THE ECONOMIC STRUCTURE OF ECUADOR'S RICE AND CORN MARKETS

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TAMRC International Research
Report No. IM-04-04
April 2004

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Texas Agribusiness Market Research Center (TAMRC) International Research Report No. IM-04-04, April 2004 by Mr. Ivan Borja Dr. Gary W. Williams.

ABSTRACT

This study is a qualitative and a quantitative examination of the economic structure of the rice and corn markets in Ecuador. The objective is to provide policy makers with sound empirical information on two of the most important and fastest growing crops in Ecuador to assist in appropriate policy formulation. Following a brief review of previous studies related to Ecuadorian corn and rice markets, a qualitative analysis of those markets is provided as background to the subsequent development of conceptual models of the two markets. The econometric estimation of the parameters of the behavioral equations of the models is then presented. The report concludes with a summary and discussion of the main conclusions of the study along with suggestions for future analysis.

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EXECUTIVE SUMMARY

Agriculture has historically been one of the most important sectors of the Ecuadorian economy and an important source of economic growth. During most of the last century until the 1960s, traditional agricultural exports like cocoa, banana and coffee were the main source of national income and revenues for the government from export taxes. Throughout the 1970s and 1980s, agriculture continued playing an important role in the Ecuadorian economy even when the industry began to stagnate in the mid-80s. During the 1990s, Ecuador decided to change its economic model and launched a process of trade liberalization to increase its participation in world markets. However, most of the "liberalization" achieved through policy change has been in form rather than in substance resulting in little change in the openness of the economy. Lack of an adequate capability to conduct trade, policy, and sector analysis and inadequate data and information systems have prevented the Ecuadorian government from designing and implementing effective trade strategies to open its markets and achieve the desired economic efficiencies.

As a consequence, marketing, trade, policy and other decisions related to the agricultural sector in Ecuador are made without an adequate understanding of the economic inter-relationships and behavioral characteristics of Ecuadorian agricultural markets. Within the Ecuadorian agricultural sector, traditional crops like bananas, cocoa, sugar cane, and palm oil have tended to dominate production. Over the last decade, however, cereal grain production has been the most rapidly growing category of production, expanding at 10% to 15% per year. Cereal production, primarily rice and corn, currently contributes about 15% of the value of total agricultural production in Ecuador. Also, the areas planted to rice and corn are now the largest of any single crops in Ecuador except for cocoa.

This study is a qualitative and a quantitative examination of the economic structure of the rice and corn markets in Ecuador. The specific emphasis of the study is on: (1) defining the structure of the two markets, (2) identifying the key economic and policy factors affecting economic behavior in both markets, and (3) measuring the impact of the identified factors on the supply and demand for both commodities in Ecuador. The objective of this study is to provide policy makers with sound empirical information on two of the most important and fastest growing crops in Ecuador to assist in appropriate policy formulation.

To achieve this goal, the study first provides a brief qualitative analysis of the corn and rice sectors in Ecuador to develop hypotheses regarding the economic relationships in the two markets for subsequent empirical testing. Based on that analysis, both conceptual and mathematical models of two markets are developed. The models include domestic demand and supply relationships for each commodity with linkages to foreign markets. In particular, the corn

market model includes seven equations representing: (1) harvested area of corn, (2) corn production, (3) corn demand for animal feed, (4) corn demand for human consumption, (5) the wholesale price of corn, (6) the producer price of corn, and (7) a market equilibrium condition. The rice market model includes 11 equations representing: (1) harvested area of rice, (2) rice production, (3) the demand for paddy rice, (4) the supply of milled rice, (5) the per capita demand for milled rice, (6) the total demand for milled rice, (7) the excess supply or demand for paddy rice, (8) the excess supply or demand for milled (white) rice, (9) the paddy rice price, (10) the milled price of rice, and (11) the consumer price of rice.

Unfortunately, no national supply and demand balance sheets for agricultural commodities are available for Ecuador from either public or private sources. As a result, the data used for the analysis were pulled together from disparate sources and, therefore, are not internally consistent which caused problems for calculating disappearance data. Nevertheless, using the data available and based on the models developed, the parameters of the behavioral relationships in the model were derived econometrically using the OLS estimator. The following conclusions flow from the empirical analysis for corn:

- Corn and soybeans are substitutes in production in Ecuador.
- Weather problems have had a major impact on Ecuador's corn production over many years.
- The availability of credit has is an important determinant of corn production in Ecuador.
- Soybeans and corn are net complements in the feed demand for corn in Ecuador.
- The feed demand for corn is significantly affected by changes in real incomes as economic growth creates a growing demand for meat and particularly poultry meat in Ecuador.
- The estimated own-price elasticity of the feed demand for corn in Ecuador is 0.25, similar to what has been found in other countries.

For rice, a similar set of conclusions emerge from the empirical analysis for rice:

- Corn is a major competitor of rice for area in Ecuador.
- Credit availability is also critically important for rice production in Ecuador.
- The estimated own-price elasticity of demand for paddy rice for processing in Ecuador is fairly high at -1.12 but within the range reported by other studies.
- Rice processors are sensitive to changes in the price of corn because many rice processors can switch to the processing of corn given appropriate shifts in their relative costs.
- The estimated own-price elasticity of the per capita demand for rice in Ecuador (-0.74) is also reasonable and within the range found by other studies.
- Potatoes and noodles are substitutes for which is consistent with observed behavior and previous research.
- The estimated income elasticity of rice demand in Ecuador is 0.51, quite consistent with previous studies.
- While the paddy, wholesale, and retail prices of rice are correlated, the relatively higher rate of growth of the retail price compared to the wholesale and of the wholesale to the paddy price suggests that marketing costs have been increasing over time in Ecuador for which a proxy needs to be found or constructed to be able to better explain the growing margin between the price of rice in Ecuador at different levels in the market.

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THE ECONOMIC STRUCTURE OF ECUADOR'S RICE AND CORN MARKETS

Ecuador's economy has performed poorly since the early 1980s (World Bank 2000). The country's foreign debt increased during the 1980s as a consequence of aggressive borrowing in international financial markets based on predictions of future petroleum revenues that were never realized. The ensuing debt crisis of the 1980s lead to an economic growth crisis from which Ecuador has never fully recovered. The current macroeconomic crisis is the result of a combination of external and climate shocks, worsened by inadequate and, in some instances, inappropriate policy responses (Hurtado, 2002).

In an effort to force economic reforms on its markets, Ecuador launched a process of trade liberalization in the mid-1990s to increase its participation in world markets. However, most of the "liberalization" achieved through policy change has been in form rather than in substance resulting in little change in the openness of the economy. In fact, in many ways, the dollarization of the national Ecuadorian currency (the Sucre) in 2002 was an effort to impose a degree of openness on the economy that the trade "reforms" have failed to achieve and to force economic re-structuring by eliminating the authority of the Ecuadorian Central Bank over the rate of money supply growth.

Lack of an adequate capability to conduct trade, policy, and sector analysis and inadequate data and information systems have prevented the Ecuadorian government from designing and implementing effective trade strategies to open its markets and achieve the desired economic efficiencies. Perhaps the most critical factors for the future growth of the Ecuadorian economy will be productivity and information (Whittaker 1996).

Because agriculture is the second most important source of economic activity in Ecuador, an increase in productivity and information for decision-making in the agriculture sector is particularly crucial for the economic future of Ecuador (Whittaker 1996). Unfortunately, little good quantitative information to support agricultural and trade policy making in Ecuador is available. What little exists tends to focus on traditional crops (cocoa, bananas, and palm oil).

Over the years, the agricultural sector has played a key role in the Ecuadorian economy, providing jobs and stability particularly during periods when the industrial sector has struggled and stagnated. Currently, the agricultural sector contributes about 17% of the real Ecuadorian Gross Domestic Product (GDP) and employs 23% of the national work force. Also, agriculture has been the only economic sector with positive and stables rates of growth over the last decade (Ministry of Agriculture and Livestock, 2003).

Within the agricultural sector, traditional crops like bananas, cocoa, sugar cane, and palm oil have tended to dominate production. Over the last decade, however, cereal grain production has been the most rapidly growing category of production, expanding at 10% to 15% per year. Cereal production, primarily rice and corn, currently contributes about 15% of the value of total agricultural production in Ecuador. Also, the areas planted to rice and corn are now the largest of any single crops in Ecuador except for cocoa.

This study is a qualitative and a quantitative examination of the economic structure of the rice and corn markets in Ecuador. The specific emphasis of the study is on: (1) defining the structure of the two markets, (2) identifying the key economic and policy factors affecting economic behavior in both markets, and (3) measuring the impact of the identified factors on the supply and demand for both commodities in Ecuador. The objective of this study is to provide policy makers with sound empirical information on two of the most important and fastest growing crops in Ecuador to assist in appropriate policy formulation.

Most quantitative studies of Ecuadorian agriculture either have been based on the experience of other countries with similar conditions as Ecuador or have provided empirical results that are simply not believable (Bucheli 1994). As a consequence, marketing, trade, policy and other decisions related to the agricultural sector in Ecuador are made without an adequate understanding of the economic inter-relationships and behavioral characteristics of Ecuadorian agricultural markets. Given the economic importance of the agricultural sector in Ecuador, analyses of the main factors affecting economic behavior in key commodities, such as rice and corn, are critically needed to provide the necessary support for informed decision-making in both the private and public sectors.

Following a brief review of previous studies related to Ecuadorian corn and rice markets, a qualitative analysis of those markets is provided as background to the subsequent development of conceptual models of the two markets. The econometric estimation of the parameters of the behavioral equations of the models is then presented. The report concludes with a summary and discussion of the main conclusions of the study along with suggestions for future analysis.

Previous Studies Related to Ecuadorian Corn and Rice Markets

Although many studies have analyzed the Ecuadorian agricultural sector and have attempted to identify key factors affecting the sector such as agricultural policy and climate, few have focused on analyzing economic behavior in specific Ecuadorian agricultural markets and even fewer have focused specifically on the corn and rice markets in Ecuador. Most of the studies that have been done, however, have been qualitative rather than quantitative. One of the earliest quantitative studies of Ecuadorian agriculture that included corn and rice was an unpublished master's thesis by Bucheli (1994) in which he estimated supply and demand parameters and elasticities for rice, corn, and soybeans in Ecuador using both ordinary least squares (OLS) and two stages least squares (2SLS). He reports difficulties using the 2SLS estimator because of the limited number of data observations available. He uses the elasticities calculated to simulate the effects of price policies on all three crops included in his study. He finds that for corn and soybeans, government policies between 1980 and 1992 boosted domestic production but reduced consumption. In contrast, he finds that government policy has had little effect on the Ecuadorian rice market. These conclusions agree with general agricultural policy behavior in Latin American countries during the 1980s when most protected their import-competing sectors and provided incentives to their export-oriented sectors.

Vallejo (1996) provides an analysis of the impact of agricultural policies on Ecuadorian agriculture over the 1992 to 1996 period and suggests alternatives for the year 2000. In the first part of the study, she presents a qualitative analysis of the effects of Ecuadorian macroeconomic policies on the main agricultural products, including soybeans, palm oil, rice, corn, wheat, fish, milk, beef, poultry, bananas, coffee, cocoa and non-traditional products. Using the Policy Analysis Matrix (PAM) methodology developed by Monke and Pearson (1989), she analyzes the effects of changes in variables like international prices, exchange rates, and the interest rate on agricultural product yields, price, area harvested, and production. She concludes that the most important macroeconomic variable influencing the Ecuadorian agriculture sector include the exchange rate, the interest rate, and government expenditures that influence the propensity to export bananas, coffee, and sugar cane. Vallejo also finds that the important internal factors affecting Ecuadorian agriculture are market policies, per capita income, tariff and non-tariff barriers, and technology. She notes that these factors are particularly important for the rice, corn, and soybean markets.

Recalde (2000) applies the Policy Analysis Matrix methodology to the Ecuadorian corn sector over the period 1996 to 1998 to compare the market (private) prices and the efficiency (social) prices for corn. He concludes that the three most important variables affecting profitability in the Ecuadorian corn sector are the price of corn, corn yields, and the exchange rate and that the main challenges facing Ecuadorian corn markets include low yields, inadequate seed genetics, inappropriate technology, lack of research, lack of competition in demand, a monopoly of agricultural supply dealers, and organizational issues.

