes: All estimated cointegrating parameters, β, are statistically significant. Asterisks (*) in the cointegration tests indicate statistical significance at the 10 percent level. Unless otherwise indicated by an asterisk, CRDW, DF, and ADF at lag 1 tests are statistically nonsignificant. Critical values are obtained from Engle and Granger (1987) for 100 observations: 3.73 at 1 percent level of significance, −3.17 for 5 percent level of significance, and −2.91 for 10 percent level of significance.

[a] Represents the cointegrating parameter between pairs of monthly regional prices of yellow and white corn.

[b] Cointegration regression for yellow corn grain with Manila price as the exogenous variable and prices in the regional markets *i* as the endogenous variable; *i* = 1, 2, 3, where 1 is Cagayan Valley, 2 is Northern Mindanao, and 3 is Southern Mindanao.

[c] Cointegration regression for yellow corn grain on the reverse causation, prices in the regional markets *i* as the exogenous variable and Manila price as the endogenous variable.

[d] Cointegration regression for white corn grain with Central Visayas price as the exogenous variable and prices in the regional markets *i* as the endogenous variable; *i* = 1, 2, 3, where 1 is Cagayan Valley, 2 is Northern Mindanao, and 3 is Southern Mindanao.

[e] Cointegration regression for white corn grain on the reverse causation, prices in the regional markets *i* as the exogenous variable, and Central Visayas price as the endogenous variable.

Cagayan Valley and Northern Mindanao are cointegrated with Manila, but not Southern Mindanao. The increase in the cointegrating parameter between Northern Mindanao and Manila, which contradicted expectations, cannot be interpreted.

Findings for white corn showed cointegrating parameters lower in value than those obtained for yellow corn. This result is not surprising, because white corn is not as extensively traded as yellow and therefore would tend to be less cointegrated. The high cointegrating parameter obtained between Central Visayas and Cagayan Valley, which are located farthest apart, is counterintuitive. Neither can the low cointegrating parameters in Northern Mindanao and Southern Mindanao be explained. Such spurious associations are also apparent in the bivariate correlation coefficients derived for yellow corn and white corn. Appendix 5 presents a discussion of the results of the estimation of correlation between regional pairs of spot cash prices for yellow corn and white corn.

In all, empirical results suggest that cointegration of the Philippine corn markets is limited. The degree of cointegration in white corn markets is even less because trading is confined within the narrow market boundaries of Mindanao and a small part of Central Visayas.

Results of the Estimated E-ARCH(P) Model

The hypothesis of white noise cannot be rejected for the residuals of the estimated generalized least squares (EGLS) estimated bivariate autoregressive models of the monthly wholesale price changes of yellow corn. Results of the calculated Ljung-Box Q test[19] statistic presented in Table 25 were less than the critical chi-square value at the 10 percent confidence level. This finding for yellow corn suggests that an autoregressive order of one month is sufficiently long to adequately capture the regularities in the wholesale price series. Analogous results were likewise obtained for white corn. These results validate the AR(1) process employed in the mean equation for yellow corn and white corn.

Measures of relative kurtosis and relative skewness reported in Appendix 6 disclose that the monthly wholesale price changes for yellow corn and white corn are non-normally distributed, leading to the suspicion that an ARCH process is present in the residuals.

The results of the Lagrange multiplier test verified a significant ARCH effect in the variances of yellow corn, with an extended memory process. Results of the Lagrange multiplier test for the presence of the univariate ARCH series exceeded the critical chi-square value at the 10 percent significance level at the eighth order. The Lagrange multiplier tests at shorter autoregressive orders were not statistically significant. The presence of an ARCH process in the series is more discernible in the "clustering" of the residuals obtained from estimation of the mean equation for Northern Mindanao, although the statistical test was inconclusive (Figure 5).

The bivariate Lagrange multiplier test confirms the significance of heteroskedasticity in the variances. This result strongly indicates that mean returns or price changes and price volatility are affected by past variances within the local market and

[19]The Ljung-Box Q test statistic is computed as

$$Q(\tau)_{(K-i)} = T(T+2)\sum_{k=1}^{K} \tau_k^2 / T-K,$$

where τ_k is the kth order of the autocorrelation of the residuals, K is the preselected number of autocorrelations, T is the number of observations, and i is the number of lagged dependent variables (Ramanathan 1989). The calculated $Q(\tau)$ statistic has a chi-square distribution with $K-s$ degrees of freedom. Nonwhite residuals are detected if the calculated $Q(\tau)$ statistic exceeds the critical chi-square value.

Table 25—Diagnostic tests for white noise and heteroskedasticity in residuals of the homoskedastic autoregressive model for yellow corn, January 1980-December 1989

Diagnostic Test	Regions: Cagayan Valley	Northern Mindanao	Southern Mindanao	Critical Chi-Square Value at 10 Percent Level
Ljung-Box Q statistic for white noise (24)[a]	25.20	30.21	16.07	33.20
Lagrange multiplier test for homoskedasticity				
Univariate ARCH				
1[b]	0.14	0.06	6.07	2.71
2	0.33	2.33	8.37	4.61
3	2.16	3.47	9.06	6.25
4	3.12	3.46	13.13	7.78
5	8.36	3.96	13.31	9.24
6	9.43	4.05	14.21	10.64
7	12.10	7.82	15.69	12.02
8	12.82	7.75	21.08	13.36
Bivariate ARCH[c]	16.04	29.21	47.53	13.36

Source: Basic data are from BAS 1990.
Note: Manila is used here as the central market. Similar results were obtained for the reverse causation where Cagayan Valley, Northern Mindanao, and Southern Mindanao were regressed separately with Manila and thus are not reported here.
[a]Test statistic follows a chi-square distribution with 24 degrees of freedom.
[b]Test statistic follows a chi-square distribution at ARCH orders, $p = 1, 2, 3, \ldots 8$.
[c]See Appendix 3 for bivariate ARCH testing procedure.

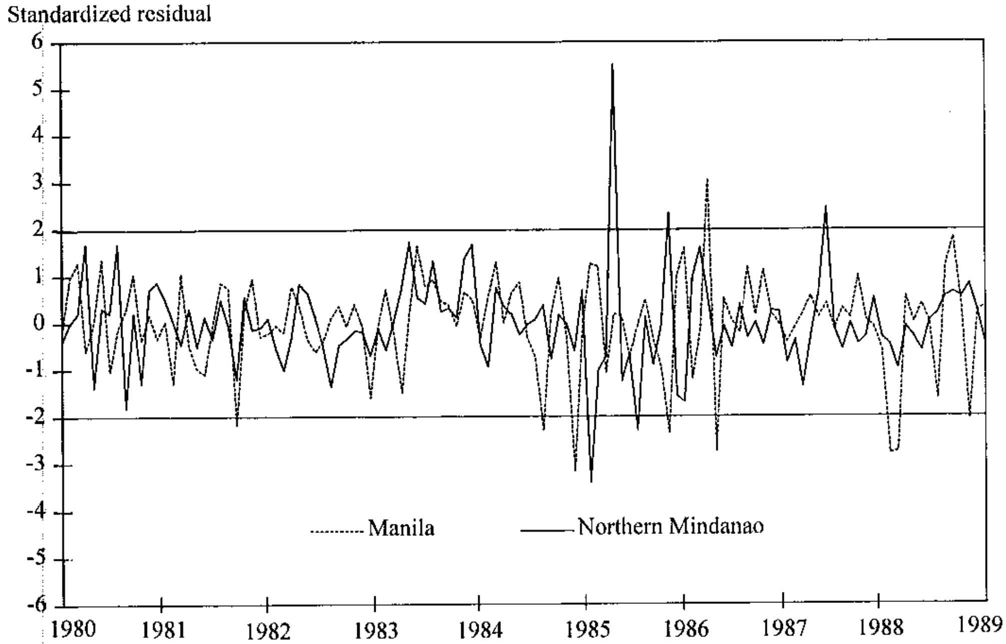
in the other markets, validating a bivariate representation and the ARCH modeling at the eighth order. Therefore, an ARCH representation of the eighth order was used.[20]

Dynamics of the Spatial Price Discovery of Corn

Findings of the Granger causality tests are summarized separately, in Table 26 for yellow corn and Table 27 for white corn. The first column of each table shows the direction of causation tested, with the market on the left side of the arrow "Granger causing" the market to the right. A significant F statistic on the Granger causality test in one direction, but an insignificant reverse causation, as shown in the second column, would indicate unidirectional causality and is denoted by a "no" in the third column. A significant F statistic in both directions would be signified by a "yes" in the third column. Cross LRM estimates and periods of market adjustments to exogenous market shocks are provided in the last two columns. For clearer presentation,

[20]Attempts to include a longer ARCH in the conditional variances were made. However, efficiency gains in these alternative specifications were very marginal. Estimates in the mean equation were insensitive to longer lag structure in the conditional variance equation. The representation of an ARCH (8) is consistent with Engle (1982) and Han, Jensen, and Penson (1990).

Figure 5— Clustering patterns of standardized squared residuals for yellow corn, Northern Mindanao and Manila, January 1980-December 1989



Note: The clustering patterns indicate the presence of an ARCH effect in the homoskedastic autoregressive model of the spatial price relationship between Northern Mindanao and Manila.

findings contained in Table 26 and Table 27 are illustrated in Figure 6 for yellow corn and Figure 7 for white corn.

The postulated leader-follower relationship was confirmed in findings for yellow corn. Manila leads the regional markets of Cagayan Valley, Southern Mindanao, and Northern Mindanao in corn pricing (Table 26 and Figure 6), as revealed by statistically significant unidirectional Granger causality originating from Manila to these markets. This means that corn prices are first discovered in Manila and then in the other markets.

No significant instantaneous causality was obtained between any market pairs, indicating that contemporaneous price changes in the regional markets do not affect contemporaneous price changes in Manila. This result is consistent with the findings of unidirectional causation, wherein past information contained in prices in the regional markets has no impact on forecast prices in Manila.

For white corn, estimates of the Granger causality tests differ slightly from those obtained for yellow corn and were inconclusive as to the importance of Central Visayas in the pricing of white corn.

Insignificant Granger causality was established between Central Visayas and Cagayan Valley but was statistically significant between Central Visayas and Mindanao unidirectionally. White corn is mostly consumed and traded within the Visayas and Mindanao areas, and therefore a significant price relationship is expected to exist

Table 26—Granger causality and spatial integration among selected major markets for yellow corn, January 1980-December 1989

Direction of Causation (1)	Unidirectional Causality[a] (2)	Feed-back[b] (3)	Instan-taneous[c] (4)	Long-run Multiplier (5)	Adjustment Period (6)
					(months)
Cagayan Valley → Manila	0.69 <0.41>	no	0.17 <0.68>	0.16 (0.99)	0
Manila → Cagayan Valley	5.45** <0.02>			0.24 (1.77)*	0
Southern Mindanao → Manila	0.61 <0.44>	no	0.076 <0.78>	0.04 (0.35)	0
Manila → Southern Mindanao	5.92** <0.02>			0.23** (2.47)	1
Northern Mindanao → Manila	0.54 <0.47>	no	0.059 <0.81>	0.06 (0.51)	0
Manila → Northern Mindanao	3.38** <0.07>			0.61** (2.34)	2

Source: Basic data are from BAS 1990.

