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Comparative Advantage and Policy Incentives for Wheat Production in Ecuador

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PREFACE

This paper by Derek Byerlee is the first in a series that staff of CIMMYT Economics Program and research organizations in selected developing countries will prepare on assessing the comparative advantage of particular regions in specific crops. The approach features domestic resource cost analysis. We believe that the approach offers great promise for those responsible for the allocation of research resources. We plan to undertake additional studies like that reported on by Byerlee, expecting that each study will be useful in itself. Beyond that, the series will provide the experience necessary for the preparation of a manual that can be used by colleagues to guide similar work by national programs.

And what can such studies contribute to those responsible for guiding the allocation of research resources? They provide a convenient format for assessing the advantages that a given region has in the production of a particular crop. Beyond that, the format offers an easy framework for assessing how that advantage might change with changes in selected policy variables or with the introduction of new technologies. This information can be combined with that from other sources, e.g. that from biological scientists describing what is likely through research or that from policy makers reflecting society's views of its priorities, to assist in deciding the relative emphasis to be given to crops or to regions.

A major advantage of the analytical format is that it permits the assessment of private profit--taking prices and costs as seen by farmers--as well as profit to the nation--abstracting from the effects of taxes, subsidies, and exchange rate anomalies. With this information, research managers can speculate on the permanence of differences between private and national gains and have a stronger sense of the direction in which research resources should be oriented. This

permits more precise insights into one of the problems that characterizes research management, that of the lag between the commitment of resources and the delivery of the product of research.

Three qualities differentiate this effort from that of others who have applied domestic resource cost analysis to the question of comparative advantage. The first is that biology is brought to center stage in the analysis. The second is that the analysis is aimed at research resource managers rather than at those responsible for policy. The third is that the resulting manual will be designed so as to offer easy guidelines for those wishing to apply the analytical framework.

We believe that managers concerned with cost-effective research will welcome such a tool as an aid to decision making. They will want to have the capacity to develop such analyses with their own resources and, therefore, will want the manual that is seen as a major product of this effort.

Over the next two years we expect to complete six to eight such studies, covering a wide range of the circumstances typically encountered by research decision makers. Each will be presented as a working paper.

This paper is in response to the question of continuing support for wheat research in the face of steady declines in the area devoted to wheat. The analysis permits distinguishing the effects of factors influencing farmer profitability, including the effects of government policies, and gives evidence of the study region's comparative advantage in wheat producton. The realization that wheat's competitive position has been eroded by policies of uncertain duration offers support for continuing research in wheat.

The bulk of the research for this paper was conducted in 1983. Some of the conditions in Ecuador have changed since then, but it is my

belief that the main conclusions still hold. The paper could not have been prepared without the active cooperation of many people in Ecuador, especially in INIAP, in the private and farming sectors, and in CIMMYT's Ecuador-based regional staff.

As with all CIMMYT working papers, we welcome comments, criticisms, or counsel so that the paper might be improved.

Donald Winkelmann,
Economics Program

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TABLE OF CONTENTS

		Page Number
PREFACE		(i)
ACKNOWLEDGEMENTS		(iv)
READING THIS REPORT		(xi)
LIST OF ACRONYMS		(xii)
Part I	EXECUTIVE SUMMARY	(xiii)
Part II	MAIN REPORT	
	1.0 Introduction	1
	2.0 A Framework for Measuring Comparative Advantage and Policy Incentives	3
	2.1 An Example of Calculating Policy Effects and Comparative Advantage	4
	2.2 Definition of Terms	6
	2.3 Comparative Advantage in a Dynamic World	9
	2.4 Data Sources and Analysis	11
	3.0 The Macro-Level Policy Environment in Ecuador: 1970-83	12
	3.1 The Petroleum Boom, 1970-81	12
	3.2 The Macro-Economic Situation in 1983	16
	4.0 The Agricultural Policy Environment for Wheat in Ecuador	18
	4.1 Price Policy for Wheat and Competing Crop-Livestock Activities, 1970-80	18
	4.2 Price Policy for Wheat and Competing Enterprises, 1980-83	28
	4.3 Price Policy for Agricultural Inputs	29
	4.4 Policies Affecting Capital, Labor and Water Costs	31

Page Number

5.0 Wheat in the Farming System - The Cayambe Area 34

5.1 Wheat Production Technology 36

5.2 Relative Profitability of Crop and Livestock Alternatives 44

5.3 Changes in Cropping Patterns in Relation to Relative Profitability 48

6.0 Profitability to the Nation of Wheat Production and Competing Crop-Livestock Activities 52

6.1 Assumptions Used to Compute Opportunity Prices 52

6.2 Results of the National Profitability Analysis 55

7.0 Conclusions 62

Part III APPENDICES

A Changes in Consumption Patterns and Consumer Pricing Policy 67

B The Wheat Marketing and Milling System 70

C The World Market for Dairy Products and the Relationship Between World Prices and Ecuadorian Prices 73

D Calculation of Mechanization Costs 79

E Budgets for Crop-Livestock Activities to Calculate Farm Level and Social Profitability 83

F Institutes and Departments Providing Data and Information for the Study 90

G Data on Wheat Production and Utilization 91

REFERENCES 98

LIST OF TABLES

		Page Number
Table 1.	Measures of Comparative Advantage and Policy Incentives	8
Table 2.	Some Possible Conflicts Between National and Farmer Profitability at Different Levels of Technology	10
Table 3.	Changes in Real Prices Paid to Producers, 1970-80, 1980-83	20
Table 4.	Import Tariffs for Wheat and Competing Crop-Livestock Commodities, Ecuador	23
Table 5.	Estimated Costs in 1983 of Imported Wheat in Ecuador Based on Expected Long Run CIF Price of US$210/ton.	30
Table 6.	Estimated Costs in 1983 of Imported Urea Based on Expected Long Run CIF Price of US$190/ton.	33
Table 7.	Practices Used in Wheat Production; Small and Medium Size Farmers, 1977	38
Table 8.	Practices Used in the Production of Wheat in Pichincha by Farm Size, 1982	40
Table 9.	Distribution of Area of Wheat by Farm Size Strata, Pichincha, 1982	41
Table 10.	Comparison of Costs of Mechanical and Animal/ Manual Practices in Wheat Production, Cayambe, 1983	41
Table 11.	Labor Intensity of Different Techniques for Wheat Production	43
Table 12.	Partial Budget for Recommended Fertilizer Application (80-80-0 kg of NPK/ha)	43
Table 13.	Farmer Profitability of Wheat and Competing Enterprises Under Different Assumptions, Cayambe, 1983	47
Table 14.	Estimated Returns to Land in Wheat, Potatoes and Dairy in 1971 and 1983	50
Table 15.	Opportunity Prices Used for National Profitability Analysis Compared to Actual Farm Prices	56

Page Number

Table 16. Estimated Profitability to Farmers and to the Nation of Wheat and Competing Enterprises at Recommended Technology Levels, Cayambe, 1983 57

Table 17. Summary of Main Policy Effects by Enterprise, Cayambe, 1983 58

Table 18. Comparison of the National Profitability of Wheat and Dairy Under Alternative Assumptions Regarding Productivity, Cayambe, 1983 59

Table 19. Comparison of National Profitability of Wheat and Dairy at Improved Technology Levels Under Alternative Assumptions About World Prices for Wheat and Milk 60

Table 20. Summary of the Ratio of Foreign Exchange, Labor and Capital Costs to the Value of Output at Improved Level of Technology 61

Table A1. Summary of Consumption Patterns for Main Food Staples and for Milk 68

Table A2. Wholesale Prices in the Quito Market, June, 1983 68

Table C1. Self-sufficiency of Ecuador and Neighboring Countries in Milk Products, 1979-81 73

Table C2. Retail Prices of Milk and Milk Products in Selected Latin American Countries, 1981 74

Table C3. Stocks, World Trade and Prices for Milk and Milk Products 75

Table C4. Nominal Protection Coefficients for Milk, Butter, and Wheat, 1970-83 76

Table D1. Parameters Used to Calculate Machinery Costs 81

Table D2. Cost of Tractor and Combine Harvester Operation Under Different Assumptions Regarding Foreign Exchange Rates, Interest Charges and Fuel, 1983 82

Table E1. Input-Output Relations for Crop Activities at Farmer Levels of Technology 85

Table E2. Input-Output Relations for Crop Activities - Recommended Technology 86

Table E3. Input-Output Relationships for Dairying 87

Page Number

Table E4. Calculation of National and Farmer Profitability at Recommended Technology Levels 68

Table G1. Area, Yield, Production, and Utilization of Wheat in Ecuador, 1964-81 92

Table G2. Supply and Utilization of Wheat in Ecuador, 1964-81 93

Table G3. Wheat Area by Province, Ecuador. 1976-82 94

Table G4. Wheat Yields by Province in Ecuador, 1976-82 94

Table G5. Total Number of Wheat Farmers, Wheat Area, and Average Farm Size in Ecuador, 1970-82 95

Table G6. Use of Bio-Chemical and Mechanical Technologies in Wheat Production in Ecuador, 1970-82 96

Table G7. Price Series for Wheat and Wheat Products in Ecuador, 1970-83 96

Table G8. Prices of Inputs Used in Wheat Production in Ecuador, 1971-83 97

LIST OF FIGURES

		Page Number
Figure 1.	Area, Production and Consumption of Wheat, Ecuador, 1970-82	2
Figure 2.	Official and Corrected Exchange Rates, 1971-80	14
Figure 3.	Real Costs of Inland Grain Transportation, 1970-83	17
Figure 4.	Producer Prices for Wheat, Milk and Potatoes, 1970-80	19
Figure 5.	Comparison of Average Wheat Price Received by Farmers with World Price Equivalent Calculated at Different Exchange Rates	21
Figure 6.	Indices of Real Consumer Prices of Milk Products	25
Figure 7.	Comparison of Producer Prices for Milk with World Equivalent Price, 1970-83	26
Figure 8.	Comparison of Retail Price of Butter with World Price Equivalent, 1970-83	27
Figure 9.	Real Prices for Wheat Seed and Fertilizer, 1975-83	32
Figure 10.	Value of Loans (in 1970 Sucres) Authorized by the Banco Nacional de Fomento for Wheat in all Ecuador and for Livestock in Cayambe	35
Figure 11.	Map of Ecuador Showing Wheat Importing Point, Consuming Point and Producing Point for the Study	37
Figure 12.	Technological Change in the Dairy Industry, Cayambe and Machachi Valleys, 1950-80	49
Figure A1.	Real Retail Prices for Basic Food Staples in Urban Areas, 1970-82	69

READING THIS REPORT

This report is written in three different parts. The readers should select those parts most relevant to their level of interest.

Part I Executive summary of the main methods and results for those interested in an overview.

Part II Main body of the report in six sections.

Part III Appendices of data and detailed explanations of some aspects of the analysis for those who may want to review the assumption and methods in detail.

LIST OF ACRONYMS

BNF	Banco Nacional de Fomento (National Development Bank)
DWM	Dry Whole Milk
ENAC	Empresa Nacional de Almacenamiento y Comercialización (National Agricultural Products Marketing and Storage Company)
ENPROVIT	Empresa Nacional de Productos Vitales (National Basic Products Company)
FERTISA	Fertilizantes Ecuatorianos, S. A. (Ecuadorian Fertilizer Company)
INEC	Instituto Nacional de Estadística y Censo (National Institute of Statistics)
INERHI	Instituto Ecuatoriano de Recursos Hidráulicos (Ecuadorian Institute of Water Resources)
INIAP	Instituto Nacional de Investigaciones Agropecuarias (National Agricultural Research Institute)
MAG	Ministerio de Agricultura y Ganadería (Ministry of Agriculture and Livestock)
NPC	Nominal Protection Coefficient
PIP	Programa de Investigación en Producción (Production Research Program)

WEIGHTS AND MEASURES

1 quintal (qq) = 100 lbs. = 45.4 kg.
1 liter (lt) = 0.26 gallons (US).
1 ton drymilk = 8.33 ton liquid milk.

Comparative Advantage and Policy Incentives for Wheat Production in Ecuador

EXECUTIVE SUMMARY

Objectives and Methodology

During the last decade wheat production in Ecuador has decreased sharply at the same time that consumption has been increasing rapidly. As a result wheat imports have grown at 12 percent annually from 1970 to 1982 and Ecuador now imports over 90 percent of the wheat consumed. Wheat is now the most important staple food in Ecuador.

These trends raise three questions; a) why has wheat production in Ecuador fallen and imports increased so rapidly, b) is it an efficient use of its resources for Ecuador to produce wheat locally, and c) if it is efficient to produce wheat, what combination of policy incentives and technological change are needed to promote domestic wheat production. The broad objectives of this study were to analyze these questions with particular attention to the effects of government policies on wheat production and the implications for INIAP's (the National Agricultural Research Institute) program of wheat research.

The framework of comparative advantage and policy incentives was used as the basis of the analysis. Comparative advantage was measured by calculating the profitability to the nation, measured by the contribution of wheat and competing enterprises to national income. Locally produced wheat was valued at the equivalent price of imported wheat while imported inputs were also valued at their import cost with appropriate adjustments for internal transport and marketing margins. Labor and capital were valued at their returns in alternative uses within Ecuador. By conducting similar calculations for competing crop and livestock enterprises, the returns to the nation of land used in wheat were compared with alternative uses of that land.

Economic returns calculated by this method often differ substan-

tially from farmers returns because of the effects of policy interventions. Government policies which set the price of wheat or subsidize inputs lead to differences between the import equivalent price and the price the farmer receives or pays. Similarly interest rates paid by farmers may be quite different from the opportunity cost of capital. In fact the difference between farmers' profitability and national profitability is a measure of the total effect of policy - that is, whether policy is providing incentives or disincentives for wheat production.

The Policy Environment for Wheat Production

The major feature of the Ecuadorian policy environment during the 1970s was the increase in oil export revenues. The petroleum boom and the related management of the exchange rate had a number of effects on agriculture. The exchange rate was kept fixed even though inflation was higher in Ecuador than in its main trading partners so that imported items such as wheat became cheaper in real terms. Incomes grew rapidly, particularly those of the urban middle class, leading to a strong demand for food products and especially livestock products that compete with wheat for land use. Employment also grew rapidly, leading to rapid rural-urban migration and increased real wage rates in urban areas. Together with very low fuel prices, this provided a strong incentive for farmers to mechanize.

Producer prices of wheat in the last decade have declined sharply in real terms and relative to prices of competing crop and livestock commodities. The decline in the price of wheat arises largely from a policy of linking producer prices to the import price of wheat at the official exchange rate which became significantly overvalued in the period 1977 to 1981. In the case of milk production, the most important alternative use of land, prices were fairly steady in real terms for much of the decade and appear to have risen in recent years. Milk prices were significantly above import prices for dry milk at the official exchange rate and prices of butter and cheese in Ecuador were over double prices prevailing in nearby countries such as Panama with more open trade policies. The producer price for barley also rose relative to

wheat, again due to import protection. Prices of potatoes and soft maize which are not widely traded on world markets were determined by domestic supply and demand. Increased labor costs and lack of technological change for these labor intensive crops resulted in relatively rapid increases in the prices of these commodities. Overall in the period 1970-83 the price of wheat declined 30 percent relative to barley and about 50 percent relative to milk.

In 1983, the official producer price of wheat was only about 50 percent of the import price equivalent, converted at an exchange rate of Sucres 80/$US1.00, to reflect the true value of foreign exchange to the nation. Milk prices were also slightly below import prices and economic recession, reduced demand and declining real prices for cheese and butter had eliminated most of the protection on milk products. Barley producer prices were below the import price equivalent but less so than in the case of wheat. The greater price disincentives for wheat arose from a policy of importing wheat at the official exchange rate while imports of other products were either prohibited (e.g. butter and cheese) or allowed only at close to the free exchange rate.

Agricultural inputs were also imported at the official exchange rate and prices of imported inputs such as fertilizer tended to decline relative to inflation over the period 1970-83 because of overvaluation of the exchange rate. In addition, wheat producers benefited from low fuel costs and more recently a subsidy on Ministry of Agriculture mechanization services which have led to a decline in machinery rental rates (adjusted for inflation) of as much as 50 percent from 1974 to 1983.

Farmers with access to bank loans also received credit at negative real rates of interest during recent years. In 1983, the differential between interest rates on agricultural loans and the inflation rate was 30 percent or more. However, wheat producers benefited little from cheap credit. Livestock production, which is a relatively capital-intensive industry, experienced rapid increases in credit at the same time that the wheat area sown with credit was reduced to only about 7 percent of the total.

Farmer Profitability and National Profitability

The profitability of wheat and competing crop and livestock activities were compared at two levels of technology, 1) farmer technology, and 2) an improved level of technology which represents expected productivity levels with the application of available research results. Because of time limitations this comparison was restricted to two different systems in the Cayambe-Tabacundo-Otavalo area: a) valley bottoms where irrigation allows intensive dairy farming with articifial pastures or two crops per year to be produced, and b) hillsides without irrigation where only extensive relatively low productivity dairying with natural pastures is practiced and usually only one crop per year can be grown.

Farmers' returns to land in wheat production are slightly less than for other cereals and less than half of the returns in dairying and potatoes. Moreover, because of the pricing policies discussed above, real returns in wheat production have fallen sharply over time while returns in dairying and potatoes have increased significantly. Not surprisingly, there has been a substantial shift in land use toward both intensive and extensive dairy. High capital and labor requirements and price risks of potato production have limited expansion of that crop.

Price policy has also been a factor in the stagnant yields in wheat production in recent years. While farmers have accepted improved wheat varieties (and probably prevented a decline in yields due to diseases), most farmers use no fertilizer or apply doses well below recommendations based on on-farm experimental data. However, economic returns to fertilizer use in wheat are modest given current prices, and well below returns in crops such as potatoes where fertilizer is widely used. Furthermore, even at improved levels of technology wheat is less profitable to farmers than either extensive or intensive dairying at current farmer levels of technology.

When national profitability of each crop-livestock activity was calculated (by expressing product and input prices at import price

equivalent, allowing for over-valuation of the official exchange rate and removing subsidies on transport, mechanization services, and credit) wheat provided the highest returns to land after potatoes, and extensive dairying the lowest. The results are somewhat sensitive to assumptions about productivity levels; wheat yields of 1.6 t/ha with moderate doses of fertilizer are needed to compete with extensive dairy on the hillsides. In the valley bottoms, wheat competes with intensive dairying when compared at either farmer or improved levels of technology. In each case, wheat also provides higher returns than barley since barley requires similar levels of inputs but the import price of barley is usually below that of wheat. Moreover if policy distortions are removed, the incentives for use of recommended technology, especially fertilizer, are significantly increased. In fact, the increase in economic returns per hectare due to use of improved technology is highest in the case of wheat.

The differences between farmers returns, which are low for wheat and returns to the country from wheat production, which are relatively high are due to the effects of policy. Overall, net policy effects taking into account effects on product and input prices and capital costs are significantly negative for wheat, zero for barley and positive for dairy and potatoes.

These conclusions have at least three important limitations. First, there is little available data on the dairy industry, particularly extensive dairying. A survey of land use patterns and productivity is needed to establish the relevant input-output parameters and extent of different livestock systems. Second, the analysis was confined to one region. Extension across other important wheat producing regions is needed to confirm the generality of the conclusions. Finally, other objectives, such as income distribution and consumer protection from fluctuations in world prices would also want to be considered in any decision to promote domestic wheat production at the expense of other products.

Implications

If there is a desire to promote wheat production in the interests of more efficient resource use, a number of possible policy measures are possible. One low cost alternative is to set the producer price of wheat at the import equivalent price, converted at the free exchange rate with appropriate means to enforce this price to millers. (Imported wheat could still be imported at the official exchange rate to maintain low consumer prices.) This would imply a current price of about S.18,300/t or S.830/qq. in 1983. It will also be important to maintain prices of wheat relative to prices of competing products in line with their relative cost of importation. This implies a price of wheat roughly 15 percent above milk and barley prices. Since domestic wheat purchases currently make up about 5 percent of wheat milled, payment of a price of S.18,300/ton would have only a negligible impact on consumer prices. While the desire to maintain low wheat prices to consumers given the present economic crisis is understandable, in the long run food security is promoted by allowing wheat prices to consumers to rise to levels that reflect the true cost of imported wheat.

Finally, the results provide justification for continuing a strong wheat research program. Although technological change alone is not sufficient to overcome the low farmer returns from wheat under current policies, agricultural research is a long term process and decisions on research resource allocation must take a long term perspective on the policy environment.

COMPARATIVE ADVANTAGE AND POLICY INCENTIVES FOR WHEAT PRODUCTION IN ECUADOR

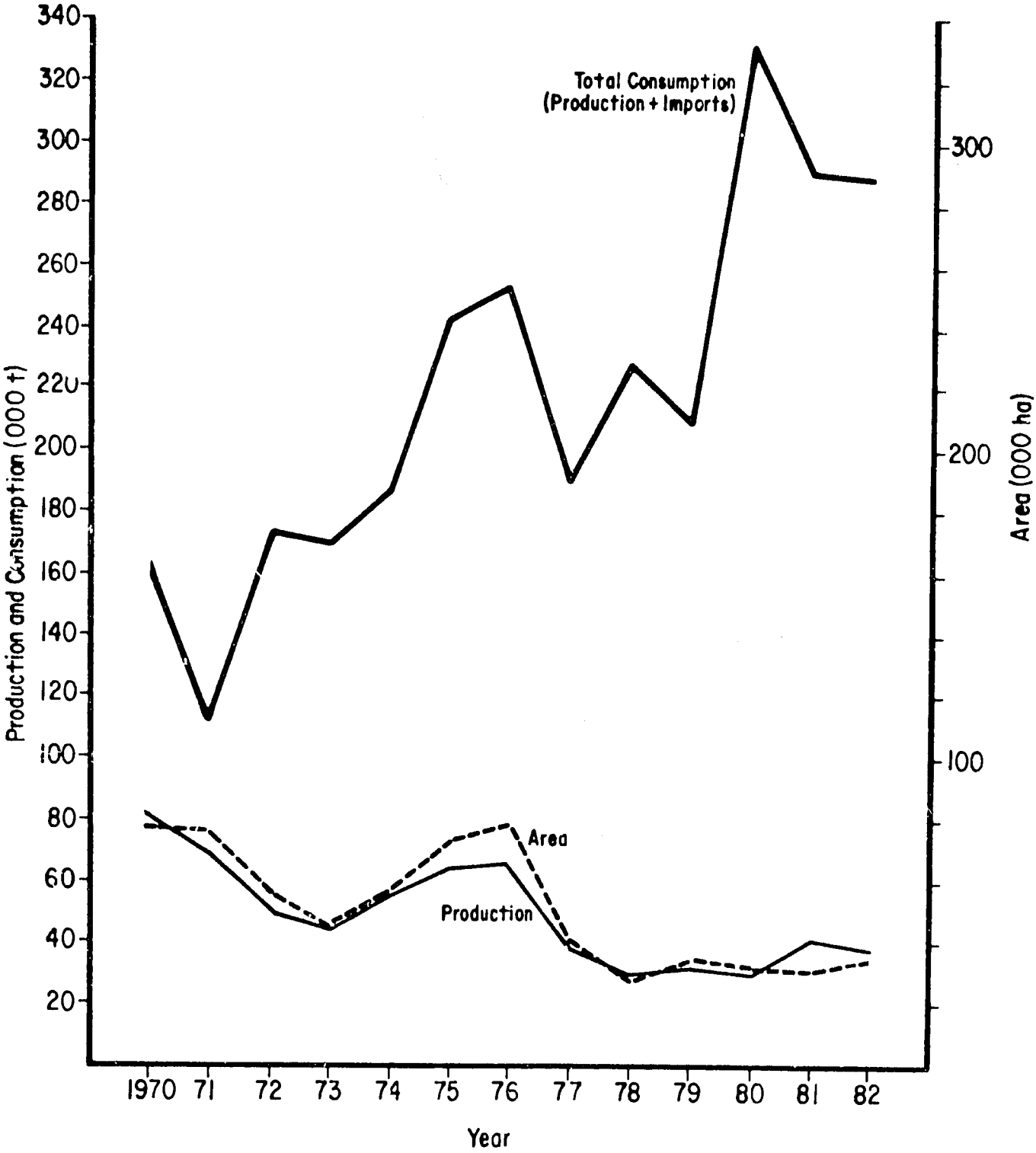
1.0 Introduction

A recent analysis of wheat imports and consumption in the developing world (CIMMYT, 1983) identified several special characteristics of the wheat economy of the Andean Region including the following: a) wheat consumption has increased steadily in the 1970s to reach about 35 kg/capita; b) wheat production has decreased at a rate of 6 percent per annum during the same period: and, c) the region now imports over 90 percent of the wheat consumed.

