# Trends in CIAT Commodities

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CIAT
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CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL
CALI, COLOMBIA

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# Impact of Improved Varieties in Bean Production in Latin America: A Preliminary Review

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By 1986 national programs in Latin America had liberated over 100 new bean varieties derived from germplasm distributed by CIAT (Table 1). Some of these lines have already achieved widespread adoption by farmers, others clearly have not been nor ever will be broadly adopted, and many lines are still in the stages of seed production and initial diffusion. To monitor the progress of these new bean varieties, CIAT has collaborated with national programs in the conduct of surveys of bean farmers. These surveys can provide useful feedback on the constraints to the adoption of new varieties. When shortcomings in the varieties are identified, this serves to guide future selection to overcome these problems. When institutional constraints to adoption are found, often it is possible to seek means to remedy these problems. When widespread adoption is observed, it is useful to document it and analyze the factors leading to success. This paper briefly reviews the findings to date of some studies of adoption of new bean varieties in Latin America.

## Costa Rica

In 1980 Costa Rica released the improved variety Talamanca, originally developed by ICA in Colombia. This was followed in 1981 by the release of Brunca, a line developed at CIAT. The adoption of these improved bean varieties in Costa Rica was first observed in a 1982 IICA survey of 98 small farmers (Chapman et al, 1983). This was followed by a survey of 195 farmers by the University of Costa Rica in 1983 (Ballestero, 1985), and surveys of 279 farmers by CIAT in 1985 (Pachico and Borbón). In 1986 the Ministry of Agriculture and the National Production Council surveyed over 300 farmers, but these data are yet to be analyzed.

The farm surveys indicate that in 1985 in the southern region (accounting for 32% of national production in 1984/85) 68% of the area in beans was planted to improved varieties, while in the northern region (21% of national production) 65% of area was in improved varieties.

Production functions estimated with the survey data from the northern region found a statistically significant effect on yield from use of new varieties, leading to an increase of 265 kg/ha, compared to an average yield of 502 kg/ha with local varieties (Pachico, Borbón, Viana and Valderrama, 1987). Adoption functions estimated for the northern region showed that the high yield of the new varieties was a significant factor in farmers' decision to adopt, while access to official seed also had a significant effect. Use of the shifting cultivation system was negatively related to adoption of new varieties, while farm size had no significant effect (Pachico et al, 1987).

Small farmers (¿ 10 ha) were found to be the most likely to couple the improved varieties with more intensive management (eg weed control, use of agrochemicals) in the south. This combination of new varieties and intensified management favors small farmer resource endowment of ample labor and scarce land because, compared to the shifting cultivation system, it absorbs significantly more labor per hectare as well as resulting in more than doubling net returns per hectare (Pachico and Borbón).

The spread of the new bean varieties has been associated with profound changes in production and imports. Production was stagnant until the new varieties were widespread, oscillating between 11,000 and 16,000 tons/yr. from 1975 to 1983. From 1984 onwards, Costa Rica has enjoyed three successive record years in bean output, as output doubled (Agrotécnico, 1986). Moreover, while Costa Rica had imported 48% of total bean consumption from 1970-1983, since 1985 Costa Rica has ceased to import beans (Stewart, 1986; Consejo Nacional de Producción).

Based on the farm survey data, it is estimated that 21,700 ha were planted to improved bean varieties in 1985, and this is calculated to have resulted in 5,300 tons of production above that which would have been produced with traditional varieties. The value of this increased production due to the improved varieties is estimated at $2,670,000 in 1985.

Guatemala

In 1979 the improved varieties ICTA Quetzal, Tamazulapa and Jutiapa were released for southeastern Guatemala. The adoption of these improved bean varieties in Guatemala was first assessed in a 1984 survey of 102 farmers who had obtained seed of the new varieties through extension trials. This was followed in 1985 by a survey of a random sample of 235 farmers. These studies were conducted in the departments of Jutiapa, Jalapa and Santa Rosa, which together produce 32% of national bean production (Dirección General de Estadística). In 1986 54 farmers were interviewed in Jutiapa.

According to the 1985 survey, 23.8% of farmers had adopted improved bean varieties that were cultivated on 24.1% of area sown to beans (Pachico et al, 1987), while the 1986 survey (which may not be fully representative) found 30% of farmers using improved varieties (Ruiz, Orozco, Viana and Aldana, 1987). These estimates are conservative compared to previous estimates of adoption ranging up to 50% (Stewart 1986).

Production functions estimated with the 1985 survey data found a statistically significant effect on yield from the use of new varieties, leading to an increase of 334 kg/ha compared to an average yield of 770 kg/ha with the local varieties. Adoption functions were also estimated and showed that access to official seed was an important determinant of adoption, but that the longer maturity of the new varieties compared to farmers' traditional varieties had a negative and statistically significant effect on adoption (Pachico et al, 1987). Thus, the preferred strategy of farmers adopting the improved varieties is to grow them for their high yield potential on part of their bean area, while keeping some land in traditional early varieties which give farmers some protection against the risk of late season drought stress (Viana, 1986). In 1986 ICTA released an earlier maturing new variety, Ostua, which may respond to farmers' needs for earliness.

Based on these studies it is estimated that 12,300 ha were planted to improved bean varieties in Guatemala in 1986. This could be an underestimate because they may to some extent be grown in departments not included in the study. Moreover, the adoption of the varieties released for the Guatemalan highlands has yet to be assessed. The estimated production increase due to the new varieties over what could have been produced with traditional varieties is 4,100 tons, worth $2,061,000 in 1986.