Andrade (2000) analyzes the impacts of Andean regional integration on the Ecuadorian rice market using an econometric, simultaneous equations model. He concludes that the 1995 implementation of the Andean Pact with the Common External Tariff and the Andean System of Price Bands has created a deficit in the supply of paddy and white rice throughout the Andean region which has generated an increase in rice trade among the member countries. He finds that Ecuador and Venezuela have benefited from the creation of rice trade in the Andean Region, especially with Colombia which has decreased its imports from third countries to the benefit of rice exports from Ecuador and Venezuela. Nevertheless, he finds that non-member countries continue to be the main suppliers of rice to the Andean Pact countries. His analysis indicates that the increased Ecuadorian exports of rice have come primarily from a decline in domestic rice consumption as a result of increasing consumer prices rather than from an increase in domestic rice production or processing.

Background on Ecuadorian Rice and Corn Markets

Following a brief overview of the Ecuadorian agricultural sector, its importance in the national economy and general characteristics, the markets for rice and corn are analyzed in more detail with a focus on the characteristics and economic factors affecting their supply, demand, international trade, and policies. The discussion is based on previous studies of rice markets by Andrade (2000), corn markets by Recalde (2000), and other sources as indicated.

Importance of Agriculture in the Economy of Ecuador

Agriculture plays a key important role in the Ecuadorian economy, contributing about 17% of the real GDP and employing 67% of the rural population and 25% of the working age population (Ecuador Ministry of Agriculture and Livestock). Also, agriculture has been the only sector in Ecuador with a positive and stable rate of economic growth (15% annual average) over the last decade. In the year 2002, the agriculture sector accounted for 40% of total Ecuadorian exports (Table 1). In that same year, the net agricultural trade balance reached more than $1.2 billion while the total trade balance was just $1.5 billion (Central Bank of Ecuador). As indicated earlier, rice and corn are the two largest, non-traditional crops produced in Ecuador. Cereal production currently contributes about 15% of the value of total agricultural production in Ecuador with rice and corn together accounting for about 80% of cereal grain production.

Ecuadorian Rice Market Structure

This section considers the structure and characteristics of the Ecuadorian rice market with emphasis on the characteristics of rice supply and demand as well as horizontal and vertical linkages in the industry, prices, trade and policy affecting the industry.

Ecuador Rice Supply

The production of rice in Ecuador has generally increased over the last 35 years (Table 2). From an average of 181,225 mt of paddy rice during the 1960s, Ecuador's production of rice increased at an annual average rate of 7% to reach an average of 1,045,933 mt during the 1990s. Rice production hit its peak in 1994 at 1,420,468 mt. The particularly rapid, 19% average annual growth of rice production between 1990 and 1994 was the result of price liberalization in the domestic market, implementation of the Andean Pact (the free trade area of Andean nations which established a mechanism of price controls), and a growing rice deficit among the Andean Pact members, particularly in Colombia. A combination of factors, however, turned around the fortunes of the Ecuador rice industry after 1994. Rice production dropped an average of 14% a year through 1999 primarily as a result of the climatic phenomena known as "El Niño". In 1997, "El Niño" caused a 27% decline in production. In 1998 and 1999, the effects of "El Niño" were accompanied by negative economic factors including an unstable exchange rate, an increase in interest rates, and a reduction in the availability of credit to finance the purchase of seed and other production inputs.

Rice production in Ecuador is concentrated in the coastal areas. Between 1990 and 1998, the area planted to rice averaged 350,000 hectares (ha) and the area harvested averaged 330,000 ha, accounting for nearly 30% of the total area dedicated to annual crops. During the 1990s, rice yields increased 2.6% annually and averaged 3.1 mt/ha.

Table 1: Agriculture's Share of Ecuadorian Exports, 2000

Product	Volume	Value (f.o.b)	Share of Total
	metric tons	US$ 1,000	%
Total Exports	19,994,931	4,821,888	100.0
Total Agriculture Exports	5,039,952	1,930,459	40.0
Top Agricultural Exports	4,991,837	1,867,307	38.7
Bananas	3,939,453	802,305	16.6
Frozen fish	227,440	303,141	6.3
Flowers	60,248	155,552	3.2
Cocoa	49,047	37,513	0.8
Passion fruit juice	26,600	28,085	0.6
Coffee	22,028	24,349	0.5
Palm hearts	14,477	23,654	0.5
Plantains	101,223	11,261	0.2
Corn	81,675	10,926	0.2
Soybeans	27,524	7,055	0.2
Others	442,162	463,466	9.6

Source: Ecuador Ministry of Agriculture

Ecuador harvests rice throughout the year. The two main harvests occur during the rainy season of April through June which accounts for nearly 60% of the production and during the dry season of October through December which accounts for about 30% of production. The remainder is harvested throughout the rest of the year.

About 100,000 to 150,000 small farmers with an average farm size of 10 ha produce about 35% of the total domestic supply. Producers with medium-size farms averaging 300 ha and large-size farms averaging 1,500 ha account for the remaining two-thirds of the production. Members of the the National Federation of Rice Producers (FENARROZ), founded in 1966, account for only about 10% of the total area planted to rice in Ecuador. FENARROZ has limited financial, administrative, and analytical capacity and little influence on national policy decisions affecting rice.

Rice Demand

Rice is a main source of calories (20%) and protein (15%) in Ecuadorian diets. The demand for rice in Ecuador has been filled in most years over the last decade from domestic production with the exception of 1990 and 1998 when Ecuador had to import rice (Table 3). Rice prices have been determined in Ecuador in various ways over the last two decades. During the 1980s, the Empresa Nacional de Comercialización (ENAC) and the Empresa Nacional de Productos Vitales (ENPROVIT) controlled rice prices through market intervention.

Table 2: Ecuador Supply of Rice, 1965-2000

Year	Beginning Stocks of Milled Rice	Imports of Milled Rice	Harvested Area	Average Yield Milled Rice	Total Production Paddy Rice	Total Production Milled Rice	Total Supply Milled Rice
	--------------- mt ---------------		ha	mt/ha	----------------------- mt ------------------------		
1965	n/a	n/a	102,806	0.94	173,118	96,946	96,946
1966	96,946	n/a	110,625	1.13	223,820	125,339	222,285
1967	222,285	n/a	113,510	1.11	225,072	126,040	348,326
1968	348,326	n/a	111,820	0.66	131,733	73,770	422,096
1969	422,096	n/a	91,672	0.93	152,383	85,441	507,537
1970	0	n/a	76,000	1.82	246,674	138,310	138,310
1971	21,150	n/a	70,516	1.60	201,125	112,771	133,921
1972	51,591	n/a	79,782	1.75	248,363	139,257	190,848
1973	86,218	n/a	82,774	1.88	277,400	155,538	241,756
1974	108,076	n/a	101,091	1.97	354,827	198,952	307,028
1975	155,218	n/a	131,600	1.91	449,077	251,797	407,015
1976	276,422	n/a	130,000	1.71	395,474	221,742	498,164
1977	379,314	n/a	107,054	1.72	327,622	183,698	563,012
1978	364,171	n/a	81,300	1.55	225,274	126,331	490,502
1979	348,582	n/a	110,875	1.61	318,470	178,566	527,148
1980	326,197	17,000	126,608	1.69	380,614	213,410	556,607
1981	305,924	11,675	131,275	1.86	434,395	243,565	561,164
1982	280,127	0	131,720	1.64	384,357	215,509	495,636
1983	253,489	4,711	94,851	1.62	273,502	153,353	411,553
1984	236,287	42,821	139,080	1.76	437,166	245,119	524,227
1985	221,846	10,071	149,897	2.11	565,006	316,799	548,715
1986	292,021	0	227,600	1.42	575,900	322,907	614,928
1987	350,271	0	275,900	1.59	780,800	437,795	788,066
1988	420,793	0	287,600	1.86	954,500	535,188	955,981
1989	517,293	49,385	277,600	1.75	867,400	486,351	1,053,030
1990	614,019	19,219	269,200	1.75	840,400	471,212	1,104,450
1991	686,918	0	283,247	1.68	848,200	475,586	1,162,504
1992	772,643	640	309,673	1.86	1,029,557	577,273	1,350,556
1993	865,018	1,056	356,328	1.95	1,239,762	694,268	1,560,342
1994	1,140,306	220	380,069	2.09	1,420,468	795,462	1,935,988
1995	1,488,169	557	395,710	1.83	1,290,518	722,983	2,211,709
1996	1,766,856	255	387,889	1.96	1,355,493	759,076	2,526,186
1997	2,022,679	3,033	320,199	1.74	992,971	556,539	2,582,251
1998	2,055,183	140,519	262,488	2.19	903,462	574,295	2,769,997
1999	2,355,842	3,144	179,500	1.92	538,500	344,640	2,703,626
2000	2,340,482	n/a	180,000	1.68	540,000	302,400	2,642,882

n/a = not available
Source: Bucheli; Andrade; and Ecuador Ministry of Agriculture and Livestock

Table 3: Ecuador Demand for Rice, 1965-2000

Year	Per Capita Demand	Population	Domestic Demand	Exports	Total Demand	Ending Stocks
	kg/person	millions	--------------------------------	mt	--------------------------------	
1965	17.30	5.19	89,860	n/a	89,860	96,946
1966	16.70	5.34	89,252	n/a	89,252	222,285
1967	20.60	5.50	113,278	n/a	113,278	348,326
1968	12.80	5.66	72,421	n/a	72,421	422,096
1969	10.50	5.82	61,125	n/a	61,125	0
1970	23.60	5.99	141,358	n/a	117,160	21,150
1971	18.60	6.33	117,760	n/a	82,330	51,591
1972	22.30	6.52	145,363	n/a	104,630	86,218
1973	24.10	6.71	161,723	n/a	133,680	108,076
1974	29.90	6.91	206,525	n/a	151,810	155,218
1975	36.90	7.11	262,329	n/a	130,593	276,422
1976	31.60	7.32	231,201	n/a	118,850	379,314
1977	25.50	7.53	191,967	n/a	198,841	364,171
1978	15.70	7.74	121,571	n/a	141,920	348,582
1979	21.60	7.96	171,966	n/a	200,951	326,197
1980	25.70	8.18	210,306	0	250,683	305,924
1981	30.40	8.41	255,637	0	281,037	280,127
1982	30.30	8.64	261,728	0	242,147	253,489
1983	20.40	8.87	180,911	0	175,266	236,287
1984	30.00	9.10	272,967	0	302,381	221,846
1985	36.10	9.33	336,799	0	256,694	292,021
1986	36.70	9.56	350,907	0	264,657	350,271
1987	49.40	9.79	483,848	22,706	367,273	420,793
1988	55.00	10.03	551,579	0	438,688	517,293
1989	47.60	10.26	488,571	25,000	439,011	614,019
1990	40.50	10.50	425,312	19,219	417,532	686,918
1991	45.10	10.74	484,410	50	389,861	772,643
1992	52.60	10.98	577,599	12,372	485,538	865,018
1993	63.30	11.22	710,294	36	420,036	1,140,306
1994	68.40	11.46	783,872	27,819	447,819	1,488,169
1995	61.00	11.70	713,608	24,853	444,853	1,766,856
1996	57.80	11.94	689,950	83,507	503,507	2,022,679
1997	37.80	12.17	460,201	107,068	527,068	2,055,183
1998	44.20	12.41	548,576	54,155	414,155	2,355,842
1999	0.00	12.50	360,000	3,144	363,144	2,340,482

n/a = not available
Source: Andrade; Bucheli; and Ecuador Ministry of Agriculture and Livestock

In 1994, the Law of Agricultural Development was approved and the liberalization of prices commenced. Since that time, consumer and producer prices have been determined by market forces. As a consequence, the nominal price of rice increased 33.5% annually on average between 1990 and 1998 while the real price decreased by an annual average of 1.2%.

Ecuador has also been able to satisfy its domestic requirements for white rice in most years over the last decade from domestic production with enough remaining for export. Colombia has been the main importer of Ecuadorian white rice. Also, the domestic consumption of rice has been less on average than the national production with an average annual surplus of 6% of the total production (about 40,000 mt/year).

The average annual per capita consumption of rice in Ecuador during the 1990s was 53.8 kg. The highest per capita consumption of rice was in 1994 at 68 kg and the lowest in 1997 at 37.8 kg. Nevertheless, the total consumption of rice during that period increased at an average annual rate of 2.8%.