Wheat production and consumption in Ecuador, shown in Figure 1, follow the same trends exhibited for the Andean Region as a whole. In fact, wheat consumption and imports in Ecuador has increased more rapidly than in neighboring countries. Wheat consumption increased from 26 kg/capita in 1970 to over 40 kg/capita in 1982. This has been made possible by a 12 percent growth in wheat imports over this period. The proportion imported has increased from 46 percent of consumption in 1970 to over 92 percent in 1982. These trends raise three questions: a) why has wheat production in Ecuador fallen and imports increased so rapidly?, b) is it an efficient use of its resources for Ecuador to produce wheat?, and c) if it is efficient to produce wheat in Ecuador, what type of policy incentives and technological change are needed to promote domestic wheat production?

The broad objective of this study is to analyze these questions as a basis for assessing INIAP's allocation of research resources to wheat (INIAP is the national agricultural research organization). With continuation of current trends, domestic wheat production is scarcely sufficient to justify a strong national wheat research program. However, if wheat production can be shown to be an efficient use of national resources and also profitable to farmers, a case can be made for continuing a strong national research program.

Figure 1. Area, Production and Consumption of Wheat, Ecuador, 1970-82.



Source: F.A.O.

The specific objectives of the study are:

i) Analyze the price policies which have influenced the decrease in wheat production.
ii) Estimate the profitability to farmers of wheat production and competing crop and livestock activities.
iii) Using product and input prices that reflect their cost of importation, calculate the profitability to the nation (i.e. change in national income) of resources used in wheat production compared to the returns in competing crop and livestock activities.
iv) Estimate the effect of improved wheat production technology on the profitability of wheat production to farmers and to the nation and determine what combination of price policy and improved technology would be necessary to efficiently produce wheat in Ecuador.

Approximately one month of the author's time was available for gathering information for this study. To limit its size, it was concentrated on wheat production in the Cayambe area of Pichincha Province and part of Imbabura Province - an area that was formerly a major wheat producing area of Ecuador. Conclusions drawn from this study are meant to provide a basis for further analysis, both in other areas of the Sierra as well as for a more in-depth study of livestock, the main competing enterprise. It is hoped that the tentative findings of this study will stimulate further analysis of the important questions of price policy, import protection and comparative advantage for different commodities in Ecuador.

2.0 A Framework for Measuring Comparative Advantage and Policy Incentives

The framework used in this study is conceptually simply, although its empirical application is sometimes more complex. The basic approach is to measure and to take into account the effects of various government policies on the prices received by farmers for their outputs and the prices paid for their inputs.

Government policy influences prices at a number of different levels.

Macro-economic policy with respect to the exchange rate and interest rates influences prices in all sectors of the economy. Exchange rate policy is particularly important in determining the prices of imported inputs and of agricultural products, such as cereals, which are widely traded in international markets. There are also usually policies that are specific to the agricultural sector such as a subsidy on fertilizer. Finally, there are policies which are specific to a crop or region. A guaranteed price for wheat is specific to that crop or a government tractor hire scheme may be specific to a region.

Governments usually have particular objectives for the implementation of each of these policies. However, the total effect of policy interventions is often not clear. In many cases, the total effect of various policies discriminates against, or favors, particular crops or groups of farmers in ways that are not readily apparent. These policy effects may be large enough that the profitability of a particular crop or technology to farmers bears little relationship to the profitability to the country. For example, guaranteed prices are often set on the basis of cost of production without reference to the cost of importing that product[1/]. In many cases, allocation of agricultural research resources on the basis of current area or production of the crop may lead to under-investment in activities in which that country is an efficient producer but whose production is reduced by policy disincentives (and vice versa).

2.1 An Example of Calculating Policy Effects and Comparative Advantage

The following simplified example shows how the effects of policy interventions can be calculated and the profitability to the nation estimated. Assume that:

a) The farmers' price of wheat is $150/ton which is below the world price.

1/ In fact, cost of production is also determined by product prices since increased prices are generally capitalized into land values (i.e., increased prices lead to increased cost of production).

b) The major purchased input in wheat production is fertilizer which costs $50/ha given a fertilizer subsidy equivalent to $25/ha.

c) The farmers' labor and capital used in wheat production are valued at $75/ha at market prices and the rental value of land is $75/ha. Clearly if the current wheat yield is 1.3 tons/ha, wheat is an unprofitable crop to farmers since net returns are -$5/ha (1.3 x 150 - 50 - 75 - 75).

However, from the national viewpoint the resources used in wheat production may be profitably employed. The value of the wheat produced from the point of view of the country is the saving in foreign exchange from substituting for wheat imports (given that the country is a wheat importer). Assume that wheat is imported at $180/ton and that it costs $20/ton to transport to the capital city. If domestic wheat costs $10/ton to transport to the capital city then the value to the nation of wheat in the producing area is $190/ton (180 + 20 - 10). This we call the "world price equivalent". At the same time, fertilizer receives a subsidy of $25/ha which is a real cost to the country. Hence the profitability to the nation which measures the contribution of wheat production to national income is (190 x 1.3 - (50+25) - 75 - 75) = 22 which indicates that wheat is marginally profitable. Despite the subsidy on fertilizer, the net effect of policy is to tax farmers by $27/ton (-5 -22) by maintaining a producer price for wheat below the import price.

Policy may also indirectly affect the profitability of wheat through effects on competing enterprises. Assume that wheat land competes with pasture for livestock production. If livestock products are protected by a 30 percent duty on imports, the market value of land will also be increased. Let us assume that the farmer receives returns of $300/ha for livestock less costs of $75 for inputs and $150 for labor and capital. The residual return on land to the farmers is $75/ha (300 - 75 - 150). However, the value to the country of the livestock output (meat or milk) is less than $300/ha since it costs less to import it -part of the $300 value of livestock produce is due to the import duty. Assume that the value of the livestock output at the <u>world price equivalent</u> (i.e., adjusted for tariffs and transport costs) is $240/ha.

Therefore, the opportunity cost of land in livestock is only $15/ha (240 - 75 - 150). The returns to the nation from wheat production using this value of land are $82/ton, (190 x 1.3 - (50+25) - 75 - 15) and wheat production is quite profitable. The total effect of policy on wheat producers is then -$87/ha (-5 - 82). The national profitability of livestock, on the other hand, is negative (240 - 75 - 150 - 97)[1/]. This means that farmers earn slightly more from livestock production than from wheat production. However, from the point of view of the country, wheat contributes substantially more to national income. In this example, policy incentives favor the livestock sector and discriminate against the wheat sector.

Of course, the opposite situation is also equally possible. If domestic wheat production is protected by an import duty on imported wheat then producer prices for wheat would be above the world price equivalent. At the same time if wheat competes with cotton that is subject to an export tax, then additional policy incentives are indirectly provided to wheat production through disincentives on cotton.

2.2 Definition of Terms

A number of measures have been developed for measuring policy incentives and comparative advantage and are summarized in Table 1 (Pearson, 1982). All inputs and outputs are divided into tradables and nontradeables. Tradeables are those products and inputs that are imported or exported, or have the potential to be traded, such as wheat or fertilizer. Nontradeables are all factors which are not readily imported or exported in world markets. They are divided into: a) those factors, labor and capital, which are mobile and can be used in other regions or sectors and b) the factor, land, which is immobile.

1/ The opportunity cost of land in livestock is its residual return in wheat production (190 x 1.3 - 75 - 75 = 97).

As shown in the above example, the profitability of production of a given commodity can be calculated at two levels. Farmer profitability is computed using the actual market prices paid and received by farmers for all inputs and outputs. This is represented by E in Table 1. National profitability, on the other hand is the measure of the contribution of a given enterprise to national income. It is calculated by estimating the value to the nation of outputs produced and costs to the nation of inputs used. That is, all inputs and outputs are valued at opportunity prices. In the case of tradeable commodities this opportunity price is the world price equivalent - that is, the import (or export) price adjusted for exchange rate distortions and internal transport and distribution costs. Nontradeables are valued at their opportunity cost to the nation - that is their value in alternative uses. This was illustrated in the earlier example by valuing land for wheat production at its return to the nation in livestock production.

Farmer profitability and national profitability differ because of government policy interventions. Individual policy effects are represented by the difference between a particular product, input or resource valued at market prices and at opportunity prices[1/]. A tariff on imports of a product is measured in K, a subsidy on fertilizer in L and a subsidy on credit in M (Table 1). Indirect policy effects, that have an impact on prices for competing crops and hence influence the opportunity cost of land, are measured in N. Total policy effects are measured by O; a positive value for O indicates that the total effect of all policies is to provide incentives additional to those provided by the world prices for the production of that commodity. Likewise a negative value indicates policy disincentives.

1/ Policies are implemented with various objectives. In the jargon of economics some policies may be implemented in order to offset market failures which result in inefficient resource allocation. In this study we ignore the incidence of market failures as a motive for policy interventions. In the particular industries under study, with the possible exception of wheat milling, competitive forces appear to operate.

Table 1. Measures of Comparative Advantage and Policy Incentives.

	Tradeables		Nontradeables		
	Products	Inputs[a/]	Capital and Labor	Land	Profits
Market Prices	A	B	C	D	E = A-B-C-D
World Price Equivalent	F	G			
Opportunity Cost of Resources			H	I	
Opportunity Price	F	G	H	I	J = F-G-H-I
Policy Effect	K=A-F	L=G-B	M=H-C	N=I-D	O = E-J = K+L+M+N

Measures of Policy Incentives

Nominal Protection Coefficient (NPC) $= \frac{A}{F}$

Effective Protection Coefficient (EPC) $= \frac{A - B}{F - G}$

Effective Subsidy Coefficient = O/F

Measures of Comparative Advantage

National Profitability = J

Domestic Resource Cost Ratio $= \frac{H + I}{F - G}$

National Returns to Land = F - G - H

a/ Most inputs consist of a tradeable component and a nontradeable component. For example, a tractor produced locally includes imports used in its manufacture plus some nontradeables such as labor and capital. These inputs should be divided into their tradeable and nontradeable components. Even fully imported inputs include some nontradeable costs incurred in their local transport and distribution (see Pearson 1982 for more details).

Source: Adapted from Pearson (1982).

National profitability, J, is the measure of the contribution of that enterprise to national income. When national profitability is positive the country is estimated to have a comparative advantage in the production of that commodity. Sometimes, a ratio, the domestic resource cost ratio, is used to compare profitability among different products (Table 1). A domestic resource cost ratio greater than one indicates that the cost of the domestic resources used in production of a given

commodity are more than the foreign exchange saved and hence it is not an efficient use of resources to produce that crop. An alternative measure used in this study which focusses on alternative uses of land in one area is to measure the national returns to land (F - G - H in Table 1). This is conceptually simple since it enables a comparison of the contribution to national incomes of alternative uses of a given type of land.

2.3 Comparative Advantage in a Dynamic World

While policy incentives frequently change from year to year with changes in government policy, measures of comparative advantage are primarily determined by a) the production technique employed, b) world prices for inputs and outputs and c) general economic developments, particularly with regard to infrastructural investment and economic growth. Production techniques may change with the introduction of improved technologies which lower the cost of production and increase profitability to the farmer and to the nation. Hence, wheat production may not be an efficient use of resources given current farmer technology but may be quite efficient with the introduction or development of improved technology. This of course has potentially important implications for investment in agricultural research. In this study, the comparative advantage of wheat in Ecuador is evaluated at two levels of technology. The first is farmers' current technology for wheat and competing crop-livestock activities. The second is an improved technology that can be recommended on the basis of on-farm research or has already been adopted successfully by some farmers. In this case, in order to facilitate comparison, an improved level of technology is also used for all competing enterprises.

Given that our primary objective is to provide information relevant to allocation of agricultural research resources, we are particularly interested in the relationship between technological change, comparative advantage and policy incentives. In Table 2 a country is shown to be efficient in wheat production at both levels of technology, (as measured by national productivity) but at farmer levels of technology it is

unprofitable for farmers to grow wheat because of policy disincentives. In case 1, however, introduction of improved technology enables wheat to become profitable to farmers despite the existence of price policy disincentives. This is clearly a strong argument for investment in research and extension to enable the country to exploit its comparative advantage in wheat production. In the second case, even a change in technology does not make wheat profitable to farmers because policy disincentives have a stronger effect. In this case the main value of the analysis is to quantify the cost to the country of pursuing its current policies. Further, investment in wheat research must be justified on the basis that price policy with respect to wheat will change in the future.

Table 2. Some Possible Conflicts Between National and Farmer Profitability at Different Levels of Technology.

	National Profitability	Farmer Profitability
Case 1		
1. Current Farmer Technology	Positive	Negative
2. Potential or Improved Technology	Positive	Positive
Case 2		
1. Current Farmer Technology	Positive	Negative
2. Potential or Improved Technology	Positive	Negative

Another major factor determining comparative advantage is the world price for wheat and competing commodities. Since we are interested in resource use over the long run, we need to estimate expected long run world prices. In some cases these prices themselves are subject to considerable distortions due to subsidies by exporting countries that lead to an export price considerably less than the price in the exporting country (e.g. wheat in the EEC, dairy products in most exporting countries). However, our interest is not whether export prices are subsidized but whether these subsidies will continue in the future. If they are expected to do so, then an importing country can take advantage of these subsidized prices in setting its own priorities.

It should be kept in mind that measures of comparative advantage are only a measure of the efficiency of resources used in production relative to the costs of imports. Governments have other objectives in resource allocation besides efficiency, especially food security and income distribution objectives. For instance, in the above example, governments may favor livestock production because of greater perceived price uncertainty in world markets for livestock products relative to grain or because small farmers emphasize livestock production. Nonetheless, the efficiency of resource use is always an important objective and is an important measure to enable decision makers to quantify the cost of pursuing other objectives.

2.4 Data Sources and Analysis

From the above example it is clear that several different types of data are needed to conduct the analysis of comparative advantage and policy incentives. These include:

a) Technical coefficients for production of wheat and competing crop-livestock enterprises, given current and potential production technologies.

b) Market prices for outputs and for inputs and resources used in production.

c) Import prices (sometimes export prices) for inputs and outputs and costs of internal transportation and marketing to the final point of consumption.

In this study, data on technical coefficients and market prices were obtained from farm-level surveys and on-farm experiments. Survey data were often available but were not usually sufficiently complete for this type of analysis. Estimates of technical coefficients were improved through informal interviews with farmers, technical scientists and extension officers.

Data on import prices and internal costs of marketing were obtained largely from secondary sources. These were supplemented by interviews

with government agencies and firms who were importing in order to provide a detailed cost breakdown into foreign exchange and local distribution and transport costs. Efforts were concentrated on obtaining information for the major outputs and inputs (e.g., fertilizer). Policy distortions on minor inputs will not usually affect the final result and were usually ignored. Appendix F provides a list of the public and private agencies who were visited in the course of obtaining data for this study.

All calculations for the analysis in this paper were done using the VISICALC program on the Apple II + micro-computer of INIAP. This program is particularly valuable since all formulas used for constructing the budgets are stored in memory. Hence new estimates of technical parameters, up-dating of price data and sensitivity analysis can be easily performed.

3.0 The Macro-Level Policy Environment in Ecuador: 1970-83

3.1 The Petroleum Boom, 1970-81

Macro-level fiscal, monetary and exchange rate policy has had a major influence on Ecuadorian agricultural performance in the 1970s. The major determinant of the Ecuadorian economic situation since 1972 has been the petroleum boom. The main characteristics of economic growth during this period are as follows:

a) Petroleum export revenues increased from a negligible amount in 1970 to 60 percent of export revenues in 1981. Export revenues increased by 14 percent annually in real terms.

b) Economic growth, led by petroleum exports, was the highest in Latin America, averaging 8.6 percent per year from 1972 to 1980. However, there were major differences between sectors in economic performance. Construction grew at 8.4 percent and manufacturing at 11.5 percent annually, while agriculture grew at 2.7 percent annually (less than population growth).

c) With slow growth of the agricultural sector, food imports increased rapidly from US$20m in 1972, to US$149m in 1980. Wheat accounted for much of this increase.

d) Government spending increased rapidly and with a continuous fiscal deficit since 1975, inflation has been considerably higher in Ecuador than in its main trading partners.

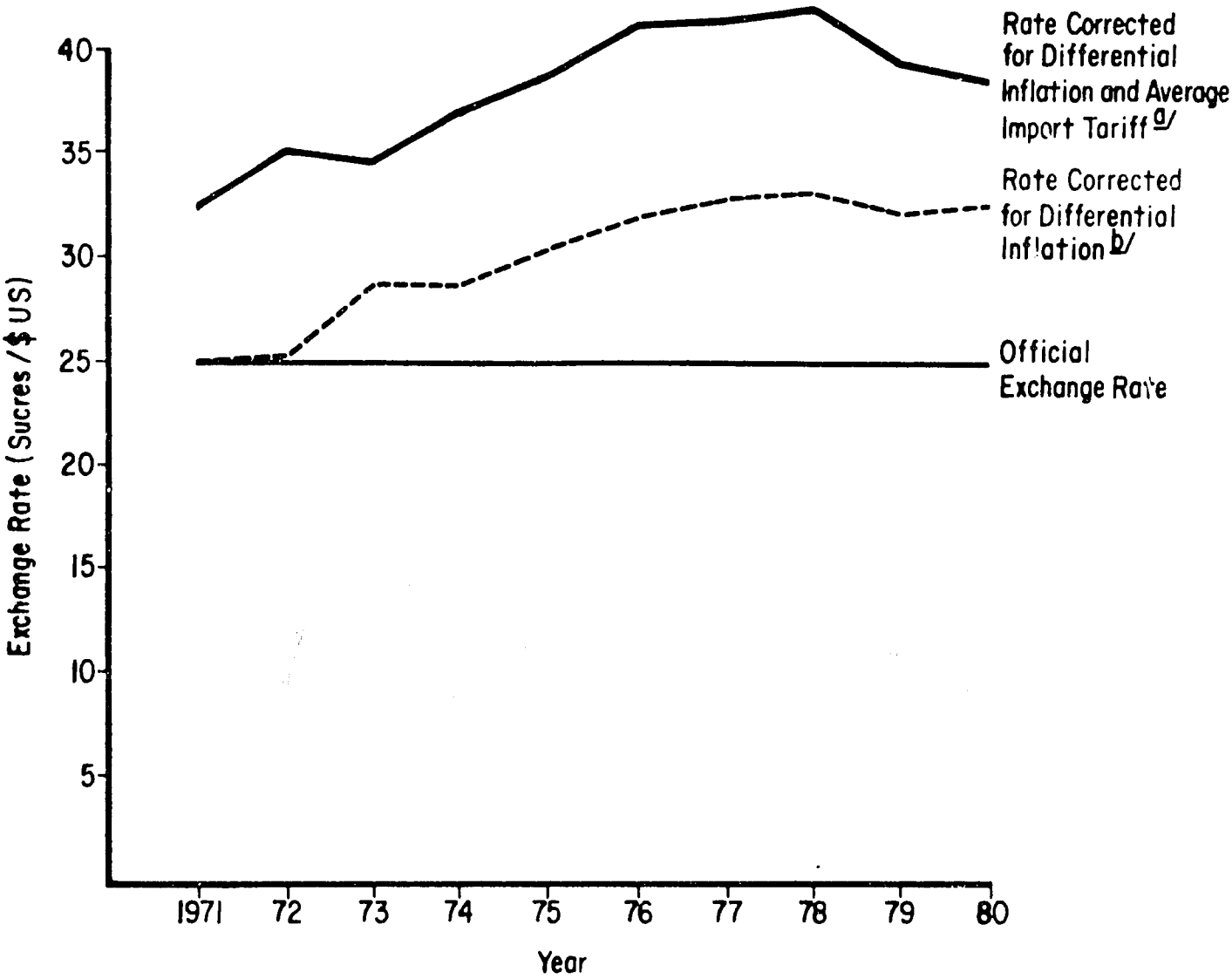
The impact of these various factors on the agricultural sector was felt in a number of ways during this period. These include the effects on a) the exchange rate, b) food demand patterns, c) wage rates, and d) transport costs.

Overvaluation of the Exchange Rate. Ecuador maintained a fixed exchange rate during the 1970s, even though the rate of inflation in Ecuador was 20-25 percent higher than the inflation rate in its main trading partners. The fixed exchange rate was made possible by rapid increases in oil prices. Rather than increasing foreign exchange reserves, additional export revenues were spent on imports and in the later years of the 1970s, the value of the Sucre was only sustained by heavy foreign borrowing. The fixed exchange rate in the face of higher inflation meant that imported (or exported) goods became cheaper relative to domestically produced goods that are not traded.

Rapid growth in the industrial sector was sustained by substantial tariff protection. This protection averaged 25 percent but was considerably higher for consumer goods where rates of protection were often well over 50 percent. This means that prices of imported goods were effectively higher on average because of these protective policies toward the industrial sector. The incomes of farmers who received less protection (and negative in the case of wheat) have effectively been reduced since they must pay higher prices (an average of at least 25 percent higher) for consumer goods, and yet receive prices for their output at or below world prices.

The combination of these exchange rate effects is shown in Figure 2. In 1971, before the petroleum boom, the main exchange rate distortion was due to tariff protection on industrial goods. During the 1960s inflation in Ecuador had been relatively low and the Sucre had been devalued by 28 percent in 1970. By 1980, the sucre was overvalued by

Figure 2. Official and Corrected Exchange Rates, 1971-80.



a/ Equivalent exchange rate estimated by correcting for average net import duties, export taxes, export credits, etc.

b/ Differential inflation between Ecuador and main trading partners weighted by export shares.

Source: Based on World Bank estimates of export weighted effective exchange rate and equivalent inflation rates.

about 22 percent due to tariff protection. At the same time, if Ecuador had allowed the sucre to change in value at the same rate as the inflation differential between Ecuador and its main trading partners, the sucre would have fallen 22 percent between 1972 and 1980 to reach a value of 37 Sucres/US$1.00[1/].

Demand Effects. Recent analysis suggests that the urban middle class population was the largest beneficiary of economic growth in the 1970s (see for example Ortiz Crespo, 1983). The population growth rate in this group was also relatively high. This led to a rapid increase in demand for food, particularly livestock products, whose demand increases rapidly with income growth. Given the reasonable assumptions that the urban population and real incomes have each grown at close to 5 percent annually, and that a 1 percent increase in income leads to a 0.8 percent increase in demand for livestock products, demand for meat, eggs and dairy products increased at 9 percent annually[2/]. Demand for bread and rice increased less rapidly - perhaps 7.5 percent annually, assuming that an income increase of 1 percent leads to a demand shift of 0.5 percent. Demand for traditional foods (maize and potatoes) were largely determined by population growth. These changes in demand patterns placed particular pressure on prices and imports for dairy products and, to a lesser extent, on wheat products.