Argentina

From 1980 four improved varieties of black beans obtained from CIAT international trials began to diffuse in Argentina: DOR 41 (same as ICTA Quetzal in Guatemala), BAT 304 (same as Brunca in Costa Rica), BAT 448 and BAT 76 (Gargiulo, 1986, p. 56). The diffusion of improved bean varieties has been measured by a survey of 183 bean farmers in northwestern Argentina, comprising a 15% sample of producers (Gargiulo, 1986, p. 58). Based on the survey data an estimated 85.5% of black bean area was sown to improved varieties in 1985 (Gargiulo, 1986, p. 98). The improved varieties obtained an average yield 292 kg/ha more than that of the traditional variety which yielded 1091 kg/ha. This difference was statistically significant at the .01 level (Gargiulo, 1986, pp. 67-8). The improved varieties are produced with the same technology as the traditional varieties.

With a substantial increase in black bean sowing in 1986 (Michigan Bean Digest, 1986), it is estimated that some 90,000 ha were planted with improved bean varieties in 1986. This resulted in an increase of production of 26,300 tons over what could have been produced with traditional varieties, worth $13,150,000. Counting benefits accrued only through 1985, the internal rate of return on bean investment in Argentina has been estimated at 40% (Gargiulo, 1986, p. 104).

Cuba

In 1979 the improved variety Pijao was released. It was originally developed by ICA in Colombia and obtained through CIAT international trials. Official sources rather than survey data have been the main measure of the impact of new bean varieties in Cuba. It has been reported that 10,000 ha are sown to new varieties in the state farm sector with an average yield increase over traditional varieties of 700 kg/ha (Sanchez and Scobie, 1986, p. 110). Data obtained directly from the Ministry of Agriculture put the area in improved varieties in the state farm sector at 11,200 in the period 1982-84. Moreover, an additional 5700 ha were reported in improved varieties in the private sector in the period 1982-84 (Galvez).

The new bean varieties in Cuba have been accompanied with improved management practices including fertilization, irrigation, and pest control, and yield an average 1,573 kg/ha (Galvez). This is more than double the national average bean yield of 729 kg/ha before the release of the new varieties (FAO 1979). This yield increase can be due to a pure varietal effect, the effect of improved management, and the greater responsiveness of the new varieties to intensified management. Attributing half of the observed yield increase to varietal related attributes leads to a yield improvement due to the new varieties of 420 kg/ha, roughly comparable to that observed elsewhere with new bean varieties. At world market prices this leads to an increase of $3,550,000 in value of increased production.

Previously the annual value of increased bean production in Cuba has been put at $2,900,000 and the internal rate of return to bean research at 23% (Sanchez and Scobie, 1986). That estimate attributed a much greater yield gain to the new varieties (700 kg/ha vs 420 kg/ha) and utilized higher world prices than those used in this paper's estimate ($570/ton vs $500/ton), but covered only the state farm sector. The price used here is the 1985 international price for black beans which reflects "normal" market conditions for the 1980's (Bean Market News, 1986; Bean Market Summary, 1986).

Nicaragua

Several improved lines developed at CIAT have been released as varieties in Nicaragua: Revolución 79 (BAT 41), Revolución 81 (A 40) and Revolución 83 (BAT 1215) being the most widespread. Improved bean varieties in Nicaragua are estimated by national program sources to be grown on 14,000 ha, or 17% of bean area (Broenniman et al, 1986, p. 22). A survey of over 300 bean farmers throughout Nicaragua carried out in 1986 by the Ministry of Agricultural Development and Land Reform indicates that about 30% of farmers are cultivating the new varieties (MIDINRA). Assuming a yield increase of 250 kg/ha with the new varieties (lower than the yield increase observed elsewhere), the new varieties are estimated to have increased bean production by 3500 tons annually, for a value of $1,925,000.

Summary

Improved bean varieties released by national programs have already had a significant impact on bean production in Latin America. Nearly 155,000 ha were planted in 1986 to varieties obtained through the CIAT germplasm network, with a total production of almost 190,000 tons (Table 2). The yield impact of these varieties led to a production increase of 46,000 tons, worth $23,560,000. This sum is more than three times the total direct and indirect costs of the CIAT bean program in 1986. These estimates do not include production from new varieties in countries like Brazil or Peru, where studies to document adoption are being planned.

This impact, of course, is due to the collaborative efforts of CIAT and national programs. For illustrative purposes, if half the benefits of the new bean varieties were attributable to CIAT, the net benefits (CIAT's share of gross benefits minus total direct and non-direct CIAT bean program costs) would be as shown in Figure 1. Since 1984 the CIAT bean program has been earning a positive and increasing return above costs.

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Table 1. Bean germplasm distributed by CIAT named as varieties in Latin America. Nov. 1986.