Notes: Figures in parentheses are calculated *t*-values. Figures in < > are levels of probability for which the calculated F values exceed their critical levels.

[a]A significant F statistic indicates that the market on the left of the arrow "Granger causes" or leads the market to its right.

[b]A significant F statistic in both directions of causation, that is, from left to right and the reverse, would indicate a feedback relationship between markets, $i \neq j$, and would be indicated by a "yes" on this column. A "no" indicates a unidirectional causality.

[c]A significant F statistic would indicate that price adjustments between markets, $i \neq j$, are instantaneous.

*Significant at the 10 percent level.

**Significant at the 5 percent level. Unless otherwise indicated, all others are statistically nonsignificant.

between these regions but not outside. Between Southern Mindanao and Central Visayas, results disclosed that white corn prices are first discovered in Southern Mindanao, where most white corn is produced. Findings for Central Visayas and Northern Mindanao revealed that Central Visayas leads the pricing process.

Spatial Integration of the Corn Markets

In general, estimates of the cross long-run multipliers (LRMs) verify the results of the Granger causality test. The cross long-run multipliers for yellow corn confirm the centrality of Manila in the pricing of yellow corn at wholesale. Positive and significant cross LRMs were obtained for the direction of causation coming from Manila to Cagayan Valley and the Mindanao regions. No reverse effects were detected, as indicated by zero cross LRMs on the opposite direction of causation. Positive cross LRMs show that price adjustments in the regional market occur in the same direction as the direction of the price changes in Manila.

Cross LRMs obtained for white corn were also consistent with results obtained from the Granger causality tests. Cagayan Valley and Central Visayas appear to be independent or segmented markets, because cross LRMs were zero in both paths of

Table 27—Granger causality and spatial integration among selected major markets for white corn, January 1980-December 1989

Direction of Causation (1)	Unidirectional Causality[a] (2)	Feed-back[b] (3)	Instan-taneous[c] (4)	Long-run Multiplier (5)	Adjustment Period (6)
					(months)
Cagayan Valley → Central Visayas	0.65	no	1.71	0.046	0
	<0.42>		<0.19>	(0.40)	
Central Visayas → Cagayan Valley	1.51			0.29	0
	<0.22>			(1.50)	
Southern Mindanao → Central Visayas	4.73**	no	6.84	0.61**	2
	<0.03>		<0.01>	(2.46)	
Central Visayas → Southern Mindanao	1.99			0.28	0
	<0.16>			(1.43)	
Northern Mindanao → Central Visayas	2.14	yes	3.99	0.30*	0
	<0.15>		<0.05>	(1.80)	
Central Visayas →Northern Mindanao	2.87*			0.28**	1
	<0.09>			(2.28)	

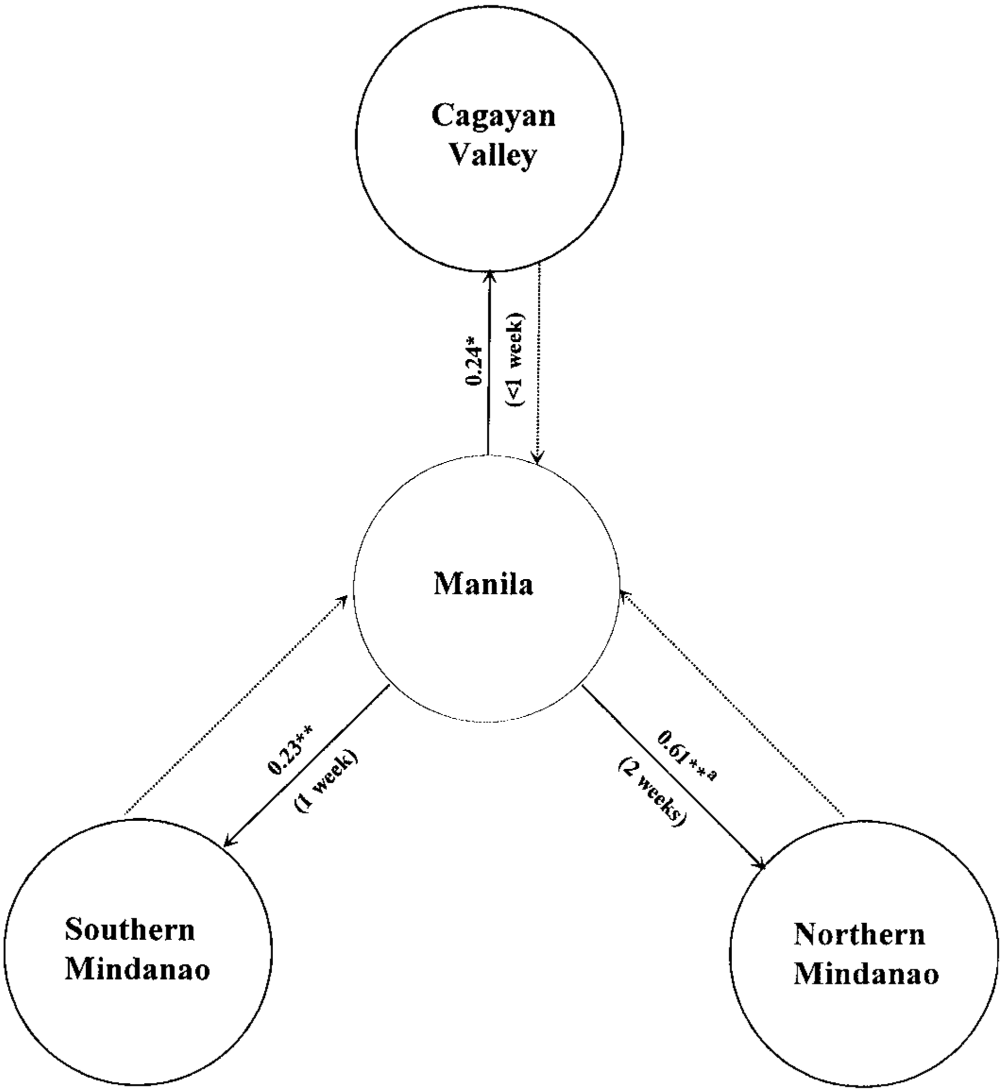
Source: Basic data are from BAS 1990.
Notes: Figures in parentheses are calculated *t*-values. Figures in < > are levels of probability that the calculated F values exceed their critical levels.
[a]A significant F statistic indicates that the market on the left of the arrow "Granger causes" or leads the market to its right.
[b]A significant F statistic in both directions of causation, that is, from left to right and the reverse, indicates a feedback relationship between markets, $i \div j$, and is indicated by a "yes" on this column. A "no" indicates a unidirectional causality.
[c]A significant F statistic would indicate that price adjustments between markets, $i \div j$, are instantaneous.
*Significant at the 10 percent level.
**Significant at the 5 percent level. Unless otherwise indicated, all others are statistically nonsignificant.

causation. Similarly, cross LRMs were significant for causation originating from Southern Mindanao to Central Visayas but not the reverse, validating the leadership of Southern Mindanao in the pricing process found in the Granger causality testing. The lead role of Central Visayas in pricing over Northern Mindanao was likewise corroborated by estimated cross LRMs between these markets.

The magnitudes of the cross LRM estimates are consistently less than unitary. Cross LRMs between Manila and the regional markets for yellow corn ranged from 0.23 to 0.61. For instance, the cross LRM of 0.24 between Manila and Cagayan Valley means that contemporaneous prices in Cagayan Valley would increase by 0.24 percent if Manila prices in the previous month increased by 1 percent. A comparable magnitude of the impact of Manila prices on Southern Mindanao was also derived at 0.23. The largest LRM, 0.61, was obtained between Manila and Northern Mindanao, which means that a 1 percent increase in the price of yellow corn in Manila would result in a 0.61 percent increase in price in Northern Mindanao.

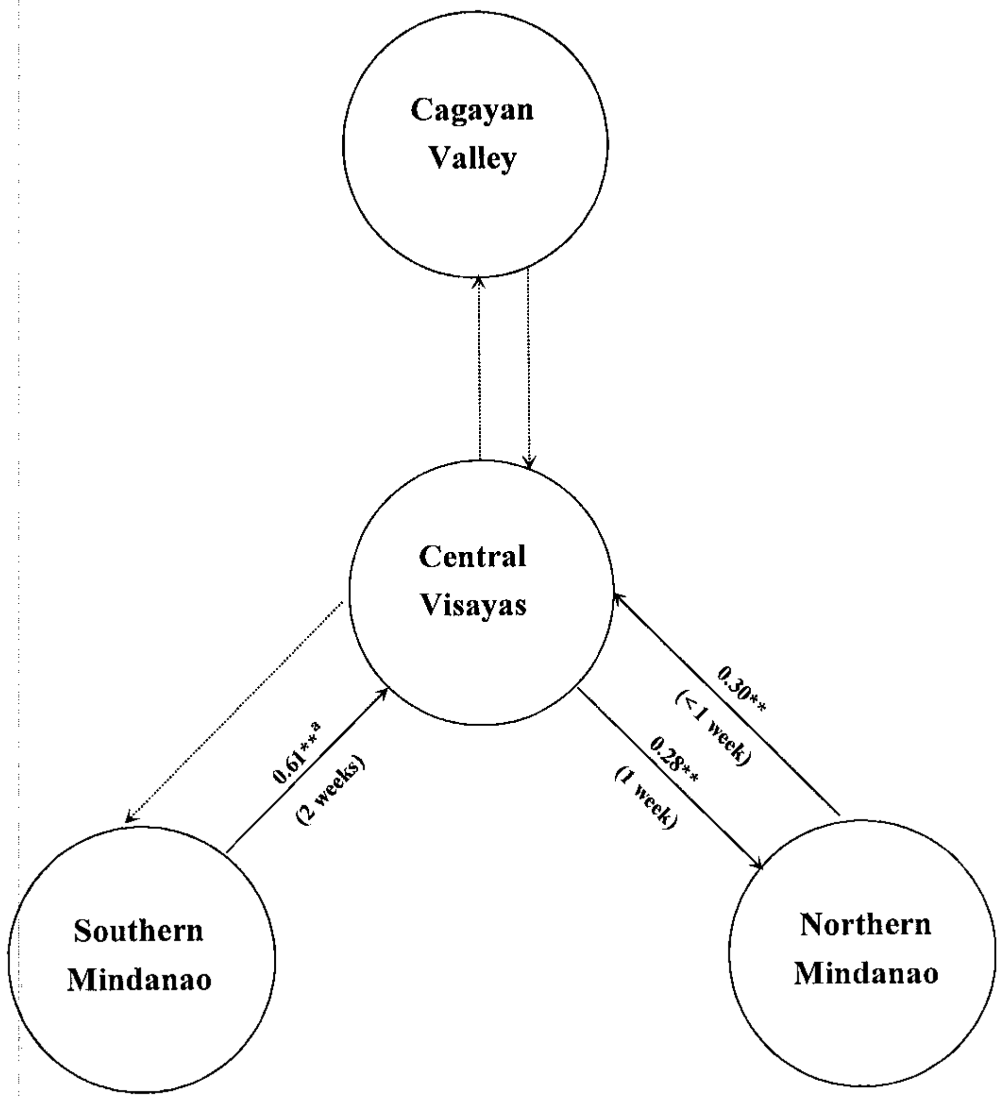
Similar findings were also obtained for white corn, as LRM estimates rarely equal one, and are no higher than those obtained for yellow corn. The values of the LRM for white corn varied from 0.28 to 0.61. A 1 percent price increase in Southern

Figure 6— Dynamics of price relationship and degree of market integration among regional yellow corn markets, January 1980-December 1989



Note: Figures in parentheses are periods of market adjustment to exogenous shocks.
[a]Cross long-run multiplier estimates.
*Statistically significant at 1 percent.
**Statistically significant at 5 percent.
·········> Not statistically significant.