1/ This would represent the upper limit of the overvaluation since there may be some double counting by including the effects of tariff protection and inflation. Normally, higher domestic inflation without exchange rate devaluation is accompanied by increased tariff protection and import controls in order to maintain the balance of payments which is subject to pressure from cheaper imports. However, in the case of Ecuador, the improved terms of trade due to increased oil prices allowed the balance of payments to be kept in equilibrium until the late 1970s. With the benefit of hindsight, it seems that the Sucre should have been devalued and foreign reserves allowed to build up. This exchange rate effect of increased export earnings from the energy (or mineral) sector has been termed by economists the "Dutch Disease", Wijnberger (1984).
2/ These are projected effects of income growth. Actual demand effects were modified by price effects since relative prices of food commodities changed considerably (see Section 4).

Increased Real Wage Rates. The rapid growth rate of the non-agricultural sectors, particularly construction, as well as increases in real wages stimulated rapid rural-urban migration (and increased off-farm employment in areas near large cities). As a result, real wages paid by farmers in the Sierra Norte increased by one third from 1972 to 1980. Increased wage rates raised costs to farmers who were unable to raise product prices because of import competition (e.g. wheat) or could not substitute for labor through mechanization (e.g. farmers on steep slopes).

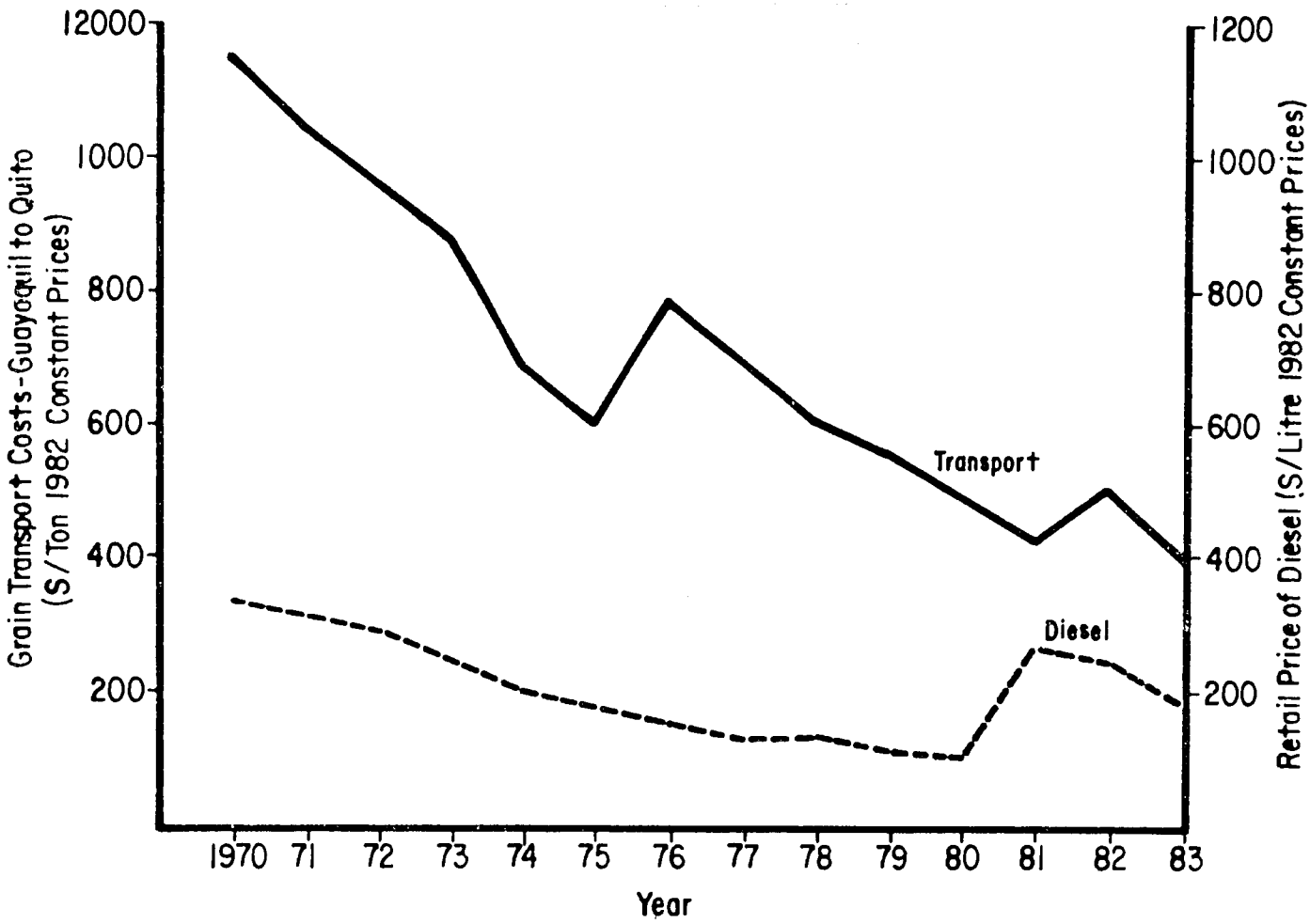
Subsidized Transport Costs. While prices of petroleum products in world markets increased significantly in real terms in the decade of the 1970s, they fell in Ecuador . The effective subsidy on diesel reached 90 percent in 1980, and was then reduced to about 70 percent in 1983[1/]. As a result, long distance transport costs also fell significantly in real terms (Figure 3). This tended to reduce the inland prices of imported and bulky commodities, including wheat.

3.2 The Macro-Economic Situation in 1983

The recent economic crisis in Ecuador due to declining oil prices and a large foreign debt has led to a reversal of some of the effects of the petroleum boom in the 1970s. The devaluation of the exchange rate has removed the effect of differential inflation between Ecuador and its trading partners although tariff protection and import controls remain high. A two-tiered exchange rate is in effect, with imports classified as "essential" imported at the official rate and other imports entering at a free rate or a second official rate (Lista II) close to the free rate. Given that approximately 50 percent of imports enter at each rate, the average exchange rate is about S.65/US$1.00. Adjusting for average import tariffs of at least 20 percent, leads to a corrected exchange rate of approximately S.80/US$1.00 which is close to the free market exchange rate. This is also close to the rate suggested by a

1/ This is an approximate calculation based on diesel prices in Ecuador and the USA.

Figure 3. Real Costs of Inland Grain Transportation, 1970-83.



Source: PRONACER and the national petroleum company.

knowledgeable Ecuadorian economist and is the rate used in this study. This rate will be referred to in the remainder of the paper as the corrected exchange rate[1/].

The negative growth of the economy has also affected the growth in demand and employment. In particular, we expect that with real income declining, the demand for livestock products is growing at less than the population growth rate. At the same time, it appears that real wages in both urban and rural areas have fallen.

4.0 The Agricultural Policy Environment for Wheat in Ecuador

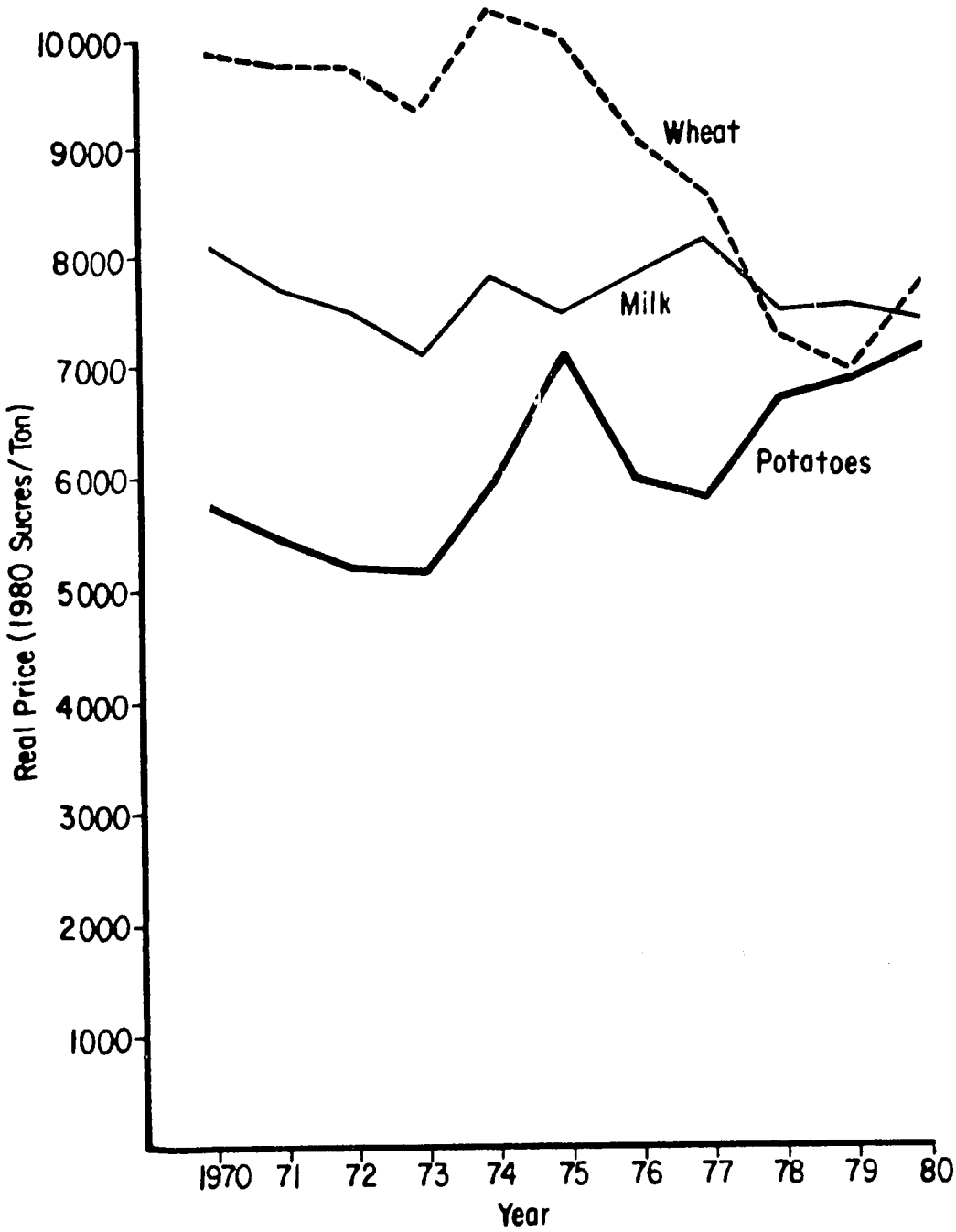
The market environment in which farmers make decisions on wheat production is influenced by a) the price policy for wheat, b) the price policy for competing crop-livestock activities, c) the price policy for specific agricultural inputs, and d) policies which affect the cost of capital and labor resources used in wheat production. All of these are, of course, directly or indirectly influenced by macro-economic policies, such as the exchange rate policy already discussed in Section 3.0. In this section, the agricultural policy environment is analyzed for each of the above components. In general, the discussion is divided into policies in effect during the years of the petroleum boom, 1970-81, when wheat production fell sharply, and policies that were in effect in 1983, after the economic crisis had taken effect.

4.1 Price Policy for Wheat and Competing Crop-Livestock Activities, 1970-1980

Relative prices of wheat and competing crop-livestock products changed sharply in the period 1970-80. Figure 4 and Table 3 show that the real price of wheat to producers declined by 22 percent (and

1/ Given a corrected exchange rate of S.38/US$1.00 in 1980 and differential inflation between Ecuador and its main trading partners over the period 1980-83 the expected exchange rate would be about S.75/US$1.00.

Figure 4. Producer Prices for Wheat, Milk and Potatoes, 1970-80.



Source: MAG, Departamento de Estadística.

Table 3. Changes in Real Prices Paid to Producers, 1970-80, 1980-83.

	Percent Changes in Real Prices		Ratio of Price of Competing Product to Wheat Price	
	1970-80	1980-83[a/]	1970	1983
Wheat	-21	- 5[b/]	1.00	1.00
Barley	- 8	- 1	.82	1.10
Maize	8	-17	.89	1.10
Potatoes	25	-19	.58	.70
Milk	- 8	23[b/]	.82	1.27

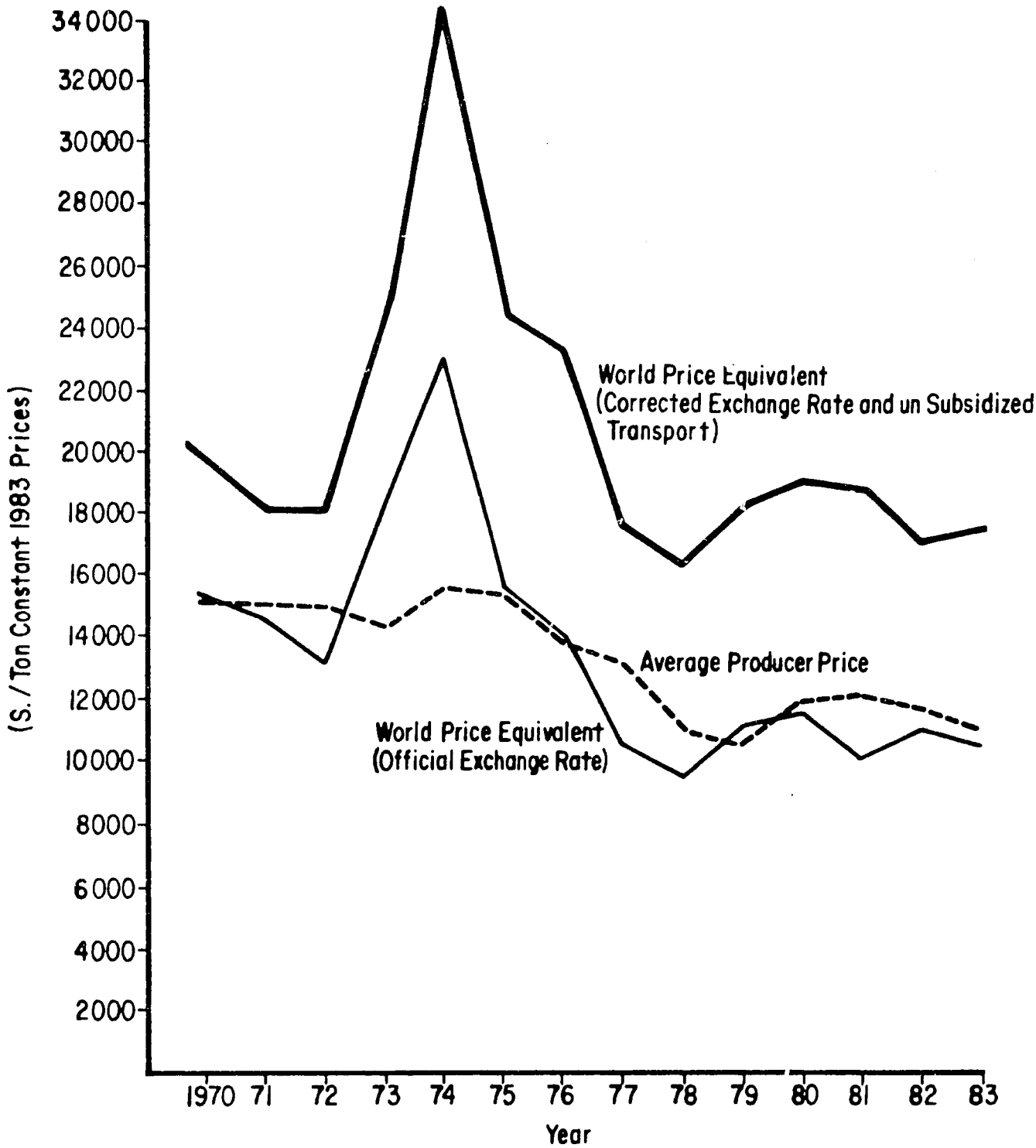
a/ Based on prices in June, 1983 of Wheat, S.500/qq; Barley, S.550/qq; Maize, S.550/qq; Potatoes, S.350/qq; and Milk S.14/lt.
b/ 1983 prices are prices actually received by producers. These prices were above guaranteed prices in the case of both milk and wheat.

Sources: 1970-80 prices from Ministry of Agriculture (1980) and Ministry of Agriculture "Precios de Productos Agropecuarios a Nivel de Productor", various issues. 1983 prices based on field interviews.

over 30 percent between 1970 and 1979), milk prices remained relatively steady, while real prices of potatoes and soft maize increased. The real price decline in the case of wheat is linked to a policy of importing wheat free of duties after about 1969 and at a significantly overvalued exchange rate with subsidized internal transportation. Figure 5 shows that the producer price of wheat was closely linked to the import price of wheat at the official exchange rate. It was somewhat lower in some years (such as 1974) but higher in 1977. However, when the real price of imported wheat is calculated by adjusting for a) an overvalued exchange rate (see Section 3.0), and b) a subsidized internal transport costs[1/], the official producer price was below the world price equivalent in all

1/ Transport subsidies were removed by using the US price of diesel fuel valued at the corrected exchange rate and assuming a fuel consumption of 0.05 lt/ton-km for 500 km.

Figure 5. Comparison of Average Wheat Price Received by Farmers with World Price Equivalent[a/] Calculated at Different Exchange Rates.



a/ Import price plus internal cost of transport, loading, etc.

Source: Producer prices - MAG, Departamento de Estadística. Prices after 1980 are tentative estimates.

World price equivalents - PRONACER. Official import prices in 1977 were not consistent with world prices. The CIF price for Rotterdam was substituted as an approximation. Transport costs have been added from Guayaquil to the Sierra.

years. On average, wheat producers received 33 percent below the real import price equivalent of wheat. The official price for wheat was on average 13 percent above the import price converted at the official exchange rate. However, the producer received on average 10-15 percent below the official price and close to the world price equivalent at the official exchange rate. Overall, exchange rate overvaluation explained about 70 percent and subsidized transport about 30 percent of the difference between world prices (at the farm level) and producer prices.

The producer price for wheat was discounted from the official price in part because of higher moisture and impuritees of local wheat as well as some monopsony buying power by local millers. Millers found it easier and cheaper to use imported wheat whose quality was strictly controlled. Moreover the government subsidized the price of imported wheat to millers during most of the 1970s. Beginning in 1973 millers were compensated for any increase in import prices above a reference price. This reference price remainded fixed at $137/t until 1982 resulting in a substantial consumer subsidies in most years (see Appendix E for details).

Because of these subsidies the price of wheat flour to bakers was kept constant from 1973 to 1982. This led to declining real prices for bread relative to competing staples such as potatoes and soft maize. Subsidized bread prices were a major factor stimulating the demand for bread and promoting rapid increases in wheat imports in the 1970s (discussed further in Appendix A).

In 1983, the reference for wheat was raised sharply to $195/ton, slightly above the import price and the consumer subsidy was effectively removed.

Barley is an alternative crop to wheat. It is used for human food, animal feed and malting. Hence, the price of barley was determined by demand for each of these uses as well as imports and import prices of barley and close substitutes such as maize for animal feed. Although

barley is generally cheaper than wheat in world markets, domestic barley prices were above wheat prices in the late 1970s because of tariffs on imported barley (Table 4).

Prices for potatoes and soft maize generally increased in real terms in the 1970s (Table 3 above). Prices of both of these products were essentially determined by domestic supply and demand and hence exhibit considerable year to year fluctuations (see Figure 4 above for potato prices). Soft maize is largely a subsistence crop and is not easily substituted by imported hard maize. Potatoes imports were possible but their high transport costs and a tariff prevented this. Both potatoes and soft maize have undergone little increase in productivity in the 1970s. This together with their relatively labor intensive production methods and increased real wage rates have tended to raise their real price at the same time that total production stagnated (or even declined in the case of soft maize).

Table 4. Import Tariffs for Wheat and Competing Crop-Livestock Commodities, Ecuador.

	1979 (percent) (ad-valorem)	1983 (percent) (ad-valorem)
Wheat	0	0
Dry Milk	85	Prohibited
Butter and Cheese	95	Prohibited
Barley	85	50
Potatoes	80	Prohibited
Maize	80	Prohibited

Price policy for milk is the most complex. The government has set guaranteed producer prices for milk which have become very politicized.

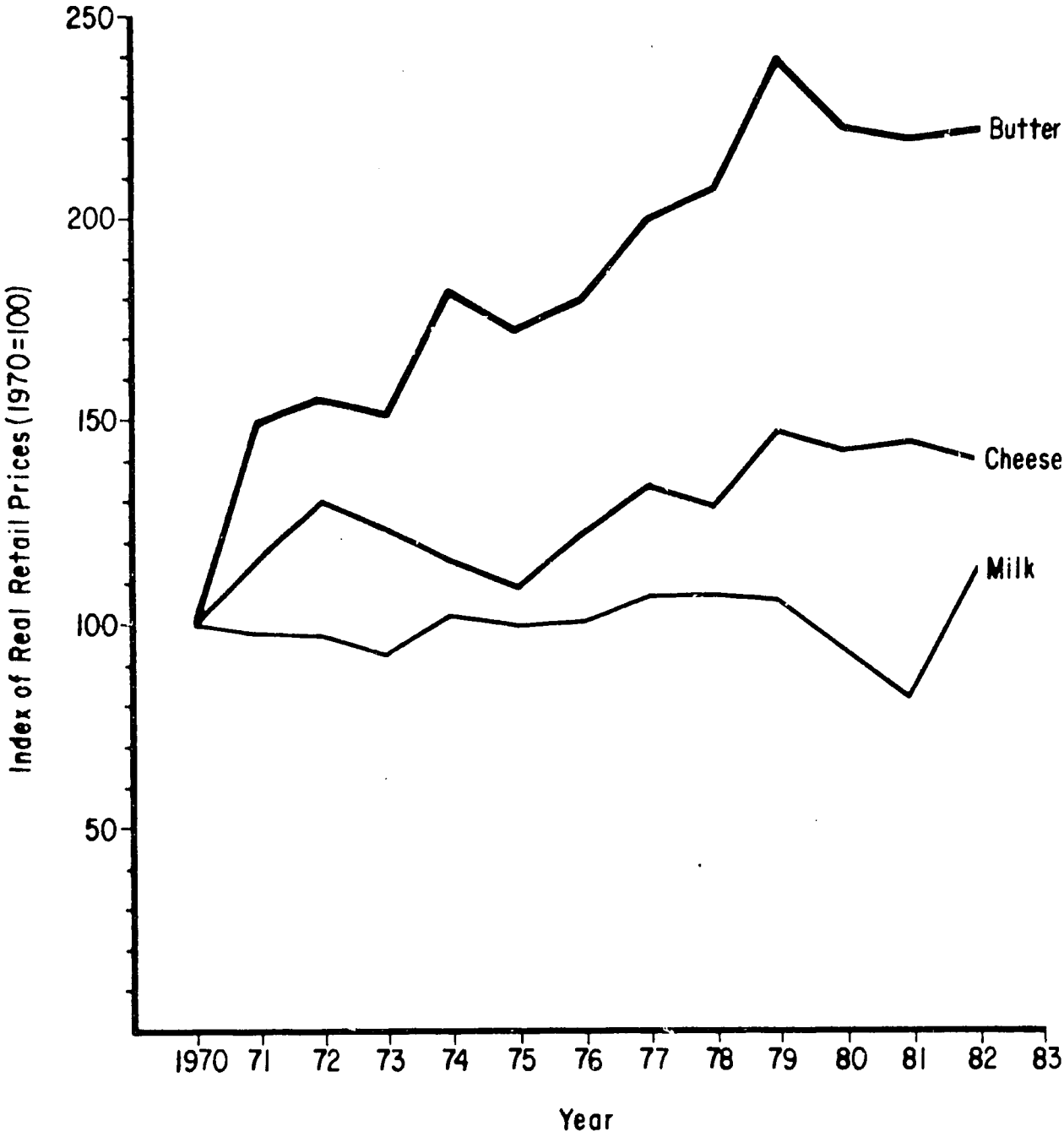
Nonetheless, farmers have usually been able to receive a price 10-20 percent higher than the guaranteed price. Dry milk has also been imported in limited quantities by the government agency, EMPROVIT, and mixed with fresh milk or sold cheaply as reconstituted milk. In total, these imports amounted to about 25 percent of milk processed industrially (i.e. pasteurized). At the same time, about half of all milk is processed into cheese, butter, and other products. There were no price controls on this sector and in fact a large share of cheese is processed in very small-scale labor intensive industries without government regulation.