Rice Prices, Marketing, and Policy

In 1968, the Almaceneras Generales de Depósito (General Storage Warehouses) were created with the passage of Law 037 CL (February, 1968). Under the supervision of the Superintendencia de Bancos (a government agency that controls all Ecuadorian financial institutions), private companies stored basic agricultural products such as rice and issued Certificates of Deposit in the Bolsa de Productos Agropecuarios (Agricultural Commodity Exchange) for the products stored. Although other institutions such as the Corporación Financiera Nacional (National Financial Corporation), insurance companies, and banks are allowed to invest in Almaceneras Generales de Depósito, the system never worked as envisioned due to legal problems.

During the 1970s and 1980s, the Ecuadorian government attempted to control consumer prices of agricultural products under the Price and Quality Control Law that authorized the Ministry of Agriculture and Livestock to set both consumer and producer prices. In 1971, the Empresa Nacional de Productos Vitales (ENPROVIT) was created to maintain food price ceilings for consumers. ENPROVIT took responsibility for the marketing and distribution of rice under the Consumer Protection Law that authorized price control. In 1974, the Empresa Nacional de Almacenamiento y Comercializacion (ENAC) was created to guarantee minimum prices to agricultural producers through the formulation and application of a marketing program for strategic agricultural products, primarily rice, corn, and soybeans. Between 1975 and 1990, ENAC controlled the marketing of an average of 11% of the total production of rice in the country up to a maximum of 33% in 1990. ENAC policies were considered a failure in the late 1980s when wholesale and retail prices of rice continued to increase more than producer prices.

In the early 1990s, Ecuador began a process of eliminating all price controls and other interventions in agricultural markets in favor of trade liberalization and more open markets. In 1993, Ecuador adopted a price stabilization system still in operation known as “Price Bands” for several agricultural products, including rice. The stabilization is achieved by increasing the ad-valorem tariff when the import price is below the designated floor level and reducing the tariff when the international price is above the designated ceiling level. In other words, the “price band” is basically a variable tariff that is automatically adjusted to control extreme fluctuations in the price of imports. In 1995, the Price Band system was adjusted to correspond more closely with the “Andean Price Band System” (Sistema Andina de Franja de Precios or SAFP) adopted by the Andean Pact countries. The SAFP has been adopted by all members of the Andean Community and covers 13 agricultural products, including rice.

In 1994, ENAC began buying Certificates of Deposit (CDs) in the Agricultural Stock Market and stopped physical purchases of the products. In 1995, ENAC bought 1.3 million quintals of paddy rice certificates for which insufficient rice was available to back the certificates. This action forced ENAC out of rice markets and precipitated the end of the CD program by 1997/1998.

As Ecuador moved towards more open markets and less intervention during the 1990s, the real producer price of rice began to drop. Despite a brief increase of 42% in 1994, the real producer price of rice dropped from 570 sucres/kg in 1990 to 366 sucres/kg in 1999, largely due to a rapidly increasing rate of price inflation.

Ecuador rice prices have traditionally exhibited a strong seasonal pattern. Rice prices tend to decline during harvest periods with May typically being the month of lowest prices. In general, prices decline from January to May. From June to December, rice prices tend to rise given the lower levels of production.

Currently, agricultural product marketing in Ecuador is financed by basic agreements between bankers, producers, and financial intermediaries. Rice marketing is financed in Ecuador in one of four ways: (1) financing provided by private banks to producers, wholesalers, and industry; (2) financing provided by intermediaries and mills owners to producers; (3) producer self-financing with personal funds or credit from various non-commercial sources; and (4) financing provided by the negotiation of Certificates of Deposit.

In the early 1990s, about 24% of the paddy rice produced in Ecuador was purchased by wholesalers, 26% by the rice processors, and nearly 50% by ENAC. Since 1995 when Colombia began buying Ecuadorian rice, new marketing channels have developed leading to less variability in domestic rice prices. The active participation of Colombian buyers during the harvest season has helped to achieve better prices for rice in Ecuador during periods when prices have historically declined.

The Ecuador rice marketing system is simple and is made up of producers, mills, storages facilities, wholesalers, retailers, and consumers. The major rice milling company in Ecuador, the Corporación de Comercializadores Agrícolas (CORPCOM), purchases 75% of the annual rice production. Another 10% is purchased by the other smaller mills, and 15% is purchased by various rice handlers and producers.

CORPCOM was created in 1995 with the objective of encouraging and expanding agricultural product marketing. About 8% of the milled rice in storage is held in the government general storage warehouses while 12% is held by foreign buyers (especially Colombians) and 80% by Ecuadorian wholesalers. To encourage a dialogue between buyers, sellers, and the government, Comités de Concertación (Negociation Committees) were formed in 1998 for most Ecuadorian agricultural products. In 1999, these committees became Consejos Consultivos (Consultative Councils) and took on more responsibility for facilitating negotiation between all participants in the productive process of each agricultural product. These Councils define strategies and resolve specific problems related to each marketing chain.

Rice Trade

The world rice market is small in comparison to the total world production of rice. Between 1990 and 1992, world exports of rice amounted to 12.9 million mt, only about 2.5% of the world production. Between 1995 until 1998, that percentage increased to 3.3%. While rice is grown in many countries, only a few export rice. The main rice exporters are Thailand, Vietnam, and United States, accounting for 28%, 18%, and 14%, respectively, of total world rice exports on average over 1996 through 1998. Pakistan is the fourth largest exporter accounting for 9% of world rice exports followed by China, Australia, Uruguay and Argentina accounting for 5% each of total exports. Over the same period, Ecuador exported 10,000 mt of rice representing 0.5% of world rice exports. Ecuador's rice exports have increased in recent years, growing at an average annual rate of 5.7% and reaching a record 19.3 million mt in 1998.

Ecuador's neighboring countries, all members of the Andean Community of Nations (Venezuela, Colombia, Ecuador, Peru and Bolivia), are the main destinations for Ecuador's rice exports. Although rice is an important cereal grain in the Andean region, accounting for an average 9.4% of the agricultural GDP in those countries, the region has little impact on world rice markets. Over the last decade, the Andean Community countries produced less than 1% of the world's rice. Between 1990 and 1998, Colombia was the largest producer among Andean Community countries (41%) followed by Ecuador (20%), Peru (20%), Venezuela (14%), and Bolivia (5%). However, after 1996, the Colombian share of total rice production in Andean Community countries declined to 30% while the share of Peru and Ecuador both increased to 28% and 22%, respectively, with no change in the Venezuelan or Bolivian shares.

Ecuador became a rice exporter in 1994, one year after the creation of the Andean Free Trade Zone. Before 1994, Ecuadorian rice exports amounted to less than 100 mt with the exception of 1992 when the country exported 12,372 mt. Between 1990 and 1992, Ecuadorian rice exports were destined primarily for Peru (50%) and Brazil (50%) at a total value of almost $1.0 billion. Then between 1993 and 1995, following the creation of the Andean Free Trade Zone, Colombia became Ecuador's largest export market, purchasing 54% of total Ecuador rice exports. Cuba and Costa Rica imported 33% and 13%, respectively, over the same period. Other minor countries importing rice from Ecuador include the United States, Italy, Greek, and the Cocos Islands.

During the second half of the last decade, Colombia became essentially the only export market for Ecuadorian rice. Only about 0.01% of the Ecuadorian rice exports went to the Cocos Islands and Italy. Colombia has experienced a large and growing deficit in its domestic rice supply. The tariff advantages of the Andean Pact and low costs of transportation make Ecuador highly competitive in selling rice to Colombia.

Ecuadorian Corn Market Structure

Corn is another important component of the Ecuadorian agricultural sector. The production of corn in Ecuador employs 3.6% of the national work force and accounts for about 1% of the national GDP. This section considers the structure and characteristics of the Ecuadorian corn market with emphasis on the characteristics of rice supply and demand as well as horizontal and vertical linkages in the industry, prices, trade and policy affecting the industry.

Corn Supply

Corn is one of the most important crops in Ecuador due to its importance in the national GDP and its role as the main source of income for a considerable number of small farmers. In the year 2000, the total production of corn was 385,247 mt (a 32% increase over 1999) on a harvested area of 153,480 ha, about 90% during the rainy season and the rest during the dry season (Table 4). Corn yields in the year 2000 averaged 2.58 mt/ha during the rainy season and 1.82 mt/ha during the dry season.

Corn production during 1997 was valued at nearly US$ 65.5 million at an average price of US$170/mt accounting for about 4% of the Ecuador agricultural GDP. An estimated 80,000 mt of corn were exported to Colombia in the year 2000 generating an estimated US$ 17 million in export revenue. The production of corn in Ecuador created jobs for approximately 140,000 unskilled workers (about 11% of the working age population).

In 1998, Ecuador’s corn production suffered from the effects of the El Niño phenomenon. Corn planted acreage dropped to 56,000 ha in that year from an average of 250,000 ha between 1995 and 1997. The area planted to corn recovered in the next two years to 130,000 ha and 150,000 ha, respectively.

Because domestic production is insufficient to meet demand, corn imports are often necessary during certain periods of the year. As a result of the devastation of El Niño, more than 373,000 mt of corn were imported at a value of US$ 47 million in 1998. As production recovered the next year, corn imports dropped by a third to about 250,000 mt.

The main problem that Ecuador’s corn producers face is their lack of competitiveness as a result of low productivity, high costs, limited resources and production financing, undeveloped marketing systems, and lack of economic power by corn producer associations. Thus, competitiveness in Ecuador’s corn market is both a technological and an economic issue.

Most corn produced in Ecuador (94%) is financed in some way with off-farm resources. About 29% of the financing is provided by the Ecuadorian financial system through private banks, savings and credit unions (SCU), the Banco Nacional de Fomento (BNF) which is a government financial institution, and the Corporación Financiera Nacional (CFN). Credit for the production and marketing of corn from these sources has nearly disappeared as a consequence of “El Niño” in 1997, a financial system crisis in 1998, and a host of other problems, including an inefficient Ecuadorian financial system which maintains a large interest margin generating a high cost of

Table 4: Ecuador Supply of Corn, 1965-2000

Year	Beginning Stocks	Imports	Harvested Area	Average Yield	Production	Total Supply
	---------------- mt ----------------		ha	mt/ha	---------------- mt ----------------	
1961	34,000	0	107,000	0.86	92,000	126,000
1962	22,000	0	115,000	0.87	100,000	122,000
1963	27,000	5,000	109,000	0.80	87,000	119,000
1964	13,000	0	61,390	0.62	37,811	50,811
1965	16,000	0	42,295	0.49	20,826	36,826
1966	23,000	0	38,000	0.53	20,176	43,176
1967	25,000	0	51,586	0.41	20,951	45,951
1968	25,000	0	26,300	0.42	11,152	36,152
1969	15,000	2,000	76,690	1.06	81,273	98,273
1970	20,000	1,000	80,200	1.27	101,500	122,500
1971	21,000	1,000	110,700	1.09	120,528	142,528
1972	19,000	6,000	101,800	0.99	100,748	125,748
1973	19,000	11,000	140,900	1.09	153,346	183,346
1974	16,000	0	161,600	1.15	185,628	201,628
1975	22,000	15,000	166,038	1.22	203,392	240,392
1976	9,000	12,000	171,210	1.22	209,108	230,108
1977	64,000	20,000	163,000	1.01	164,100	248,100
1978	85,000	0	132,537	1.03	136,512	221,512
1979	51,000	0	170,371	1.07	182,329	233,329
1980	36,000	10,000	166,708	1.18	196,414	242,414
1981	79,000	0	184,729	1.26	232,620	311,620
1982	65,000	10,000	155,418	1.73	269,287	344,287
1983	49,000	30,000	145,275	1.27	184,996	263,996
1984	51,000	0	182,830	1.47	269,020	320,020
1985	50,000	0	174,308	1.68	292,887	342,887
1986	55,000	0	261,300	1.21	315,505	370,505
1987	48,000	2,000	258,900	1.15	296,600	346,600
1988	42,000	0	245,700	1.25	307,700	349,700
1989	50,000	23	276,600	1.39	384,800	434,823
1990	40,000	145	193,671	2.26	438,100	478,245
1991	46,000	586	206,693	2.29	473,000	519,586
1992	55,000	28,841	218,954	1.93	422,760	506,601
1993	80,000	10,701	225,261	1.57	353,660	444,361
1994	100,000	100,935	232,228	1.56	362,276	563,211
1995	75,000	128,040	222,868	1.60	356,589	559,629
1996	115,000	127,714	244,910	1.73	423,229	665,943
1997	50,000	373,029	278,800	2.29	638,450	1,061,479
1998	145,000	248,126	56,481	1.89	106,970	500,096
1999	85,000	150,487	129,690	2.25	291,388	526,875
2000	85,000	156,586	153,480	2.51	385,247	626,833

n/a = not available
Source: Bucheli; Recalde; Ecuador Ministry of Agriculture and Livestock

institutions; the unavailability of agricultural insurance; and excessive guarantee requirements credit and a low rate of savings; long distances between production regions and financial institutions; excessively short payment periods; lack of credit planning services by financial beyond the means of small farmers.