Figure 7—Dynamics of price relationship and degree of market integration among regional white corn markets, January 1980-December 1989



Note: Figures in parentheses are periods of market adjustment to exogenous shocks.
[a]Cross long-run multiplier estimates.
*Statistically significant at 1 percent.
**Statistically significant at 5 percent.
·········> Not statistically significant.

Mindanao would raise prices in Central Visayas by 0.61 percent. The size of impact of a 1 percent increase in price in Northern Mindanao would yield a 0.28 percent increase in Central Visayas prices.

The empirical applications indicate that the spatial integration of the Philippine corn markets are limited, because LRMs ranged from low, 0.23, to moderate, 0.61. This finding is compatible with results of the cointegration tests discussed earlier. The presence of imperfect integration in Philippine corn markets may suggest that the efficient exploration of arbitrage opportunities is hampered by high transportation costs, high storage costs, irregular shipping schedules between ports, and other market barriers. Alternatively, the results may suggest the presence of some form of discriminatory pricing.

Examining price differentials, Faminow and Benson (1990) determined the existence of base-point pricing arrangements by calculating the price differences between a reference (base) market and another market and comparing them with transportation cost. If base-point pricing exists, price differences should equal the cost of transportation between markets and thus should increase as markets are situated farther away from the base market. Absolute price margins between regions considered in the study were calculated over time (Table 28). Base markets are Manila for yellow corn and Central Visayas for white corn. No discernible trends could be detected in the margins, which narrowed for some markets and then widened in others, regardless of the distance between marketing points. Supplementary analysis of the seasonality in price differentials is provided in Appendix 7. Although margins between marketing levels fluctuated, these variations followed the seasonality patterns in corn production. Margins were relatively wider during the harvest months, when supply is abundant, than during the lean months.

Time Needed for Markets to Adjust to Exogenous Shocks

Price responses to exogenous market shocks are rarely instantaneous. It is notable, however, that since the frequency of the data series used in the study is monthly reported prices, causality between regional markets with a causal lag shorter than a month may show up as an instantaneous price response. That is, the calculated period of market adjustments would be zero, as was obtained between Manila and Cagayan Valley yellow corn markets. In this case, it would be reasonable to presume that a zero period of adjustment would imply that wholesalers in Cagayan Valley responded to price changes in Manila within a month. This finding is justified because of the proximity of Cagayan Valley to Manila, such that market response between these markets would tend to be quicker when compared with others. Located farthest from Manila, corn traders in Southern Mindanao and Northern Mindanao required about one to two months to adjust their prices to price changes in Manila.

For white corn, wholesalers in Central Visayas took two months to respond to price shocks from Southern Mindanao. On the other hand, Northern Mindanao corn traders were able to adjust their prices to price changes in Central Visayas in one month.

The sluggish market response observed for yellow corn and white corn may be partly explained by the time needed for spatial arbitrage to move corn between islands due to inadequate shipping and erratic cargo shipping schedules.

Table 28— Average wholesale price differences between major corn regions for yellow and white corn, January 1980-December 1989

Year	White Corn			Yellow Corn			
	Central Visayas-Cagayan Valley	Central Visayas-Northern Mindanao	Central Visayas-Southern Mindanao	Manila-Cagayan Valley	Manila-Central Visayas	Manila-Northern Mindanao	Manila-Southern Mindanao
	(pesos/kilogram)						
1980	0.03	0.03	0.06	0.27	−0.03	0.42	0.43
1981	−0.13	−0.01	−0.05	0.37	−0.28	0.65	0.56
1982	−0.01	−0.03	0.02	0.44	−0.22	0.66	0.67
1983	−0.19	−0.30	−0.13	0.24	−0.18	0.43	0.54
1984	0.62	0.67	0.86	0.66	−0.09	0.75	0.89
1985	1.42	1.14	1.54	0.80	−0.24	1.04	1.25
1986	0.74	0.84	1.02	0.95	−0.21	1.17	1.46
1987	0.27	0.69	0.79	0.69	−0.78	1.47	1.47
1988	−0.99	0.57	0.53	−0.18	−2.35	2.17	1.77
1989	0.12	0.89	0.70	0.78	−0.55	1.33	0.99

Source: BAS 1990.

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CONCLUSIONS AND IMPLICATIONS FOR MARKET EFFICIENCY

Evidence of spatial integration of Philippine yellow corn markets is presented in this study. Results of cointegration tests, employed as a preliminary test of market integration, rejected the maintained hypothesis of non-cointegration. Findings of cointegration imply that stable long-run relationships exist among spatial markets for Philippine yellow corn and that any divergence from market equilibrium due to exogenous shocks will not persist.

Estimates of cross long-run multipliers (LRMs) obtained from the bivariate E-ARCH model further confirm spatial integration for yellow corn markets. Cross LRMs were positive and statistically significant, indicating that information is transmitted during the process of price discovery across markets, via arbitrage. Because regional yellow corn markets are integrated, price changes in one region are linked to price changes in another region.

The radial configuration of markets characterizes Philippine corn markets, with an urban market leading the local pricing process. Granger causality tests confirm the centrality of Manila in the local formation of corn prices. The market leadership of Manila in the local pricing of yellow corn, with the regions of Cagayan Valley, Northern Mindanao, and Southern Mindanao as market followers, is established in the study. These results indicate that domestic prices of corn are first discovered in the region of final demand, Manila, and then in the other regional markets after two months.

However, the efficiency of arbitrage in the spatial integration of Philippine corn markets is imperfect. Rural corn traders do not fully respond to price changes in the central markets, as indicated by less than unitary estimates of cross long-run multipliers, which imply the presence of market frictions that could impair the complete transmission and processing of information through markets. These results of imperfect market integration are comparable with those obtained by Brorsen (1983) and Ravallion (1986).

Adjustments in the regional markets to shocks coming from the urban markets are sluggish, being noninstantaneous. On average, it takes about one to two months for traders in the regional markets to fully adjust to price changes in the rural markets, while traders in Manila are quicker in processing new information from the other regional markets. As expected, price adjustments between markets located farther apart tend to be more delayed than those between markets in close proximity, partly because of the time required to ship corn between islands. High costs of transportation and inadequacy of interisland shipping vessels may also contribute to the inefficiency of arbitrage in equilibrating prices between spatial markets.

Results of the study invalidate the classical time-series models in testing the market-efficiency hypothesis for Philippine corn markets. Findings of nonnormality in price distribution and heteroskedasticity in variances, typically ignored in classical time-series models, imply the appropriateness of using the autoregressive conditional heteroskedasticity (ARCH) model. Because standard errors are underestimated in the presence of nonnormality and time-variant variance, and conventional statistical tests are biased, inferences derived from the use of the ARCH, which successfully models the violation of these least squares assumptions, are more valid than those derived from classical time-series models.

Results obtained from the bivariate ARCH model, modified to an exponential ARCH (E-ARCH) model due to restricting the predicted variances to be positive, are consistent with those obtained from the 1990 IFPRI field survey conducted in selected provinces in the major corn-producing regions in the Philippines. Contrary to popular belief, the opportunity for traders to "exploit" farmers may be small, because farmers are generally knowledgeable about market conditions and therefore able to interpret market signals accurately. Most farmers reported that they are informed about prevailing market prices and that those prices are the most important factor they consider in negotiating prices with traders.

However, there are also indications of imperfect market knowledge. Although there are several traders buying and selling corn within a geographical market area, indicating a relatively competitive market structure, access to these outlets by farmers appears to be partly restricted by the absence of better transportation and infrastructure facilities. In addition, market intelligence is more developed and accessible in some areas than in others. Poor market knowledge also exists because grades and standards are rarely followed by traders, although available. This may be partly explained by the problems of relevant grades and the difficulty of enforcing the government standards of 14 percent moisture content and 98 percent purity. Inadequate and improper drying and storage facilities and high costs of these services likewise may impede farm prices from reflecting the demand for better-quality corn at the retail level.

Findings of the study showing imperfect market integration for Philippine corn indicate that there may be substantial benefits in developing better infrastructure facilities to effectively link production centers to market centers and in improving market knowledge by providing more relevant, accurate, and timely public market information. Marketing costs could be significantly reduced if better roads and marketing facilities were built. Improvements in the methods of collecting and disseminating public market information could result in more "transparent" prices to all market agents, thus reducing the opportunity of the more knowledgeable to "exploit" the less informed by manipulating prices. Better market information services would also enable market agents to read price signals more accurately and promptly, and therefore to make more reliable price forecasts that would aid them in making correct marketing decisions. This analysis does not, however, permit analysis of the relative returns to alternative investments in market infrastructure and services. Extensions of the time-series analysis to test the effect of structural variables, such as density and quality of roads and bridges and penetration of extension and market services, would help to identify the most productive investments.

APPENDIX 1: REPRESENTATIVE SAMPLES AND METHODS OF SAMPLING EMPLOYED IN THE 1990 IFPRI SURVEY

The primary survey of the Philippine corn/livestock production and marketing system, referred to hereafter as the corn/livestock survey, was conducted by the International Food Policy Research Institute (IFPRI) in cooperation with the International Rice Research Institute (IRRI), the University of the Philippines at Los Baños (UPLB), and the Philippine Department of Agriculture between March and July 1990. The field survey was part of the project, "The Philippine Corn/Livestock Sector: Performance and Policy Implications," funded by the U.S. Agency for International Development.