In 1979, both butter and cheese prices were protected by a 90 percent import tariff (Table 4 above). The result of these various policy measures is that butter and cheese prices have risen significantly in real terms, while milk prices to the consumer have fallen slightly due to imports of dry milk (Figure 6). Higher prices for butter and cheese were also made possible by a strong consumer demand due to rising urban incomes. Milk processors have probably also subsidized their fluid milk processing by profits from cheese, butter and other dairy products.

The dairy sector in Ecuador has to a large extent been protected from imports. Figures 7 and 8 show world price equivalents for milk and butter (see Appendix C for assumptions used in these calculations). At the official exchange rate both milk and butter have been increasingly protected from imports in the 1970s. In the case of milk this protection was not, however, large enough to compensate for an overvalued exchange rate, whereas butter received significant protection even using a more realistic exchange rate. Overall, at the corrected exchange rate the estimated average Nominal Protection Coefficient, which expresses local prices as a percent of world price equivalents, was .67 for wheat, 1.32 for butter and .86 for milk in the period 1977-80. Moreover, it is likely that producers received a somewhat higher price for milk than indicated by the statistics, due to diversion to cheese making or to sale as raw milk.

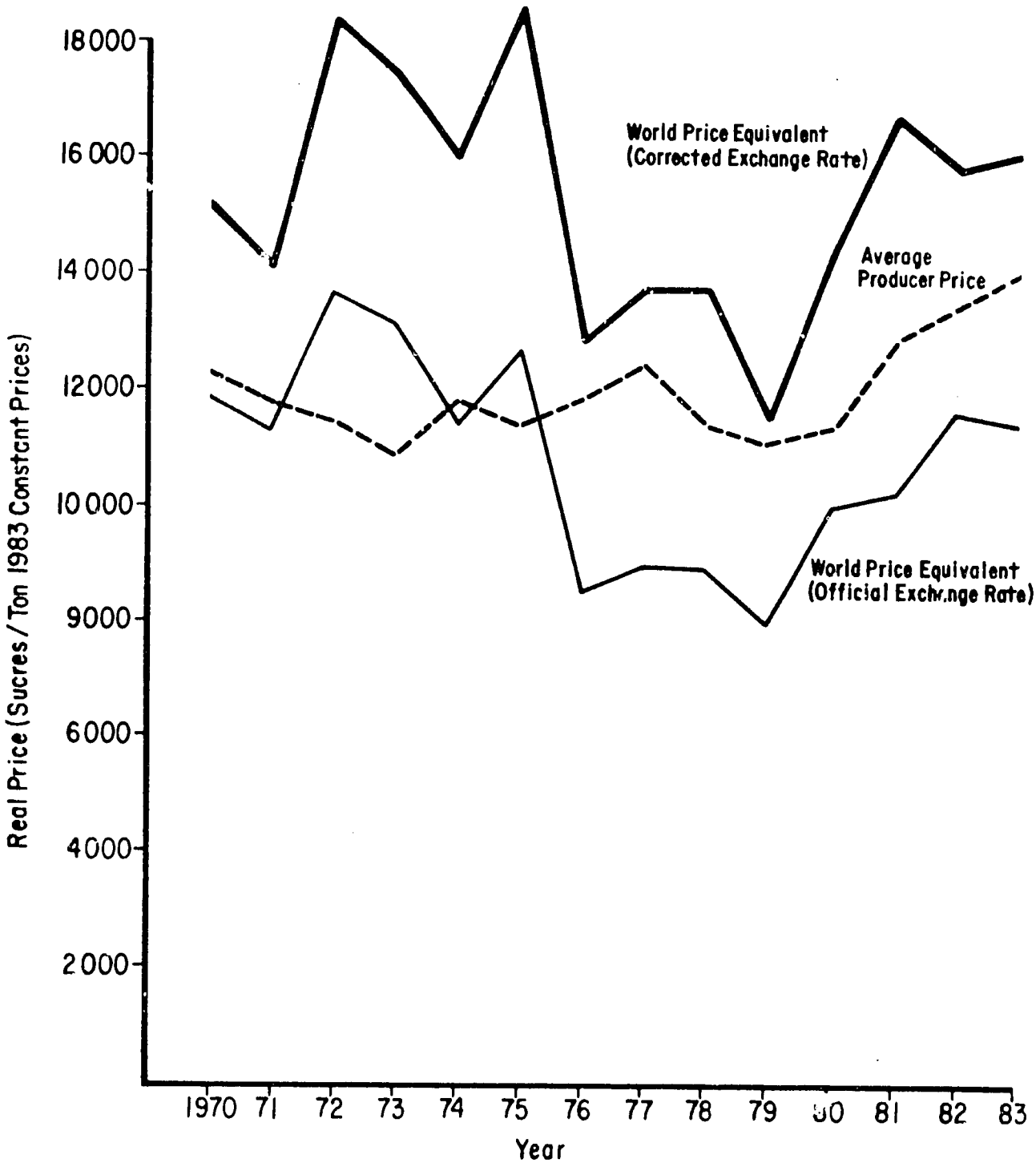
The world market for dairy products has been distorted by

Figure 6. Indices of Real Consumer Prices of Milk Products.



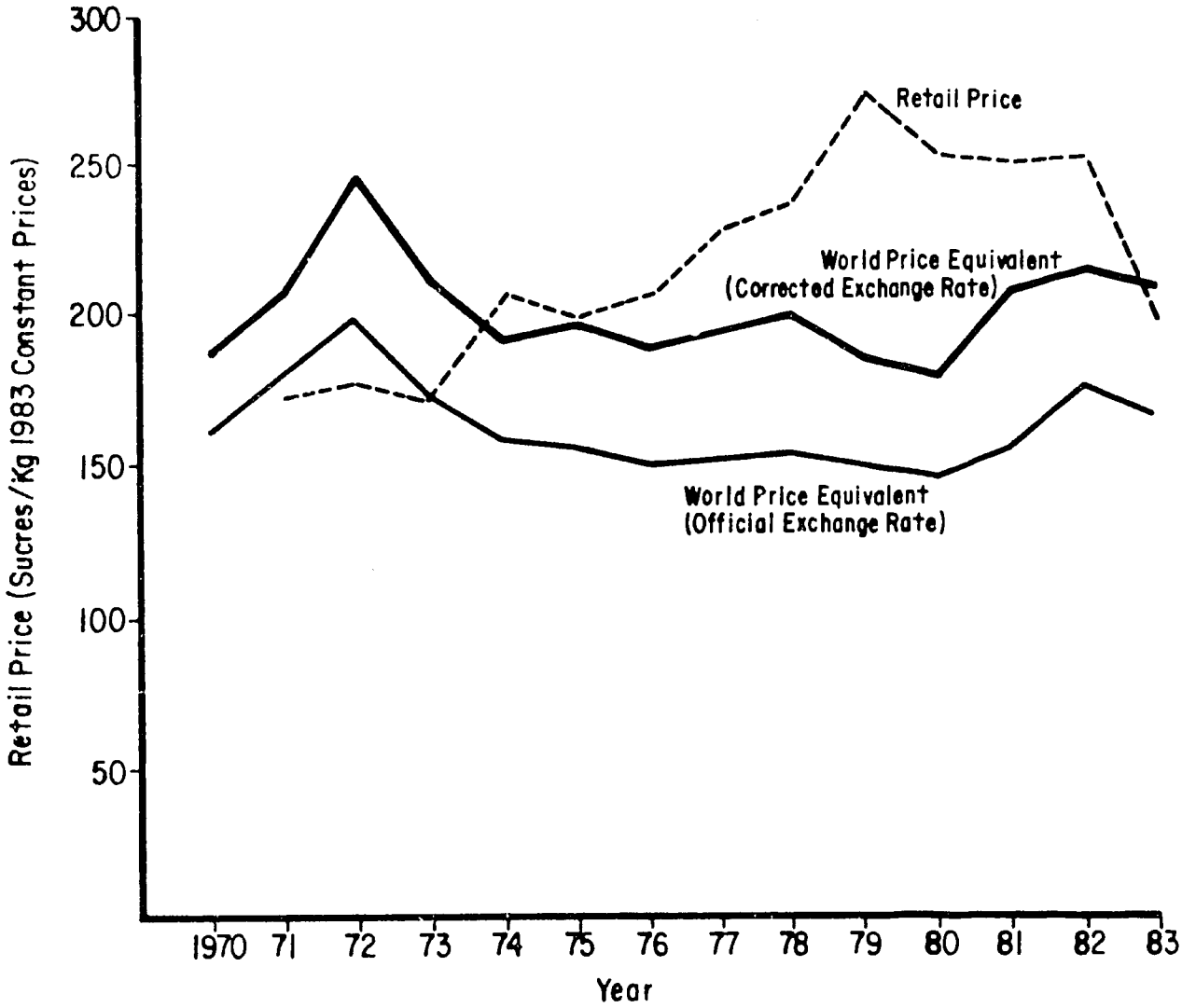
Source: INEC

Figure 7. Comparison of Producer Prices for Milk with World Equivalent Price, 1970-83.



Source: Producer price - MAG, Departamento de Estadística. Prices in 1979, 1981 and 1983 were estimated from other sources. World price equivalent-1976-83 data based on CIF price of dry milk, EMPROVIT estimates, and 1970-75 data are average CIF prices for Latin America estimated from data on volume and value of dry milk imports, FAO Trade Yearbook, various issues. Marketing margins and conversion to liquid milk equivalents are detailed in Appendix C.

Figure 8. Comparison of Retail Price of Butter with World Price Equivalent, 1970-83.



Source: Retail price - INEC.

World price equivalent - based on New Zealand export price and estimated transport and marketing margins (see Appendix C for details).

subsidized exports by the EEC and more recently by the USA. In these exporting countries the export price of dairy products, especially dry milk, is as low as half of the prevailing wholesale price in that country. These subsidized export prices seem, however, to be a permanent characteristic of the world market for the foreseeable future. Neighboring countries in Latin America have depended more on imported dairy products and have as a result, maintained significantly lower consumer prices for cheese and butter than in Ecuador which has not imported these products.

In sum, the following price policy effects seem to have prevailed for the dairy industry in the 1970s:

a) Rapid growth of incomes, especially in the urban middle class, promoted a strong demand for milk and milk products.

b) Imports of dairy products were either limited in quantity, as in the case of dry milk, or subject to high tariffs.

c) The guaranteed producer price of milk was kept relatively constant in real terms. Producers obtained somewhat higher prices because they were able to sell to small-scale cheese manufacturers or for distribution as raw milk.

d) The ratio of butter and cheese prices to milk prices was high in Ecuador and butter and cheese have received substantial protection from imports.

e) Sales of imported dry milk allowed milk prices to consumers to remain constant (in real terms).

4.2 Price Policy for Wheat and Competing Enterprises, 1980-1983

With the economic crisis and high inflation there were changes in relative prices from 1980 to 1983. Wheat prices received by producers have fallen further in real terms since 1980. Wheat has been imported at the official exchange rate. Even though wheat producers have received above the guaranteed price (largely due to demand for livestock feed and from Colombia), the producer price in June, 1983 was nearly 40 percent below the import price equivalent of close to S.17,600/ton (S.800/qq) based on the corrected exchange rate and unsubsidized transport costs

(calculations are given in Table 5).

Barley, on the other hand, was given lower priority in foreign exchange allocations and hence is imported at close to the free exchange rate. There continues to be a strong incentive to raise domestic barley prices above wheat prices and this seems to have occurred in 1983.

Imports of dairy products were prohibited in 1983 except for small amounts of dry milk imported by the government. Real prices of milk remained stable from 1980 to 1983. However, the negative growth of the economy has severely weakened the demand for milk products and there was evidence that real prices of butter and cheese had declined significantly. With these changes and an increase in prices of dairy products in the world market, the protection to the dairy industry has been eliminated (based on the corrected exchange rate). Given prices of dry milk and butter in world markets, it would seem that the level of protection is negative for milk and insignificant in the case of cheese and butter (see Appendix C). However price disincentives were substantially higher for wheat (NPC = .75) than milk (NPC = .87), even though world wheat prices were depressed in 1983.

Overall during the period 1970-83 the price of wheat relative to barley decreased by some 30 percent. Wheat prices relative to official milk prices decreased by 36 percent. The actual difference in the case of milk was probably even larger. Farm surveys in 1971 and 1983 suggest that real milk prices received by farmers increased 27 percent while wheat prices declined 28 percent.

4.3 Price Policy for Agricultural Inputs

Most agricultural inputs have been imported free of duty or at very low duties of 3 to 10 percent. Some inputs such as compound fertilizers are also made up in Ecuador but using imported raw materials. Since 1982 most agricultural inputs have been imported at the official exchange rate. Hence exchange rate overvaluation has and continues to make agricultural inputs cheaper. Real fertilizer prices, for example, declined

Table 5. Estimated Costs in 1983 of Imported Wheat in Ecuador based on Expected Long Run FOB Price of US$170/ton.

	Actual Costs of Importation	Costs of Importation with Corrected Exchange Rate and Transport Unsubsidized
Foreign Currency Costs	(US$/ton)	
Cost and Freight[a/]	195195	
Interest (15 percent for 120 days)	9.75	9.75
Central Bank Monetary Stabilization Fund (15 percent for 120 days)	9.75	b/
Other Bank Charges (2.6 percent)	5.07	5.07
Insurance (.375 percent)	.71	.71
Losses (0.5 percent)	.98	.98
CIF Price	221.26	211.51
Sucre Costs	(S./ton)	
CIF Price in Local Currency	10,500[c/]	16,921[c/]
Port and Unloading Costs	272	272
Transport to the Sierra	608	1,168[d/]
Loading and Unloading	5	5
Total Cost/ton	11,385	18,366
Total Cost/qq	518	835
Producer Price Equivalent for Local Wheat[e/]	466	750

a/ FOB Price of $170 plus $25/ton freight. This is the current reference price fixed by the government. In 1983 it was above actual FOB prices but close to the long run trend in the world price.
b/ Assumed to be zero at corrected exchange rate.
c/ Official exchange rate of S.47.5/$US1.00 and corrected exchange rate of S.80/$US1.00.
d/ Unsubsidized fuel price of S.20.8/lt assuming 0.05 lt/ton-km for 500 km. Nonfuel costs are divided equally between tradeable costs which are adjusted to the corrected exchange rate, and nontradeable costs.
e/ Assumes 10 percent discount for quality, humidity and impurities.

Source: Actual costs of importation obtained from PRONACER and interviews with millers.

significantly from 1975 to 1983 (see Figure 9). However this policy is changing and agricultural machinery was imported at close to the free exchange rate in 1983.

Estimated components of fertilizer costs are shown in Table 6. Relatively high costs of bagging and profits lead to a relatively high margin between CIF and retail prices. However, the importation at the official exchange rate and subsidized internal transport costs led to a significant subsidy of one third of real fertilizer costs.

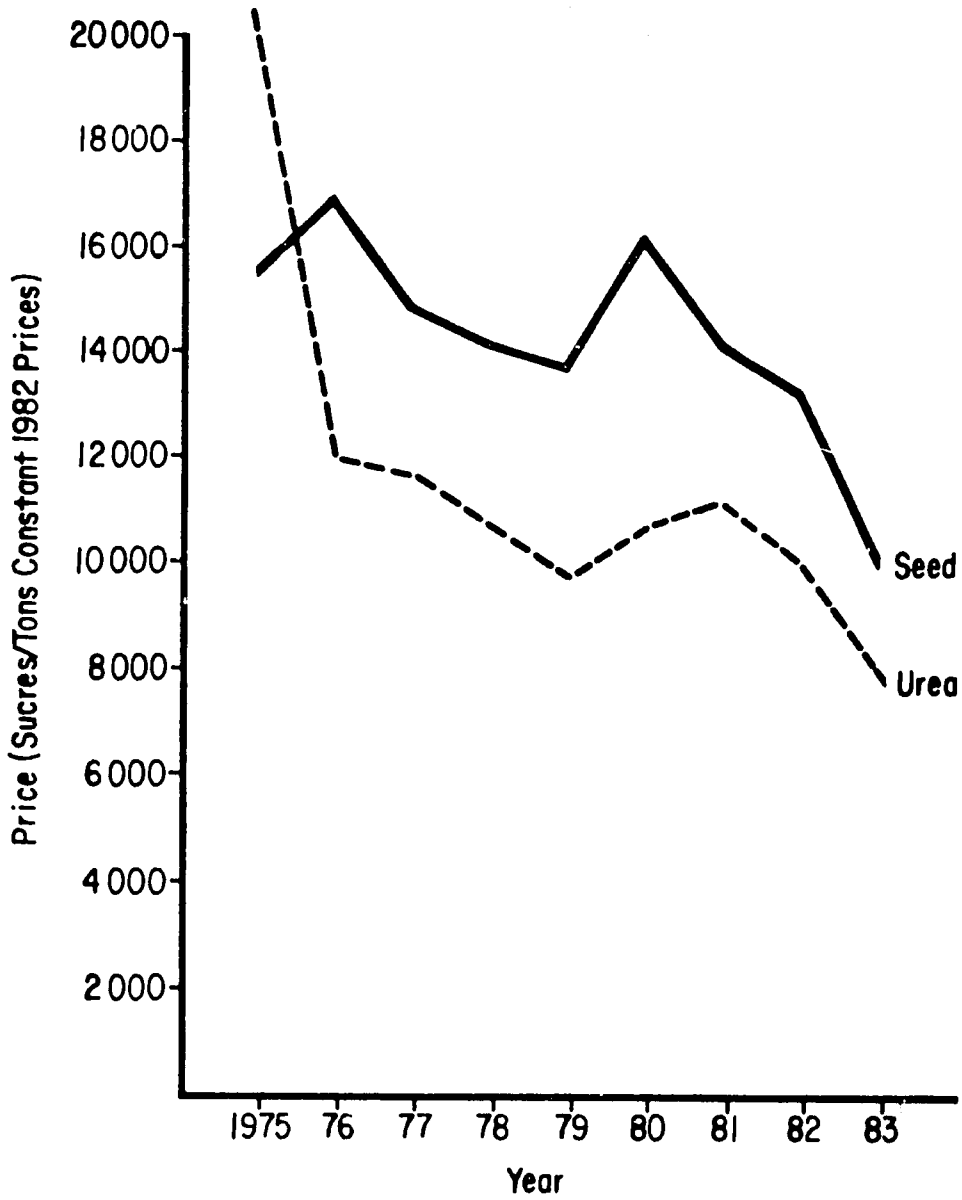
Costs of mechanization have been subsidized through a) subsidized diesel prices and b) subsidies by the Ministry of Agriculture for machinery hire services. Private tractor hire services in areas without competition from MAG were charging double the price of the MAG in 1983. Prices of private tractor hire services are close to our estimated actual cost of tractor operation (see Appendix D). It seems that the MAG is charging for operating costs but not covering capital and depreciation costs.

4.4 Policies Affecting Capital, Labor and Water Costs

The petroleum boom has resulted in rapid increases in credit at low cost interest rates for all sectors of the economy. Much of this credit has been available through the Banco Nacional de Fomento (BNF) where interest rates have been consistently below the inflation rate. By 1983, these differences had become very large. The BNF charged 13 percent interest plus some administrative costs for short term agricultural loans while inflation exceeded 50 percent.

Cheap interest rate policies had differential effects on crop-livestock activities. Most dairy farmers have received credit from the BNF or private banks to improve livestock, pastures or adopt other productivity increasing innovations. One survey found that all large dairy farmers used bank credit and that credit covered an average of two thirds of investment costs (Barskey and Cosse, 1981). Credit to livestock enterprises issued by the BNF in Cayambe quadrupled from 1970 to

Figure 9. Real Prices for Wheat Seed and Fertilizer[a/], 1975-83.



a/ Prices quoted for Urea in Guayaquil.

Sources: FERTISA-BNF-Departamento de Fertilización del MAG.

Table 6. Estimated Costs in 1983 of Imported Urea based on Expected Long Run CIF Price of US$190/ton.

	Actual Costs of Importation	Costs of Importation with Corrected Exchange Rate and Transport Unsubsidized
	(US$/ton)	
Foreign Currency Costs		
CIF Price Urea	190	190
Port Charges	4.32	4.32
Commission (4 percent)	8.20	8.20
Central Bank Monetary Stabilization Fund (5 percent)	10.25	a/
Total	212.77	202.52
	(S./ton)	
Sucre Costs		
Total Cost at Guayaquil Port	10,000	16,202
Costs of Bagging	1,200	1,200
Transport to the Sierra	600	1,168
Storage	58	58
Insurance	78	78
Administration	124	124
Profits (10 percent)	1,206	2,000
Total Costs	13,266	20,830
Costs per bag (50 kg)	663	1,040

a/ Assumed to be zero for corrected exchange rate.

Source: Interviews with MAG and private input supplier.

1977 in real terms, (see Figure 10). At the same time, credit for wheat production has steadily declined since 1974. By 1980 only 7 percent of the wheat area was sown with funds from credit institutions compared to 77 percent for rice. Credit was also disproportionately channelled to large farmers.

The reasons for lack of credit for wheat production were not investigated in depth. Farmers complained about delays and paper work required for credit. Reduced use of credit for wheat production may also reflect the low costs and profitability attached to wheat (see next section) since farmers seem willing to use bank credit for livestock activities.