The BNF and the SCUs are the main sources of production credit. Private banks and similar institutions finance primarily for marketing with little available for production financing. The SCUs are the most feasible alternative for medium and small producers because of their experience with farmers and a social objective to improve conditions in the rural sector. Nevertheless, even the SCUs maintain a wide interest margin.

The BNF was created with the objective of "assisting in the social and economic development of the country by providing credit to the Ecuadorian productive sector (especially small and medium farmers)" (Recalde 2000). However, beginning in 1993, the BNF began encountering financial problems that eventually ended in bankruptcy. Factors contributing to the problems of the BNF included reforms of the Monetary Regime Law that suspended transfers of funds from the Central Bank to the BNF; the administration of international credits by the CFN beginning in 1994; negative real interest rates that generated few profitable investment opportunities; the lack of effective policies to collect debt; and inefficient management reflected in an excessive number of employees and a high rate of debt forgiveness. Between 1996 and 1998, the BNF financed only an average of 7,834 ha of corn per year (3% of the total area planted to corn) despite charging a lower rate of interest (5.5% less) than market rates during that period in an effort to subsidize corn production.

Although, in principle, the CFN specializes in agricultural production financing, their credit rates are regulated to prevent excessive profits by private banks. As a result, CFN and other private banks have preferred to invest in more profitable alternatives, limiting producer access to credit from those sources. In 1998, CFN provided no financing for corn production but extended credit to the Ecuador poultry industry, a more profitable activity) that year.

Up to 50% of the financing received by corn farmers comes from informal sources such as wholesalers and intermediaries who offer various types of financing with resources from different sources. Often the credit is from the personal resources of the person or firm offering the financing or credit. This type of credit is most often based on the personal relationship between the borrower and the lenders and often is not accompanied by a formal contract or any explicit guarantee.

This informal system of credit is particularly important in rural areas because credit is more accessible and responds quicker to the requirements of the community. Often, however, the cost of this type of credit is higher than credit from other sources. Interest rates of up to 200% on such financing have been reported.

Commercial credit provided by supply companies such as AGRIPAC and from related agricultural industries such as PRONACA account for about 15% of the credit received by the agricultural sector. Often technical assistance is provided by such commercial lenders along with the credit to help guarantee a positive return on the investment. Between 1996 and 1998, 30,000 ha (5% of the production) of corn were financed in this way. PRONACA financed 26,000 ha. UNICOL financed 2,000 ha and the remainder was financed by AGRIPAC.

Corn Demand

Although corn is used in Ecuador as both an animal feed and for human consumption, the primary use is by animal feed manufacturers (especially for the poultry industry) accounting for about 54% of national corn production. Most corn produced in Ecuador is purchased by one of three large poultry poultry producers or animal feed manufacturers, including PRONACA (Procesadora Nacional Compañía Anónima), Grasas Unicol, and Champion Mills. PRONACA is the largest of the three accounting for 83% of all corn purchases. Because Ecuadorian corn producers must sell in an oligopsonistic market, they are concerned that they are not receiving fair prices which negatively affects their incentive to produce corn.

Intensive corn production in Ecuador began in the 1950s with the birth of the poultry industry and intensified in the 1960s with the growth of animal feed manufacturing. Over time, these two industries have largely merged to achieve cost efficiencies through vertical integration.

Animal feed manufacturers produce just over 1% of Ecuador's GDP (1997) and employ 4,000 workers. Animal feed manufacturers are organized in the Asociación de Fabricantes de Balanceado (AFABA). Both PRONACA and Unicol provide supplies as well as technical and financial assistance to some corn producers to assure supplies of raw materials.

The poultry industry accounts for 67% of the output of animal feed manufacturers in Ecuador. Raw materials, of which corn comprises 55%, represent 85% of feed manufacturers' production costs. About 65% of the raw materials for feed manufacturing is produced in Ecuador and the rest is imported.

The poultry industry contributes 2% of the agricultural GDP and employs 25,000 workers (0.6 % of the national work force). Poultry inventories reached 90 million head in 1997 with PRONACA as the leading producer. PRONACA has adequate facilities for processing, storage, transporting, and distributing their supplies and products.

During the 1990s, the poultry industry grew at an average annual rate of 9% using technology similar to that in the U.S. and other developed countries. About 96% of domestic poultry production is destined for the domestic market and the remainder is exported to Colombia and Peru. The 8 largest poultry companies in Ecuador are vertically integrated from genetic material imports through the marketing of eggs and poultry meat.

As a consequence of the growth of the poultry industry, corn demand grew rapidly in the mid-1990s, expanding by nearly 165% between 1993 and 1995 (Table 5). In recent years, domestic demand has dropped sharply as a result of both growing exports and increasing prices.

Because corn is used primarily for animal feed production, corn has not traditionally been considered as a food for human consumption in Ecuador. In recent years, however, corn has been making its way into Ecuadorian diets through the production and consumption of flour,

Table 5: Ecuador Demand for Corn, 1965-2000

Year	Domestic Demand	Feed Demand	Food Demand	Exports	Other Uses	Total Demand	Ending Stocks
	----------------	----------------	----------------	mt	----------------	----------------	----------------
1961	99,400	41,098	58,302	0	4,600	104,000	22,000
1962	88,000	36,903	51,097	2,000	5,000	95,000	27,000
1963	101,650	38,358	63,292	0	4,350	106,000	13,000
1964	32,920	42,690	-9,769	0	1,891	34,811	16,000
1965	12,785	43,547	-30,762	0	1,041	13,826	23,000
1966	17,167	47,458	-30,290	0	1,009	18,176	25,000
1967	19,903	52,250	-32,347	0	1,048	20,951	25,000
1968	20,594	54,409	-33,815	0	558	21,152	15,000
1969	74,209	33,207	41,002	0	4,064	78,273	20,000
1970	91,425	36,030	55,395	5,000	5,075	101,500	21,000
1971	114,502	41,800	72,702	3,000	6,026	123,528	19,000
1972	81,711	42,478	39,232	20,000	5,037	106,748	19,000
1973	149,679	52,339	97,340	10,000	7,667	167,346	16,000
1974	166,347	61,504	104,843	4,000	9,281	179,628	22,000
1975	216,222	67,092	149,130	5,000	10,170	231,392	9,000
1976	155,653	39,106	116,547	0	10,455	166,108	64,000
1977	154,895	136,759	18,136	0	8,205	163,100	85,000
1978	159,686	142,792	16,895	4,000	6,826	170,512	51,000
1979	188,213	161,184	27,029	0	9,116	197,329	36,000
1980	153,593	151,559	2,034	0	9,821	163,414	79,000
1981	189,989	174,422	15,567	45,000	11,631	246,620	65,000
1982	256,823	185,294	71,528	25,000	13,464	295,287	49,000
1983	173,746	197,514	-23,768	30,000	9,250	212,996	51,000
1984	231,569	206,145	25,424	25,000	13,451	270,020	50,000
1985	263,243	208,377	54,865	10,000	14,644	287,887	55,000
1986	296,730	189,888	106,842	10,000	15,775	322,505	48,000
1987	249,770	188,416	61,354	40,000	14,830	304,600	42,000
1988	284,315	180,155	104,160	0	15,385	299,700	50,000
1989	375,583	190,418	185,165	0	19,240	394,823	40,000
1990	410,340	205,585	204,755	0	21,905	432,245	46,000
1991	440,936	200,566	240,370	0	23,650	464,586	55,000
1992	405,463	200,285	205,178	0	21,138	426,601	80,000
1993	326,678	241,594	85,084	0	17,683	344,361	100,000
1994	453,292	356,801	96,492	16,805	18,114	488,211	75,000
1995	370,733	285,698	85,035	56,066	17,829	444,629	115,000
1996	465,475	363,540	101,934	129,307	21,161	615,943	50,000
1997	862,779	763,493	99,285	21,778	31,923	916,479	145,000
1998	334,236	276,680	57,556	75,512	5,349	415,096	85,000
1999	430,898	388,317	42,581	81,408	14,569	526,875	0

n/a = not available
Source: Bucheli, Recalde, Ecuador Ministry of Agriculture and Livestock

pasta, snacks, beer, starch, and flakes that use corn as the main ingredient (Table 5). This new industry uses modern technology and has launched an advertising campaign to create domestic demand and compete in international markets.

Corn Prices, Marketing, and Policy

Corn is marketed primarily by the large poultry companies and animal feed manufacturers and a host of handlers or middlemen, including medium and small companies and wholesalers. Only 20% of the annual corn production is sold directly from producers to users. There are least 20 large corn handlers and hundreds of medium and small handlers. The large and growing number of intermediaries in the corn market has reduced corn producers' profits and forced them to search for more profitable production alternatives. Although corn handlers are an important part of the process of marketing corn, the handlers profit from the inefficiencies in the marketing system. The large corn users actually prefer to work with the relatively fewer handlers rather than the large number of unorganized producers who lack the capacity for cooperative negotiation of sales and prices. Because most small and medium producers do not have access to drying, cleaning, or storage facilities, they must sell directly to the corn handlers soon after harvest.

The Ecuador domestic corn market has two important prices: producer prices and wholesale prices. Retail prices are less important since the main destination of the national corn production is the poultry and animal feed manufacturing industries. Domestic prices are influenced by domestic supply and demand conditions as affected by climatic and macroeconomic factors and by international markets. For example, producer and wholesale prices jumped by 11% and 7%, respectively, in 1998 as a result of El Niño even though the international price of corn had diminished. Ecuador corn imports increased nearly 230% that year.

Over time, however, corn prices and the prospects for Ecuador's corn industry have been closely associated with Ecuador's import policy, particularly changes in import tariff levels, the Price Band policy, and the results of Ecuador's negotiations with MERCOSUR members. Because both Brazil and Argentina have better yields and lower costs than Ecuador, a reduction of Ecuador's tariffs, without an decrease in costs and an increase in production efficiency in Ecuador, could signal a considerable increase in imports by Ecuador from those countries. Ecuador currently maintains a 50% tariff on corn imports from non-Andean Pact countries but only a 25% tariff on corn imports from Andean Pact members. A major concern of corn producers in Ecuador, therefore, is the potential impact on their competitiveness and profitability as the government continues to move towards greater trade liberalization and less price protection from import tariffs.

Over the long run, the future of corn production in Ecuador will depend critically on the ability of the sector to increase yields, obtain access to credit, and modernize the marketing infrastructure. Improvement in the competitiveness of the corn sector will require substantial technical change, including the adoption of new production techniques by small farmers, new contract mechanisms between producers and buyers, and improved credit availability.

Corn Trade

Even though Ecuador imports corn in some years, the country also exports corn to Colombia when Ecuador's production is at its peak and Colombian corn supply is at a low ebb. Corn exports represent almost 23% of the total Ecuador corn production. The geographic proximity of Ecuador and the lower tariff for Ecuador corn to Andean Pact countries creates a preference for Ecuador corn in Colombia when supplies are low. Ecuador corn is also reportedly high quality with a high lysine and carbohydrate content (Recalde, 2000).

Between 1996 and 1998, nearly all of Ecuador's corn exports were shipped to Colombia with small amounts going to the U.S., Canada, and the United Kingdom. An informal market between Ecuador to Colombia adds a reported 25% to the total official corn exports. The existence of this informal market is the result of the lack of control of the borders between the two countries and emphasizes the need for clear trading regulations between them.

In 1996, Ecuador exported 56,033 mt of corn ($11.8 million), an increase of 234% over the previous year. In 1997, exports jumped to 129,306 mt ($30.7 million). Although El Niño reduced exports the next year to only 23,643 mt ($4.8 million), they rebounded somewhat in 1999 and 2000 to 75,512 mt and 81,408 mt, respectively.

Corn imports occurr primarily at the end of the marketing year when supplies run out before the next harvest begins. Only four companies (PRONACA, Champion Mills, Unicol, and Figallo) and 2 producer associations (Asociación de Fabricantes de Balanceados (AFABA) and Anhalzer) control imports. PRONACA and AFABA together account for 80% of total corn imports. During 1996 and 1997, all Ecuadorian corn imports were from the U.S. Since 1998, Ecuador has diversified its import sources and now imports from Argentina, Uruguay, Mexico, and Peru as well as the U.S.