The corn/livestock survey covered four principal corn-producing regions: Region 2, Cagayan Valley; Region 7, Central Visayas; Region 10, Northern Mindanao; and Region 11, Southern Mindanao. Altogether, these regions accounted for approximately 80 percent of domestic corn supply and 75 percent of total agricultural area harvested in 1989 (BAS 1990). From each sample corn region, provinces growing corn as a major crop were selected as representative samples (Table 29). Of the total samples, analysis in the study focused on three regions and five provinces consisting of Isabela and Nueva Viscaya provinces in Cagayan Valley; Bukidnon in Northern Mindanao; and Davao and South Cotabato in Southern Mindanao.

The sample corn farmers were selected randomly. Due to the small number of respondents, a complete enumeration of large corn traders and poultry and hog raisers operating within the survey area was done. A total of 1,127 samples were interviewed, of which 840 were corn farmers and 118 were corn traders. Due to large occurrences of nonresponse, 56 sample corn farmers, 10 traders/middlemen, 9 trader/shippers, 44 poultry raisers, 25 swine breeders, and 25 millers were excluded in the analysis.[21]

The field study was administered using three sets of structured questionnaires: one set for farmer respondents, a second for traders, and another for poultry/livestock breeders. Farmers were asked for general farm and nonfarm information pertaining to household size, farm size, land-tenure status, types of irrigation, crops grown, and numbers of poultry and livestock raised. Information on corn production, marketing, pricing, and costs was also obtained. Details relating to area covered in buying and selling corn, percentage of time allotted to corn trading, and type of ownership of business were gathered from traders. Marketing information, including volume of trading, prices, payment method, costs, and barriers encountered in market entry, was likewise sought. For the analysis, data on relevant sociodemographic and farm characteristics, prices, sources of market news, methods employed in pricing, and factors influencing the price-formation process were utilized.

[21] An analysis of the production aspect of Philippine corn using the same survey can be found in Gonzales and Perez 1992.

Table 29—Distribution of samples by type of respondent and sample area covered in the 1990 IFPRI survey

	Regional and Provincial Samples					
	Region 2		Region 7	Region 10	Region 11	
Type of Respondent	Isabela	Nueva Viscaya	Cebu City/ Mandaue	Bukidnon/ Cagayan de Oro	Davao City/ Davao del Norte	General Santos/ South Cotabato
Corn farmers	295	64	. . .	181	21	335
Traders/middlemen	24	. . .	10	32	19	43
Trader/shippers	. . .	. . .	. . .	5	1	3
Millers	. . .	. . .	12	6	5	2
Poultry raisers	. . .	. . .	10	21	5	8
Hog raisers	. . .	. . .	4	9	5	7
Total sample size	319	64	36	254	56	390

Source: 1990 IFPRI survey of the Philippine corn/livestock production and marketing system.
Note: Leaders (. . .) indicate that no respondents were identified. Region 2 is Cagayan Valley, Region 7 is Central Visayas, Region 10 is Northern Mindanao, and Region 11 is Southern Mindanao.

APPENDIX 2: DESCRIPTION OF PRICE SERIES DATA USED IN COINTEGRATION TESTS AND CONDITIONAL HETEROSKEDASTICITY MODELING

The price series consist of wholesale prices of white corn grain and yellow corn grain obtained from the Bureau of Agricultural Statistics (BAS), Department of Agriculture, Quezon City, Philippines.

The BAS collects wholesale prices of about 62 agricultural commodities, including grains, fruits and vegetables, commercial crops, livestock, poultry, and fish, in 59 major trading centers all over the country. These trading centers include 13 public markets and 4 supermarkets in Metropolitan Manila and 42 provincial market centers outside Manila. Sample trading centers are selected on the basis of the following criteria (BAS 1986):

- a major buying and selling market station in the province
- location in a leading producing province for the commodity
- location in an area where there is a "nationally recognized assembly and/or processing point for at least one major crop"
- accessibility to either the provincial or regional headquarters of the BAS

Based on these criteria, wholesale prices collected in these sample markets are an accurate representation of prices at the wholesale level. At the initial phase of the survey, traders are selected at random, and they are maintained as regular respondents thereafter.

The frequency of wholesale prices is collected during the day when the volume of trading is the heaviest. For the Metropolitan Manila market, wholesale prices are collected between 5:00 a.m. and 7:00 a.m. For provincial markets, prices are collected from 5:00 a.m. to 9:00 a.m. Transmission to the BAS Central Office in Manila is made between 9:30 a.m. and 11:30 a.m. After verification and validation, the market reports are completed for distribution, and price information is released to the public.

Due to the discontinuities and incompleteness in high-frequency series obtained from the BAS, monthly prices were used instead of daily or weekly prices. In the absence of continuous and pertinent prices at market centers, regional prices were used. Regional prices are average prices in high-volume markets in major corn-producing regions and thus are accurate representations of market demand and supply conditions and are appropriate for use in the analysis.

For yellow corn, monthly wholesale prices were collected for four major corn regions: Cagayan Valley, Northern Mindanao, Southern Mindanao, and the urban market of Manila. For white corn, monthly wholesale prices in Cagayan Valley, Central Visayas, Northern Mindanao, and Southern Mindanao were used because it is in these regions that the white-corn-eating population is concentrated. Manila price quotations are not available for white corn. Although a major corn region, Central Mindanao was omitted from the analysis because of numerous missing values.

The analysis covers a 10-year period from January 1980 to December 1989, a total of 120 observations. The choice of this period is motivated by two important reasons. The first is to avoid discontinuity in the price series arising from changes in the sampling design employed by the BAS in collecting and reporting prices prior to this period. And the second is to capture significant structural changes in the domestic corn market over these years, which may cause variances to be time-variant and prices to have a nonnormal distribution.

APPENDIX 3: PROCEDURES FOR NORMALITY AND HETEROSKEDASTICITY TESTING

This appendix presents the procedures employed in testing normality in the distribution of the price series used and in determining heteroskedasticity in the variances.

Relative Kurtosis and Skewness as Measures of Normality

Relative kurtosis, which measures peakedness, α_4 in the distribution is defined as

$$\alpha_4 = \frac{\frac{1}{n}\sum_{i=1}^{n}(X_i - \bar{X})^4}{s^4},$$

where s^4 denotes the fourth power of the standard deviation and $\bar{X}$ is the mean.

For the price series to have a normal distribution, a distribution that is bell-shaped, α_4 is equal to zero. If α_4 exceeds zero, the distribution is leptokurtic, meaning a more peaked distribution, with fatter tails than normal. A platykurtic distribution, indicated by α_4 being negative, is flat-shaped, with thinner tails than normal.

Skewness measures the symmetry in the frequency distribution about the mean. A distribution is symmetric if the mean, median, and mode are equal. A positively skewed distribution is obtained if the mean is greater than the median, and negatively skewed if the median is larger than the mean. A measure of skewness, α^3 is defined as

$$\alpha_3 = \frac{\frac{1}{n}\sum_{i=1}^{n}(X_i - \bar{X})^3}{s^3},$$

where s^3 is the cubic power of the standard deviation and $\bar{X}$ is the mean.

The distribution is symmetric if α_3 equals zero. Positive values of α_3 would mean that the distribution is positively skewed, that is, has a longer tail to the right than normal. A more negatively skewed distribution than normal, that is, a longer tail to the left, would have negative values of α^3.

Lagrange Multiplier Test for Heteroskedasticity

The ARCH modeling is valid in the presence of heteroskedastic variances. To determine the presence of heteroskedasticity, the Lagrange multiplier (LM) test was employed. A univariate ARCH test and bivariate ARCH test were conducted for each of the autoregressive models estimated.

The univariate ARCH test involves the estimation of the auxiliary regressions from the residuals of the least squares calculation of the univariate homoskedastic autoregressive models at lag orders 1 to 8 and a constant, and testing the value TR^2 as a chi-square distribution at the specified lag orders, where T denotes the number of observations and R^2 is the coefficient of determination obtained from regressing contemporaneous squared residuals on a constant and its p lagged values. The hypothesis of homoskedasticity is rejected if the calculated chi-square statistic exceeds the critical chi-square value at the appropriate lags.

The bivariate ARCH test uses the residuals from the least squares estimation of the bivariate homoskedastic autoregressive models in calculating the auxiliary regressions and is defined as (Engle 1982)

$$LM(p) = T \cdot N \cdot \left(\sum_{i=1}^{N} R_i^2 \right),$$

where N represents the number of auxiliary regressions estimated, T is the number of observations, and R^2 is the coefficient of determination obtained by regressing squared residuals against their lagged values of the eighth order and an intercept. Time dependence in the variance is detected if the calculated Lagrange multiplier statistic exceeds the critical chi-square value.

APPENDIX 4: PROCEDURE FOR ESTIMATING THE E-ARCH (P) MODEL

Equations (4) and (5) were calculated iteratively using the estimated generalized least squares (EGLS) procedure, which involves the following steps:

Step 1. Identification of the autoregressive (AR) process, *i*, of the logarithm of the first differences in monthly wholesale prices of corn in each of the selected major regional corn markets, *j* and *k*, being analyzed, adjusted for seasonality, using the Akaike Information Criterion (AIC) procedure.
Step 2. Least squares estimation of equation (4) and obtaining the residuals.
Step 3. Identification of the ARCH (*p*) process of the squared residuals within each market adjusted for seasonality, (again) using the AIC procedure.
Step 4. Least squares estimation of equation (5), using the identified ARCH process and obtaining the exponential values of the forecast variances.
Step 5. Identification of the autoregressive process of the rescaled price changes (monthly price changes divided by forecast squared deviations) within each market, using the AIC procedure.
Step 6. EGLS reestimation of equation (4), using the rescaled data.

The EGLS estimation in Step 1 to Step 6 is asymptotically equivalent to maximum likelihood, and parameter estimates will be best, linear and unbiased (BLUE) (Ramanathan 1989). Estimation is terminated if the squared innovations in the EGLS conditional mean equations estimated in Step 6 no longer exhibit a statistically significant ARCH effect and, therefore, their variances are homoskedastic. Otherwise, a longer ARCH order, *p*, than initially identified by the AIC in Step 3 is included, and equation (4) is reestimated.

For convergence, the nonnegativity restriction imposed by Engle on the parameters of the residuals was not used here.[22] Because the sum of the coefficients of the lagged squared residuals for all *p* are less than unitary, the finite variance required in estimation of the ARCH (*p*) model is satisfied. Nonnegativity is ensured by obtaining their exponential values prior to rescaling the series.

[22]Convergence was not achieved when the nonnegativity constraints on the coefficients of the lagged residuals were imposed. Positive values of the variances were obtained by calculating their exponential values.

APPENDIX 5: BIVARIATE CORRELATION BETWEEN SPOT WHOLESALE PRICES FOR YELLOW AND WHITE CORN

Another widely used method of evaluating market integration is the bivariate correlation procedure. Bivariate correlation involves estimating the correlation coefficient between pairs of spot or cash prices of homogeneous products between markets separated by time, space, and form. Typically, statistically significant and close to unitary coefficients suggest well-integrated markets and thereby efficiently operating markets, while low correlation coefficients indicate nonintegrated markets. Results of the pairwise correlation estimation between wholesale corn prices in the regions considered in the study are presented here. Some limitations and criticisms of this procedure in inferring market integration are also highlighted in this section.