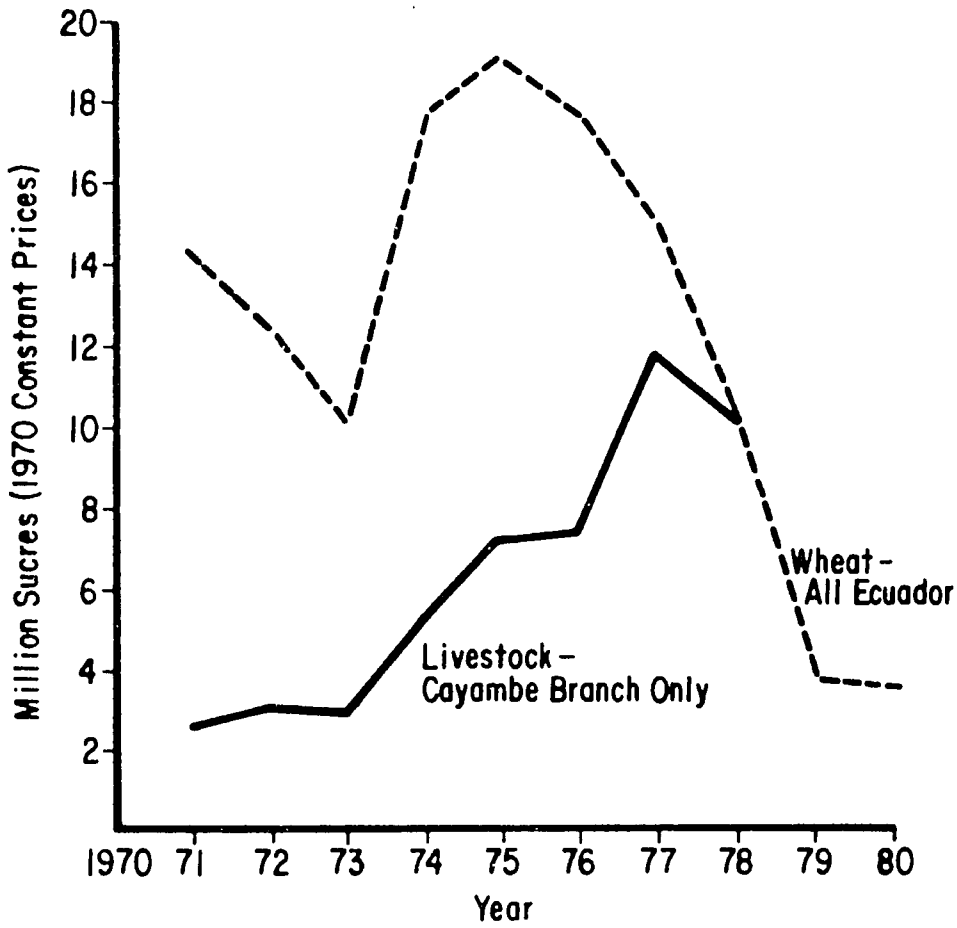
Labor costs are influenced by minimum wage legislation especially in the case of large farmers. Minimum wages have been set somewhat higher than the corresponding market wage rate. Nonetheless the difference does not seem to be large and we have not taken account of this policy effect in this study.

Water resources for irrigation are important for intensive dairy farming. We did not attempt to look at costs of providing irrigation services from surface water from mountain springs. But since this is a low cost source and farmers paid for the water, it is unlikely that a large subsidy was included in the price of the water. However, some farmers were receiving water from a new program of INIEHRI to dig deep tube wells. We were informed that these services were subsidized but since the area covered in Cayambe is not large (less tha 2000 ha) we did not attempt to quantify the extent of the subsidy.

5.0 Wheat in the Farming System - The Cayambe Area

Measures of comparative advantage and policy incentives are specific to a particular region. Technical coefficients, transportation costs and competing crop-livestock activities are all likely to depend on the particular recommendation domain - that is, a group of farmers in similar circumstances for whom the same technology can be recommended

Figure 10. Value of Loans (in 1970 Sucres) Authorized by the Banco Nacional de Fomento for Wheat in all Ecuador and for Livestock in Cayambe.



Sources: Wheat - Banco Nacional de Fomento.
Livestock - Barskey and Cosse, 1981.

(see Harrington and Tripp 1984). This is particularly true in Ecuador, where there is considerable variability in the agro-climatic and socio-economic conditions under which wheat is grown. In this study, the analysis is conducted for the Cayambe area of the INIAP Programa de Investigación en Producción (PIP). This area which comprises the Cantons of Tabacundo and Cayambe in the Province of Pichincha and the southern part of the Canton of Otavalo in Imbabura, has traditionally been one of the most important wheat producing areas of Ecuador (Figure 11).

On-farm research of the PIP in the Cayambe area, since its establishment in 1977, has focused on wheat and provides basic data for estimating the profitability of wheat under alternative technological assumptions. There were an estimated 6000 ha of wheat in this area and 10,000 ha of barley in 1977 and some 60,000 dairy cows in 1983 (estimates of the local staff of the Ministry of Agriculture). Maize and potatoes are the other principle crops.

The study area is diverse with respect to both physical characteristics, especially slope and altitude and to a lesser extent rainfall and soils, and socio-economic characteristics of farmers such as farm size, tenure and distance and ease of access to markets. To simplify the analysis we emphasized two basic types of farming systems or recommendation domains - land in the valleys where farmers have access to irrigation which allows intensive dairying with improved pastures farming or production of two crops per year; and land on the sides of the valley without irrigation where extensive dairying with natural pastures is practised and usually only one crop per year can be grown. In addition there are substantial differences in wheat technologies used by small and large farmers so two levels of farmer technology are often employed in the analysis.

5.1 Wheat Production Technology

The PIP in Cayambe conducted a diagnostic survey of small and medium size farmers in 1977 as a basis for on-farm experimentation in the area. Results are shown in Table 7. The Ministry of Agriculture also

Figure 11. Map of Ecuador Showing Wheat Importing Point, Consuming Point and Producing Point for the Study.

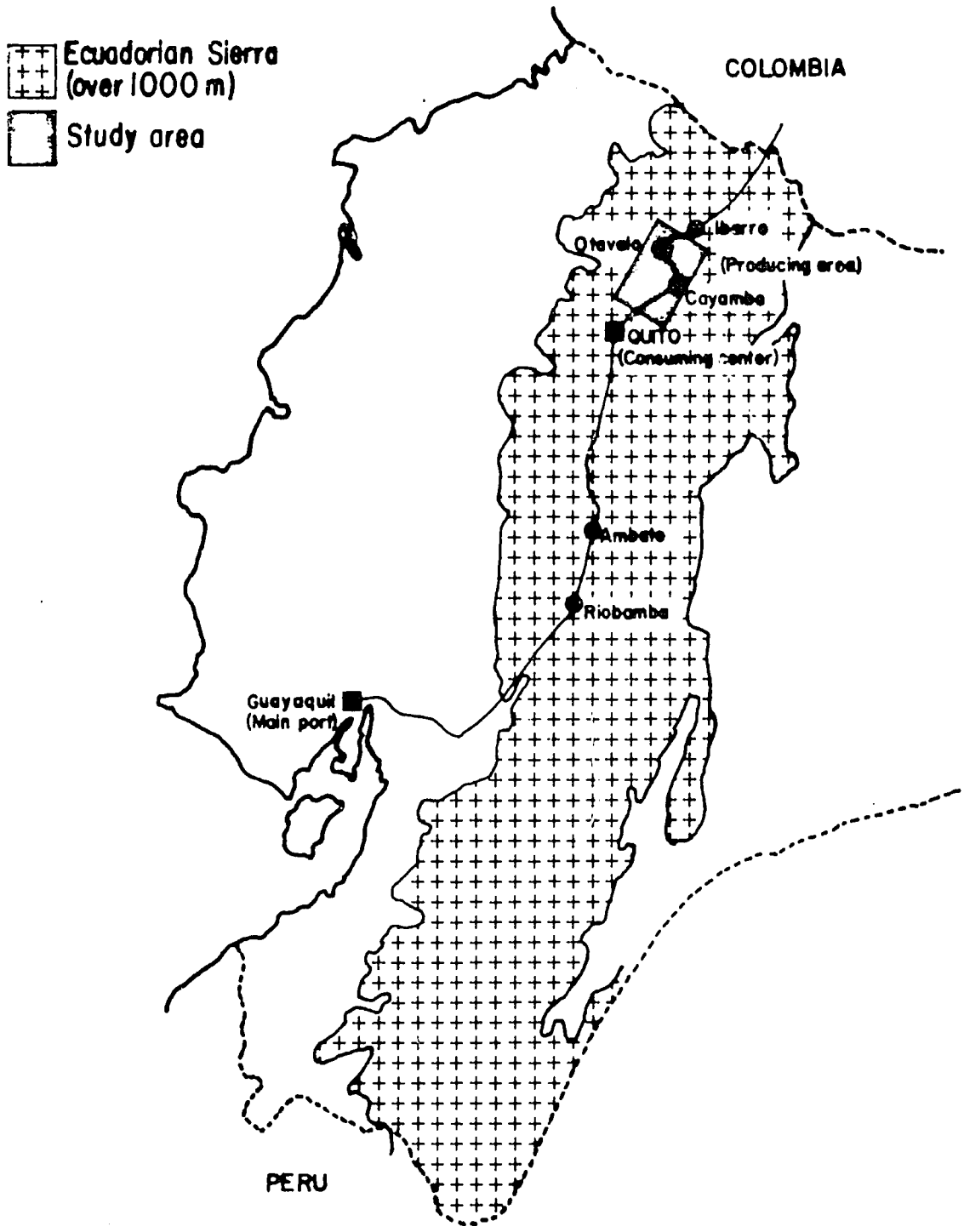


Table 7. Practices Used in Wheat Production, Small and Medium Size Farmers, 1977[1/].

Farm Characteristics	
Total area (ha)	2.5
Area in wheat (ha)	1.1
Percent of farmers who work off-farm	89
Mechanical Technology	
Percent of farmers who used:	
Tractor for land preparation	62
Drill	0
Combine	21
Stationary thresher	68
Biochemical Technology	
Percent of farmers who used variety released:	
In the previous 5 years	27
In the previous 10 years	64
In the previous 15 years	99
Percent of farmers who used:	
Certified seed	20
Fertilizer	31
Herbicide (2-4,D)	65
Average amount of fertilizer applied (of farmers who used fertilizer):	
Nitrogen (kg/ha)	29
Phosphorous (kg/ha)	41
Potassium (kg/ha)	16
Utilization of Wheat	
Average yield (t/ha)	0.7
Percent of farmers who sold wheat	35
Percent of farmers (who sold) selling wheat to mills	15

1/ The survey used a sample of farmers with less than 30ha as well as the cooperatives of the Agrarian Reform.
2/ The varieties used and year released were: Romero, 1973; Cayambe, 1973; Amazonas, 1969; Atacazo, 1969; Crespo, 1963; Napo, 1963; 150, traditional.

Source: Espinoza, 1982.

conducts annual surveys of wheat production practices stratified by farm size[1/]. Data for 1982 for the province of Pichincha (which includes most of the study area) are given in Table 8. Results of the two surveys are reasonably consistent despite the five year gap between the two.

There is a clear division in wheat production between small and large farmers. Small farmers (approximately 5 ha or less) make up three quarters of wheat producers but with less than 1 hectare of wheat per farmer account for only one quarter of the wheat produced. A small number of large farmers (including cooperatives) with over 50ha, produced over half of the wheat (Table 9).

Small farmers use most of their land for crop production, and about a quarter to a third of this land is usually sown to wheat. Tractor preparation of land is common, especially given the availability of government tractor hire services. Animal traction is also widely used, although the cost of animal power is higher than for tractors (Table 10). Harvesting is done by hand but usually threshed with a stationary thresher. Hand harvesting and mechanical threshing is considerably more expensive than use of a combine (Table 10). Difficulties in obtaining machinery when needed and the location of wheat on steep slopes or inaccessible areas, have slowed the use of mechanical practices on small farms, despite the cost advantage.

Small farmers in Cayambe have widely adopted improved varieties released by INIAP (Table 7), although they rarely use certified seed. Farmers often praised the better rust resistance of new varieties tested in the PIP as a distinct advantage. The PIP survey and our own interviews indicate that herbicide (2,4-D) is also widely used but fertilizer is only used by a small proportion of farmers. Fertilizer doses are also well below current recommendations (80-80-0 kg/ha of NPK) and are also low in nitrogen and high in potassium, since most farmers use "potato"

1/ Unfortunately the strata used to divide farmers in this survey are not clearly defined. We have simply used the average farm size calculated as total area divided by number of farmers, to characterize the strata.

Table 8. Practices used in the Production of Wheat in Pichincha Province by Farm Size, 1982.

	Farm Size Strata			
	I	II	III	Average
Land Use				
Average farm size (ha)	2.7	6.6	556	21.7
Area in wheat (ha)	0.8	1.5	47	2.5
Percent of land in crop	97	95	58	64
Percent of crop land in wheat	32	23	15	18
Mechanical Technology				
Percent of farmers who use:				
-Tractor for land preparation	29	34	97	32
-Drill	0	1	32	1
-Combine	18	32	85	23
-Stationary thresher	43	51	13	43
Biochemical Technology				
Percent of farmers who use:				
-Certified seed	0	2	43	27
-Fertilizer	27	41	73	31
-Insecticide	5	23	19	9
-Herbicide	24	40	63	29
Amount of seed (kg/ha)	129	133	130	130
Average doses of fertilizer (for farmers who use fertilizer):				
-Nitrogen (kg/ha)	13	18	22	20
-Phosphorous (kg/ha)	33	40	34	35
-Potassium (kg/ha)	11	13	8	9
Production				
Average yield (kg/ha)	761	939	1384	1157
Percent sold	67	84	94	88

Source: División de Informática y Estadística, MAG.

Table 9. Distribution of Area of Wheat by Farm Size Strata, Pichincha, 1982.

Strata	Average Farm Size (ha)	Percent of Farmers	Percent of Wheat Production
I	2.7	75	26
II	6.6	19	11
III	556	5	62
	217	100	100

Source: División de Informática y Estadística, MAG.

Table 10. Comparison of Costs of Mechanical and Animal/Manual Practices in Wheat Production, Cayambe, 1983.

		Unit	Unit/ha	Cost/Unit (Sucres)	Costs/ha
Tillage	- Animal	day	4	200	800
	- Tractor	hour	2.5	220	550
Crop	- Hand cut	day	7	135	945
	- Thresher	quintal	20	35	700
	- Combine	quintal	20	50	1000

Source: Informal interviews with farmers.

fertilizer (10-30-10).

Large farmers (over 50ha) are generally mechanized except for planting which is still largely done by broadcasting. Most large farmers also planted a recently released variety[1/] (often with certified seed), and used herbicide and fertilizer. However, fertilizer doses were low although the nutrient balance was closer to the recommendations than for small farmers because of greater use of 18-46-0 and Urea.

Wheat yields in Pichincha in 1981-1982 averaged 1.25 t/ha (28 qq/ha). Yields were over 50 percent higher for large farmers than for small farmers. Most wheat was sold although small farmer sales were dependent on having a good crop that allows sales above consumption needs.

The wide variation both in mechanical and bio-chemical technologies leads to several different alternatives in wheat production. Table 11 shows different possibilities for using labor saving techniques. For this study we only considered the first two alternatives. Fertilizer is the major factor leading to differences in yields between farmers. Data from on-farm experiments suggest that application of 80-80-0 of NPK increases yields by at least 1.0 ton/ha. This implies a return on capital invested in fertilizer of over 100 percent using wheat prices of June, 1983 but only 65 percent at the guaranteed minimum price of S.8800/t (S.400/qq) (Table 12). In general the rate of return on fertilizer investment for wheat has been around 80 percent in recent years. These rates of return, however, are considerably below the rates of return to applying fertilizer on potatoes which are estimated at about 600 percent[2/]. Not surprisingly small farmers with a shortage of capital and little access to credit usually apply fertilizer to potatoes but not to wheat. In addition there is a significant risk in fertilizer application in wheat.

1/ Thirty five percent of the seed used by larger farmers in Pichincha in 1982 was of the varieties Chimborazo and Antisana which were released in 1978.

2/ Based on INIAP experimental data, it seems that an average fertilizer response in potatoes is about 800kg/ha (18qq) per 50kg bag of fertilizer (usually 10-30-10) applied.

Table 11. Labor Intensity of Different Techniques for Wheat Production.

	Preparation	Weeding	Harvesting	Threshing	Mandays/ha
I	Tractor	Herbicide	Combine	Combine	8
II	Tractor	Herbicide	Hand	Mechanical	15
III	Animal	Herbicide	Hand	Mechanical	22
IV	Animal	Hand	Hand	Animal	29

Table 12. Partial Budget for Recommended Fertilizer Application (80-80-0 kg of NPK/ha).

	Sucre/ha
Fertilizer	
3.5 bags 18-46-0 at S.876/50 kg bag.	3063
2.0 bags Urea at S.660/50 kg bag.	1320
Labor	
2 mandays for application at S.135/day	270
Total costs that vary	4653
Increased yield	1.0t/ha
Field price of wheat[a/]	S.9900/t
Increased revenues	S.9900/ha
Net benefits	S.5247/ha
Marginal rate of return on capital	113 percent
Marginal rate of return using official wheat price[b/]	65 percent

a/ Excludes cost of harvesting at S.50/qq.

b/ S.400/qq (S.8800/t) less cost of harvesting.

Source: Calculated from results of 34 on-farm experiments in the Cayambe area, 1977-82. Experimental yields were adjusted downward by 10 percent to reflect farmer yields.

5.2 Relative Profitability of Crop and Livestock Alternatives

The major competitive enterprises for wheat production are barley and milk production. Barley is produced on small and large farms on the slopes and high areas. Much of this land, except for the highest parts above 3,500m above sea level, is suitable for wheat production.

Budgets for dairying were constructed for two different systems. In the first system, which characterizes much of the lower area of the Cayambe Valley, intensive dairying with artificial pastures and multiple cropping are possible because of availability of irrigation. To compare returns in this system with cropping activities we have expressed returns in dairying per six-month cycle - that is, half of the annual returns. In the second system which characterizes much of the sloping areas, artificial pastures are not possible because of lack of irrigation. Here we have assumed an extensive dairy system, with about half the milk yield per hectare. In this system only one crop per year is usually possible and hence returns in dairying are expressed on an annual basis.

Potatoes and maize are less important competitors to wheat production. Potatoes are a small-scale labor and capital intensive crop produced for both home consumption and sales. However, the area under potatoes is small in relation to the total area available for wheat production. Soft maize is the main subsistence crop of small farmers. Only a small part is marketed and the potential for substitution by wheat is small.

All five crop-livestock activities are produced as part of a crop rotation. On small farms a potato-wheat-maize-wheat-barley-legume rotation is common. On large farms in the valley, wheat has often been planted as part of a program to renovate pastures. However in each case and especially for large farmers the crop rotation pattern is flexible depending on relatively profitability and risks of each alternative.

Budgets were constructed for each major crop-livestock enterprise

using farm level prices prevailing in June, 1983. Detailed budgets are found in Appendix E. Technical coefficients and prices used in the budgets have been obtained from many different sources. These include: a) informal interviews with farmers in the area, b) interviews with INIAP scientists and Ministry of Agriculture officials, c) estimates of costs of production for annual crops published by the Ministry of Agriculture and the Banco Nacional de Fomento, and d) surveys undertaken by INIAP and other research groups. We were able to obtain reasonably consistent data for annual crops but we have less confidence in the data for the dairy sector. A number of surveys (e.g. Nelson Flores, 1974; and Barskey and Cosse, 1981) provide reasonable estimates of average technical coefficients for intensive dairying. However, none of these provide a stratification by agro-climatic zone (i.e. rainfall or access to irrigation), to estimate coefficients for the extensive dairy system. Hence, technical coefficients for this system should be regarded as an example of some extensive dairy operations but are not necessarily representative.

Farmers' returns were calculated under alternative assumptions regarding technology. In general two levels of technology were used - the average technology of farmers and a recommended technology. In the case of wheat, two levels of farmer technology were included: a) small farmer technology with no fertilizer used and hand harvesting and threshing with a stationary thresher; b) technology for larger farmers which includes some fertilizer use and combine harvesting.

Recommended technologies were chosen to represent an improved technology that could be applied given current knowledge from agricultural research and that is in use by some farmers. In the case of wheat, technical coefficients were based on five years' results of on-farm experiments. The major difference to the current farmer technology is the use of 80-80-0 kg/ha of NPK to give an average yield of 2.5 t/ha.

Data for improved technologies in maize, potatoes, barley and dairy were based on experiences in PIPs in nearby areas, informed estimates of INIAP scientists and experiences of some farmers with higher yields than

the average. Because of lack of data and time, no effort was made to estimate returns for extensive dairying at improved productivity levels. Coefficients for each level of technology are listed in Appendix E.

Returns per hectare for wheat and dairy are also calculated for two assumptions regarding costs of capital. In the first case, farmers use their own funds and a 10 percent real cost of capital is assumed. In the second case, farmers receive credit from the banking system where rates of interest have been less than the rate of inflation in recent years. Calculations of returns in this case assume a zero real rate of interest. In practice most wheat, barley and maize is produced using farmers' own capital resources, while nearly all dairy farmers received credit from banks, mainly the Banco Nacional de Fomento, at subsidized interest rates (Barskey and Cosse, 1981). Hence, unless stated otherwise, returns in the dairy sector are calculated at zero real interest rates. Also, because the dairy industry provides returns on a daily basis, no account is taken of costs of working capital as in cropping activities.

Finally, the substantial difference between the cost of tractor hire from the Ministry and the costs to tractor owners also leads to some differences in farmer returns. Most large farmers own their tractors and returns to both wheat and dairy were calculated under this assumption. (Appendix D gives further details on calculation of mechanization costs).

The returns per hectare, summarized in Table 13, indicate that potatoes and dairy are the most profitable enterprises under all assumptions. For both levels of technology, potatoes provide over five times the return on land in wheat production. For both levels of technology, dairy is in second place. Intensive dairy operations provided over double the returns to wheat even when measured over a six-month cycle. Wheat yields of 3.5 t/ha at the same costs would be needed to compete with intensive dairy. Even for a dairy farmer who uses his own capital, returns from dairying are higher than for wheat. Significantly, returns in the extensive dairy operation expressed on an

Table 13. Farmer Profitability of Wheat and Competing Enterprises Under Different Assumptions, Cayambe, 1983.

	Returns to Land (S./ha)
Farmer Technology	
Wheat - No fertilizer, hand harvesting	2,890
- Moderate fertilizer (15-45-15 of NPK/ha) and combine harvesting	6,080
Barley - Moderate fertilizer and combine harvesting	5,990
Maize	6,660
Potatoes	36.160
Dairy - Intensive system	14,920 a/
- Extensive system	15,540
Recommended Technology	
Wheat	13,360
Barley	13,890
Maize	14,930
Potatoes	64,200
Dairy - Intensive system	26,545 a/
- Intensive system with unsubsidized capital and machinery costs	18,220 a/
Wheat - At unsubsidized machinery costs	11,820

a/ Returns for a six-month cycle.

annual basis are also higher than for even wheat produced with the recommended technology.

Returns to wheat are generally comparable with other cereal crops, although slightly lower than barley. Use of improved technology is a critical determinant of profitability of these crops. In the case of wheat, returns for small farmers who use no fertilizer are only half of those for farmers who apply a moderate fertilizer dose and only a fifth of returns using the recommended technology. Higher costs of harvesting by hand also explain part of the reason for low returns to the small farmer.

In addition to economic returns, a number of other factors determine the farmers' choice of enterprise. Dairying is a low risk enterprise. Farmers receive a guaranteed price and in recent years the strong demand for milk has enabled the producer to receive a margin above the guaranteed price (S.14/lt in 1983 versus a guaranteed price of S.12/lt). Furthermore, irrigation and supplemental feeding allow year-

round stable production. Dairying also requires less labor than some crops, especially potatoes and maize, and much of this labor is needed in small amounts each day for milking. Women usually perform this task. The major constraint on dairying is the capital investment needed to establish and maintain pastures and develop a dairy herd. The availability of credit for dairying at low interest rates has enabled this constraint to be relaxed for those farmers with access to this credit.