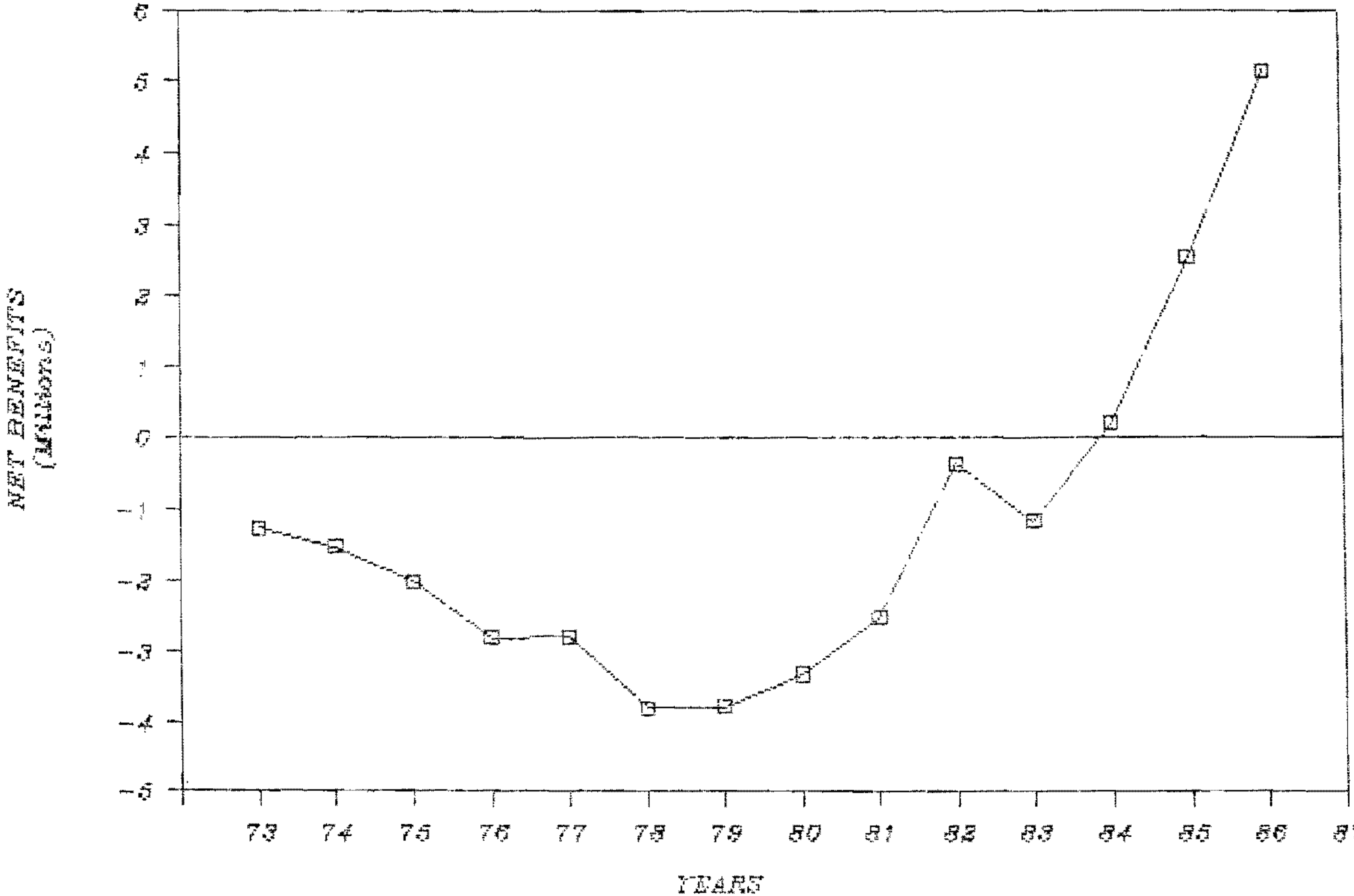
| | Achieved widespread adoption | Released to farmers | In seed multiplication | Never widely adopted |
|---|---|---|---|---|
| Total | 17 | 28 | 39 | 22 |
| <u>Central America</u> | | | | |
| Costa Rica | 2 | 5 | 1 | 1 |
| El Salvador | 0 | 0 | 1 | 1 |
| Guatemala | 3 | 0 | 1 | 1 |
| Honduras | 0 | 1 | 3 | 3 |
| Nicaragua | 3 | 0 | 2 | 0 |
| Panama | 0 | 2 | 0 | 1 |
| <u>Caribbean</u> | | | | |
| Cuba | 2 | 0 | 7 | 2 |
| Dominican R. | 0 | 0 | 2 | 0 |
| Haiti | 0 | 1 | 0 | 0 |
| Brazil | 2 | 8 | 8 | 2 |
| Mexico | 0 | 1 | 0 | 0 |
| <u>Andes</u> | | | | |
| Bolivia | 0 | 3 | 5 | 2 |
| Colombia | 0 | 4 | 0 | 1 |
| Ecuador | 0 | 0 | 0 | 1 |
| Peru | 0 | 2 | 1 | 1 |
| Venezuela | 0 | 0 | 0 | 0 |
| <u>Southern Cone</u> | | | | |
| Argentina | 5 | 0 | 6 | 4 |
| Chile | 0 | 0 | 2 | 2 |
| Paraguay | 0 | 3 | 0 | 0 |

Table 2. Documented impact of improved bean varieties from CIAT germplasm network, 1986.

| | Area in improved varieties (ha) | PerCent area in improved varieties | Total production of improved varieties (tons) | Production increase due to new varieties (tons) |
|---|---|---|---|---|
| Argentina | 90,000 | 40 | 120,000 | 26,300 |
| Costa Rica | 21,700 | 62 | 18,900 | 5,300 |
| Cuba | 16,900 | 80 | 26,600 | 7,100 |
| Guatemala | 12,300 | 13 | 11,700 | 4,100 |
| Nicaragua | 14,000 | 17 | 11,900 | 3,500 |
| Total | 154,900 | | 189,100 | 46,300 |

FIGURE1: NET BENEFITS OF BEAN PROGRAM

(1985 $U.S.MILLIONS)



# Integrating Social Science Research Into the Development and Testing of New Agricultural Technology: The Case of CIAT's Great Lakes Bean Project

Joachim Voss

## INTRODUCTION

This paper illustrates the effectiveness of adding social science research to an interdisciplinary team, that combines on-farm research with research conducted on-station to increase the productivity and stability of bean production in the Great Lakes region of Central Africa. Emphasis is placed on the role of on-farm research in general, and social science research in particular, in setting research priorities and devising ways of testing and transferring technologies.