Bivariate Price Correlations Between Wholesale Corn Markets

Using monthly wholesale prices between principal corn regions, price correlations were calculated for the 1980-89 sample period and are presented separately for white corn grains in Table 30 and for yellow corn grains in Table 31. For yellow corn, price correlations were estimated separately between Manila and each of the regional markets of Cagayan Valley, Southern Mindanao, and Northern Mindanao; for white corn, estimation was conducted between Central Visayas, in place of Manila, and the same regional markets.

Generally, price correlation coefficients between regions for yellow corn and white corn are high, ranging from 0.79 to 0.96, and statistically significant at the 1 percent level. Findings for white corn suggest that the regional wholesale markets

Table 30—Correlation coefficient estimates between pairs of monthly wholesale prices of white corn in Central Visayas and the centers of Cagayan Valley, Southern Mindanao, and Northern Mindanao, 1980-89

Region	Central Visayas	Cagayan Valley	Southern Mindanao	Northern Mindanao
Central Visayas	1.00[a]			
Cagayan Valley	0.89	1.00		
Southern Mindanao	0.94	0.91	1.00	
Northern Mindanao	0.93	0.79	0.89	1.00

Source: Basic data are from BAS 1990.
Notes: Central Visayas is an urban market center; the other three regions are rural market centers. Only the lower triangular matrix of the estimated correlation coefficients is reported.
[a]Unless otherwise specified, all price correlation coefficient estimates are statistically highly significant at the 1 percent level.

Table 31—Correlation coefficient estimates between pairs of monthly wholesale prices of yellow corn in Manila and the centers of Cagayan Valley, Southern Mindanao, and Northern Mindanao, 1980-89

Region	Manila	Cagayan Valley	Southern Mindanao	Northern Mindanao
Manila	1.00[a]			
Cagayan Valley	0.96	1.00		
Southern Mindanao	0.94	0.93	1.00	
Northern Mindanao	0.87	0.86	0.81	1.00

Source: Basic data are from BAS 1990.
Notes: Manila is an urban market center; the other three regions are rural market centers. Only the lower triangular matrix of the estimated correlation coefficients is reported.
[a]Unless otherwise specified, all price correlation coefficient estimates are statistically highly significant at the 1 percent level.

of Southern Mindanao and Northern Mindanao, the regions near Central Visayas, are closely integrated with Central Visayas, as indicated by correlation coefficients of 0.94 to 0.93. Contrary to expectations, Cagayan Valley, the region located north of Luzon and farthest from Central Visayas, is well integrated with Central Visayas, with a 0.89 correlation coefficient, and a similar estimate is obtained between Southern Mindanao and contiguous Northern Mindanao.

The appearance of well-integrated spatial markets can also be inferred for yellow corn. Price correlations between Manila and the closest region of Cagayan Valley as well as the farthest regions of Southern Mindanao and Northern Mindanao are fairly high, at or exceeding 0.87. In comparison, Southern Mindanao and Northern Mindanao, expected to be most closely integrated, obtained a correlation coefficient of 0.81, which is lower than the estimate obtained between Northern Mindanao and Cagayan Valley, 0.86.

Limitations of Bivariate Price Correlations

However, price correlation estimate as a measure of spatial integration and market performance is highly problematic. As shown earlier, price correlations are inconclusive, since estimates are consistently high between adjoining regions and even between distant regions. Thus, inferences of well-integrated markets do not necessarily follow from correlation coefficient estimates converging to unitary.

In an extensive review of empirical work utilizing this method, Harriss (1979) stated that inflationary trends and highly aggregated data could yield high correlation coefficients, leading one to infer incorrectly that markets are well integrated. Additionally, "similar price responses to temporally synchronous local forces of supply and demand" (Harriss 1979, 202), may generate unitary correlation coefficients even between markets that do not trade with one another. Ravallion (1986, 102), expressing a similar criticism, wrote,

> ". . . the time series of prices at the two locations are synchronously, identically, and linearly affected by another variable. Possible examples include the price of a related third good traded in a common market or a shared dynamic seasonal structure in production. Then one can readily express price in one market as a linear function of price in the other market, with slope unity, even though the markets are segmented."

Such synchronous movement in prices across separated markets can be observed in markets where prices are administratively determined. Collusive pricing behavior could likewise result in high interdependence between prices (Faminow and Benson 1990).

Other criticisms of the price-correlation technique relate more to econometric issues. Problems of spurious correlation, serial dependence, measurement errors, and model misspecification that would result in imprecise estimates diminish the validity of inferences on market integration and performance drawn from estimates of price correlations (Blyn 1973; Granger and Newbold 1974; Harriss 1979; Ravallion 1986).

APPENDIX 6: RELATIVE KURTOSIS AND SKEWNESS IN THE DISTRIBUTION OF MONTHLY WHOLESALE REGIONAL PRICE CHANGES OF YELLOW AND WHITE CORN

Measures of relative kurtosis are in general non-zero, suggesting that monthly wholesale regional prices of yellow corn and white corn have nonnormal distributions (Table 32). Relative kurtosis of monthly prices of yellow corn at wholesale across the major corn-producing regions including Manila are negative, indicating a platykurtic distribution, that is, thinner-tailed than normal.

To determine whether there are systematic patterns in the distribution of price changes across regions, monthly and yearly estimates of relative kurtosis and relative skewness were estimated and illustrated in separate graphs. There is no discernible pattern observed. As shown in Figure 8, relative kurtosis for yellow corn is generally non-zero in value from month to month for all regions. Monthly relative skewness illustrated in Figure 9 is generally non-zero, indicating a highly skewed distribution.

Similar patterns were also observed for white corn, as shown in Figure 10 for monthly relative kurtosis and Figure 11 for monthly relative skewness.

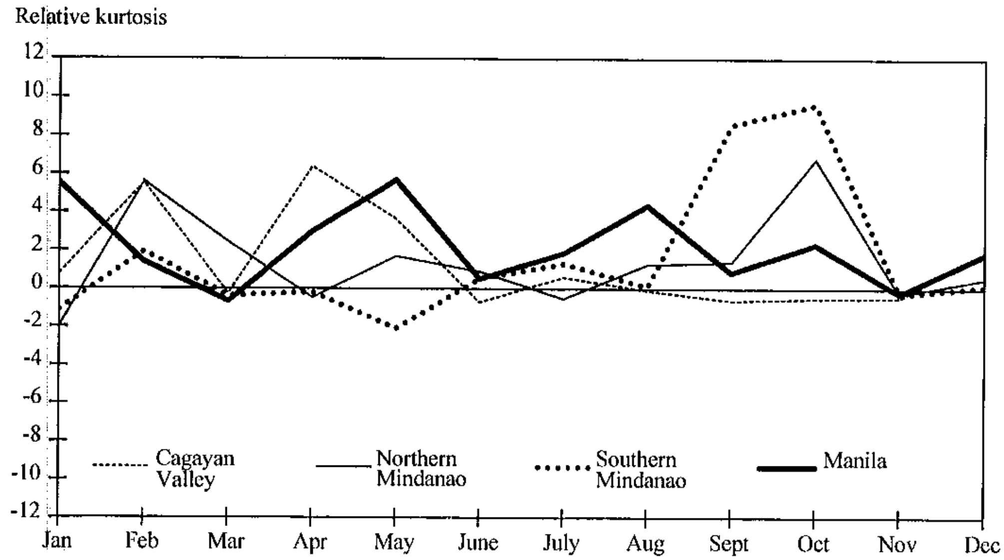
No systematic pattern in the yearly kurtosis and skewness was obtained. Figure 12 illustrates the yearly kurtosis of the monthly changes in the wholesale prices of yellow corn. In general, relative kurtosis is either negative for some months in some regions, indicating a more platykurtic distribution than normal, or positive in other months. An asymmetric distribution is also observed, as shown in Figure 13. Similar patterns are also exhibited by white corn.

Table 32— Mean, variability, and normality in the distribution of monthly wholesale price changes of yellow and white corn, by selected major corn-producing regions, January 1980-December 1989

Type of Corn/ Regional Market	Mean	Skewness[a]	Kurtosis[b]	Coefficient of Variation[c]
Yellow corn				
Cagayan Valley	0.91	−0.017	−1.41	52.29
Manila	1.09	−0.218	−1.57	40.45
Northern Mindanao	0.73	−0.113	−1.47	60.04
Southern Mindanao	0.73	0.052	−1.23	61.93
White corn				
Cagayan Valley	0.69	0.539	3.88	41.78
Central Visayas	0.15	−0.187	1.49	150.74
Northern Mindanao	0.65	0.566	1.00	34.14
Southern Mindanao	0.74	−0.126	2.13	40.98

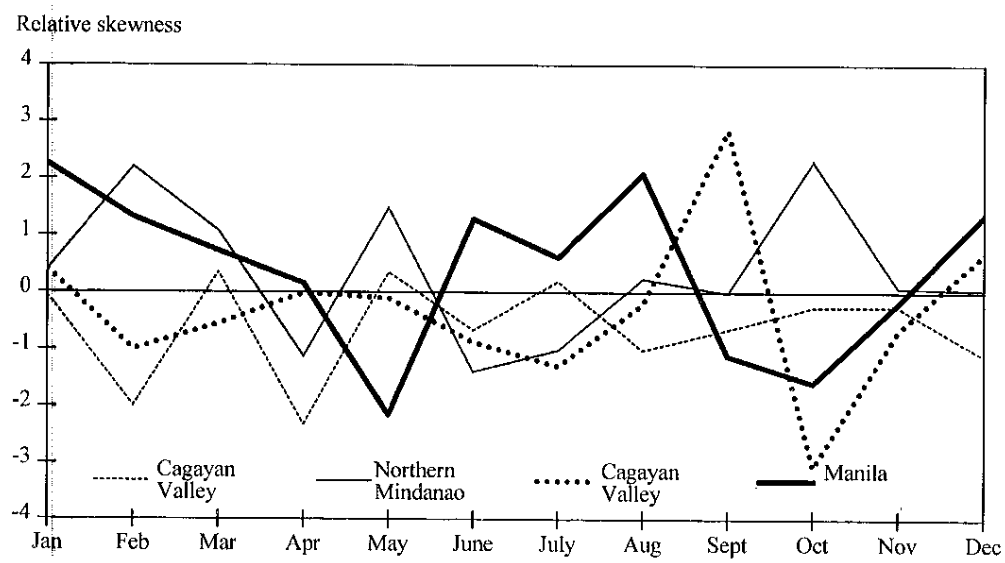
Source: Basic data are from BAS 1990.
[a]If equal to zero, distribution is symmetric. Unless indicated otherwise, relative skewness is statistically significant at the 1 percent level.
[b]If equal to three, distribution is normal. Unless indicated otherwise, relative kurtosis is statistically significant at the 1 percent level.
[c]Coefficient of variation calculated as $(s/\overline{X})$, where s is standard deviation and $\overline{X}$ is the mean.