The long-run prospects for the Ecuador corn market are not clear. Corn producers have been competitive over the last few years primarily due to high tariffs (50%) and the Colombian demand that have keep the domestic price at reasonable levels. However, negotiated reductions in tariffs under free trade agreements will provide extreme pressure on the Ecuador corn sector. Low productivity and high costs are the main problems facing the sector. For example, the cost of producing a metric ton of corn in Ecuador is $156 compared to $87 in Brazil. In the future, without huge investments in production technology and infrastructure or subsidies to producers, only the larger, lower cost producers will have any chance of remaining when Ecuador completes the liberalization of its markets.

Conceptual Models of the Corn and Rice Markets of Ecuador

In this section of the report, conceptual models of Ecuadorian corn and rice markets are developed as the basis for the econometric analysis in the next section. Following a graphical representation and discussion of the two markets, a more formal mathematical representation of the markets is presented and discussed. The assumptions underlying the model and the particular way in which the model is structured are based on the preceding qualitative analysis of the markets. The model for each crop includes a set of equations capturing behavioral relationships in the supply and demand for each crop.

Graphical Representation of the Corn and Rice Markets in Ecuador

Before presenting a more formal mathematical representation of the corn and rice markets in Ecuador in the next section, this section provides a more intuitive, graphical depiction of the economic characteristics of each market along with relevant linkages and policy considerations. The models are based on previous work by Williams (2001) and the information in the preceding background section. Since Ecuador is a small country in world markets for both rice and corn, the models assume that Ecuador is a price taker so that market prices reflect international prices as impacted by domestic and trade policies, transportation costs, etc.

Graphical Representation of the Ecuador Corn Market

During the period before the early 1990s when the Andean Pact was implemented and Ecuador began the process of liberalizing its markets, Ecuador was a small net exporter of corn, represented as XM_0 in Figure 1, calculated as the difference between the supply (EMAISPC) and demand (EMAIDTC) for corn in Ecuador at the market price (EMAIPMC). After about 1993, Ecuador's corn yields and area under production began dropping (shift of EMAISPC to EMAISPC' in Figure 1) as a result of climate problems and changing relative prices at the producer level. At the same time, the demand for corn as a feed ingredient began growing in Ecuador (shift of EMAIDTC to EMAIDTC' in Figure 1) while other countries like Brazil and Argentina experienced technology-induced increases in supply reducing the price at which corn was available from external sources (drop of EMAIPMC to EMAIPMC'). The price band policy implemented by Ecuador during that same period, however, imposed some restrictions on imports and corn and prevented the internal price of corn from dropping as much as might have otherwise occurred. The consequence was that Ecuador switched from being a net exporter of corn before the 1990s to being a net importer of corn after that period (shown as a change from the export level of XM_0 to the import level of XM' in Figure 1).

Graphical Representation of the Ecuador Rice Market

As discussed in the preceding section, the experience of rice markets in Ecuador has been much the opposite of that of corn. Prior to the 1990s, Ecuador was a net importer of rice at the prevailing import price (ERICPMC in Figure 2). In Figure 2, rice imports before the 1990s are represented by MR_0 which is the difference between the domestic demand (ERICDTC) and supply (ERICSPC) of rice at the market price (ERICPMC) which includes the effects of the import tariff imposed on rice during that period. When Ecuador joined the Andean Community of Nations in the early 1990s, the high external tariff for rice of the Community raised internal rice prices as the rice demand by member countries, and Colombia in particular, was diverted in search of internal sources of rice supplies. Given its proximity to Colombia, a ready source of rice during harvest season, and rising prices, Ecuador rapidly became a net exporter of rice. In Figure 2, this is depicted as a change from net rice imports of MR_0 to net rice exports of MR' with a price increase from ERICPMC to ERICPMC'.

Figure 1: Graphical Representation of Ecuador Corn Market

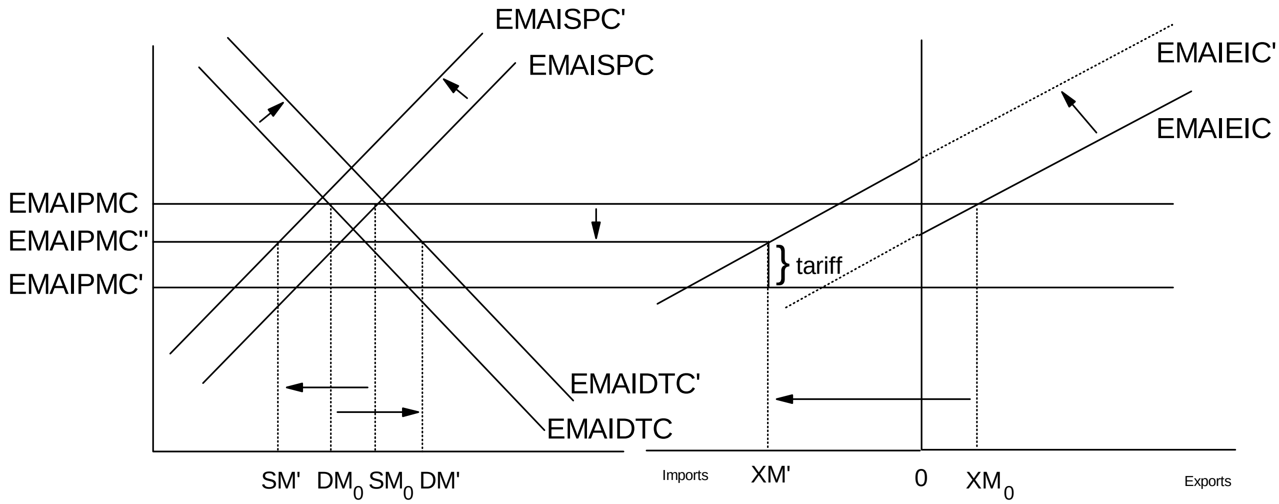
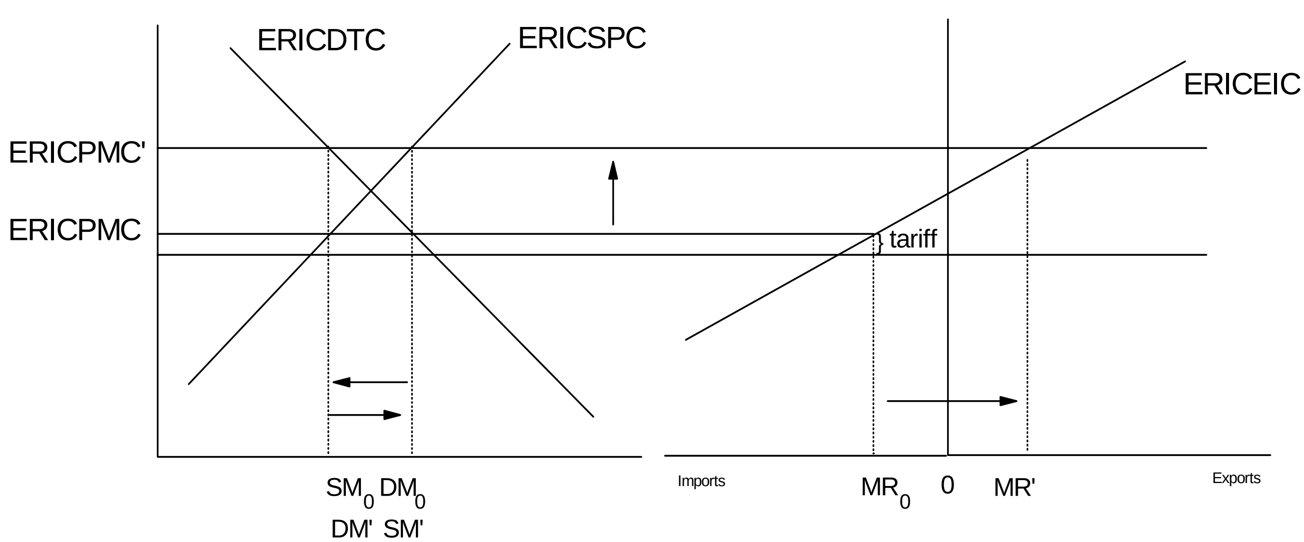


Figure 2: Graphical Representation of Ecuador Rice Market



Mathematical Representation of the Corn and Rice Markets in Ecuador

The mathematical representations of the conceptual models for rice and corn parallel the graphical representations.

Model of Ecuadorian Corn Markets

Table 6 presents the model for corn and Table 7 provides a definition of the variables in the model. Equation (1) en Table 6 represents the harvested area of corn (EMAISCC) as a function of the real expected producer price of corn (the price paid to corn producers (EMAIPFC) deflated by the producer price index (EIPF7879) both lagged one period), the real expected producer price of soybeans as a competing crop (ESOYPFC/EIPF7879 lagged one period), the real production credit available to corn producers from the government (CREDIT/EIPF7879), the corn area harvested in the previous period, and a dummy variable for climatic problems affecting the corn production cycle (CLIMA). The CLIMA variable was set equal to 1 for the years of 1978, 1983, 1990, and 1998 when weather problems imposed large negative effects on corn production.

Equation (2) is an identity that calculates the production of corn (EMAISPC) as the product of the average corn yield (EMAISYC) and the harvested area of corn (EMAISCC).

Equation (3) specifies the animal feed manufacturers demand for corn as a function of the real wholesale price of corn (the price paid to corn wholesalers (EMAIPMC) deflated by the wholesaler price index (EIPM7879)), the real wholesale price of soybean meal (the price paid to soybean meal wholesalers (ESOTPMC) deflated by the wholesaler price index (EIPM7879)), the real price of chicken (the price paid by consumers (EPOUPIC) deflated by the consumer price index (EIPC7879)), and the real Ecuador GDP (the per capita income (EPINPA) multiplied by the total population (EPOBA) and deflated by the wholesaler price index (EIPM7879)).

Equation (4) represents the human consumption demand for corn as a function of the real wholesale price of corn (the price paid to corn wholesalers (EMAIPMC) deflated by the wholesaler price index (EIPM7879)), the real retail price of rice as a substitute in consumers' diets (the rice paid by consumers (EARRPFC) deflated by the consumers price index (EIPC7879)) and the real Ecuador GDP (the per capita income (EPINPA) multiplied by the total population (EPOBA) and deflated by the wholesaler price index (EIPM7879)).

Equation (5) represents the international corn price linkage. The wholesale price of corn (EMAIPMC) is specified as a function of its corresponding international (import) price (EMAIPIC) in U.S. dollars multiplied by the Sucre/US$ exchange rate (XSUUSA) for years before 2000 when the U.S. dollar was adopted as the national currency, and the prevailing corn import tariff (CTARIFF).

Equation (6) is the producer to wholesale price linkage in which the producer price of corn (EMAIPFC) is specified as a function of the wholesale price of corn (EMAIPMC).