## THE GREAT LAKES REGION

The Great Lakes Region is at the heart of the Central African Highlands, on either side of one branch of the Rift Valley System. Running from North to South, the valley contains lakes Edward, Kivu, and Tanganyika. Composed of high plateaus, volcanoes and high mountain ridges on either side of the rift, it descends into Savanna plains toward the east. The altitude ranges between 900 and 4,500 meters above sea level and rainfall varies between less than 1000 mm in the east and along the valley bottom, to more than 1,800 mm along the Nile Zaire crest and in the area of the volcanoes. The Central Plateau region of Rwanda and Burundi receives between 1000 and 1400 mm of rain (Sirven 1974 p. 25). There are two major cropping and rainy seasons, from mid-September to early January and from late February to early June; however, the intensity and duration of the rainy seasons varies considerably from year to year. The dry seasons are longer and more pronounced in the east.

The region supports the highest population density in Africa, over 350 people per square kilometer of agricultural land, with a projected density of over 500 by the end of the decade. Over 95% of the population is rural, with an average farm size of less than 1 hectare (Gahamanyi 1985 p. 4). In the most densely populated areas such as the Central Plateau and the shores of Lake Kivu, over 50% of the farms are smaller than .5 ha. The Eastern part of the region is lower and hotter with more intense dry seasons and generally larger farms averaging about 3.5 ha. The Central Plateau is characterized by thousands of rolling hills separated by marshes which provide a dry season crop. It is extremely variable in soil composition and fertility (Sirven 1974 p. 41). In terms of land area cultivated, bananas are the dominant crop, followed by beans, sweet potatoes, cassava and sorghum. The highlands of the Nile-Zaire Crest have soils with high organic content, but are highly acidic and high in aluminum. Bananas and beans predominate in the more fertile valleys, cassava and sweet potatoes on the heavily eroded slopes, and maize, peas, beans, sorghum, wheat and potatoes in the higher areas. Rainfall is more intense than in most other regions, with lodging and hail damage being serious problems at certain times of the year. The western slopes down to Lakes Kivu and Tanganyika have similar rainfall to the Central Plateau. The major crops are maize, beans, cassava and bananas (Jones and Egli 1984 pp. 26-32).

In the region as a whole all the major types of beans: bush, semi-climbing and climbing are grown; however, climbing bean production is concentrated in a few high rainfall areas and is little known in most of the rest of the region. Beans are typically grown as varietal mixtures and intercropped with a wide range of other crops, especially bananas, maize, sweet potatoes, peas, cassava, cocoyams and, at higher altitudes, potatoes. Because of heavy population pressure and a scarcity of fertile land, fallow periods have declined and bean production has expanded into marginal land, causing average yields to drop from .9 tons/ha to .7 tons/ha while total output has barely kept up with a population increase of 3.5% (CIAT 1984, p. 274). Beans are the single most important source of protein in the region, contributing some 45% of protein needs. They also provide a significant proportion of caloric requirements, approximately 25% (CIAT 1984, p. 279).

Given that sparsely occupied land available for new settlement has now virtually been exhausted, further increases in food production will have to be achieved through intensified production on existing farm land. Such intensification provides a major challenge, since the reduction of fallow presumably accelerates the decline in soil fertility if farming systems are not adjusted to fit this new reality.

## THE PROJECT

The Centro Internacional de Agricultura Tropical (CIAT), with funding from the Swiss Development Corporation (SDC), has placed a team of five scientists in the Great Lakes region. These include a breeder/coordinator, a plant pathologist, an anthropologist, an agronomist and a nutritionist. The major objective of the project is to develop technologies which can increase the productivity of common beans (phaseolus vulgaris) in the region. The principal strategy for achieving this is to work together with national programs and projects on methodology, research and extension strategy development (CIAT, 1985 p. 274).

### The Role of Social Science Surveys in Helping to Set Research Priorities

In association with the project nutritionist, and in collaboration with the national programs, a combined bean production and consumption survey has been conducted in most of the major production zones of the region.

The fundamental objective of the surveys is the description and diagnosis of farmers' production and consumption systems. This includes their knowledge, practices, production constraints, capabilities, consumption preferences and practices. This diagnosis is of significance for the other research carried out by the team in several important ways.

First, it aims to aid the selection process by identifying which varietal criteria or features farmers consider to be beneficial and those which they evaluate negatively. Such information greatly increases the likelihood of producing varieties that will be acceptable to farmers and can considerably increase the efficiency of the selection process by the early elimination of varieties with undesirable characteristics.

Second, it attempts to ascertain what farmers consider to be their main production constraints, and thus has direct relevance to the design and conduct of agronomic research, aimed at overcoming these problems. Solutions which address the perceived needs of farmers are likely to have a faster rate of diffusion and a greater impact.

Third, by analyzing how farmers obtain and experiment with new varieties, the diagnosis has direct impact on the design of the on-farm varietal trials and on future avenues of diffusion of those varieties that perform well.

Let me give a few concrete examples of the utility of the survey research for each of these three fields. The examples are drawn from surveys carried out in Ruhengeri and Butare Prefectures of Rwanda. In both cases the sample size was 120 farmers.