Figure 8— Relative kurtosis of the monthly wholesale price changes of yellow corn, by month and region, January 1980-December 1989



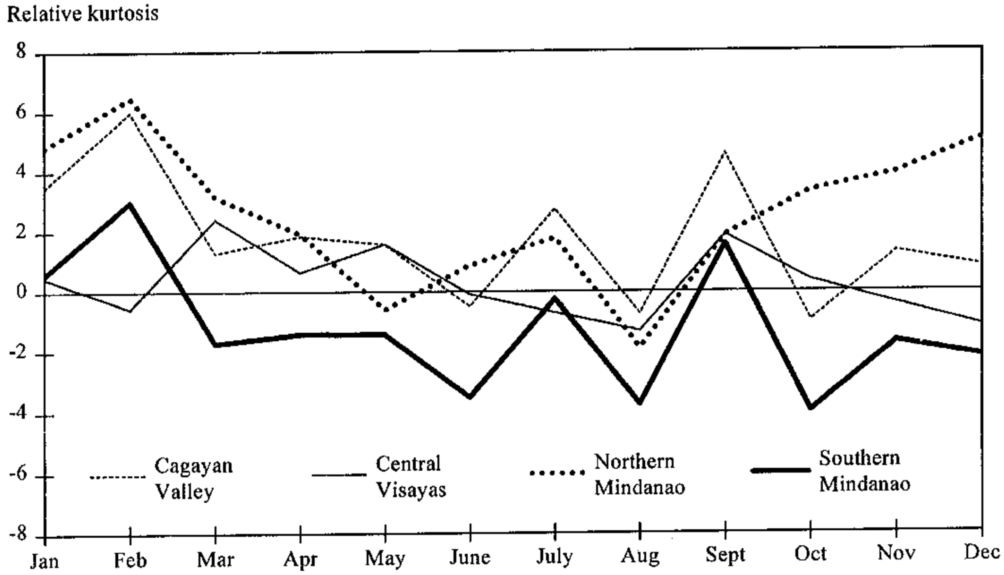
Source: BAS 1990.

Figure 9— Relative skewness of the monthly wholesale price changes of yellow corn, by month and region, January 1980-December 1989



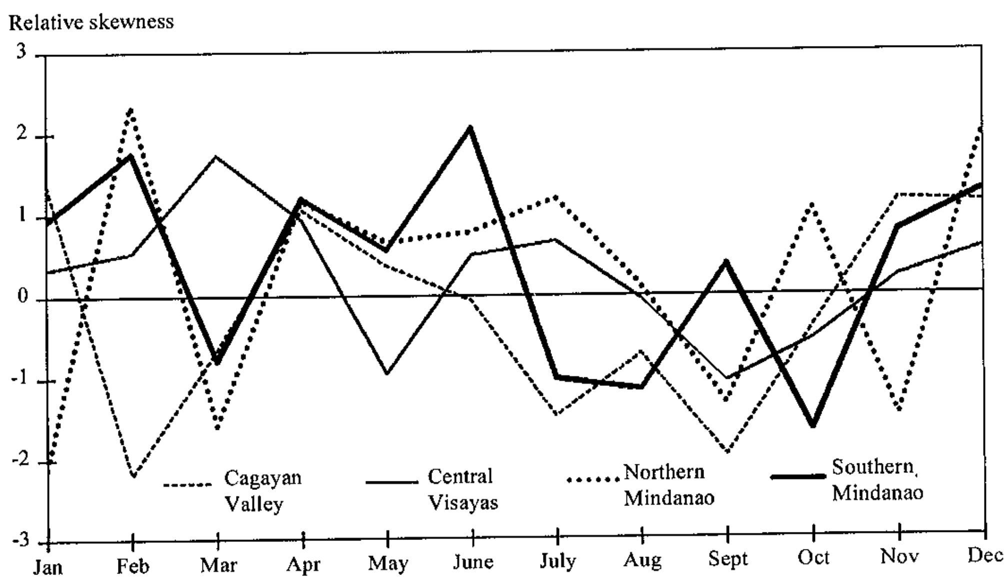
Source: BAS 1990.

Figure 10—Relative kurtosis of the monthly wholesale price changes of white corn, by month and region, January 1980-December 1989



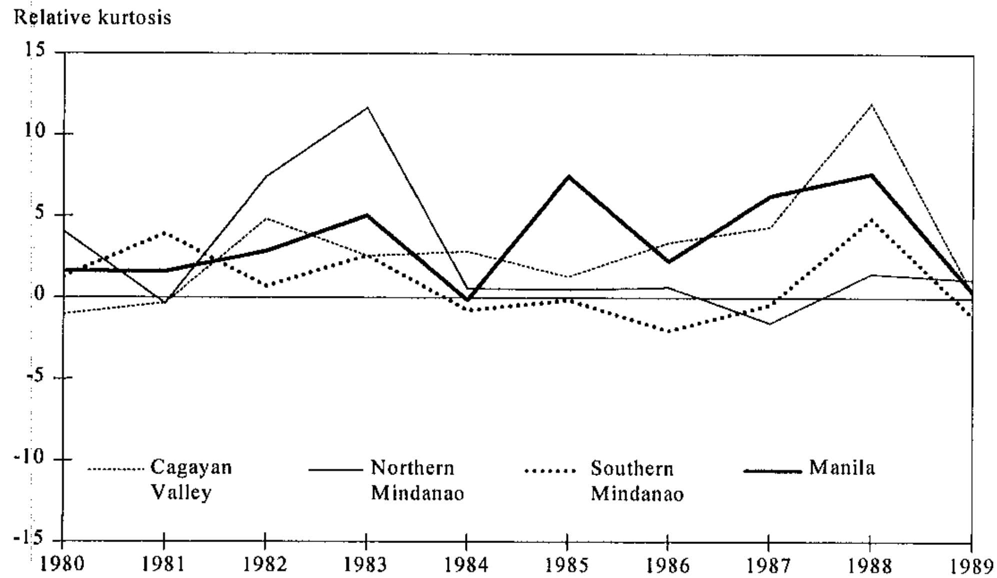
Source: BAS 1990.

Figure 11—Relative skewness of the monthly wholesale price changes of white corn, by month and region, January 1980-December 1989



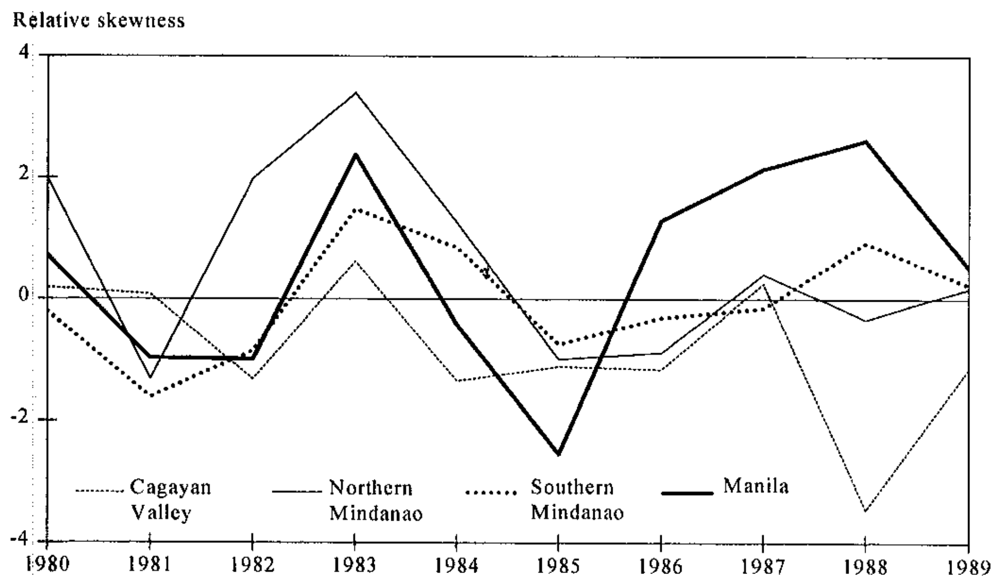
Source: BAS 1990.

Figure 12—Relative kurtosis of the monthly wholesale price changes of yellow corn, by year and region, January 1980-December 1989



Source: BAS 1990.

Figure 13—Relative skewness of the monthly wholesale price changes of yellow corn, by year and region, January 1980-December 1989



Source: BAS 1990.

APPENDIX 7: ANALYSIS OF PRICE SPREADS

Price-spread analysis (margins analysis) was conducted by calculating the price differences between major nodes of the vertical marketing system. To determine discernible and systematic patterns of movement in price margins over time, monthly and yearly farm-wholesale-retail price spreads were estimated.[23] Price spreads (in absolute levels) were calculated separately for yellow corn and white corn and the results are discussed here.

Seasonal Price Indices as Indicator

The 10-year average seasonal indices calculated for the farm, wholesale, and retail prices for yellow corn are illustrated in Figure 14.[24] They display a discernible systematic pattern of movement in yellow corn prices, which vary from one month to another. Generally, a low price for yellow corn tends to prevail during the harvest months, as shown in the sharp dips in the seasonal price indices in January and August. Then prices start to rise and reach their peak levels during periods when corn supply is tight. Yellow corn prices tend to be highest during the lean months of June to July and November to December, as detected by the distinct spikes in the seasonal price indices during these periods.

The seasonality pattern is, however, more pronounced for farm prices and wholesale prices than for retail prices. Prices at the farm and wholesale levels tend to emulate similar and distinct patterns of peaks, as detected during the second quarter of the year, and troughs in August and September. The seasonal movement in the retail price tends to be less distinct than that observed in the farm price and wholesale price.