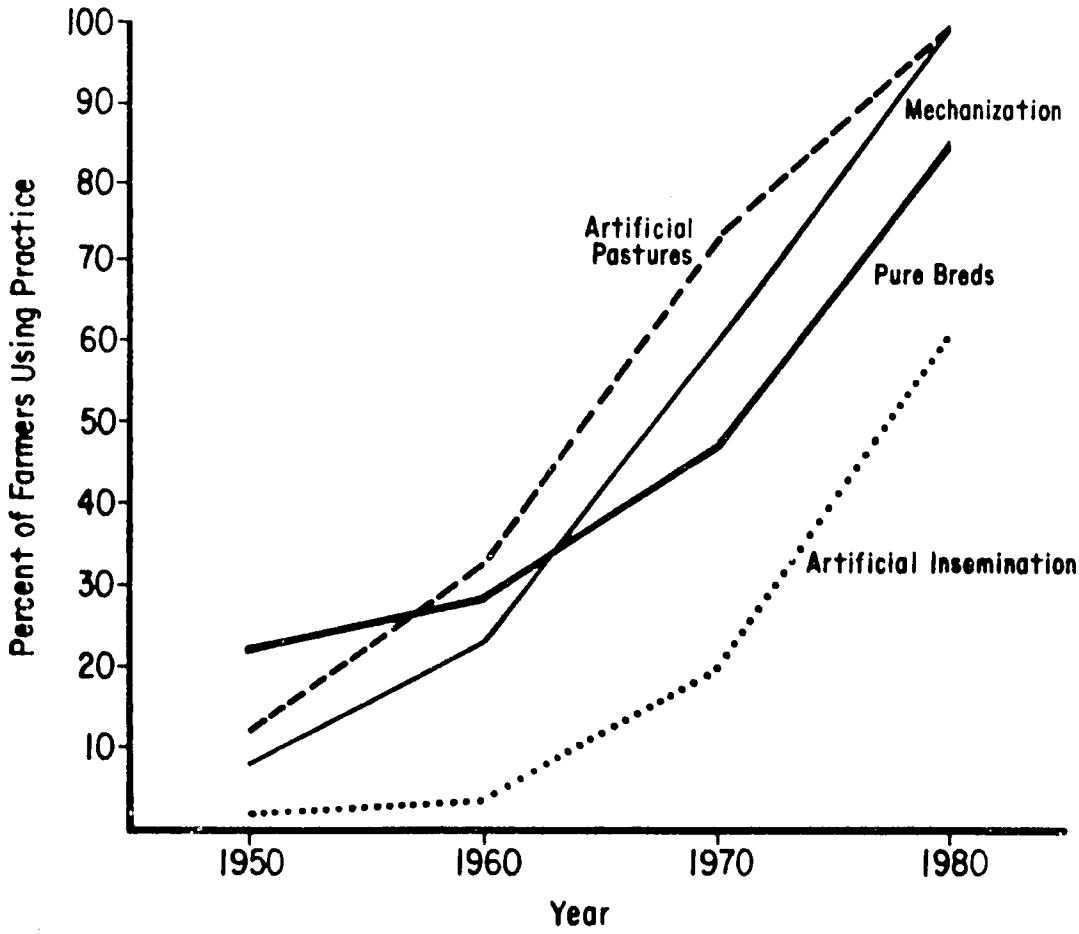
The production of potatoes is, on the other hand, limited by: a) high capital and labor requirements, and b) high market risk. Prices have tended to show a cyclical behaviour due to a relatively inelastic demand.

5.3 Changes in Cropping Patterns in Relation to Relative Profitability

The relatively profitability of different crop and livestock activities has changed markedly over time. A rough approximation is given in Table 13. In 1971, potatoes and wheat gave similar returns while returns in dairying were slightly higher. Returns in dairying and potatoes have increased by 50-100 percent in real terms, while returns in wheat are less than half of returns in 1971. These changes in relative profitability reflect two major factors. First, real prices of potatoes and milk have tended to increase while real prices of inputs, especially imported inputs, have declined. At the same time, real prices of wheat have dropped sharply. Second, technological change has been rapid in the dairy sector and to a lesser extent in potatoes while yields of wheat have changed little.

Figure 12 shows rapid adoption of improved techniques in dairy farming in Machachi and Cayambe in the 1960s and especially in the decade of the 1970s. Potato yields increased in the 1960s and early 1970s with increased use of fertilizer and plant protection but seemed to have levelled off in recent years. In Carchi province, potato yields reportedly increased from 3.6 qq per quintal of seed in 1961 to 10 qq in 1974 (Barskey and Lovell (1982)). Labor inputs also increased but labor productivity was much higher in 1974. The increase in real prices of potatoes in the 1970s would suggest that productivity has increased little in this period.

Figure 12. Technological Change in the Dairy Industry, Cayambe and Machachi Valleys, 1950-80.



Source: Calculated from Barskey and Cosse.

Table 14. Estimated Returns to Land in Wheat, Potatoes and Dairy in 1971 and 1983.

	Southern Pichincha Province, 1971 (S./ha)	Northern Pichincha Province, 1983 (S./ha)	Real Change[b/] 1971-83
Dairy[a/]	3284	28520	46%
Potatoes	2885	38440	124%
Wheat	2821	6600	-61%

a/ Returns expressed on an annual basis.

b/ Deflated by consumer price index.

Source: 1971 data are from Nelson Flores (1974) using the average for farmers with over 20 ha. 1983 data are for a similar group of farmers. Conditions in Southern Pichincha are similar to those in Northern Pichincha.

These changes in relative profitability have been associated with important changes in cropping patterns. Small farmers have probably not made large changes in their wheat area but these are some factors which have probably led to some decline in the area of wheat on small farms are. These include:

a) Increases in specialty cash crops such as potatoes and onions.

b) A decreased interest in wheat as a subsistence food due to the availability of subsidized wheat flour in nearby towns. In 1980 wheat flour was sold to consumers for about the same as the producer price for wheat.

c) Some reduction in cropped area on steep slopes with outmigration to urban areas and inability to mechanize.

Almost certainly wheat production has dropped sharply on larger farms. Much of this change is due to substitution by pastures. Unfortunately statistics on the area in pastures and milk production are neither reliable nor consistent. Some estimates suggest that the area in pasture has increased substantially, doubling from 1968 to 1982. Statistics on milk production suggest a 5 percent growth rate for 1969-1978 (Barskey and Lovell (1982)), while official MAG Statistics indicate a growth rate of only 2.7 percent. Our observations would suggest that the area devoted to pastures and milk production has increased substantially with changes in relative prices. This substitution has ocurred in a number of ways.

a) Wheat was formerly sown to renovate pastures after 2 to 4 years. This practice is diminishing as better pasture management increases the period in pasture. Pasture renovation is also now often carried out by sowing potatoes and forage crops.

b) Area that was formerly cereal land or natural pasture has been brought into intensive pastures through an expanded irrigation system.

c) Steeper land on large farms that was formerly used for cereals is now used for grazing of young animals or dry cows as a complement to the irrigated land which is used for milk cows.

d) Land with no irrigation has been converted to natural pastures for extensive dairy operations with low milk yields per hectare.

The process of converting land to pasture use is still going on; even in some of the higher areas (above 3200m) cereal land is being converted to pastures.

Some wheat has also been replaced by barley because of better market prospects (see Section 3). Some land in the Cangahua area is ideally suited for wheat but is now sown to barley. Official statistics note a drastic decline in barley area in the 1970s. However, almost certainly the official estimate of 5,000 ha of barley in Pichincha Province in 1982 is a substantial underestimate.

Finally, in land reform areas where land has been subdivided some land that was formerly sown to wheat is now sown to subsistence crops such as maize. There is also a substantial area of natural pastures in these cooperatives which is being developed into artificial pastures.

In sum, the use of land in the Cayambe area has shifted with the declining profitability of wheat relative to dairy (and to some extent, barley). Increased prices for milk, rapid technological change, and access to cheap credit have significantly increased the returns in dairying. Much of these returns have been capitalized into higher land prices, which has of course raised the cost of production for all enterprises. The average returns in dairying at improved levels of technology would pay about an 8 to 15 percent return on capital invested

in land in 1983[1/].

6.0 Profitability to the Nation of Wheat Production and Competing Crop-Livestock Activities

The final step in analyzing the wheat situation in Ecuador was to calculate the social or national profitability of wheat and competing enterprises, using prices that correct for policy distortions. That is, prices of items such as wheat, fertilizer and machinery, which are imported or exported were based on import prices converted at the corrected exchange rate. Labor and capital were valued at their opportunity costs in alternative uses and then returns to land calculated. Section 6.1 presents the assumptions used in the calculations and Section 6.2 summarizes results.

6.1 Assumptions Used to Compute Opportunity Prices

Wheat. The import price for wheat was based on a long run expected price in world markets of $US170/ton FOB (USA, No.2 Hard Red Winter) or $US210/ton landed in Guayaquil[2/]. This is above actual import prices in 1983 when world prices were below the long run trend.

Internal transportation costs were divided into three components: a) fuel, b) depreciation and repairs, and c) other. Unsubsidized fuel costs were estimated by assuming an export equivalent price of diesel of US$0.26/lt and fuel consumption from Guayaquil to the Sierra of 0.05 lt/ton-km. Remaining transport costs were divided equally between depreciation and spare parts which are tradeable items, and capital and labor costs which are non-tradeable. The tradeable component was then revalued at the corrected exchange rate.

1/ Prices for good dairy land were around S.350,000/ha with a return of S.28,500/ha for average productivity and S.53,500/ha for high productivity.

2/ Estimated from the long term trend line, Log_e (price) = 3.611 + .0485 T for the period, 1953-83, for the U.S. f.o.b. price.

Transportation costs for domestic wheat were not included since imported wheat must be transported to mills in the producing area. The mill at Cayambe which purchased up to 7,000 tons of local wheat in the 1960s, was expected to purchase less than 1,000 tons in 1983. Hence, any increase in local wheat production could substitute for imported wheat at this mill.

Other marketing, handling, and distribution costs were assumed to be similar for local and imported wheat. The cost of storage, loading, and unloading of imported wheat is probably more than offset by additional costs of handling local wheat in bags and additional cleaning and drying costs for local wheat. Price differences due to higher quality of imported wheat were not considered.

Based on these assumptions, the world price equivalent (i.e. the import price equivalent at the mill less marketing and transport costs to transfer local wheat from the producer to the mill) would be about S.17,600/t (S.800/qq).

Barley, Maize and Potatoes. Barley is also an imported commodity. Long run prices for malting quality barley in world markets are 10-20 percent lower than wheat, although in 1983 high prices for coarse grains reduced this differential. An import price of US$180 was used for barley and transport costs calculated as in the case of wheat.

Potatoes and soft maize were considered as nontraded commodities, although some potatoes and soft maize do cross the Colombian border. Average domestic prices for potatoes of S.7,700/t (S.350/qq) are roughly equivalent to potato prices in the USA or Europe when converted at the corrected exchange rate (i.e. about US$100/ton).

Soft maize is a basic subsistence crop with no close import substitute. Only a small part enters the market. Hence, this crop was not considered in the analysis of national profitability.

Milk. Estimating the import price of milk presented special problems for

the reasons already discussed. Based on the analysis of Appendix C, it seems that declining real prices of dairy products with decreased demand have eliminated much of the protection that was received by the dairy industry in the 1970s. The milk price in 1983 was slightly below the import price for dry milk, converted at the corrected exchange rate. For calculating national profitability an import price equivalent of S.16/lt for liquid milk was used.

Fertilizer. Fertilizer prices were calculated in a similar manner to import prices for wheat. For example, for urea, import prices were based on an FOB price USA of US$150/t plus US$50 freight and handling charges. This was converted at the corrected exchange rate and unsubsidized transport costs and a marketing margin of S.3,550/ton included. The producer price for urea based on this method was estimated at S.1020 per 50 kg bag.

Machinery. Machinery costs include a) depreciation and repairs, b) capital costs, c) fuel costs, and d) costs of operator labor. The major adjustments in these costs to compute national profitability were a) taking account of the overvalued official exchange rate, and b) removing the diesel subsidy and the MAG subsidy on tractor services. Details are provided in Appendix D. These adjustments raise machinery costs quite substantially. The estimated true cost of tractor operations is about S.900/hour compared to S.220/hour charged by the Ministry of Agriculture. It should be noted that farm machinery is now imported at close to the free market exchange rate so that except for the Ministry subsidy, actual costs of machinery operation approximate true costs. Private machinery hire services that do not compete with the Ministry are expected to raise their prices accordingly.

Other Inputs. Most other inputs such as herbicides, fungicides for potatoes and vetinary medicines for livestock are imported. The real cost of these inputs was estimated by simply assuming that 70 percent of the cost to farmers was foreign exchange costs and allocating the remainder to local marketing and distribution costs. Because of their high value to volume ratio, no adjustments for subsidized transport costs were

made. Foreign exchange costs of the inputs were adjusted to take account of the overvalued official exchange rate.

Supplemental feeding of livestock is common. Some of this, such as wheat bran and mineral supplements, is imported at the official exchange rate, while others such as hard maize, are purchased at local market prices. Arbitrarily we assumed that 50 percent of the costs of supplemental feeding were foreign exchange costs.

Seed. Most seed used by farmers for all crops is seed saved from the previous season. This was simply valued at the same prices as the product. Seed for pasture establishment and maintenance is however largely imported. This cost was adjusted for exchange rate overvaluation in the same way as for other inputs.

Capital and Labor. All capital expenses were based on a real rate of interest of 10 percent. Most estimates indicate that the opportunity cost of capital in developing nations is at least this amount. Labor costs were valued at the actual wage rate paid to workers.

Table 15 summarizes farmer prices and estimated opportunity prices, free of policy distortions. In most cases, the farmer receives and pays prices less than the opportunity price due to exchange rate overvaluation (i.e. imports at the official exchange rate). Larger differences occur due to subsidies on diesel fuel, bank credit and government tractor hire services.

6.2 Results of the National Profitability Analysis

National profitability of each enterprise was calculated for a "base run" using technical coefficients that reflect the recommended or "best bet" technology (except for extensive dairy where a farmer technology was used). Sensitivity analysis was then conducted to calculate national profitability at farmer levels of technology and also with variations in world prices.

Table 15. Opportunity Prices Used for National Profitability Analysis Compared to Actual Farm Prices.

	Farm Price June, 1983	Opportunity Price	Farm Price as Percent Opportunity Price
Products			
Wheat (S./qq)	500	830	60
Barley (S./qq)	550	720	76
Milk (S./lt)	14	16	87
Potatoes (S./qq)	350	350	100
Inputs			
Seed	500	830	60
Diesel (S./lt)	3.4	20.8	16
Urea (S./50 kg)	660	1020	65
18-46-0 (S./50 kg)	875	1130	78
10-30-10 (S./50 kg)	750	1060	71
2-4,D (S./lt)	250	445	56
Tractor Use (S./hour)	220[a/]	800	28
Real interest on bank credit (percent)	negative	10	-
Labor (S./day)	135	135	100
Animal power (S./day)	270	270	100
Investments			
Tractor (75 H.P.) (S.)	1,100,000	1,690,740	65
Combine Harvester (S.)	3,668,000	5,000,000	68
Value of dairy herd (S./adult animal equiv.)	40,000	40,000	100

[a/] Based on government tractor hire services.

Table 16. Estimated Profitability to Farmers and to the Nation of Wheat and Competing Enterprises at Recommended Technology Levels, Cayambe, 1983.

	Farmer Returns to Land	National Returns to Land (Sucres/ha)	Total Policy Effect b/
Wheat	13,360	23,330	-9,960
Barley	13,880	14,620	-740
Potatoes	64,200	45,300	18,900
Intensive Dairy a/	26,550	18,850	7,700
Extensive Dairy	15,540	12,830	2,710

a/ Expressed per 6 month cycle.
b/ Excludes indirect effects operating through policies affecting returns to land in competing activities. See Table 2.1 for definitions of policy effects.

Results for the base run are shown in Table 16. Note that national profitability for intensive dairy is calculated for a six month cycle in order to compare with a crop cycle. Potatoes are the most profitable enterprise. However, for this technology level, wheat is in second place followed by intensive dairy. Barley and extensive dairy are the least profitable alternatives. That is, when products and inputs are valued at their import prices and subsidies removed from capital and mechanization costs, one hectare of wheat contributes more to national income than one hectare of pasture for intensive dairy over a six month period. sub-stantially more than one hectare of barley or extensive dairy.

The results also clearly show the difference between the ranking of wheat and dairy based on private and national profitability. To the farmers, wheat is the least profitable enterprise and intensive dairying gives the second highest profits (after potatoes). In the case of wheat, policies, especially wheat prices lower than world prices, tax the farmer about 23 percent (net) of the value of his production. On the other hand, policies such as subsidized credit and diesel as well as the importation of inputs at the official exchange rate combine to provide a total net subsidy on intensive dairy of 19 percent of the value of pro-duction. These various subsidy effects are summarized in Table 17.

Table 17. Summary of Main Policy Effects by Enterprise, Cayambe, 1983[a/].

	Price of Output in Relation to World Price	Subsidy on Diesel and Mechanization Services	Import of Other Inputs at Official Exchange Rate	Subsidy on Credit
		(Sucres/ha)		
Wheat	-17,300	4,590	1 990	0
Barley	- 7,890	4,590	1,680	0
Potatoes	0	4,740	13,000	0
Intensive Dairy[a/]	- 4,690	3,160	1,920	7,300
Extensive Dairy	- 2,490	0	701	4,500

a/ Calculations of policy effects are defined in Table 1.
b/ Calculated for a six month cycle.

The national profitability analysis also clearly shows the expected superiority of wheat in relation to barley. Their costs are similar but higher yields of wheat and higher prices for wheat in world markets provide greater benefits from wheat production. In areas which are suited to wheat production, wheat will provide a return almost 50 percent higher than barley. However, price policy, especially the importation of barley at a close to the free market exchange rate, provides incentives to farmers to grow barley. Again, there is a conflict between what is profitable to farmers and what is profitable to the country.

Wheat is definitively less profitable than potatoes to both farmers and the country. However, the limited and risky market for potatoes provides little likelihood that potato area will expand significantly. Potatoes also provide high profits to farmers so there is no conflict between profitability to farmers and to the nation.

The most interesting case concerns the competition between wheat

and dairy, especially given the fact that expansion of dairy production has been largely responsible for the decline in wheat area. Sensitivity analysis was conducted on alternative price and technological assumptions to determine to what extent the conclusions on the higher national profitability of wheat are sensitive to these assumptions.

Table 18 gives results for national profitability of wheat and dairy at farmer levels of technology. Wheat gives somewhat higher returns than intensive dairy on a six-month cycle. However, returns in extensive dairy on an annual basis are slightly higher than for a wheat crop. Some improvements in wheat productivity are needed to compete with extensive dairying - national profitability in the two enterprises are equal at a wheat yield of only 1.6t/ha compared to farmers' yields of 1.5t/ha. On the other hand, at the recommended level of technology for wheat (2.5t/ha), milk productivity in extensive dairying needs to exceed 2000 lt/ha (with no change in costs) to compete with wheat. Hence the results of national profitability analysis are quite sensitive to assumptions about current technology and the potential for improvement in productivity in wheat and dairy.

Table 18. Comparison of the National Profitability of Wheat and Dairying Under Alternative Assumptions Regarding Productivity, Cayambe, 1983.

	National Profitability (Sucres/ha)
Current Farmer Productivities	
Wheat (Yield 1.5 t/ha)	10,550
Intensive Dairy (Milk Yield 3000 lt/ha)[a/]	8,450
Extensive Dairy (Milk Yield 1300 lt/ha)	12,830
Productivities with Improved Technology[b/]	
Wheat (Yield 2.5 t/ha)	23,330
Intensive Dairy (Milk Yield 4900 lt/ha)[a/]	18,850

a/ Calculated for six-month cycle.
b/ Based on results of on-farm experiments on wheat and productivity levels of the best farmers in the case of dairy.

Table 18 also shows that wheat gives the largest increase in returns to land from use of improved technology. This implies that if promoting the use of improved technology requires the same investment of research and extension services per hectare for wheat and dairy, then allocation of these resources to wheat will provide substantially higher payoffs to the nation, providing farmers have the market incentives to grow wheat.

Table 19 shows the effect of changes in world prices on national profitability. Using the maximum expected import price of dry milk (see Appendix C), intensive dairying becomes slightly more profitable than wheat but there is still a large advantage of wheat over extensive dairying. If wheat prices are expected to remain at their current low levels and if an adjustment of 10 percent is made to allow for quality differences between local and imported wheat, the relative ranking is rather similar (Table 19). The competition between wheat and intensive dairy is sensitive to assumptions about world prices but wheat at improved levels of technology maintains its comparative advantage over extensive dairy.

Table 19. Comparison of National Profitability of Wheat and Dairy at Improved Technology Levels Under Alternative Assumptions about World Prices for Wheat and Milk.

	National Profitability
1. Base Run - Expected Import Prices	(Sucres/ha)
Wheat ($US210/ton)	23,330
Intensive Dairy ($US1500/t) a/	18,850
Extensive Dairy ($US1500/t)	12,830
2. Milk at Maximum Expected Import Price	
Intensive Dairy ($US1800/t) a/	25,200
Extensive Dairy ($US1800/t)	16,200
3. Wheat Price Based on Minimum Expected Import Price ($US175/t) b/	18,500

a/ Calculated for six-month cycle.
b/ Import price in 1983 less 10 percent discount to allow for higher moisture and impurities of local wheat.

Finally, because it is difficult to estimate the opportunity price for foreign exchange, sensitivity analysis was conducted at different exchange rates. However, the ranking among enterprises was unchanged for exchange rates between S.65/$US1.00 and S.95/$US1.00. Table 20 shows the relative foreign exchange, labor and capital costs of each enterprise. For every three units of foreign exchange saved by growing wheat in Ecuador instead of importing it, about one unit must be used for importing inputs and machinery. Ratios are similar for other enterprises, except extensive dairying which uses little foreign exchange. Potatoes are by far the most labor intensive crop while dairying requires three times more capital than crop production. National profitability estimates of these enterprises will be quite sensitive to wage rates and interest rates, respectively.

Table 20. Summary of the Ratio of Foreign Exchange, Labor and Capital Costs to the Value of Output at Improved Level of Technology.[a/]

	Foreign Exchange Costs per Unit Value of Output	Labor Costs per Unit Value of Output ($x10^3$)	Capital Costs per Unit Value of Output c/ ($x10^3$)
Wheat	.31	36	57
Barley	.37	46	72
Potatoes	.35	157	41
Intensive Dairy	.24	54	193
Extensive Dairy[b/]	.10	62	270

a/ All prices expressed in opportunity prices.
b/ Farmer level of technology.
c/ Excludes capital invested in land.

7.0 Conclusions

Wheat production in Ecuador has declined because of reduced area combined with stagnant yields. The reduction in wheat area reflects declining profitability in real terms and in relation to competing crop-livestock enterprises, particularly dairying and to a lesser extent barley. The failure to achieve widespread use of yield increasing technologies in wheat, especially fertilizer, also reflects relatively low returns to investment in improved technologies at prevailing input and output prices.

Government policies have played an important role in the declinig profitability of wheat production. These include:

a) An overvalued exchange rate (along with subsidized transport costs) which kept prices of imported wheat low and also led to declining real prices for wheat to producers.

b) Importation of wheat free of duty at the same time that milk, potatoes and barley were subject to tariffs or import controls.

c) Substantial increases in bank credit at negative real interest rates which particularly favored capital intensive industries such as dairying and enabled rapid increases in productivity.

At the same time, policy interventions also favored reduced costs of wheat production. The overvalued exchange rate reduced the price of imported inputs and machinery. Subsidised diesel prices and more recently MAG subsidization of mechanization services sharply reduced costs of tractor use below the real cost. However, wheat and competing enterprises benefited in approximately equal terms from these policies.

By 1982/83, wheat provided farmers less than a third of the returns to dairying, including extensive dairying carried out with low productivity on natural pastures. Even if farmers employed the best available technology, wheat production would be less profitable than extensive dairying at current levels of productivity. Furthermore returns associated with use of improved wheat technology are not high enough to induce widespread adoption by small farmers with capital scarcity and inability

to withstand risks. Under these circumstances it is not surprising that there has been a substantial switch from wheat production to livestock and in some cases barley. This change has occurred in both the valleys where wheat is no longer sown to renovate pastures, and increasingly on the slopes and higher areas.