Varietal Development

One of the most striking aspects of bean production in the region is the widespread use of varietal mixtures. Virtually all of the farmers interviewed (96%), say they prefer to grow such mixtures. The usual reason stated is that mixtures are more likely to produce an adequate yield under uncontrollable climatic conditions. Such yield stability is of paramount importance to small subsistence farmers. It has also become clear that many farmers, especially women, select and maintain different mixtures for different agronomic conditions. Of the farmers interviewed in Ruhengeri, 37% planted two different mixtures, 51% planted three different mixtures and only 9% planted a single mixture. The usual criteria for choosing different mixture types are soil quality and association with bananas.

Among the farmers surveyed, 78% also indicated a strong preference for earlier maturing varieties. Although many farmers recognize that later maturing varieties can have higher yields, they consider that extra time in the field means greater risk. There are several implications of this information for the varietal development program:

1. Since new varieties are likely to be incorporated into existing mixtures (an aspect currently being investigated), the varietal development program's aim of increasing yields will require the successive incorporation of several improved varieties into these mixtures in order to have an appreciable effect. This program's work, thus, is essentially long-term with only incremental gains to be expected from the release of each new variety. The cumulative effect of several new varieties, especially if they also succeed in buffering the mixture against disease can, however, be considerable. For a more immediate impact, other possibilities must be investigated.

2. Since farmers select different mixtures for poor soil, good soil, and banana association, varietal development needs to be targeted for these conditions. Thus, both on-station and on-farm screening and evaluation should take place under similar sets of conditions.

3. Late maturing varieties are likely to be less acceptable to farmers, even though they are higher yielding. On-station selection should therefore be oriented toward the highest yielding among the earlier maturing varieties. On-farm research needs to establish the limits of acceptable vegetative duration for the most common cropping patterns.

Production Constraints

The project has been using both farmer interviews and limiting factor trials to determine the major yield constraints. The two approaches are complementary in that the interviews reveal what farmers consider to be their major problems and the trials measure the extent to which these limit yields.

Farmers consider their major bean production constraints to be excessive rainfall (and associated diseases)*, lack of manure and compost, drought, insect attack and lack of sufficient land.

It should be noted that many farmer practices already serve to control these problems. Drought stress, for example, is controlled by sowing under bananas and by using early varieties. Growing mixtures and associations with other crops helps to control the spread of diseases (Ref. 6), as does the removal of old leaves from the bottom of the plant.

From an agronomic standpoint, the related problems of land shortage and insufficient manure and compost present major research challenges. For example, 78% of the farmers interviewed lacked manure for more than half of their fields. The limiting factors trials also show soil fertility to be the prime constraint. Only 6% of farmers considered their production of manure to be sufficient for their needs. Consequently, improved practices now under agronomic investigation include the use of green manures, nitrogen fixing plants, agro-foresty systems and better erosion control. There is also considerable room for improved management and better use of the organic matter that is available on most farms.

Given that half of Rwanda's farmers now have only .5 hectares of land or less and given a population growth rate of 3.5%, the already serious land shortage will soon reach critical proportions. Until the population/ land ratio can be stabilized, the apparent solution is to further intensify production systems. Improving soil fertility through better management and other techniques is only part of the answer. Other potential means for increasing productivity include: 1) greater use of climbing beans because they have a higher yield potential than bush beans; 2) use of associations

* Rain and diseases are conceptually related to one another in the farmers' categorization of agricultural problems.

with the highest land equivalent ratios; 3) development of higher yielding stable varieties; 4) increased selection for materials that produce under marginal conditions; 5) judicious use of agro-chemicals, such as seed treatments and rock phosphate and 6) inclusion of more disease resistant varieties into farmers' mixtures.

Faced with these options, the team decided that climbing beans had the greatest short to medium term potential for increasing productivity. However, the introduction of this technology raises some difficult farm management problems. Here the social scientist can play a major role, as will be discussed in the last section of this paper.

## Farmers' Experimentation with New Varieties

The survey in Ruhengeri indicated a very high degree of farmer experimentation with new varieties. Only 8% of farmers had never tried new varieties. Of those who did, 78% tried them first in pure stands before incorporating them into a mixture. Almost all, (96%), of these farmers multiplied their own seed of new varieties that performed well. It also became clear in informal interviews that many farmers will try new varieties under different agronomic conditions before deciding into which mixtures to incorporate them. In addition, it was strikingly apparent that all tasks having to do with seed, i.e. seed selection, sowing and storage, were done exclusively by women.

This information has several important implications for on-farm trials and varietal diffusion. First, on-farm varietal trials should be in pure stands and, ideally, under the same kinds of conditions as farmers try and select for themselves, i.e. on good soil, on poorer soils and in association with bananas. Secondly, both the trials and subsequent diffusion should emphasize dialogue with women since they will ultimately make the choice. Also, since acceptable varieties will be multiplied by farmers themselves, small quantities can be diffused and still have a significant effect one or two seasons later. In order to better understand and to optimize the effect of the diffusion process, more research is now being done on the channels and rate of diffusion among the farmers themselves.

## On-Farm Varietal Trials and the Diffusion of New Varieties

The design of the project's on-farm variety trials closely follows the recommendation described. Besides allowing researchers to evaluate the varieties under farmer management, the trials provide an excellent forum for discussing preferred and non-preferred varietal characteristics with farmers. The information thus obtained was more precise, more reliable and more detailed than that gleaned from the surveys.