The sharp differences in seasonality patterns detected may be ascribed to the unavailability of adequate storage services at the farm and wholesale levels, compared with the retail level, and the relative flexibility of the farm price in relation to the retail price.[25] Without access to storage, farmers and wholesalers are compelled to immediately dispose of harvested corn, resulting in a market glut and consequently triggering farm and wholesale prices to drop dramatically. Confronted by low market prices during harvest months, retailers curb the release of corn from storage while

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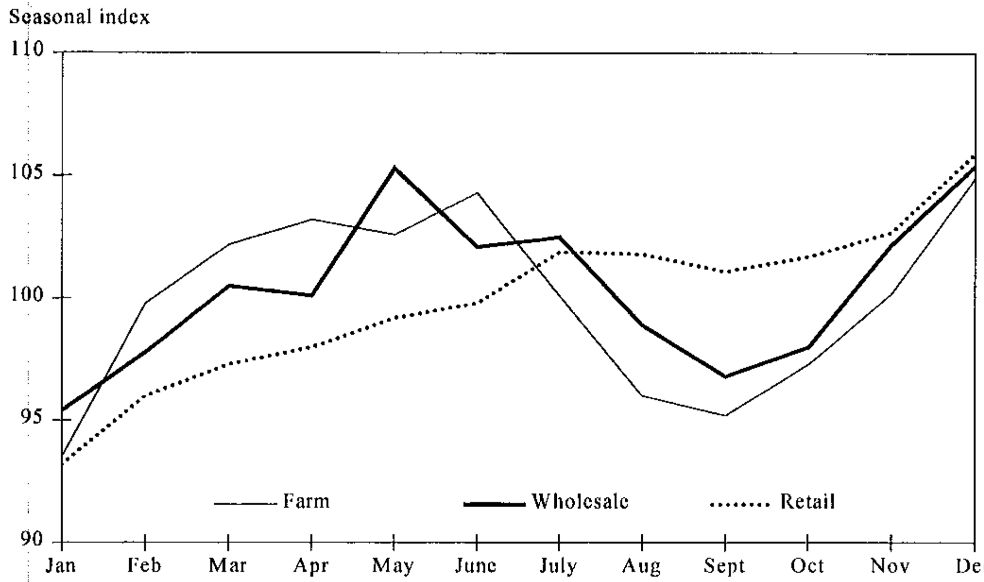
[23]Margins were calculated based on secondary data obtained from the Bureau of Agriculture Statistics. Monthly farm, wholesale, and retail prices for yellow corn grains and white corn grains covering a 10-year period, 1980-89 inclusive, were used in the computation of price spreads. For consistency, this sample period was used throughout the study. Continuous price series at the farm and retail levels of marketing were not available on a regional basis; therefore, national prices were utilized in the analysis of margins and in the bivariate price correlation estimation.

[24]For each price series, an appropriate seasonal price index was constructed using the average percentage method. The calculation involves two steps: Step 1 entails expressing prices for each month as a percentage of the average price for the year, and in Step 2 the averages of the percentages for the corresponding months are calculated to obtain the seasonal index for that particular month (Merrill and Fox 1970, 474-480).

[25]The inadequacy of storage facilities available at the farm level and the wholesale level is supported by the survey results.

Figure 14—Seasonality in the farm, wholesale, and retail prices of yellow corn, January 1980-December 1989



Source: BAS 1990.
Note: Seasonal indices were calculated using the average percentage method.

increasing their purchases of cheap corn. During periods of tight corn supply, retailers take advantage of high prices by removing corn from storage promptly, while limiting their buying of corn.

White corn exhibited a similar seasonality pattern of price movements, as shown in Figure 15. The calculated 10-year average farm, wholesale, and retail price indices for white corn were lowest in August and September. The farm price for white corn was highest in April and December, while wholesale and retail prices peaked in June-July and November-December.

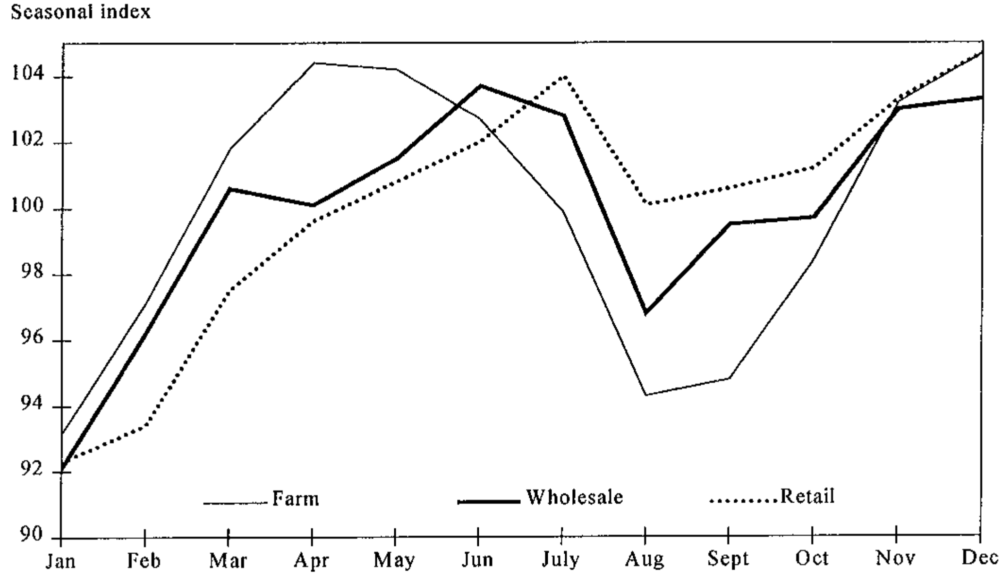
Seasonality in Marketing Price Spreads

Per unit (absolute) margins calculated between farm price and wholesale price, between wholesale price and retail price, and between farm price and retail price for yellow corn and white corn revealed some seasonality patterns.

The narrowest per unit price spread for both yellow and white corn was obtained in April, when yellow corn prices are highest (Table 33). Thus, when yellow corn becomes costly to obtain, traders tend to operate on a squeeze margin due to cost increases.

The tightening of margins is apparent from the calculated percentage share of the farm-to-retail margin to farm price and the percentage share of the farm-to-retail margin to retail price being smallest in April, 58 percent and 37 percent, respectively (Table 33).

Figure 15—Seasonality in the farm, wholesale, and retail prices of white corn, January 1980-December 1989



Source: BAS 1990.
Note: Seasonal indices were calculated using the average percentage method.

During periods of ample supply when yellow corn is the cheapest, marketing margins tend to be widest as manifested by the large share of margins to farm price and retail price. Beginning in August, farm-to-retail margins accounted for 75 percent of farm price and 43 percent of retail price.

Although the widening of margins in some months and narrowing in other months suggest that intertemporal arbitrage may be profitable, information on costs is unavailable to allow the calculation of the benefits from storage.

White corn margins also exhibited similar patterns of narrowing in margins in the lean month of April and widening during the abundant months, starting in June. Overall, however, the margins for cheaper white corn tend to be less than those obtained from yellow corn for comparable months. Compared with yellow corn, white corn is relatively a lower-valued commodity.

Farmer's Share of the Retail Cost

An issue of great public interest concerns the share of the Filipino farmers in the consumer peso.[26] Considered as a measure of welfare, though highly contested in empirical works, approximately 60 percent of the retail cost of yellow corn and white

[26]The farmer's share is computed as the percentage of the price received by farmers over the price paid by the consumers at retail.

Table 33—Seasonality in price spreads for corn, by variety, 1980-89

Variety/Month	Price Spread				
	Absolute Margin			Percentage Share of Margin	
	F – W	W – R	R – F	(R – F)/F	(R – F)/R
	(pesos/kilogram)			(percent)	
Yellow corn					
January	0.57	0.93	1.50	70	41
February	0.46	0.94	1.40	60	38
March	0.46	0.93	1.39	59	37
April	0.44	0.95	1.39	58	37
May	0.45	0.99	1.44	61	38
June	0.47	0.99	1.44	61	38
July	0.56	1.12	1.68	72	42
August	0.59	1.05	1.64	75	43
September	0.53	1.16	1.69	76	43
October	0.55	1.33	1.88	83	45
November	0.53	1.05	1.58	66	40
December	0.54	1.08	1.62	66	40
White corn					
January	0.62	0.92	1.54	88	47
February	0.37	0.79	1.16	53	35
March	0.33	0.85	1.18	51	34
April	0.23	0.96	1.19	51	34
May	0.27	0.98	1.25	54	34
June	0.37	0.97	1.34	59	37
July	0.36	1.08	1.44	64	39
August	0.38	1.07	1.45	68	41
September	0.47	0.96	1.43	67	40
October	0.37	0.98	1.35	61	38
November	0.35	0.96	1.31	56	36
December	0.32	1.03	1.35	57	36

Source: BAS 1990.
Note: F refers to farm price, W to wholesale price, and R to retail price.

Table 34—Farmer's share of the retail price paid by consumers for corn, by month, 1980-89

Month	Yellow Corn	White Corn
	(percent)	
January	59	53
February	62	65
March	63	66
April	63	66
May	62	65
June	62	63
July	58	61
August	57	59
September	57	59
October	55	59
November	60	64
December	60	64

Source: BAS 1990.

corn is received by Filipino farmers (Table 34). That is, a farmer gets P 0.60 of P 1.00 paid by consumers for a kilogram of corn.

The farmer's share of the retail price moves up and down jointly with the rise and fall in farm price. When farm prices were highest in April, the farmer's share was also highest, accounting for 63 percent of the retail price for yellow corn and 66 percent for white corn. During periods of low farm price, the farmer's share registered the lowest.

The synchronous pattern of movement in farmer's share and price received by farmers indicates the flexibility in farm price and the relative stickiness in marketing margins. As farm price declines, it becomes a smaller percentage of the retail cost. Its share of the retail price inflates as farm price increases.

BIBLIOGRAPHY

Agcaoli, M., and M. W. Rosegrant. 1992. Regional trends and projections for food supply, demand, and trade in Asia. Terminal report submitted to the Asian Development Bank on the project Food Situation and Outlook for Asia. International Food Policy Research Institute, Washington, D.C.

Akaike, H. 1969. Fitting autoregressive models for prediction. *Annals of Institute of Statistical Mathematics* 21: 826-839.

Anderson, R. W. 1985. Some determinants of the volatility of futures prices. *Journal of Futures Markets* 5 (3): 332-348.

Ardeni, P. G. 1989. Does the law of one price really hold for commodity prices? *American Journal of Agricultural Economics* 72 (August): 663-669.

Bailey, D., and B. W. Brorsen. 1989. Price asymmetry in spatial fed cattle market. *Western Journal of Agricultural Economics* 14: 246-252.

Baillie, R. T., and T. Bollerslev. 1989. The message in daily exchange rates: A conditional-variance tale. *Journal of Business and Economic Statistics* 7 (July): 297-305.

BAS (Bureau of Agricultural Statistics). 1986. *Agricultural marketing news (AMNEWS) manual of operation.* Quezon City, Philippines: BAS.

______. 1987. Farm prices survey manual of operations. Quezon City, Philippines: BAS.

______. 1990. *Monthly market prices of yellow and white corn.* Quezon City, Philippines: BAS.

Bessler, D. 1984. An analysis of dynamic economic relationships: An application to the U.S. hog market. *Canadian Journal of Agricultural Economics* 32 (March): 109-124.

Bessler, D., and J. A. Brandt. 1982. *Causality and inference: An application in livestock markets.* Research Bulletin No. 972. West Lafayette, Ind., U.S.A.: Purdue University.

Blyn, G. 1973. Price series correlation as a measure of market integration. *Indian Journal of Agricultural Economics* 28 (January-March): 56-59.

Bollerslev, T. 1986. Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics* 31: 307-327.