Table 6: Mathematical Model of the Ecuadorian Corn Market

[1] Harvested Area:

EMAISCC = f_1((EMAIPFC/EIPF7879)$_{t-1}$, (ESOYPFC/EIPF7879)$_{t-1}$, CREDIT/ EIPF7879, CLIMA, EMAISCC$_{t-1}$)

[2] Production:

EMAISPC = EMAISYC * EMAISCC

[3] Demand for animal feed:

EMAIDGC = f_3(EMAIPMC/EIPM7879, ESOTPMC/EIPM7879, EPOUPIC/EIPC7879, EPINPA*EPOBA/EIPM7879)

[4] Demand for Human Consumption:

EMAIDHC/EPOBA = f_4(EMAIPMC/EIPM7879, EARRPFC/EIPC7879, EPINPA * EPOBA/EIPM7879)

[5] Wholesale Price:

EMAIPMC = f_5(EMAIPIC * EXCHRATE/EIPC7879, CTARIFF)

[6] Producer Price:

EMAIPFC = f_6(EMAIPMC)

[7] Market Equilibrium Condition:

EMAINTC = EMAIHFC$_{t-1}$ + EMAISPC – EMAIDGC - EMAIDHC - EMAIDZC- EMAIHFC

Table 7: Ecuadorian Corn Market Model Variables

Endogenous Variables		
EMAIDGC=		Animal Consumption of Corn
EMAIDHC=		Human Consumption of Corn
EMAINTC=		Net Trade of Corn
EMAIPFC=		Producers' Price for Corn
EMAIPMC=		Wholesalers' Price of Corn
EMAISPC=		Production of Corn
EMAISSC=		Harvested Area for Corn
Exogenous Variables		
CLIMA	=	Weather (dummy variable for "El Niño" climatic phenomenon)
CREDIT	=	Credit
Exogenous Variables (continued)		
CTARIFF	=	Corn tariff rate
EARRPFC	=	Consumers' Price of Rice
EINPA	=	Per Capita GDP
EIPC7879	=	Consumer Price Index (1978/1979 = 100)
EIPF7879	=	Producer Price Index (1978/1979 = 100)
EIPM7879	=	Wholesaler Price Index (1978/1979 = 100)
EMAIDZC	=	Others Uses of Corn
EMAIHFC	=	Final Stocks of Corn
EMAIMIC	=	Corn Imports
EMAIPIC	=	Importing Price (CIF) of Corn
EMAISYC	=	Corn Yields
EMANPMC	=	Wholesalers Price of Vegetable Oil
EPAAPMC	=	Wholesalers Price of Oil Palm Oil
EPOBA	=	Total Population
EPOUPIC	=	Consumers' Price of Chicken
ESOTPMC	=	Wholesalers' Price for Soybean Meal
ESOYPMC	=	Producers' Price for Soybean
EXCHRATE	=	Exchange Rate (Sucres/Dollar)

Equation (7) is an identity that represents the market equilibrium in the corn sector. Because Ecuador is assumed to be a small country in world corn markets, Ecuador's

Model of Ecuadorian Rice Markets

Based on the preceding descriptive analysis of Ecuadorian rice markets, the model of the Ecuador rice market presented in Table 8 includes both the paddy rice market and the milled (white) rice market that are linked through the demand for rice for milling. Consequently, the mathematical model in Table 8 includes not only the primary but also the industrial rice sectors whereas the graphical representation in Figure 2 presented only an aggregate rice market. Table 9 presents the definitions of the variables in the model.

Equation (1) in Table 8 represents the harvested area of paddy rice (RICEHAAR) as a function of the real expected producer price of rice (the price paid to rice producers (RICEPRP) deflated by the consumer price index (EIPC7879) lagged one period), the real expected producer price of corn as a competing crop (the price paid to corn producers (EMAIPFC) deflated by the consumer price index lagged one period), the real production credit available to rice producers from the government (RICECR/EIPF7879), the rice area harvested in the previous period, and a dummy variable for weather problems affecting the rice production cycle (DRICE). DRICE is set to one for the years of 1971, 1978, 1979, 1983, 1985, 1990, 1992, 1997 and 1998 when weather imposed severe negative impacts on rice production and 0 for all other years.

Equation (2) is an identity that calculates the production of rice (RICETOP) as the product of the average rice yield (RICEAVY) and the area harvested of rice (RICEHAAR).

Equation (3) specifies the milling demand for paddy rice as a function of the real producer price of paddy rice (the rice milling input price) and the real wholesale price of milled rice (the output price received for milled rice by rice millers). The real prices paid to corn producers and received by corn wholesalers are also included because many of the smaller rice millers also process a variety of other grains, including corn. Finally, because the availability of rice milling capacity limits the volume of rice that can be milled each year, the national installed rice milling capacity is also included as a variable.

Equation (4) is an identity that calculates the volume of milled rice produced (RICETOW) as the historical average milling coefficient (0.56) times the volume of rice milled (RICEDDP).

Equation (5) specifies the per capita demand for milled rice (RICEPECO) as a function of the consumer price of rice (RICECOP) deflated by the consumer price index (EIPC7879), real per capita income (EINPA/EIPC7879), the real price of potatoes as a substitute (POTAPR/EIPR7879), and the real price of noodles (FIDEPR/EIPC7879), another substitute for rice in Ecuador.

Equation (6) in Table 8 calculates the total national demand for rice (RICETOCO) as the per capita demand for rice (RICEPECO) times the Ecuadorian population (EPOBA).

The market clearing condition for paddy rice (Equation (7)) requires that the excess supply (or demand depending on the time period) of paddy rice (EXCPA) equal the difference between the production of rice (RICETOP) and the milling demand for paddy rice (RICEDDP).

Equation (8) is the market clearing condition for milled rice which requires that the excess supply of milled rice (EXCWH) equal the difference between the total supply of white rice (RICETOW) and the total demand for white rice (RICETOCO).

Equations (9) and (10) are the international price linkages for paddy and milled rice, respectively. Each price is specified as a function of its corresponding world price (PWP for paddy rice and PWW for milled rice) and the respective tariff rates (PTARIFF for paddy rice and MTARIFF for milled rice).

Table 8: Mathematical Model of the Ecuadorian Rice Market

[1] Harvested Area (Paddy Rice):
RICEHAAR = f_1 ((RICEPRP/EIPC7879)$_{t-1}$, RICEHAAR $_{t-1}$,
(EMAIPFC/EIPC7879)$_{t-1,}$ RICECR/EIPF7879, DRICE)

[2] Production (Paddy Rice):
RICETOP = RICEAVY * RICEHAAR

[3] Milling Demand (Paddy Rice):
RICEDDP = f_3 (RICEPRP/EIPC7879, RICEWHP/EIPC7879, EMAIPFC/EIPC7879,
EMAIPMC/EIPC7879, MILLCAP)

[4] Supply (Milled Rice):
RICETOW = 0.56 * RICETOP

[5] Per Capita Demand (Milled Rice):
RICEPECO = f_5 (RICECOP/EIPC7879, EINPA/EIPC7879, POTAPR/EIPC7879,
FIDEPR/EIPC7879)

[6] Total Demand (Milled Rice):
RICETOCO = RICEPECO * EPOBA

[7] Excess Supply or Demand (Paddy Rice):
EXCPA= RICETOP – RICEDDP

[8] Excess Supply or Demand (Milled Rice):
EXCWH= RICETOW - RICETOCO

[9] Paddy Price:
RICEPRP$_t$ = f_9 (RICEWHP$_t$)

[10] Milled Price:
RICEWHP$_t$ = f_9 (PWW, MTARIFF)

[11] Consumer Price:
RICECOP$_t$ = f_{11} (RICEWHP$_t$)

Table 9: Ecuadorian Rice Market Model Variables

Endogenous Variables

EXCPA	=	Excess Supply or Demand of Paddy Rice
EXCWH	=	Excess Supply or Demand of White Rice
RICECOP	=	Consumers’ Price of Rice
RICEDDP	=	Demand of Paddy Rice
RICEHAAR	=	Harvested Area of Rice
RICEPECO	=	Per Capita Demand of White Rice
RICEPRP	=	Producers’ Price of Rice
RICETOCO	=	Total Demand of White Rice
RICETOP	=	Total Supply of Paddy Rice
RICETOW	=	Total Supply of White Rice
RICEWHP	=	Wholesalers’ Price of Rice

Exogenous Variables

DRICE	=	Dummy Variable for effect of weather on Rice
EINPA	=	Ecuadorian Per Capita Income
EIPC7879	=	Price Consumer Index (78/79 = 100)
EMAIPFC	=	Producers’ Price of Corn
EMAIPMC	=	Wholesalers’ Price of Corn
EPOBA	=	Total Population of Ecuador
ERICDTC	=	Demand Curve of Rice
ERICNPC	=	Upper Referential Price of Rice
ERICPIC	=	Importing Price of Rice
ERICPMC	=	Wholesalers’ Price of Rice
ERICSPC	=	Supply Curve of Rice
FIDEPR	=	Price of Paste
MTARIFF	=	Tariff on milled rice imports
POTAPR	=	Price of Potatoes
PTARIFF	=	Tariff on paddy rice imports
PWP	=	World Price of Paddy Rice
PWW	=	World Price of Milled Rice
RICEAVY	=	Average Yield of Rice
RICECR	=	Credit for Rice
RICEEXP	=	Rice Exports
RICEIMPO	=	Rice Imports
RICEINS	=	Initial Stocks of Rice
RICEPRP	=	Producers’ Price of Rice
RICETOP	=	Total Supply of Paddy Rice

Equation (11) is the consumer-to-wholesale price linkage in which the consumer price of rice (RICECOP) is specified as a function of the wholesale price of rice (RICEWHP).

Empirical Analysis

This section presents the results of the empirical estimation of the parameters of the behavioral equations in the corn and rice models laid out in the preceding section. Following a discussion first of the data sources and problems, the results of the single linear estimations of the behavioral equations are presented and discussed.

Data Sources and Considerations

The data used in the estimation of the parameters of the econometric models came from various public and private sources. The main sources included databases generated by Bucheli (1994), Andrade (1998), and Williams (2001); the Agricultural Census and Information Service Project (SICA) of the Ecuador Ministry of Agriculture and Livestock; the National Institute of Statistics and Census (INEC); the Central Bank of Ecuador; the National Agricultural Assistance Bank; and personal interviews by the authors with members of the corn and rice sectors. Summary statistics for the data available for use in the estimation of the parameters of the corn and rice models are provided in Tables 10 and 11, respectively.

Problems with the data created a number of difficulties for the econometric estimation of the parameters of the behavioral equations. Major problems included multiple sources of data with different values for the same variables; no one source with consistent data series for corn and rice supply and utilization data; the lack of reliable data for several key variables over long time periods; and data generated by unknown methods with apparent errors. One inevitable consequence was that data for rice and corn disappearance, for example, that must calculated from other data vary widely from year to year apparently containing large statistical errors that prevent reliable parameter estimation and render the measurement of goodness of fit, standard errors, and other regression statistics largely meaningless. To minimize the data problems, the supply and utilization and other data finally used for the analysis were validated based on knowledge of the Ecuadorian corn and rice sectors, the advice of knowledgeable experts, and, in the end, common sense. Nevertheless, remaining data errors generated some difficult to interpret econometric results as will be discussed later.

Linear Single Equation Estimation Results

Because the number of observations available for the variables in the two models varied, a systems estimator like 3SLS could not be used to estimate the behavioral equation parameters. The potential loss of information from the use of a systems estimator would far outweigh any gain in efficiency. Also, the number of predetermined variables in each of the two models was greater than the number of observations for some equations so that even the 2SLS could not be used. Consequently, OLS was the estimator of choice for estimating the parameters in each model particularly since the consistency and/or efficiency gained with the use of systems estimators are really large-sample properties any way.

Table 10: Summary of Statistics for Variables Used in the Corn Model

Variable	N	Mean	Minimum	Maximum	St. Dev.
Producers' Price of Rice	20	13,923	255	66,477	19,254
Real Producers' Price of Rice	20	234	148	363	63
Per Capita GDP	29	2,626,727	7,401	27,298,000	5,673,889
Real National GDP	29	291,559	117,125	407,614	77,979
Demand of Corn for Animal Feed	39	162,199	33,207	763,493	141,327
Demand of Corn for Humans	39	66,549	-33,815	240,370	67,182
Per Capita Demand of Corn for Humans	35	7,292	-6,262	22,381	7,795
Producers' Price of Corn	36	248,742	1,124	3,438,468	638,141
Real Producers' Price of Corn	32	4,712	3,281	7,165	1,069
Import Price of Corn (US dollars)	7	181	168	201	10
Real Import Price of Corn (Sucres)	7	4,207	3,646	5,077	561
Wholesalers' Price of Corn	36	184,962	1,213	1,785,460	371,384
Real Wholesalers' Price of Corn	32	5,415	2,407	8,020	1,637
Harvested Area of Corn	40	156,011	26,300	278,800	70,025
Total Population (millions)	35	8.68	4.92	12.50	2.34
Producers' Price of Soybean	35	358,378	3,036	4,550,000	851,223
Real Producers' Price of Soybean	32	8,160	3,975	13,493	2,671
Wholesalers' Price of Soybean	35	410,557	3,036	5,575,000	1,026,670
Real Wholesalers' Price of Soybean	32	8,303	4,695	13,493	2,546

Table 11: Summary of Statistics for Variables Used in the Rice Model

Variable	N	Mean	Minimum	Maximum	St. Dev.
Per Capita GDP	29	2,626,727	7,401	27,298,000	5,673,889
Real Per Capita GDP	28	31,100	18,503	35,878	4,030
Producers' Price of Corn	36	248,742	1,124	3,438,468	638,141
Real Producers' Price of Corn	32	4,712	3,281	7,165	1,069
Wholesalers' Price of Corn	36	184,962	1,213	1,785,460	371,384
Real Wholesalers' Price of Corn	32	5,415	2,407	8,020	1,637
Real Price of Noddles	34	2,823,958	2,310,843	3,753,298	332,946
Real Price of Potatoes	34	1,304,310	537,717	2,660,247	668,079
Importing Price of Rice (US dollars)	13	409	335	526	66
Real Importing Price of Rice (sucres)	12	9	8	9	2,243
Consumers' Price of Rice	36	770	4	8,370	1,760
Real Consumers' Price of Rice	32	12	6	19	4
Harvested Area of Rice	36	185,218	70,516	395,710	103,176
Per Capita Demand of Rice	35	33	11	68	16
Producers' Price of Rice	36	14,158	120	176,448	32,388
Real Producers' Price of Rice	32	355	124	576	134
Wholesalers' Price of Rice	36	654,876	3,902	8,143,740	1,590,613
Real Wholesalers' Price of Rice	32	9,698	4,980	15,287	2,795

Corn Model Behavioral Equations

Table 12 presents the results of the linear parameter estimation for the corn model. Table 13 provides variable definitions for the corresponding set of equations. The numbers in parentheses in Table 12 are t-values and those in brackets are elasticities calculated at the means of the data. Also, the number of observations (N) used in each of the estimations is shown as well.