After many informal discussions with trial farmers, a simple farmer evaluation sheet, which allowed us to measure the acceptability of each variety, was created. Table 1, which compares acceptability with yield, shows that yield by itself is not always a good indicator of acceptability. The highest yielding variety, Ikinimba, scored rather low. The evaluation sheet allowed us to pinpoint the reasons for this low score: a sprawling plant type, which caused weeding problems, difficulty of threshing, and less desirable black seed colour turned out to be the main negative varietal characteristics (Table 2). Fortunately another variety, Kiliumukwe, which consistently had the highest acceptability rating, also significantly out yielded the farmers' mixture in some regions.

After five seasons of trials, carried out between 1984 and 1986, a follow up survey was initiated. The objectives of this survey were to double check our information on varietal acceptability, to find out the conditions under which farmers were growing the varieties without researcher intervention, and to start measuring the diffusability and the rate of diffusion of each variety.

Table 3 shows that our confidence in Kiliumukwe's acceptability was justified. Fully 100% of the 45 farmers interviewed still grew the variety and still gave it their highest rating. It also had by far the highest rate of diffusion; having reached more than twice as many other farmers as the next best variety.

As was to be expected, the main recipients were family members, neighbours and friends, in that order. Although it tells us how much of a variety has been diffused to how many people, the follow up survey does not examine how far it has gone, i.e. its range. For this, a few cases need to be followed in detail to the limits of their range of diffusion, or a random sampling of the target area can be undertaken.

Ikinimba turned out to have a much higher retention and diffusion rate than we had expected from its low initial evaluation. The reason for this became apparent by analyzing the conditions under which the farmers were growing each variety. In comparison with the other varieties, Ikinimba has a much higher sowing rate on infertile soils. It seems that a variety can be forgiven some other failings if it performs well under marginal conditions.

The follow up also confirmed one result of our initial diagnostic survey: that the great majority of farmers initially test a new variety in pure form. Furthermore, many of the farmers experiment with it under a number of conditions to see where its greatest advantage lies.

Results of the on-farm varietal trials show a considerable yield advantage of the new varieties in the eastern part of the country, but no significant effect on the densely populated Plateau Central. The probable explanation for this is that on the Plateau Central farmer selection over the centuries has already improved local mixtures to such an extent that station varietal improvement programs have found it difficult to offer anything better to the farmers. The east, on the other hand, is a region of recent immigration with different agro-climatic conditions than that found in the points of origin of most of the migrants. Thus, the varieties the migrants brought with them may not be well adapted. Systematic screening and testing procedures have rapidly identified new varieties with up to a 30% yield advantage (Table 4).

In seeking to have an impact on the populous Plateau Central region of Rwanda and Burundi, the team analyzed the known constraints and the available possibilities. The possibility that seems the most promising for a short term impact is the expansion of climbing beans, since these have a much greater yield potential than bush beans. The problem lies in fitting an existing technology into different cropping systems. This requires some modifications of the system and some changes in farmer management practices. The job of the project anthropologist was to help analyze the problems and potentials for the introduction of this crop.

## Constraints and Potentials of the Production of Climbing Beans on the Plateau Central

A multi-tiered approach was chosen to address this problem. First, a small plot of climbing beans was included in the on-farm varietal trials and farmers were interviewed with regard to their reactions. Those few farmers already growing climbing beans were interviewed to find out what advantages and disadvantages they perceived in their production and consumption and whether or not their neighbours were adopting the practice. Second, a survey of 120 farmers was carried out in Gisenyi, where the great majority of farmers were very successfully growing climbing beans. We wanted to establish whether any aspects of their production techniques could be transferred to other parts of the region, and to see what solutions they had found to the production problems that most limited climbing bean production on the Plateau Central. Third, the results of multi-year on-station trials which compared the yields of climbing beans with bush beans were reviewed to see if the findings were really as promising as we believed.

The diagnostic surveys on the Plateau Central showed that only 5% of farmers were actually growing climbing beans. Why not more? Were their experiences transferrable to their neighbours or did they have some special advantage the others did not have?

## Results of On-Station Research

The Institute de Sciences Agronomiques du Rwanda (ISAR), has spent many years comparing the yields of bush and climbing beans and the effectiveness of various kinds and lengths of staking material. The results, summarized in Table 5, show a yield advantage of up to 100% for climbing beans when they are adequately staked. Given such an advantage, why were more farmers close to the station not growing them?

## Results of On-Farm Research

### On-Farm Trials

The on-farm trials carried out by the project agronomist included one plot of a climbing bean mixture among the new varieties of bush beans. His analysis of the results, depicted in Table 6, shows that on fertile soils the climbing beans had a considerable yield advantage over the bush beans, but not quite to the level expected from the station results.

The overall results of the acceptability interviews, summarized in Table 7, are somewhat mixed. In general, the climbing bean mixture variety scored considerably lower than the most preferred bush variety.

It was remarked, however, that in many cases the climbers had been sown under very unfavourable conditions. Most of those farmers who had trials on richer soil found them to be very acceptable.

Particular attention was given to climbing beans in the follow-up surveys. Although only 27% of the farmers were still growing climbing beans, 83% of these stated they liked them very much and a further 13% stated they like them. The acceptability of the climbers seems to be directly related to soil fertility (Table 8).

Farmer interviews

The diagnostic interviews with 24 farmers who already produced climbing beans supported the above finding. The results of these interviews were more encouraging than those from the follow-up survey of the trials. Almost universally the farmers noted that they were approximately doubling their yields by using climbing beans. There was also a clear trend for some of the neighbours of farmers who had succeeded with climbing beans to start growing them. We feel that we are working along the grain of an established trend. Our efforts are dedicated to accelerating the process by researching the problems and by trying to find and test possible solutions to them.