Bouis, H. E. 1992. Food demand elasticities by income group by urban and rural populations for the Philippines. In The Philippine corn/livestock sector: Performance and policy implications, ed. M. W. Rosegrant and L. Gonzales, 309-324. Terminal report submitted to the U.S. Agency for International Development. International Food Policy Research Institute, Washington, D.C.

Boyd, M., and B. W. Brorsen. 1986. Dynamic relationship for US and EC corn gluten feed and related markets. *European Review of Agricultural Economics* 13 (2): 199-215.

Brandt, J., and D. Bessler. 1984. Forecasting with vector autoregressions versus a univariate ARIMA process: An empirical example with U.S. hog prices. *North Central Journal of Agricultural Economics* 6 (July): 9-26.

Brorsen, B. W. 1983. A study of the efficiency and dynamics of rice prices. Ph.D. dissertation, Texas A&M University, College Station, Tex., U.S.A.

Brorsen, B. W., J. P. Chavas, and W. Grant. 1984. Dynamic relationship of rice import prices in Europe. *European Review of Agricultural Economics* 11 (1): 29-42.

______. 1989. Market structure and spatial price dynamics. Purdue University, West Lafayette, Ind., U.S.A. Mimeo.

Chow, G. C. 1975. *Analysis and control of dynamic systems.* New York: Wiley and Sons.

Costales, A. 1989. *The feedmilling industry in the Philippines: A description of the market structure.* Los Baños, Laguna, Philippines: University of the Philippines.

Deomampo, N. R. 1983. The coconut and copra marketing in the Philippines: Its structure, conduct and performance. Paper presented at the seminar on Coconut: 1983 and the Year After, January 1983, Xavier University, Cagayan de Oro, Philippines.

Engle, R. F. 1982. Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation. *Econometrica* 50 (July): 987-1007.

Engle, R. F., and C. W. J. Granger, 1987. Co-integration and error correction: Representation, estimation, and testing. *Econometrica* 55 (March): 251-276.

Engle, R. F., and B. S. Yoo. 1987. Forecasting and testing in cointegrated systems. *Journal of Econometrics* 35: 143-159.

Faminow, M., and B. L. Benson. 1990. Integration of spatial markets. *American Journal of Agricultural Economics* 72 (February): 49-62.

Ford, S. 1986. A beginner's guide to vector autoregression. Staff Paper P86-28, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul, Minn., U.S.A. Mimeo.

Garrod, P. V., and R. K. Roberts. 1986. Prices as proxies for prices. *American Journal of Agricultural Economics* 68 (August): 626-633.

Gilmore, R. 1982. *A Poor Harvest.* New York: Longmans.

Gonzales, L. A., and N. D. Perez. 1992. The economics of corn production in the Philippines. In The Philippine corn/livestock sector: Performance and policy implications, ed. M. W. Rosegrant and L. Gonzales, 45-147. Terminal report submitted to the U.S. Agency for International Development. International Food Policy Research Institute, Washington, D.C.

______. 1992. The economics of hog and poultry production. In The Philippine corn/livestock sector: Performance and policy implications, ed. M. W. Rosegrant and L. Gonzales, 149-159. Terminal report submitted to the U.S. Agency for International Development. International Food Policy Research Institute, Washington, D.C.

Gonzales, L. A., B. V. Dimaranan, and P. H. Manzo. 1992. Trends in the supply and demand for corn and livestock. In The Philippine corn/livestock sector: Performance and policy implications, ed. M. W. Rosegrant and L. Gonzales, 3-44. Terminal report submitted to the U.S. Agency for International Development. International Food Policy Research Institute, Washington, D.C.

Goodwin, B. K., and T. C. Schroeder. 1991. Cointegration tests and spatial price linkages in regional cattle markets. *American Journal of Agricultural Economics* 2 (May): 452-464.

Granger, C. W. J. 1969. Investigating causal relations by econometric models and cross spectral methods. *Econometrica* 37: 424-438.

Granger, C. W. J., and P. Newbold. 1974. Spurious regressions in econometrics. *Journal of Econometrics* 37 (July): 45-66.

Gupta, S., and R. A. E. Mueller. 1982. Intertemporal pricing and competitive price system. *European Review of Agricultural Economics* 9 (3): 301-312.

Habito, C. 1983. Policy issues in the coconut industry: A survey. University of the Philippines, Los Baños, Laguna, Philippines. Mimeo.

Han, D. B., D. Jensen, and J. Penson. 1990. Variance of agricultural prices, industrial prices and money. *American Journal of Agricultural Economics* 72 (November): 1066-1073.

Harriss, B. 1979. There is method in my madness or is it vice versa? Measuring agricultural market performance. *Food Research Institute Studies* 17 (2): 197-218.

Hayenga, M. (ed.) 1979. *Pricing problems in food industry with emphasis on thin markets*. Monograph 7. North Central Project 117, College of Agricultural and Life Sciences. Madison, Wisc., U.S.A.: University of Wisconsin-Madison.

Heytens, P. J. 1986. Testing market integration. *Food Research Institute Studies* 20 (1): 25-41.

Hsieh, D. 1989. Modeling heteroskedasticity in daily foreign exchange rates. *Journal of Business and Economics Statistics* 7 (July): 307-317.

Kardasz, S. W., and K. Stollery. 1988. Market structure and price adjustment in Canadian manufacturing industry. *Journal of Economics and Business* 40: 335-342.

Kenyon, D., K. Kling, J. Jordan, W. Seale, and N. McCabe. 1987. Factors affecting agricultural futures price variances. *Journal of Futures Markets* 7 (1): 73-91.

Kinnucan, H., and O. D. Forker. 1987. Asymmetry in farm-retail price transmission for major dairy products. *American Journal of Agricultural Economics* 69 (May): 285-292.

Kohls, R., and J. Uhl. 1980. *Marketing of agricultural products*. New York: Macmillan.

Manalaysay, R., M. Menegay, E. Soguilon, G. dela Pena, N. Burgos, S. Mate, J. dela Cruz, H. Montalvo, and C. Ines. N.d. The corn marketing system: A rapid marketing appraisal in the Southern Mindanao region. Report of the joint project of the Philippine Chamber of Commerce and Industry, Food, Agriculture and Forestry Committee, and the Department of Agriculture.

Manuel, P., and M. V. Maunahan. 1982. Coconut/copra marketing system: Its structure, conduct, performance. Philippine Council for Agricultural Resource and Research Development, Los Baños, Laguna, Philippines. Mimeo.

Marion, B. W. 1986. Pricing and vertical coordination in the food system. In *Organization and Performance of the U.S. Food System*, 59-106. Lexington, Mass., U.S.A.: D. C. Heath.

Mendoza, M. S. 1992. The informational efficiency and integration of Philippine agricultural markets. Ph.D. dissertation, Purdue University, West Lafayette, Ind., U.S.A.

Merrill, W. C., and K. A. Fox. 1970. Univariate analysis of time series. In *Economic Statistics*, 450-489. New York: John Wiley and Sons.

Nachane, D. M., R. Nadkarni, and A. Karnik. 1988. Cointegration and causality testing of the energy-GDP relationship: A cross-country study. *Applied Economics* 20 (November): 1511-1531.

NEDA (National Economic Development Authority). Various years: 1970, 1988, and 1992. *Statistical Yearbook*. Quezon City, Philippines: NEDA.

Ngenge, A. W. 1983. The time series analysis of the efficiency of selected U.S. farm commodity markets. Ph.D. dissertation, Texas A&M University, College Station, Tex., U.S.A.

Olgado, S., J. Abunyawan, and B. Domingo. 1977. Yellow corn marketing. Part III, Ilocos region. Special Studies Division, Office of the Secretary, Department of Agriculture, Quezon City, Philippines. Mimeo.

Pabuayon, I. 1985. Corn marketing in the Philippines: An overview and a review of trade and pricing policies. *Journal of Agricultural Economics and Development* 15 (January-July): 55-80.

Perloff, J., and G. Rausser. 1983. The effect of asymmetrically held information and market power in agricultural markets. *American Journal of Agricultural Economics* 65 (May): 365-372.

Phillips, P. C. B., and S. Oularis. 1990. Asymptotic properties of residual based tests for cointegration. *Econometrica* 58 (January): 165-193.

Pierce, D. A., and L. D. Haugh. 1977. Causality in temporal systems. *Journal of Econometrics* 5: 265-293.

Quero, R., M. Menegay, W. Puno, S. Mate, V. Letaba, Jr., J. Tagalo, Jr., C. Tala, D. Diong, M. Menguita, G. Tan, and F. Venegas. N.d. The corn marketing system: A rapid marketing appraisal in the Northern Mindanao region. Technical report on the project of the Cagayan de Oro Chamber of Commerce and Industry Foundation, Inc., under the Accelerated Agricultural Production Project of the Department of Agriculture, Philippines, and the United States Agency for International Development. Department of Agriculture, Quezon City, Philippines.

Ramanathan, R., 1989. *Introductory Econometrics with Applications*. Orlando, Florida: Harcourt Brace Jovanovich.

Ravallion, M. 1986. Testing market integration. *American Journal of Agricultural Economics* 1 (February): 102-109.

Rosegrant, M. W., L. A. Gonzales, H. Bouis, and J. F. Sison. 1987. Price and investment policies for food crop sector growth in the Philippines. Final report submitted to the Asian Development Bank for the project on the Study of Food Demand/ Supply Prospects and Related Strategies for Developing Member Countries of ADB, Phase II. International Food Policy Research Institute, Washington, D.C.

Rosegrant, M., L. Gonzales, B. V. Dimaranan, P. J. Manzo, N. D. Perez, M. S. Mendoza, S. Setboonsarng, and H. E. Bouis. 1992. The Philippine corn/livestock sector: Performance and policy implications. Terminal report submitted to the U.S. Agency for International Development. International Food Policy Research Institute, Washington, D.C.

Setboonsarng, S., and M. W. Rosegrant. 1992. Comparative analysis of production and marketing of corn in the Philippines and Thailand. In The Philippine corn/livestock sector: Performance and policy implications, ed. M. W. Rosegrant and L. Gonzales, 267-274. Terminal report submitted to the Agricultural Policy Analysis Project, Phase II, U.S. Agency for International Development. International Food Policy Research Institute, Washington, D.C.

Taylor, S. 1986. *Modeling financial time series.* New York: John Wiley and Sons.

Timmer, P. C. 1987. *The corn economy of Indonesia.* Ithaca, N.Y., U.S.A.: Cornell University Press.

Ward, R. 1982. Asymmetry in retail, wholesale, and shipping point pricing for fresh vegetables. *American Journal of Agricultural Economics* 64 (May): 205-212.

Webb, P., J. von Braun, and Y. Yohannes. 1992. *Famine in Ethiopia: Policy implications of coping failure at national and household levels.* Research Report 92. Washington, D.C.: International Food Policy Research Institute.

Yang, S. R. 1989. The distribution of speculative price changes. Ph.D. thesis, Purdue University, West Lafayette, Ind., U.S.A.

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