Equation (1) estimates the statistical relationship between the harvested corn area (EMAISCC) and those independent variables hypothesized to affect its behavior, including the lagged real producer prices of corn and soybeans, a dummy variable representing the effect of El Niño in 1998, and the lagged dependent variable. The data range for estimation was 1968 through 1999. All estimated coefficients are statistically significant and have the expected signs.

Credit was hypothesized earlier to be an important variable explaining the behavior of the harvested area of corn over time. Because data for the credit available to corn producers were only available through 1992, the Credit variable was not included in the final model. Further work to extend this data series is needed.

The estimated results suggest that the lagged producer prices of corn and soybeans are significant factors affecting the area planted to corn each year in Ecuador. Weather problems over the years appear to have been a highly significant factor affecting corn production as well as indicated by the negative sign of the estimated coefficient for the CLIMA variable. Also, the significant coefficient on the lagged corn harvested area indicates that the harvested area adjusts toward equilibrium over time with a lag in response to changes in prices and weather. In other words, there appear to be obstacles that prevent producers from fully adjusting their acreage each year to the desired equilibrium given changes in factors like prices and credit.

The estimated coefficients for the lagged real price of corn and soybeans also appear to be of appropriate magnitude as indicated by their elasticities (0.47 and –0.39, respectively). Thus, a 1% change in either variable leads to a 0.47% increase and a 0.39 decline, respectively, in the harvested corn area in a given year. The lagged real producer price of rice was originally included among the explanatory variables in this equation. Because the estimated coefficient had an unexpected positive sign and was insignificant, however the rice price was dropped from the equation.

Table 12: Estimation of Ecuador Corn Demand and Supply Parameters

(1) Harvested Area

EMAISCC = 78676 + 9.27*(EMAIPFC/EIPC7879)$_{t-1}$ –6.04*(ESOYPFC/EIPC7879)$_{t-1}$

(1.71) (1.35) (-1.75)

[0.47] [-0.39]

- 95026*CLIMA + 0.65*EMAISCC$_{t-1}$

(-4.61) (5.18)

[-0.64] [0.60]

Rsq = 0.72 DW = 2.509 N=31

(2) Demand for Animal Feed

LN(EMAIDCG)= 2.15–0.24*LN(EMAIPMC/EIPC7879)–0.64*LN(ESOYPMC/EIPC7879)

(0.35) (-1.04) (-1.98)

[-0.24] [-0.64]

+1.40*LN(EINPA*EPOBA/EIPC7879)

(4.66)

[1.40]

Rsq = 0.80 DW = 1.74 N=27

(3) Demand for Humans

EMAIDHC/EPOBA = 12327 + 0.56*EMAIPMC/EIPC7879 - 53.48*EARRPFC/EIPC7879

(0.51) (0.24) (-1.30)

[1.19] [-1.97]

+ 0.02*(EINPA*EPOBA/EIPC7879)

(0.32)

[2.38]

Rsq = 0.22 DW = 0.84 N=19

(4) Wholesalers' Price of Corn

EMAIPMC/EIPC7879 = 4115 – 0.24*(EMAIPIC*EXCHRATE/EIPC7879)

(3.22) (-0.8)

[-0.34]

Rsq = 0.12 DW = 0.836 N = 6

(5) Producers' Price of Corn

EMAIPFC/EIPC7879 = 1578 + 0.58*(EMAIPMC/EIPC7879)

(5.03) (10.46)

[0.59]

Rsq = 0.75 DW = 1.502 N = 31

Table 13: Definition of Variables in the Ecuador Corn Market

Endogenous Variables

EMAIDCG	=	Animal Consumption of Corn
EMAIDHC	=	Human Consumption of Corn
EMAISSC	=	Harvested Area for Corn
EMAIPMC	=	Wholesalers' Price of Corn
EMAIPFC	=	Producers' Price of Corn

Exogenous Variables

CLIMA	=	Weather (dummy variable for "El Niño" climatic phenomen)
CREDIT	=	Credit
CTARIFF	=	Corn tariff rate
EARRPFC	=	Consumers' Price of Rice
EINPA	=	Per Capita GDP
EIPC7879	=	Consumer Price Index (1978/1979 = 100)
EIPF7879	=	Producer Price Index (1978/1979 = 100)
EIPM7879	=	Wholesaler Price Index (1978/1979 = 100)
EMAIMEC	=	Corn Exports
EMAIPFC	=	Producers' Price for Corn
EMAIPMC	=	Wholesalers' Price of Corn
EMAISPC	=	Production of Corn
EMAIDZC	=	Others Uses of Corn
EMAIHFC	=	Final Stocks of Corn
EMAIMIC	=	Corn Imports
EMAIPIC	=	Importing Price (CIF) of Corn
EMAISYC	=	Corn Yields
EMANPMC	=	Wholesalers Price of Vegetable Oil
EPAAPMC	=	Wholesalers Price of Oil Palm Oil
EPOBA	=	Total Population
ESOTPMC	=	Wholesalers' Price for Soybean Meal
ESOYPMC	=	Producers' Price for Soybean
EXCHRATE	=	Exchange Rate (Sucres/Dollar)

Equation (1) in Table 12 explains 72% of the variation in corn area as indicated by the coefficient of multiple correlation or R-squared. The Durbin Watson coefficient (DW = 2.509) does not indicate the presence of serial correlation.

Eqaution (2) in Table 12 estimates the relationship between the feed demand for corn (EMAIDGC) and the independent variables affecting its behavior, including the real wholesaler prices of corn and soybeans, and real GDP. Despite the importance of the growing poultry industry to the feed demand for corn in Ecuador, the consumer price of chicken (EPOUPIC) was excluded from the model due to the lack of a consistent set of data for the variable. The data range for estimation was 1971 through 1998. Given an apparent non-linear pattern of change over time in the feed demand for corn, equation (2) was estimated in log-linear form to more appropriately capture the historical behavior of corn demand. This was also done for other behavioral equations for which the dependent variable demonstrated a non-linear pattern of change over time.

The estimated coefficients of all three independent variables in equation (2) have the expected signs and together explain 80% of the variation in the feed demand for corn. The values of the elasticities for the real prices of corn and soybeans (-0.24 and -0.64, respectively) are reasonable and indicate that soybeans have a complementary relationship with corn in the demand for and production of animal feed. The high income elasticity of the demand for corn for feed reflects the close relationship between the demand for poultry as affected by changes in real incomes and the demand for corn to feed chickens and produce poultry. The Durbin Watson coefficient (DW = 1.74) indicates the absence of serial correlation.

Equation (3) in Table 12 provides the estimated coefficients of the independent variables hypothesized to affect the food demand for corn in Ecuador (EMAIDHC). The data range for estimation was 1979 through 1998. None of the coefficients is significant and the coefficients of neither price have the expected signs. At the same time, the Durbin Watson statistic (DW = 0.84) indicates possible serial correlation. Several reasons likely explain this result. First, as discussed earlier, the food demand for corn is quite small and not culturally accepted on a wide scale. At the same time, the corn demand data are highly variable (partly the reason for the low DW statistic) indicating potential data problems that remain to be resolved. In such cases, econometric estimation is not likely to provide meaningful results. The low DW also indicates the possibility of omitted variables for this equation suggesting the need for further research to determine what other factors are important for the food demand for corn in Ecuador.

Equation (4) in Table 12 is the linkage between the wholesale price of corn and the import price of corn in Ecuador. The data range for estimation is only 1992 through 1998 because of the unavailability of the corn import price data. The estimated coefficient of the import price is not significant and the equation explains only 11% of the variation in the producer price of corn. The low DW coefficient (0.836) suggests the presence of serial correlation and could be due to omitted variables, most likely tariffs, marketing, storage and other costs for which data is not available in Ecuador for corn. Additional research to find or construct a proxy for such costs is needed.

Finally, equation (5) in Table 12 is the marketing linkage between the real producer price of corn and the real wholesale price of corn in Ecuador. The data range for estimation was 1967 through 1998. While the estimated coefficient of the real wholesale price is highly significant, the equation explains only 79% of the variation in the producer price of corn. The calculated elasticity (0.59) shows that the producer price is responsive to changes in the wholesale price. The low DW coefficient (1.502) suggests the presence of serial correlation and could be due to omitted variables, most likely marketing, storage and other costs for which data is not available in Ecuador for corn. Additional research to find or construct a proxy for such costs is needed.

Rice Model Behavioral Equations

Table 14 presents the results of the linear parameter estimation for the rice model. Table 15 provides variable definitions for the corresponding set of equations. As with the corn model estimations results presented earlier, the numbers in parentheses in Table 14 are t-values and those in brackets are elasticities calculated at the means of the data. Also, the number of observations (N) used in each of the estimations is shown as well.

Equations (1) through (6) in Table 14 provide the estimated coefficients and regression statistics for the Ecuador rice supply and demand relationships as hypothesized earlier in this report. Equation (1) is the harvested rice area (RICEHAAR) as a function of the real producer price of rice in the previous period, the harvested area of rice in the previous period , and a dummy variable (DRICE) for the effect of weather on rice acreage in Ecuador. All of the estimated coefficients of the independent variables are statistically significant. Due to lack of data, a variable representing the credit available to producers could not be included in the final estimation. The lagged real producer price of corn was initially included in the estimated model. The sign of the estimated coefficient was inconsistent with expectations and not significant and was, therefore, dropped from the equation. The data range for estimation was 1968 through 1999.

The estimation results for this equation suggest that producer price of rice is an important consideration in the area planted to rice in Ecuador. Also, El Niño had the expected negative effect as indicated by the negative sign on the coefficient of the dummy variable (DRICE). As is the case for corn, the estimated coefficient of the lagged acreage variable is less than one, indicating that Ecuador rice acreage also adjusts with a lag toward long-run equilibrium. This equation explains 93% of the variation in the rice area harvested each year in Ecuador. The Durbin Watson test for serial correlation was inconclusive.