Constraints

Among the main production problems noted by the farmers, first and foremost was a general insufficiency of staking material. Many farmers said they would like to increase the area in climbers, but were hindered by the lack of staking material. Larger farmers with woodlots were at a distinct advantage here. Second, the climbing beans required a more fertile soil. Production was generally limited to fields near the house which received sufficient compost. Third, was a longer vegetative cycle. This has at least two serious implications: a) it increases risk in the face of possible short rains, and b) it can interfere with the traditional crop rotational pattern between beans and sorghum. Fourth, staking requires considerable work and care. Further research is now being planned to measure the extra labour costs involved and the increase in productivity that is necessary to provide an adequate return on this labour.

Of course, the combination of high yields and labour intensity potentially makes the crop of greatest interest to poor families who generally have a shortage of land and a surplus of family labour. The introduction of climbing beans could, thus, have a positive impact on equity and on the quality of nutrition for smaller farmers. Pachico (1984, p. 74) notes that climbing and semi-climbing beans have an inherent small farmer bias because their production is labour intensive and not mechanizable. Pottier (personal communication) has observed that the smallest farmers in Rwanda often sell high value foods, such as beans, in order to meet their total calorie requirements by buying a larger amount of lower value sweet potatoes or cassava. Producing enough beans to meet the households protein requirements on a smaller area by partially switching to climbing beans would liberate more land to tuber production thus reducing the necessity of selling beans to meet carbohydrate needs.

For this potential to be realized, however, the problem of added risk needs to be resolved, for it is the poorer farmers who are the least able to absorb loss. A final constraint, observed in the on-farm trials, was the susceptability of the varieties being tested to bean common mosaic virus (BCMV), which badly affected some of the plots. Considerable emphasis in the on-station research is now being placed on screening and breeding for well-adapted, BCMV resistant varieties.

Potential Solutions

Given the primary importance of the lack of sufficient staking material, considerable emphasis was placed on analyzing how farmers in the Gisenyi climbing bean area had solved this problem and the effectiveness of their solutions. The rationale behind this research was that it seemed more likely that the practices of other farmers in the region would be manageable by those on the Plateau Central, than completely new solutions imported from the outside.

Table 8 summarizes some of the practices used by the Gisenyi farmers. Their solutions were clearly effective. More than 85% of the farmers interviewed had sufficient staking material and did not find the extra work of staking bothersome.

By far the main source of stakes was the anti-erosion hedges of pennisetum which are planted in bands about 20 meters apart along the contour lines.

Some farmers on the Plateau Central also grow pennisetum, primarily for construction purposes. When interviewed they stated that their main problem with pennisetum was its competitiveness with the yield of adjacent crops.

Based on this information, the Gisenyi survey also sought to describe the techniques farmers used to manage their hedges so as to reduce the problem of yield reducing competition. These methods include regular cutting, thinning and pruning of the hedge, as well as limiting the width of the pennisetum band by cutting the roots on the field side of the hedge. Cutting takes place once a year, a few weeks before beginning of the major bean season. This provides sufficient stakes, immediately beside the field, thus cutting down enormously on the amount of time required to find and transport stakes. The ensuing hoe cultivation incorporates the leaves and other debris into the soil, as well as cutting the roots extending into the field. At the time of first weeding, the hedge is thinned if necessary and any plants growing out into the field are cut back.

It is important that staking plants be multi-functional in order to optimize the land area they occupy. The farmers in Gisenyi liked the multi-purpose nature of pennisetum. Old stakes are an important fuel source for cooking; the hedge provides considerable protection from erosion; debris from the hedge increase soil fertility and the leaves can be used for fodder.

The Gisenyi research shows that an effective, manageable solution to the staking problem exists near to hand. The applicability and acceptability of this method and of more novel solutions involving the use of leguminous shrubs such as Leucaena, Calliandra and Sesbania, are currently being tested by the CIAT agronomist and by a number of University and development projects.

Interviews on the Plateau Central, with the farmers already growing climbing beans, also indicated a partial solution to the problems of drought stress, soil fertility and of "fit" within the existing cropping systems. This solution is to associate the climbing beans with thinned banana stands near the house. Such stands are ubiquitous, since a house is not considered a home without sufficient beer-producing bananas. Indeed, suitability for growing bananas is one of the most important criteria in choosing a house site. The banana plots tend to be the most fertile, both because they are near the house and because they receive preferential composting. Because it provides shade and wind break, the banana association apparently reduces evapo-transpiration considerably. What is important is choosing a near-optimal density for the banana plants.

Finally, the informal interviews were also instrumental in the choice of one of the two varieties, Gisenyi 2, that are being tested on farmers' fields.

Conclusion

To summarize the potential of climbing beans on the Plateau Central the basic questions asked and their answers are restated below.

1. Can climbing beans significantly increase bean productivity on the plateau? On rich soil with sufficient humidity, the answer is undoubtedly yes. Their impact will, however, be limited by the availability of compost, manure and staking material.

2. Would this yield increase be stable, i.e. not too risky for the smallest farmers? Probably. The association with bananas already goes some way toward this, but ways of further increasing stability such as by using early maturing, BCMV resistant varieties, need to be explored.

3. How can the problems of staking and soil fertility be solved? Trials are being conducted by the team agronomist and by several other projects to test the possibilities of leguminous shrubs as hedges, or integrated directly into field systems, as sources of staking

material, fodder and as green manure to enhance soil fertility. Such improved agro-forestry systems promise to alleviate the problems of system stability, soil fertility and staking material in an integrated manner. Still, much more work needs to be done on the better management, production and utilization of manure and compost.