A major objective of this study has been to determine if wheat production would be an efficient use of resources from the national viewpoint. The profitability to the nation of each crop-livestock activity was computed by expressing product and input prices at their world price equivalent and removing subsidies on prices of fuel, tractor services and credit. The results clearly show that except for potatoes, wheat provides the highest national returns to land and extensive dairying the lowest. This result holds for both current levels of technology (except for small farmers) and for improved levels of technology. Moreover if farmers faced world price equivalents for both wheat and fertilizer the incentives for use of recommended fertilizer doses would be significantly increased.

Some uncertainty surrounds future trends in world prices for milk products, given the large subsidies now paid by exporting countries. Sensitivity analysis assuming an expected maximum world price for milk products suggests that intensive dairy would provide somewhat higher national profits but that wheat would still compete with lower productivity extensive dairying.

These conclusions have at least three important limitations. First, there is little available data on the dairy industry, particularly extensive dairying. A survey of land use patterns and productivity is needed to establish the relevant input-output parameters and extent of different livestock systems. Second, the analysis was confined to one region. Extension across other important wheat regions is needed to confirm the generality of the conclusions. Nonetheless, Cayambe is a high potential region and it is expected that livestock activities would have lower productivity in other regions. Finally, the results focus on efficiency of resource use. Other objectives, such as income distribu-

tion and consumer protection from fluctuations in world prices will also want to be considered in any decision to promote domestic wheat production at the expense of other products.

The results of this study do not suggest that all the policy interventions listed should be eliminated in order to promote wheat production. Many of the policies, such as subsidized transport costs or maintenance of a low official exchange rate are implemented with broader objectives in mind and have implications for all sectors of the economy. However, if there is a desire to promote wheat production in the interests of more efficient resource use, a number of possible policy measures are possible. One low cost alternative is to set the producer price of wheat at the import equivalent price, converted at the free market exchange rate. (Imported wheat could still be imported at the official exchange rate to maintain low consumer prices.) This would imply a current price of about S.18,300/t or S.830/qq[1/]. It will also be important to maintain prices of wheat relative to prices of competing products in line with relative import equivalent prices. This implies a price of wheat roughly 15 percent above milk and barley prices.

Since domestic wheat purchases currently make up about 5 percent of wheat milled, payment of a price of S.18,300/ton would have only a negligible impact on consumer prices. The difference between this producer price and the price of imported wheat at the official exchange rate could be financed by a small tax on imported wheat. While the desire to maintain wheat prices low to consumers given the present economic crisis is understandable, in the long run food security is promoted by allowing wheat prices to consumers to rise to levels that reflect the cost of imported wheat at the corrected exchange rate. If domestic wheat production expands, the tax on imported wheat (at the official exchange rate) can be increased to support domestic producer

1/ Actual producer prices would be about 10 percent lower to allow for quality differences. Some mechanism is also needed to enforce minimum producer prices at the mills given the buying power of local millers. ENAC which is heavily involved in rice purchases could play this role. See Appendix B for a discussion of some of these issues.

prices and at the same time gradually bring the price of imported wheat to a price based on the free exchange rate.

A second option for promoting wheat would be to reallocate credit that is now heavily focussed on livestock and rice production toward wheat production. The results of on-farm research suggest that significant productivity increases in wheat are possible through use of recommended fertilizer levels which could be promoted by greater credit availability for fertilizer purchases. Recently the BNF has announced increased credit allocations for wheat.

Finally, the current results provide justification for continuing a strong wheat research program. Although technological change alone is not sufficient to overcome the low farmer returns from wheat under current policies, agricultural research is a long term process and decisions on research resource allocation must take a long term perspective on the policy environment. The current negative policy environment for wheat is only a decade old and could change in the future. More analysis of policy alternatives is needed to provide a better information base for such decisions.

Finally, research decisions should take a broader perspective on possible pay-offs to increased productivity. Increased productivity in wheat will increase the competitiveness of wheat with other crops. At the same time increased productivity in dairying might reduce milk prices and indirectly allow expanded cereal production through removal of land from low productivity dairying.

APPENDICES

A Changes in Consumption Patterns and Consumer Price Policy

B The Wheat Marketing and Milling System

C The World Market for Dairy Products and The Relationship Between World Prices and Ecuadorian Prices

D Calculation of Mechanization Costs

E Budgets for Crop-Livestock Activities to Calculate Farm-Level and Social Profitability

F Institute and Departments Providing Data and Information for the Study

G Data on Wheat Production and Utilization

Appendix A. Changes in Consumption Patterns and Consumer Pricing Policy.

Consumption of basic food staples has undergone rapid change in the 1970s, in part induced by pricing policy. Table A1 summarizes these changes as well as the importance of various food staples for different groups. Consumption of rice and wheat has expanded extremely rapidly. Both commodities, are consumed more in urban areas than in rural areas, and wheat tends to be consumed more by higher income groups. Consumption of rice and wheat has expanded in large part through declining consumption of traditional staples such as barley, soft maize and potatoes. Rapid urbanization has been one factor in this substitution since urban consumers often prefer rice and bread (see Byerlee (1983)). However, pricing policy has also been a major influence. Figure A1 shows that real retail prices for rice and bread have declined quite sharply in the 1970s while prices for potatoes and soft maize have increased. The decline in bread prices reflects two factors a) imports of wheat free of duty and at an increasingly overvalued exchange rate and b) a consumer subsidy on wheat flour that maintained wheat flour prices constant from 1973 to 1982 but led to a decline of 70 percent in real prices (see Figure A1). The decline in rice prices probably reflects strong government programs to increase production including a large allocation of BNF credits.

The removal of the subsidy on wheat flour in late 1982 led to a sharp increase in flour prices of almost 200 percent. However the importation of wheat at the official exchange rate still resulted in low prices of wheat flour relative to other foods (see Table A2). In June 1983, wheat flour in the Quito market was still cheaper than all other staples including hard maize. The removal of the subsidy on wheat flour is estimated to have caused a 15-18 percent decline in consumption from late 1982 to May 1983. However, rapid increase in prices of other staples, including a shortage of rice, removed the initial price effect and wheat imports and consumption were expected to increase in 1983 to record levels.

Table A1. Summary of Consumption Patterns for Main Food Staples and for Milk.

	Per capita Consumption, 1976/78	Annual Growth Rate Per Capita Consumption 1972/74 to 1976/78	Ratio of Consumption of Higher Income Groups to Lower Income Groups in Urban Areas a/	Ratio of Consumption in Urban Areas to Rural Areas
	(kg/year)	(percent/year)		
Rice	25.5	9.1	1.08	1.17
Wheat	37.5	9.8	1.63	1.23
Barley	8.1	- 7.0		
Soft Maize	7.6	-17.2	1.41	.41
Hard Maize	23.4	1.3		
Potato	57.3	- 6.9	1.36	.93
Cassava	35.2	- 5.1		
Milk	63.2	0.8	1.41	2.41

a/ The lower income group includes all households with incomes less than S.83,000/year. They comprise 64.2 percent of the population and the remaining 35.8 percent is classified as higher income.

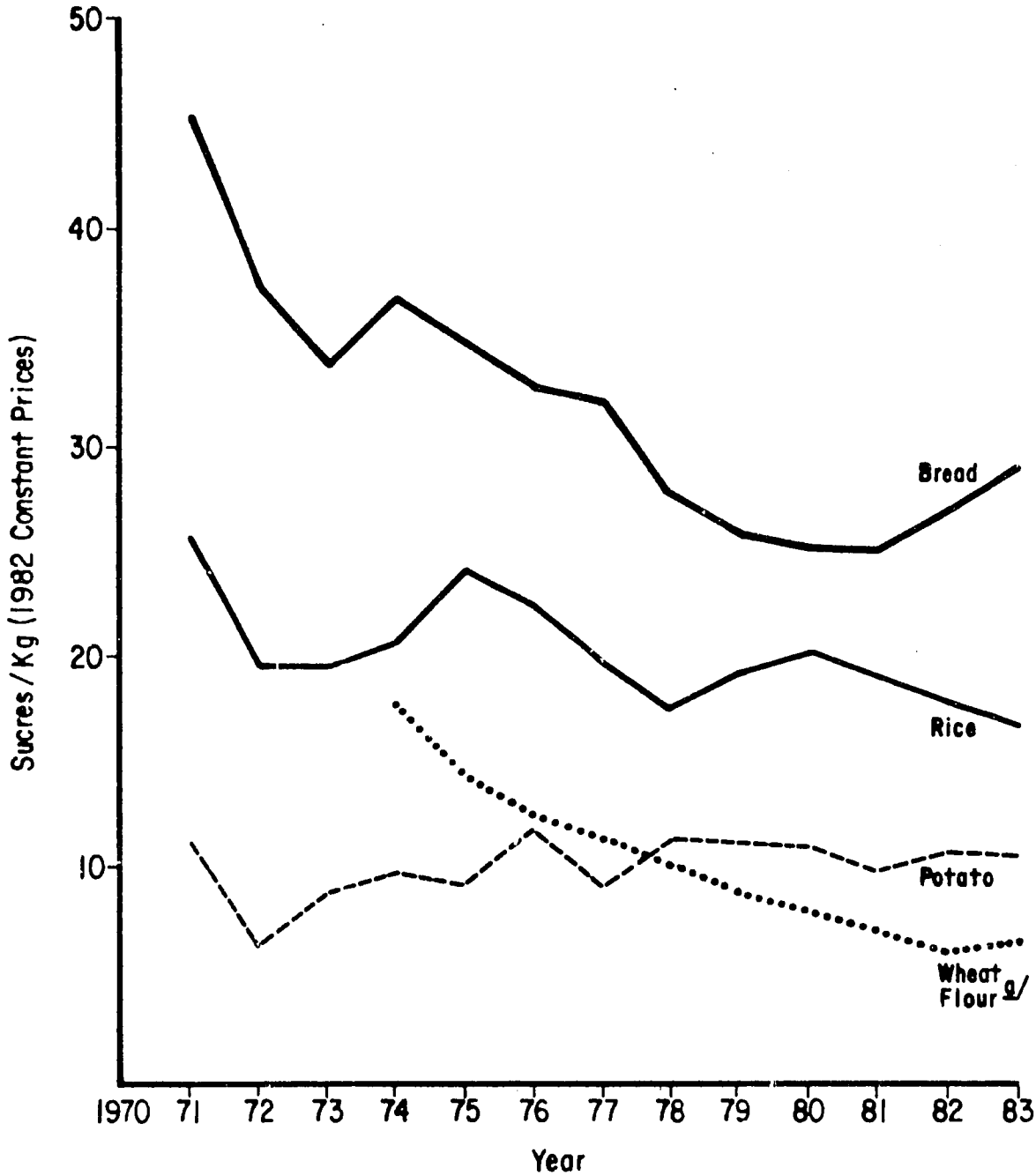
Source: Calculated from data in Szretter, 1982.

Table A2. Wholesale Prices in the Quito Market, June, 1983.

	Price (S./qq)
Potatoes	1,300
Soft Maize	1,100
Hard maize	800
Barley	700
Wheat Flour	740 a/
Barley Flour	1,200

a/ Quintal converted from 50 kg to 44.5 kg.

Figure A1. Real Retail Prices for Basic Food Staples in Urban Areas, 1970-82.



a/ Wholesale price to bakers.

Source: INEC

Appendix B. The Wheat Marketing and Milling System

By 1983, well over 90 percent of the wheat milled in Ecuador was imported. Almost all wheat has been imported as Hard Red Winter No.2 from the USA, although much of it is wheat of intermediate hardness grown in California.

In 1983, all wheat imports were covered by Commodity Corporation Credits (CCC) of the U.S. government. These credits provide loans at market interest rates over a three year period from private banks, but with security of the loans guaranteed by the U.S. government. The availability of this credit is reported to have been an important factor in maintaining and even increasing wheat imports in the face of the recent scarcity of foreign exchange. CCC credits are a direct agreement between the lending bank and the Ecuadorian Central Bank.

Wheat is imported up to a limit set by the MAG. (Each mill has its own quota although wheat is often freely traded between mills.) The millers themselves do the wheat importing. This was formerly done by the two large coastal mills on behalf of other mills. More recently the millers of the Sierra have formed their own importing company, Ecuatoriana de Granos to import directly. Imports are on a C and F basis under a tender system. Imports are usually received in vessels of 13,000-14,000 tons.

The government has established a reference price for imported wheat. This reference price remained at about $135/t between 1973 and 1982 and was below the import price during most of the period. The difference was made up by a government subsidy. In 1983, the reference price C and F was $US195/t which was above the import price. The difference goes to government revenues. Flour prices are also controlled but these controls were not effective in 1983 when market prices rose above the official price.

Local wheat is purchased following a schedule of official prices. In 1983 this price was set at S.400/qq (S.8800/t) for wheat at 72

kg/hecto-litre, 15 percent moisture and 2 percent impurities. Discounts (or premiums) of S.5.50/qq were made for each one kg per hecto-litre change from the standard. In addition, prices were discounted for excess moisture and impurities. One estimate is that on average, this discount from the official price was about 10 percent.

In practice the difference between the official price and the price actually paid to producers has varied substantially. When imported wheat is widely available there is little incentive for millers to receive local wheat for several reasons. First, imported wheat has been provided at subsidized prices and although local wheat also received a direct subsidy at the mill between 1979 and 1982, it is generally believed that there was a strong incentive to use imported wheat. Second, even when local wheat is discounted in price for moisture and impurities there are additional costs of handling local wheat due to the variation in quality, the receival of wheat in bags and also the extra costs of cleaning and drying local wheat. Third, millers because of their small numbers enjoyed same monopsony power in buying local wheat. Finally, millers complained about the milling and baking quality of local wheat. For these reasons local wheat prices seem to have fallen as much as 20 percent below official prices in some years. The government has attempted to correct this problem by determining the quota for each mill for imported wheat in terms of the quantity of local wheat purchased. However, this seems to be enforced loosely, if at all. ENAC the government food marketing agency has not intervened in the wheat market although they play an active role in purchasing rice from farmers.

There are some 22 flour mills in Ecuador but their size varies greatly. The two largest mills on the Coast account for half of the total milling capacity. Four others in the Sierra make up 30 percent of the capacity and the remaining 20 percent is shared between 16 relatively small mills. Total milling capacity is estimated at 16,000-18,000 t/day. At current rates of consumption only 60 percent of capacity is utilized. Capacity expansion was very rapid during the period of rapid increases in wheat imports in the 1970s. The decreased growth of wheat imports has led to overcapacity in some mills and more

competition to purchase local wheat and in pricing of flour.

Milling margins are relatively low by developing country standards. Based on a wheat purchase price of S.520/qq of 44.5 kg, a selling price for flour of S.830/50 kg bag and an extraction rate of 75 percent the mark-up on the purchase price of wheat is 9 percent - higher than in the US but lower than many countries such as Mexico.

Approximately 65 percent of flour is used in breadmaking, 20 percent in noodles, 5 percent in biscuits, and another 5 percent in other uses including home consumption. Noodles are a close substitute for rice - hence relative prices of rice and flour are an important determinant of noodle consumption.

Appendix C. The World Market for Dairy Products and the Relationship Between World Prices and Ecuadorian Prices.

Over the last decade Ecuador has chosen a policy of near self-sufficiency in dairy products. Table C1 shows the percentage dependence on imports of dairy products for Ecuador in comparison with neighboring countries of Latin America. Ecuador has been completely self-sufficient in butter and cheese and has achieved over 90 percent self-sufficiency in all milk consumed. In contrast, neighboring countries, with the exception of Colombia, have imported sizable quantities of dry milk, butter and cheese.

Table C1. Self-sufficiency of Ecuador and Neighboring Countries in Milk Products, 1979-81.

	Percent Self-Sufficiency In			Per capita Consumption of Milk[b/] (kg/year)
	All Milk[a/]	Butter	Cheese	
Ecuador	93	100	100	101
Peru	74	33	99	61
Colombia	96	82	100	116
Venezuela	62	81	76	137
Panama	61	4	18	81
Costa Rica	90	74	97	157
Mexico	82	54	98	119
Latin America	87	73	93	112

a/ Domestic milk production as a percent of production plus imports. Imports of dry milk, butter and cheese are converted at the ratio of 8:1 to milk equivalents and imports of evaporated and condensed milk at a ratio of 2:1.

b/ Expressed in milk equivalents converted as in footnote a/.

Source: FAO Production Yearbook, 1981 and FAO Trade Yearbook, 1981.

Overall self-sufficiency rates in milk range from only about 60 percent in Venezuela to 80-90 percent in Mexico and in Latin America as a whole, compared to 93 percent in Ecuador.

Near self-sufficiency in dairy products in Ecuador has been achieved at the expense of significant levels of protection to local producers resulting in relatively high prices of milk products to consumers. For example, prices of butter and cheese were well above those in Peru and other Latin American countries in 1981 (Table C2). However, consumer prices for milk were below prices in neighboring countries. This resulted from the importation of dry milk and subsidized sales of this milk to consumers. Milk processors have maintained low margins through use of imported dry milk and by subsidizing milk processing through profits from butter and cheese manufacturing.

Table C2. Retail Prices of Milk and Milk Products in Selected Latin American Countries, 1981.

	Milk ($US/lt)	Cheese ($US/kg)	Butter ($US/kg)
Ecuador	.30	4.50[a/]	9.32
Peru	na	2.87	3.77
Colombia	.41	4.29	4.03
Venezuela	.68	6.89	7.08
Mexico	.43	na	5.12
Panama	.49	3.20	3.67

a/ Soft cheese which usually sells for two-thirds of the price of hard cheese.

na = not available.

Source: ILO Bulletin of Labor Statistics, 1982. Ecuadorian prices from INEC. Prices converted to US Dollars at the official exchange rate from IMF, International Financial Statistics Yearbook, 1982.

World markets for dairy products are complicated by large and growing stocks in exporting countries, particularly in the USA and the EEC (Table C3). This has led to export prices as much as 50 percent below prevailing wholesale prices in the exporting countries. The difference is made up by a large export subsidy, especially in Western Europe which accounts for nearly 80 percent of world exports of dairy products (expressed in milk equivalent). The US also exports sizeable quantities of dairy products under food aid programs.

Table C3. Stocks, World Trade and Prices for Milk and Milk Products.

	Estimated Ending Stocks 1983 (million t)	World Trade (1979-81) (million t)	Wholesale Prices EEC,1982 ($US/t)	Approximate Export Prices EEC,1982 ($US/t)
Nonfat Dry Milk	1.9	2.5	2200	825
Butter	1.0	1.35	3400	2000
Cheese	1.5	1.4	2500	1750

Source: World Trade - FAO Trade Yearbook, 1981: Wholesale Prices, FAO Monthly Bulletin of Statistics, May, 1982; Stocks and Export Prices, USDA Foreign Agricultural Circular-Dairy, various issues.

Because of these factors, it is not easy to determine a world price for dairy products. However some estimates are possible. In the case of dry milk, Ecuador has been a consistent but not a large importer. The CIF price was determined from MAG records and a margin for internal transport and distribution added. This margin was estimated by EMPROVIT at S.14,000/t in 1983. Margins for previous years were determined by assuming that the margin had changed by the same rate as inflation. Export prices for New Zealand butter are available from IMF International

Financial Statistics. A 15 percent margin was added to obtain Ecuadorian CIF prices, resulting in slightly higher prices than the London CIF price for New Zealand butter. The internal marketing margin was estimated at about S.120/kg in 1983. This margin was used to estimate margins in previous years as for dry milk.

The Nominal Protection Coefficient expressing the relationship between national prices and world prices was estimated using the official exchange rate and also the corrected exchange rate as derived in Section 3.0. Results are shown in Table C4.

Table C4. Nominal Protection Coefficients for Milk, Butter, and Wheat, 1970-83.

	Nominal Protection Coefficient			Adjusted Nominal Protection Coefficient[a/]		
	Milk	Butter	Wheat	Milk	Butter	Wheat
1970-73	.92	.94	.98	.70	.79	.73
1974-76	1.09	1.31	.88	.74	1.06	.55
1977-80	1.28	1.65	1.09	.86	1.32	.67
1983	1.23	1.19	1.04	.87	.95	.65

a/ Adjusted for overvalued exchange rate.

Prices of milk and butter were generally below world prices in the early 1970s but increased to well above world prices in the late 1970s. In the case of milk the increase was not sufficient to compensate for the overvalued exchange rate so that the adjusted NPC remained below one. Butter on the other hand received substantial protection even when an adjustment was made for exchange rate overvaluation. Wheat prices on the other hand approximated world prices at the official exchange rate during much of the period but received increasingly negative protection at the corrected exchange rate.

A reliable series of world prices for cheese is not available. However, for hard or cheddar cheese both Ecuadorian and world prices closely followed butter prices. For soft cheese (queso de ternero) that is commonly consumed in Ecuador, the situation is probably intermediate between milk and butter - that is, significant import protection was received for domestic production but less than in the case of butter. The large number of small-scale industrial establishments for cheese manufacturing probably allowed greater competition in this sector.

It is also likely that the producer prices for milk underestimate prices actually received. The strong demand for milk and high prices for milk products has allowed the milk producer to receive prices higher than the guaranteed minimum price, especially in the period 1977-81. Hence, actual NPCs for milk during this period are probably close to one.

In 1983, milk prices at the corrected exchange rate were below import price levels and even butter received little or no protection. The slow-down in demand for milk products (and probable decline in demand in the case of butter and cheese) has led to real price declines. Nonetheless the level of discrimination was significantly less than in the case of wheat.

In this study we are primarily interested in the longrun trend in world prices for milk products. After a substantial jump in world prices in the period 1979-81, prices have fallen somewhat. The build up of stocks and the high subsidy on EEC exports is a subject of a good deal of discussion in international trade forums. The EEC Commission has developed a plan to reduce milk production but it is unlikely to lead to a fall in stocks in the medium term. Continuing growth in productivity in the dairy industry combined with stagnant demand has led to large surpluses in both the EEC and the US.

The ceiling on world prices for dairy products is the internal price in exporting countries (e.g. the EEC wholesale price). However, this is unlikely to be achieved since a number of exporting countries,

especially Australia and New Zealand, have low levels of protection and could expand production substantially even if the EEC were to cut back exports. Hence, in this study an upper limit on import prices for dry milk is assumed to be $1800/ton which is intermediate between the medium term estimated price of $1500/ton and the EEC internal price of $2200/ton.

Appendix D. Calculation of Mechanization Costs.

Use of tractors for land preparation is the most common source of mechanical power in the Cayambe area. Larger farmers also use combine harvesters for wheat and barley. Some other forms of mechanization are also practiced, such as use of milking machines by some dairy farmers. Only the costs of tractors and combine harvesters were considered in detail in this study. These mechanization services are provided through a) machinery ownership, b) rental from private machinery contractors or, c) rental from the mechanization service of the Ministry of Agriculture. The latter is the most common practice among small and medium size farmers.