Equation (2) in Table 14 is the milling demand for paddy or rough rice (RICEDDP) which is estimated as a function of the real wholesale prices of rice and corn and the lagged dependent variable. The data range for estimation was 1967 through 1998. The was 1967 through 1998. The results suggest that the coefficient of the wholesale price of rice is significantly and negatively related to the demand for paddy rice. The price of paddy rice had also been included in this equation but because the two rice prices are highly correlated, the paddy price was dropped out of the equation. The results reflect a negative response of rice processing in Ecuador to an increase in rice prices. The coefficient of the wholesale price of corn was also negative, contrary to expectations, but not statistically significant. The conceptual model for the

Table 14: Estimation of Ecuador Rice Demand and Supply Parameters

(1) Harvested Area

$RICEHAAR = -79503 + 181.25*(RICEPRP/EIPC7879)_{t-1} + 1.28*(RICEHAAR)_{t-1} - 25801*DRICE$

(-2.17) (2.81) (14.06) (-2.27)

[0.18] [1.05] [-0.12]

Rsq = 0.93 DW = 1.05 N=31

(2) Demand for Paddy Rice

RICEDDP = 1,133,502 – 0.67*(RICEWHP/EIPC7879) – 0.30*(EMAIPMC/EIPC7879)

(2.58) (-2.89) (-1.01)

[-1.12] [-0.28]

$+0.50*(DPRICE)_{t-1}$

(2.59)

[0.50]

Rsq = 0.87 N=32

DPRICE =

(3) Per Capita Demand for White Rice

LN(RICEPECO) = -18.74 – 0.74*LN(RICECOP/EIPC7879) +0.51*LN(EINPA/EIPC7879)

(-2.58) (-4.11) (1.46)

[-0.74] [0.51]

+ 0.16*LN(POTAPR/EIPC7879) + 1.11*LN(FIDEPR/EIPC7879)

(1.45) (2.46)

[0.16] [1.11]

Rsq = 0.68 DW = 1.25 N=27

(4) Producer Price of Rice

RICEPRP/EIPC7879 = -6.05 + 0.04*(RICEWHP/EIPC7879)

(-0.109) (6.77)

[1.18]

Rsq = 0.61 DW = 0.484 N=31

(5) Consumer Price of Rice

LN(RICECOP/EIPC7879) = -6.52 + 0.98*LN(RICEWHP/EIPC7879)

(-11.68) (16.07)

[0.98]

Table 14 continued

Rsq = 0.89 DW = 0.772 N=31

(6) Wholesalers' Price of Rice

RICEWHP/EIPC7879 = 4449.39 + 0.52*(PWW*EXCHRATE/EIPC7879)

(1.93) (2.06)

[0.42]

Rsq = 0.29 DW = 1.01 N=11

Table 15: Definition of Variables in the Ecuador Rice Market

Endogenous Variables		
RICECOP	=	Consumers' Price of Rice
RICEDDP	=	Demand of Paddy Rice
RICEHAAR	=	Harvested Area of Rice
RICEPECO	=	Per Capita Demand of White Rice
RICEPRP	=	Producers' Price of Rice
RICEWHP	=	Wholesalers' Price of Rice
Exogenous Variables		
DRICE	=	Dummy Variable for effect of weather on Rice
EINPA	=	Ecuadorian Per Capita Income
EIPC7879	=	Price Consumer Index (78/79 = 100)
EMAIPMC	=	Wholesalers' Price of Corn
EPOBA	=	Total Population of Ecuador
ERICDTC	=	Demand Curve of Rice
ERICNPC	=	Upper Referential Price of Rice
ERICPIC	=	Importing Price of Rice
ERICPMC	=	Wholesalers' Price of Rice
ERICSPC	=	Supply Curve of Rice
FIDEPR	=	Price of Paste
MTARIFF	=	Tariff on milled rice imports
POTAPR	=	Price of Potatoes
PTARIFF	=	Tariff on paddy rice imports
PWP	=	World Price of Paddy Rice
PWW	=	World Price of Milled Rice
RICEEXP	=	Rice Exports
RICEIMPO	=	Rice Imports
RICEINS	=	Initial Stocks of Rice
RICEPRP	=	Producers' Price of Rice
RICETOP	=	Total Supply of Paddy Rice
MTARIFF	=	Tariff on milled rice imports

demand for paddy rice also included milling capacity as a constraint on the annual volume of rice that can be milled. Lacking data on milling capacity, the lagged demand was included as a proxy because milling capacity has reportedly been growing in Ecuador as the production and consumption of rice has grown. the coefficient on the lagged dependent variable is positive as expected and statistically significant suggesting that obstacles prevent rice milling to adjust from year to year in response to economic towards desired levels. In this case, the hypothesis is that capacity has grown more slowly than rice production which restricts the volume of rice that can be processed in each year. The estimated equation explains 89% of the variation in the annual volume of milled rice. The Durbin Watson coefficient indicates the absence of serial correlation (DW = 1.644).

Equation (3) in Table 14 specifies the per capita demand for milled rice (RICEPECO) as a function of the real retail price of milled rice, the Ecuadorian real per capita GDP, and the real retail prices of potatoes and noodles. The data range for estimation was 1971 through 1998. The coefficients of all variables have the expected signs and are statistically significant. The own price elasticity of milled rice demand is reasonable at –0.73. Although the noodle price elasticity of milled rice demand is somewhat high at 1.11, noodles have become a close substitute for rice in Ecuador so that the high elasticity is quite plausible. Potatoes, on the other hand, are a staple food in Ecuador so that changes in its prices have little impact on rice consumption as indicated by its low price elasticity (0.16). Taken together, the independent variables explain only 68% of the variation in the per capita rice demand in Ecuador. The Durbin Watson indicates no evidence of serial correlation (DW = 1.25).

Equation (4) in Table 14 is the marketing linkages between the real producer price of rice and the real wholesale price of rice in Ecuador. The data range for estimation was 1967 through 1998. While the estimated coefficient of wholesale price is highly significant, the equation explains only 60% of the variation in the producer price of rice. The calculated elasticity (1.18) indicates that that the producer price is highly responsive to changes in the wholesale price, perhaps more than is economically reasonable. The low Durbin Watson coefficient (0.484), however, suggests the presence of serial correlation and could be due to omitted variables, most likely marketing, storage and other costs for which data are not available in Ecuador for rice. Additional research to find or construct a proxy for such costs is needed.

Equation (5) in Table 14 is the marketing linkage between the real consumer price of rice and the real wholesale price of rice in Ecuador. The data range for estimation was 1967 through 1998. The estimated coefficient of the real wholesale price is again highly significant and has the expected positive sign. The estimated coefficient, however, implies a smaller and more reasonable responsiveness of the consumer price to the wholesale price than was the case for the producer price of rice. Although the equation explains 84% of the variation in the consumer price of rice, the Durbin Watson statistic is once again a low (0.759) indicating the absence of other key explanatory variables from the model. As with the producer price of rice equation, the most likely missing data are marketing, storage and other costs for which data are not available in Ecuador for rice. Again, additional research is needed to find or construct a proxy for such costs.

Finally, equation (6) in Table 14 is the linkage between the real wholesale price of rice and the real world price of rice in Ecuador. The data range for estimation was 1988 through 1998. The estimated coefficient of the inflation-adjusted world price of rice is significant although the equation explains only 30% of the variation in the wholesale price of rice. The calculated elasticity (0.42) shows that the wholesale price is responsive to changes in the international price of rice. The low DW coefficient (1.018) suggests the possible presence of serial correlation and could be due to omitted variables, most likely tariffs, marketing, storage and other costs for which data is not available in Ecuador for corn. Once again, additional research to find or construct a proxy for such costs is needed.

Comparison of Results with Previous Studies

Although no other studies of the corn market in Ecuador has been done, at least two other similar studies have been done for rice which allows a comparison of at least the rice demand results in this study with what other researchers have found. The estimated elasticities for the processing demand for paddy rice and for milled rice from this study are compared in Table 15 with those from the work of Bucheli (1994) and Andrade (2000).

The estimations show that while they are different in absolute value, almost all of them have the same sign and the expected behavior (with exemption of potatoes).

In the case of paddy rice, the own price elasticities of this study is somewhat higher than and estimated by Andrade. The cross price elasticity of demand with respect to corn, however, estimated in this study was negative but not statistically significant. Andrade found a positive and inelastic relationship consistent with a priori expectations. Data issues could be the reason for the highly different results.

In the case of milled rice, the results were more similar. The own price elasticity of demand for milled rice estimated in this study (–0.74) was between those estimated by Bucheli (–0.62) and Andrade (-0.92). The cross price elasticity of rice demand with respect to the price of potatoes estimated in this study (0.16) was close to that found by Bucheli (0.22).. Andrade reported an implausible negative cross price elasticity for potatoes. In this study, the demand for rice was found to be elastic with respect to the price of noodles. Andrade reported a more inelastic relationship between rice demand and the price of noodles. In general, the results seem to confirm the hypothesis that potatoes and noodles are substitutes in demand for rice. In all three studies, the demand for rice was found to be inelastic with respect to changes in income. This result is plausible since rice is considered a staple in Ecuadorian diets.

Conclusions

This study was a qualitative and a quantitative examination of the economic structure of the rice and corn markets in Ecuador. The primary objectives of the study were to define the structure of the two markets, identify the key economic and policy factors affecting economic behavior in both markets, and then measure the impact of the identified factors on the supply and demand for

Table 16: Comparison of Estimated Rice Demand Elasticities

	Current Study	Andrade	Bucheli
Demand for Paddy Rice			
Own Price Elasticity	-1.12	-0.72	n/e
Cross Price Elasticity (corn)	-0.28*	0.49	n/e
Demand for Milled Rice			
Own Price Elasticity	-0.74	-0.92	-0.62
Cross Price Elasticity:			
Potatoes	0.16*	-0.18	0.22
Noddles	1.11	0.74	n/e
Income Elasticity	0.51*	0.55	0.37

* = not statistically significant
n/e = not estimated
Source: Andrade (2000), Bucheli (1994)

both commodities in Ecuador. This study should provide policy makers with better information on two of the most important and fastest growing crops in Ecuador to assist in appropriate policy formulation.

In the case of corn markets in Ecuador, the major findings include the following:

- Corn and soybeans are substitutes in production.
- Weather problems have had a major impact on corn production in Ecuador over a number of years.
- The availability of credit has played a significant role in the production of corn in Ecuador over time.
- Soybeans and corn are net complements in the feed demand for corn.
- The feed demand for corn is significantly affected by changes in real incomes as economic growth creates a growing demand for meat and particularly poultry meat in Ecuador.
- The estimated own-price elasticity of corn demand for animal feed in Ecuador is -0.24, similar to what has been found in other countries.
- The data for food demand for corn has many problems that may be responsible for the poor econometric results for that equation.

In the case of rice markets in Ecuador, major findings include:

- Credit availability is also critically important for rice production in Ecuador.

- Rice processors are sensitive to changes in the price of corn because many rice processors can switch to the processing of corn given appropriate shifts in their relative costs.
- The estimated own-price elasticity of the per capita demand for rice in Ecuador is –0.74, within the range found in other countries.
- Potatoes and noodles are strong substitute for rice in Ecuador, a conclusion that is consistent with observed behavior and the findings of other studies.
- The per capita consumption of rice is relatively unresponsive to changes in p[er capita income. The estimated income elasticity of 0.50 is similar to what other studies have concluded.
- While the paddy, wholesale, and retail prices of rice are correlated, the relatively higher rate of growth of the retail price compared to the wholesale and of the wholesale to the paddy price suggests that marketing costs have been increasing over time in Ecuador for which a proxy needs to be found or constructed to be able to better explain the growing margin between the price of rice in Ecuador at different levels in the market.

Suggestions for Further Research

The qualitative and empirical analysis developed in this paper provided a better understanding of the Ecuador rice and corn market, its characteristics, and behavior. Nevertheless, more research and analysis is required to clarify and expand the results obtained and discussed in this study. Some issues to be considered in future research should include the following.

First, a more coherent, complete, and validated database for the Ecuador corn and rice markets is indispensable. The Ecuador government through the SICA Project (the Agricultural Census and Information Service Project) has begun developing databases for most of Ecuador's agricultural markets. Future research on Ecuador agriculture must will need to be done in close consultation with the SICA project analysts developing those databases.

Second, the conceptual models on which the estimated models were based should be enhanced to include more detail on the structure of the markets, including additional cross commodity, horizontal, and vertical linkages to provide a better representation of the Ecuador corn and rice markets. Also, the closed market assumption may need to be relaxed since both corn and rice are traded.

Third, the econometric models used in this study could be improved in a number of ways. Additional research to determine more details about the forces affecting the corn and rice sectors would allow more precise specification of the estimating equations and eliminate complicating problems like omitted variables bias and, thereby, improve the precision of the parameter estimates. At the same time, more current observations on variables like credit availability would allow more recent observations on the dependent variables of some equations to be included in the estimation period. Also, tests for structural change for the periods before and after Ecuador entered the Andean Pact in the early 1990s could help improve parameter precision and the fit of the equations. Finally, given adequate data, the use of a simultaneous equations estimator, such as three stage least squares, could help resolve both serial correlation problems and simultaneous equations bias and improve both the consistency and the efficiency of the parameter estimates.

Fourth, future research could use the models developed to conduct simulation analyses of important policy and other issues, such as the effects that liberalization, El Niño, and joining the Andean Pact have had on the two markets. Forecast simulation analyses of trade policy issues such as the potential effect of a Free Trade Area of the Americas on the two markets could also be done.

Finally, while this study provides good background for future research, the commodity scope has been too limited. To be truly useful for policy analysis, the model will need to be expanded to include other key agricultural markets in Ecuador such as bananas, palm oil, coffee, livestock (particularly poultry), and wheat and other grains.

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