In order to separate out tradeable from nontradeable inputs and correct for taxes and subsidies on machinery and fuel prices we divided costs of mechanization services into the following components: a) depreciation b) capital costs c) fuel costs d) maintenance and repair costs and e) operator's labor (Byerlee, 1983). These costs were calculated per hour of machine use as follows:

a) Depreciation.

$$D = [(1-s)P_a]/nh,$$

where D = depreciation cost per hour

s = salvage value of machine as a proportion of acquisition value

P_a = current purchase price of machine

n = number of years of life of the machine

h = number of hours worked per year.

b) Capital Cost

$$C = i[(1+s)P_a/2]/h,$$

where C = capital cost of machine per hour

i = real cost of capital

Other variables are as defined above.

c) Fuel

$$F = .10\ p\ A,$$

where F = Fuel cost/hour of machine use

p = horse-power of machine

A = price of fuel/lt.

d) Maintenance and Repairs

$$M = mP_a/nh,$$

$$M_t = .75\ M,$$

where M = maintenance and repair cost per hour

m = coefficient of maintenance for life of machine

M_t = tradeable (i.e. spare parts) component of maintenance

Other variables are as defined above.

e) Operator Labor

$$L = bw/8,$$

where L = operator labor costs per hour

b = operator wage relative to minimum wage

w = minimum wage per day.

f) Total Cost/ha

$$T = c(D_t+D_i+C_t+C_i+F_t+M_t+M_i+L_t),$$

where T = total machinery cost per hectare for a task

c = Number of hours per hectare required for task and t and i are subscripts representing the tractor and implement respectively.

The method uses simple straight line depreciation. Inflation can be considered by two methods. In the first case, the actual average purchase price of the machine is used together with the actual prevailing interest rate. In the second case, the current replacement value of the machine is used together with the real rate of interest adjusted for inflation. This second method was used in this study.

Parameters used in the calculations, shown in Table D1, are derived from the following sources: a) data constructed for machinery operations in Mexico (Byerlee, 1983), and b) calculations by the mechanization service of the Ministry of Agriculture. Farmers' mechanization costs were based on prices of machinery, fuel and labor prevailing in June, 1983. However, these costs were substantially higher than those charged by MAG. Hence, farmer budgets were also calculated using MAG rates for machinery rental.

Table D1. Parameters Used to Calculate Machinery Costs.

	Symbol	Tractor	Plough	Combine
Horsepower	p	75	0	130
Residual Value	s	.2	.2	.2
Years Life	n	8	8	10
Hours/year	h	1000	300	400
Coefficient of Maintenance	m	.8	.9	.8
Interest Rate	i	.10	.10	.10
Relative Wage	b	3.0	0	3.0

For calculation of national profitability, the prices of machinery were adjusted upward to reflect exchange rate overvaluation by assuming that 90 percent of the purchase price were foreign exchange costs. Small import duties of 3 percent on tractors and 8 percent on combines were also substracted. Diesel prices were also adjusted to world prices (US$.26/lt in 1983).

Results of various assumptions are shown in Table D2. The MAG rental rates for tractors were only about half of actual costs incurred even if machinery is purchased with bank credit at negative or zero real interest rates. The actual costs are, however, close to rental rates charged by private contractors in areas where the MAG tractor hire services are less active. In June, private rental rates were quoted as S.500/hour for tractor hire and S.70-80/qq for rental of a combine harvester.

For national profitability analysis, machinery was priced at an exchange rate of S.80/US$1.00 and diesel at the unsubsidized price. This raises the cost of tractor rental to nearly three times the MAG rates. Hence, a substantial subsidy was implicit in mechanization costs due to: a) imports of machinery at the official exchange rate, b) highly subsidized diesel fuel, and c) an additional government subsidy on MAG machinery services.

In 1983, it was reported that agricultural machinery would be imported at close to the free exchange rate, which will raise actual costs of machinery use to close to the opportunity price used in calculating national profitability.

Table D2. Cost of Tractor and Combine Harvester Operation Under Different Assumptions Regarding Foreign Exchange Rates, Interest Charges and Fuel, 1983.

Assumption	Purchase Price: Tractor (,000 Sucres)	Purchase Price: Combine Harvester (,000 Sucres)	Real Interest Rate (%)	Diesel Price (S./gal)	Estimated Cost for a/: Tractor b/ (S./hour)	Estimated Cost for a/: Combine c/ (S./qq)
1. Market prices June, 1983	1100	3700	10	13	490	65
2. Market prices June, 1983 with bank credit	1100	3700	0	13	390	50
3. Market prices Nov., 1983	1400	n.a. d/	10	13	600	n.a.
4. Machinery imported at corrected exchange rate	1750	5800	10	13	730	100
5. Machinery imported at corrected exchange rate and diesel unsubsidized	1750	5800	10	78	860	106

a/ MAG rates were S.220/hour for tractor hire and S.35/qq for harvesting.

b/ Includes cost of plough.

c/ Assumes yield of 33qq/ha or 1.5t/ha.

d/ n.a. not available.

Appendix E. Budgets for Crop-Livestock Activities to Calculate Farmer and National Profitability

For calculation of both farmer and national profitability, physical input-output relationships are needed. These are shown in Tables E1 to E3 for each enterprise and for two levels of technology - current farmer technology and recommended technology. These budgets were used to calculate the number of labor, animal and tractor hours used in each enterprise and the requirements for inputs such as fertilizers.

A second requirement was to calculate prices for all inputs. To calculate farmer profitability, actual prices paid and received by farmers were used (see Table 15). Calculation of costs of mechanical operations are described in Appendix C. For national profitability, prices of traded inputs were based on the world price equivalent converted at the corrected exchange rate including unsubsidized transport and distribution costs.

The calculation of capital costs in these budgets require further explanation. In a period of high inflation, two alternatives are available to include capital costs. In the first case, budgets are calculated using prices actually paid and received by farmers during the cycle. In this case, for example, fertilizer would be included at prices at the beginning of the cycle when fertilizer is purchased. Costs of capital would then be based on actual interest rates paid which will usually be directly related to the rate of inflation. In the second case, all outputs and inputs are priced at the same point in time and the cost of capital is calculated using a real interest rate. This second case is simpler and was used in constructing budgets. All prices used are for the month of June, 1983.

Real interest rates were assumed to be zero for farmers, such as dairy farmers, receiving bank credit. In recent years, real interest rates have been negative, but since bank loans do not normally cover all costs, some of the farmers' own capital is also invested and it is reasonable to assume an average interest rate of zero.

For crops, working capital costs were calculated for an average six month cycle between the time of expenditure and the time of harvest. No working capital costs were included for dairying; however, investment in the herd is a substantial capital cost for dairy farmers and a cost was computed based on the average value of the herd.

For all enterprises miscellaneous costs were included as 5 percent of total costs.

Table E4 shows the calculation of farmer and national profitability for the recommended technology. All costs are divided between their tradeable and non-tradeable components.

Table E1. Input-Output Relations for Crop Activities at Farmer Levels of Technology.

	Wheat (Small farmer)	Wheat (Medium-large farmer)	Barley (Medium-large farmer)	Maize	Potatoes
Tractor Hours/ha	5.5	5.5	5.5	4.0	8.0
Ploughing	2.5	2.5	2.5	2.5	5.0
Harrowing	1.5	1.5	1.5	1.5	3.0
Covering	1.5	1.5	1.5	-	-
Combine Hours/ha	-	1.0	1.0	-	-
Labor Days/ha	14	8	8	40	100
Planting	1	1	1	5	8
Weeding	-	-	-	6	30
Fertilizing	-	1	1	2	7
Applying Pesticide	1	1	1	-	20
Harvesting	7	3	3	10	35
Post Harvest	5	2	2	17	-
Animal Days/ha					
Furrowing	-	-	-	1	1
Cultivating	-	-	-	2	-
Inputs/ha					
Seed (t/ha)	.13	.13	.13	.023	0.9
Urea (t/ha)	-	-	-	-	0.05
18-46-0 (t/ha)	-	-	-	-	-
10-30-10 (t/ha)	0	.15	.15	.15	.5
2-4,D (lt/ha)	1	1	1	-	-
Bags (no./ha)	20	33	30	33	250
Other Inputs					
Sucre/ha	700 a/	-	-	-	6750 b/
Yield t/ha	0.9	1.5	1.35	1.5	11.0

a/ Stationary thresher.

b/ Pesticides.

Table E2. Input-Output Relations for Crop Activities - Recommended Technology.

	Wheat	Barley	Maize	Potatoes
Tractor Hours/ha	7.0	7.0	5.5	8.0
Ploughing	2.5	2.5	2.5	5.0
Harrowing	3.0	3.0	3.0	3.0
Covering	1.5	1.5	-	-
Combine Hours/ha	1.0	1.0	-	-
Labor Days/ha	8.5	8.5	51	148
Planting	1	1	5	8
Weeding	-	-	6	60
Fertilizing	2	2	2	7
Applying Pesticide	1	1	0	23
Harvesting	3	3	10	50
Post harvest	1.5	1.5	28	0
Animal Days/ha	-	-	3	3
Furrowing	-	-	1	1
Cultivating	-	-	2	0
Inputs/ha				
Seed (t/ha)	.13	.13	.023	1.1
Urea (t/ha)	.1	.06	.1	.1
18-46-0 (t/ha	.18	.18	0	0
10-30-10 (t/ha	0	0	.15	1
2-4,D (1t/ha)	1	1	0	0
Bags (no/ha)	56	50	56	400
Other Inputs				
Sucres/ha	-	-	-	10,000[a/]
Yield (t/ha)	2.5	2.25	2.5	18.0

a/ Pesticides.

Table E3. Input-Output Relationships for Dairying.

	Intensive Dairying-Farmer Technology	Intensive Dairying-Improved Technology	Extensive Dairying-Farmer Technology
Tractor Hours/ha	8	12	-
Pasture maintenance	5	8	-
Replanting pasture[a/]	3	4	-
Labor Hours/ha	22	28	10
Pasture maintenance	6	6	-
Replanting pasture[a/]	2	2	-
Milking, Herding, etc.	14	20	10
Inputs			
Urea (t/ha)	.05	.05	-
10-30-10 (t/ha)	.2	.2	-
Other Inputs			
Seed (S./ha)	1,000	1,000	-
Animal feeding (S./animal)	1,500	3,000	1,200
Veterinary expenses (S./animal)	400	500	400
Milk for rearing calves (lt/ha) [b/]	296	490	131
Depreciation of sheds [c/]	2,000	2,000	1,000
Output			
Adult animals/ha	1.8	2.6	1.0
Milk/cow (lt/day)	10	11.5	8
Milk (lt/ha)	2,960	4,900	1,310
Net Value Animal Sales and Purchases (S./year)	8,960	14,720	3,930

a/ Half of costs for replanting every two years.
b/ Ten percent of milk production.
c/ Assumes 30 year life.

Table E4. Calculation of National and Farmer Profitability at Recommended Technology Levels.[a/]

	National Profitability				Farmer Profitability			
	Wheat	Barley	Potatoes	Intensive[b/] Dairy	Wheat	Barley	Potatoes	Intensive[b/] Dairy
1. Tradeable Input Costs								
2. Fuel	1379	1379	1421	1895	223	223	230	306
3. Fertilizer	5064	4392	19280	4360	3630	3222	13020	2910
4. Machinery depreciation /maintenance	5232	5232	4155	5540	3344	3344	2602	3470
5. Other tradeable inputs	1711	1556	20741	7363	1155	1050	14000	4970
6. Non-tradeable Input Costs								
7. Seed	2379	2057	8470	7902	1430	1573	8470	6860
8. Fertilizer-distribution	1030	888	3985	904	1030	888	3985	904
9. Machinery-distribution	425	425	289	386	445	425	289	386
10. Other inputs distribution	495	450	6000	2130	495	450	6000	2130
11. Labor	1547	1547	20430	4380	1547	1418	20430	4380
12. Capital - machinery	1823	1823	1309	1745	1212	1212	851	1135
13. Capital - working	660	594	3990	0	515	457	3281	0
14. Capital - other investment	0	0	0	14000	0	0	0	0
15. Other miscellaneous costs	679	634	3234	1030	679	634	3234	1030
16. Total Tradeable Input Costs	13386	12558	45597	19158	8352	7839	29852	11656
17. Total Non-tradeable Input Costs	6659	6361	39238	24573	5902	5484	38071	9964
18. Total Revenues	45750	35595	130130	790174	26070	25650	130130	72050
19. Returns to Land	23326	14619	45295	37700	11815	12328	62207	50433
20. Returns to Land with Mechanization Subsidy					13364	13878	64200	53090

a/ See next page for explanatory notes.
b/ Calculated on an annual basis. Comparison of wheat and intensive dairy was made assuming a six-month cycle.

Explanatory Notes on Table E4

Line

2. Cost of fuel for tractor and combine operation. See Appendix D for calculations.

3. Foreign exchange cost of fertilizer including CIF price, fuel costs and half of non-fuel transport costs.

4. Foreign exchange costs of machinery depreciation and maintenance based on 90 percent of current price. See Appendix D for calculations of depreciation and maintenance.

5. Foreign exchange costs estimated as 70 percent of current prices.

8. Costs of distribution of S.3550/t, S.3750/t and S.3630/t for Urea, 18-46-0, and 10-30-10 respectively.

9. and 10. Based on distribution costs of 10 percent of machinery prices and 30 percent for other inputs.

11. Includes labor of machinery operator at three times the rural wage rate.

12. Based on calculations of machinery costs in Appendix D.

13. Working capital charges for 6 months to all costs except machinery costs. No working capital costs are charged to dairy because daily income is received.

14. Capital costs for other investments including animal stock, pasture establishment and sheds.

15. Included as 5 percent of all costs.

18. Dairy includes net sales of animals at a value of S.14700/year.

20. Calculated for farmers who use subsidized MAG mechanization services.

Appendix F. Institutes and Departments Providing Data and Information for the Study

This list is provided as a guide to potential sources of information for comparative advantage studies. The name of the institute or department is not complete in some cases.

1. INIAP (Agricultural Research).
   Departments - Production Research
   Wheat and Barley
   Livestock
   Potatoes

2. Ministry of Agriculture.
   Departments - Statistics
   Mechanization
   Livestock
   Marketing
   Import Authorization
   Fertilizers
   Land-use Planning
   Irrigation (INERHI)
   Agrarian Reform Project (Proyecto Cayambe)
   Cereals Program (PRONACER)
   Consumer Sales of Basic Staples (ENPROVIT)
   Produce Buying Agency (ENAC)
   Field Extension Officers
   Veterinary Officers

3. National Statistics Institute (INEC)

4. Private Sector
   Small and Large Farmers
   Millers
   Wheat Importing Agency
   Fertilizer Distributor
   Agricultural Input Firm
   Agricultural Machinery Distributor and Contractor
   Agricultural Input Store in Rural Area
   Private Agricultural Consultant
   Milk Processing Plant
   Small-Scale Cheese Factory
   Long Distance Road Transportation Companies

5. International
   Dairy Board of Exporting Country
   FAO Statistics
   USDA Statistics

Appendix G. Data on Wheat Production and Utilization

Table G1 Area, Yield, Production and Utilization of Wheat, in Ecuador, 1964-81.

Table G2 Supply and Utilization of Wheat in Ecuador, 1964-81.

Table G3 Wheat Area by Province, Ecuador, 1976-82.

Table G4 Wheat Yields by Province in Ecuador, 1976-82.

Table G5 Total Number of Wheat Farmers, Wheat Area, and Average Farm Size in Ecuador 1970-82.

Table G6 Use of Bio-chemical and Mechanical Technologies in Wheat Production in Ecuador, 1970-82.

Table G7 Price Series for Wheat and Wheat Products in Ecuador, 1970-83.

Table G8 Prices of Inputs Used in Wheat Production in Ecuador, 1971-83.

Table G1. Area, Yield, Production, and Utilization of Wheat in Ecuador, 1964-81.

Year	Area Sown	Yield	Production	Utilization	
				Sold to Mills	Other [1/]
	(ha)	(kg/ha)	(ton)	(ton)	(ton)
1964	63,548	816	51,875	36,965	14,910
1965	62,555	745	46,580	30,004	7,576
1966	63,844	946	60,403	41,214	19,189
1967	65,004	963	62,596	46,633	15,963
1968	79,585	985	78,378	52,973	25,405
1969	79,399	1,042	82,736	59,047	23,689
1970	98,741	862	85,086	61,030	24,056
1971	75,721	1,068	80,863	51,901	28,962
1972	67,482	933	62,957	39,101	23,856
1973	56,047	902	50,527	30,859	19,668
1974	45,331	959	43,490	28,645	14,845
1975	53,309	854	45,552	29,552	16,000
1976	59,226	858	50,788	26,634	24,154
1977	51,928	885	45,965	23,285	22,680
1978	40,941	971	39,761	22,872	16,889
1979	42,568	806	34,318	22,497	11,821
1980	31,615	972	30,718	5,905	24,813
1981	32,752	1,176	38,298	14,296	24,002

1/ Includes seed, waste, losses and home consumption as well as wheat sold indirectly to millers.

Source: División de Informática y Estadística - DISEPLAN.

Table G2. Supply and Utilization of Wheat in Ecuador, 1964-81.

Year	Domestic Purchases (ton)	Imports (ton)	Wheat Milled (ton)	Consumption per Capita (kg/cap)
1964	36,965	53,421	89,383	9.1
1965	39,004	62,852	95,988	20.0
1966	41,314	58,513	103,203	20.9
1967	46,633	67,012	106,664	20.4
1968	52,973	60,942	116,272	21.5
1969	59,047	65,585	125,677	22.5
1970	61,030	69,879	127,845	22.5
1971	51,901	82,100	126,890	21.3
1972	39,101	92,325	134,431	21.8
1973	30,859	129,880	153,598	24.1
1974	28,645	131,049	153,129	23.2
1975	29,552	156,593	193,632	28.4
1976	26,634	225,698	224,040	31.7
1977	23,285	227,973	246,235	33.7
1978	22,872	237,510	268,175	35.5
1979	22,545	264,678	283,979	36.3
1980	17,055	293,347	293,526	36.3
1981	22,685	301,797	331,202	39.7

Source: National Cereals Program.

Table G3. Wheat Area by Province, Ecuador. 1976-82.

Province	1976	1977	1978	1979 (ha)	1980	1981	1982
Carchi	2,687	1,999	1,216	1,063	2,116	3,204	2,543
Imbabura	5,331	5,676	2,800	2,353	3,720	5,530	3,182
Pichincha	9,907	6,008	6,501	2,244	5,530	4,747	4,718
Cotopaxi	2,198	1,428	1,449	875	531	1,030	638
Tungurahua	793	280	536	723	477	387	322
Chimborazo	12,880	5,380	5,930	5,290	2,496	5,829	6,133
Bolivar	12,067	15,698	12,380	8,934	8,876	7,359	10,589
Cañar	2,521	4,705	1,372	540	902	1,274	815
Azuay	2,294	4,798	2,186	3,835	1,704	2,057	830
Loja	8,549	5,956	6,571	4,509	5,263	4,783	2,782
Ecuador	59,227	51,928	40,941	30,366	31,615	36,200	32,752

Table G4. Wheat Yields by Province in Ecuador, 1976-82.

Province	1976	1977	1978	1979 (kg/ha)	1980	1981	1982
Carchi	956	1,053	1,176	1,343	1,360	1,420	1,494
Imbabura	1,087	1,091	1,151	1,163	1,185	1,788	1,280
Pichincha	950	984	1,010	984	1,010	1,360	1,183
Cotopaxi	840	822	676	715	851	817	1,043
Tungurahua	989	821	922	899	799	556	693
Chimborazo	670	805	638	1,076	694	893	1,508
Bolivar	1,053	863	1,320	1,175	1,131	1,074	1,100
Cañar	820	827	959	1,180	886	931	1,160
Azuay	679	822	675	829	657	716	461
Loja	648	797	645	799	646	627	545
Ecuador	859	887	973	1,029	974	1,125	1,169

Table G5. Total Number of Wheat Farmers, Wheat Area, and Average Farm Size in Ecuador, 1970-82.

	1970-71	1972	1973	1976/77	1981	1982
Total No. of farmers						
Less than 10ha	24,550	22,160	23,860	32,844	6,535	7,313
10ha to 50ha	4,774	5,580	4,920	3,201	10,916	8,595
Over 50ha	807	700	636	636	2,756	1,517
Total wheat area (ha)						
Less than 10ha	30,490	26,860	23,541	30,554	4,080	5,133
10ha to 50ha	26,516	21,219	11,684	9,994	14,442	14,066
Over 50ha	24,716	19,553	15,822	11,380	18,345	13,532
Average farm size (ha)						
Less than 10ha	3.0	3.0	3.1	2.9	1.4	1.4
10ha to 50ha	17.7	17.0	17.7	17.5	4.4	4.4
Over 50ha	298.2	270.4	282.0	223.1	51.8	70.1

Note: These data suggest a change in sampling procedures after 1976/77. The sharp drop in wheat area of small farms is not consistent with field observations, so total wheat area in 1980-82 may be higher than suggested by the statistics. Average farm size is calculated by dividing total area by number of farmers in the group. Data on average farm size after 1980 are inconsistent with the classification strata.

Source: National Wheat Surveys.

Table G6. Use of Bio-chemical and Mechanical Technologies in Wheat Production in Ecuador, 1970-82.

Percent	1970/71	1972	1973	1976/77	1980	1981	1982
Use Seed Certified	13	8	6	27	33	19	15
Farmers Use Fertilizer	20	16	15	14	33	22	30
Area Fertilized	47	39	40	37	60	42	56
Farmers Use Herbicide	4.6	1.3	8.2	12.4	24.5	18.9	33.0
Use Tractor for Land Preparation	14.2	1.5	7.2	5.9	14.0	19.9	16.2
Use Combine	2.0	0.5	0.5	0.5	4.5	7.7	4.2
Use Mechanical Thresher	58.6	2.3	16.5	18.1	58.4	42.6	59.7

Source: National Wheat Surveys.

Table G7. Price Series for Wheat and Wheat Products in Ecuador, 1970-83.

Year	Producer Price (S./t)	Official Price (S./t)	Mill Price For Local Wheat (S./t)	CIF Price Imported Wheat (S./t)	Retail Bread Price (S./kg)	Wholesale Flour Price (S./kg)
1970	2323	2640	-	2100	10.6	-
1971	2315	2640	-	2175	9.6	-
1972	2707	2640	-	2125	9.4	-
1973	2900	3234	2904	3458	11.5	-
1974	3920	4400	3663	5521	13.3	5.6
1975	4391	5500	3960	4245	14.5	5.6
1976	4409	5500	4862	4130	15.6	5.6
1977	4731	5500	4906	3425	15.3	5.6
1978	4530	5500	4950	3523	16.2	5.6
1979	4760	-	5192	4620	17.4	5.6
1980	6020	-	6160	5480	19.4	5.6
1981	-	-	6610	5462	24.2	5.6
1982	-	7260	7260	6726	29.1	6.7
1983	11000	8800	11000	9913	49.0	16.4

Source: PRONACER, Ecuatoriana de Granos, División de Informática y Estadística, MAG and INEC.

Table G8. Prices of Inputs Used in Wheat Production in Ecuador, 1971-83.

Year	Seed[a/] (S./qq)	Urea[b/] (S./qq)	18-46-0[b/] (S./qq)	10-30-10[b/] (S./qq)	Diesel (S./gal)	Minimum Salary Sierra[c/] (S./day)
1971	-	-	-	-	3.5	18
1972	-	-	-	-	3.5	-
1973	-	166	191	151	3.5	-
1974	-	450	460	453	3.5	28
1975	300	395	460	355	3.5	-
1976	360	255	360	355	3.5	38
1977	360	280	350	355	3.5	-
1978	390	290	372	360	3.5	-
1979	410	290	394	360	3.5	54
1980	550	360	515	456	3.5	100
1981	550	430	600	538	11.0	-
1982	-	434	604	540	11.0	-
1983	-	520	750	674	15.0	135-150

a/ Division de Informática y Estadística, MAG.

b/ Dept. de Fertilización del MAG - prices are for Guayaquil.

c/ Banco Central de Ecuador.

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