In collaboration with the Project Agro-Pastoral (GTZ) and the extension service, the agronomist and anthropologist have recently distributed climbing bean seed and have provided training, detailed instructions and information brochures to over 110 collaborating farmers. These trials will be closely followed over the next two seasons in order to more accurately assess the real potential of increasing small farmer productivity through the increased use of climbing beans.

Finally, it cannot be over-emphasized that close interdisciplinary collaboration between biological and social scientists is indispensable for both the formulation of survey topics and for drawing the proper conclusions from the information gathered. The program's orientation and responses to information from farmers are the result of intense discussion amongst the team members and between team members and our colleagues in international institutes.

On-Farm survey work and experimentation with farmers on new varieties and new production methods also need to be seen as a constant feedback process where both farmers and researchers learn from the experience. Thus, systems diagnosis is more appropriately viewed as a continuing process, rather than as an initial stage in farming systems research.

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Table 1. Farmer Evaluation of On Farm Variety Trials, Plateau Central, 1986 a & b.

| Variety | No. of Trials | Overall Evaluation | (Rank) | Average of all Criteria | (Rank) | Average Yield Kg/ha | (Rank) |
|---|---|---|---|---|---|---|---|
| Ikinimba | 41 | 67.4 | (8) | 73.4 | (8) | 1,723 | (1) |
| Local Mixture | 41 | 92.1 | (3) | 86.6 | (5) | 1,472 | (2) |
| ISAR Mixture | 41 | 81.3 | (7) | 83.6 | (7) | 1,414 | (3) |
| Kilimukwe | 41 | 99.4 | (1) | 98.6 | (1) | 1,385 | (4) |
| Rubona 5 | 41 | 82.5 | (6) | 85.3 | (6) | 1,351 | (5) |
| Kirundo | 40 | 92.0 | (4) | 88.9 | (4) | 1,328 | (6) |
| A 197 | 18 | 87.5 | (5) | 88.4 | (5) | 1,252 | (7) |
| Umutikili | 18 | 95.0 | (2) | 89.3 | (2) | 1,114 | (8) |

The evaluation scale is calculated on the basis that:
100 = Excellent  80 = Good  60 = Fair  40 = Poor  20 = Very Poor
Sample size 18-41 farmers

Table 2. Comparison of the Most Appreciated Variety with the Least Appreciated Variety, Plateau Central, 1986 a & b.

| | Kiliumukwe | Ikinimba |
|---|---|---|
| Performance on good soil | 88.4 | 96.1 |
| Performance on poor soil | 82.1 | 97.2 |
| Type of plant | 92.1 | 53.8 |
| Threshing | 100.1 | 42.2 |
| Colour of grain | 96.1 | 50.0 |

Sample size 41 farmers

Table 3. Follow-Up of On-Farm Varietal Adaptation Trials After Two to Five Seasons, 1986b.

| Variety | Still grown | Given to # of other farmers | Quantity | Sown mixed (M) or pure (P) | Conditions under which it was grown* fertile | infertile | banana |
|---|---|---|---|---|---|---|---|
| Kilimukwe | 100% | 51 | 453 kg | P = 52%<br>M = 48% | 68% | 4% | 28% |
| Rubona 5 | 70% | 24 | 270 kg | P = 52%<br>M = 48% | 48% | 17% | 35% |
| Ikinimba | 67% | 24 | 156 kg | P = 40%<br>M = 60% | 45% | 45% | 10% |
| Kirundo | 65% | 16 | 50 kg | P = 34%<br>M = 66% | 72% | 0 | 28% |
| A 197 | 22% | 0 | - | - | - | - | - |
| Climbing Mixture | 27% | 5 | - | - | 60% | 0 | 40% |

Sample size = 45 farmers

Table 4. Sommaire des résultats des essais d'adaptabilité variétale en milieu rural, ISAR Rubona, saisons 85B/86A.

| | Highland | | Plateau | | Central | | Eastern Lowlands | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Gisenyi | | Nyabisindu | | Ruhashya | | Mayana | | Muhazi | Sake |
| Variétés saison | 85B | 86A | 85B | 86A | 85B | 86A | 85B | 86A | 86A | 86A |
| Mél. local | 370 | 1208 | 1294 | 2139 | 1029 | 1603 | 760 | 1393 | 805 | 1355 |
| Kilyumukwe | 358 | 1245 | 1324 | 2460 | - | 1830* | 763 | 2000* | 1080* | 1540 |
| Ikinimba | 700 | 1344 | 1761* | 1820 | - | 1764 | 1361* | 1848* | 1074* | 1712* |
| Rubona 5 | 366 | 1275 | 1122 | 2038 | 1040 | 1670 | 843 | 1849* | 673 | 1645* |
| A 197 | 136 | - | 1158 | 2137 | 1314 | 1600 | 858 | 1445 | 688 | 1564 |
| Nsizebashonje | | | | | | | | 1897* | 822 | 1441 |
| Kinundo | 426 | 1344 | 1439 | - | 850 | - | 564 | | | |
| Umutikili | | | 1137 | - | 1005 | 1419 | 773 | | | |
| Mél. ISAR | | | 1480 | - | | | 1038 | 1661 | | |
| (Mél. volubile) | | 1094 | | 2587 | 1411 | 1908 | | 1481 | - | 2047 |
| No. des essais | 5 | 14 | 21 | 9 | 15 | 36 | 8 | 13 | 12 | 14 |
| Altidude | 2200 | | 1700 | | 1600 | | 1500 | | 1400 | 1300 |

* au niveau de p = 0,05 significativement mieux que le mélange local
Source: Willi Graf, ISAR Rapport Annuel 1986.

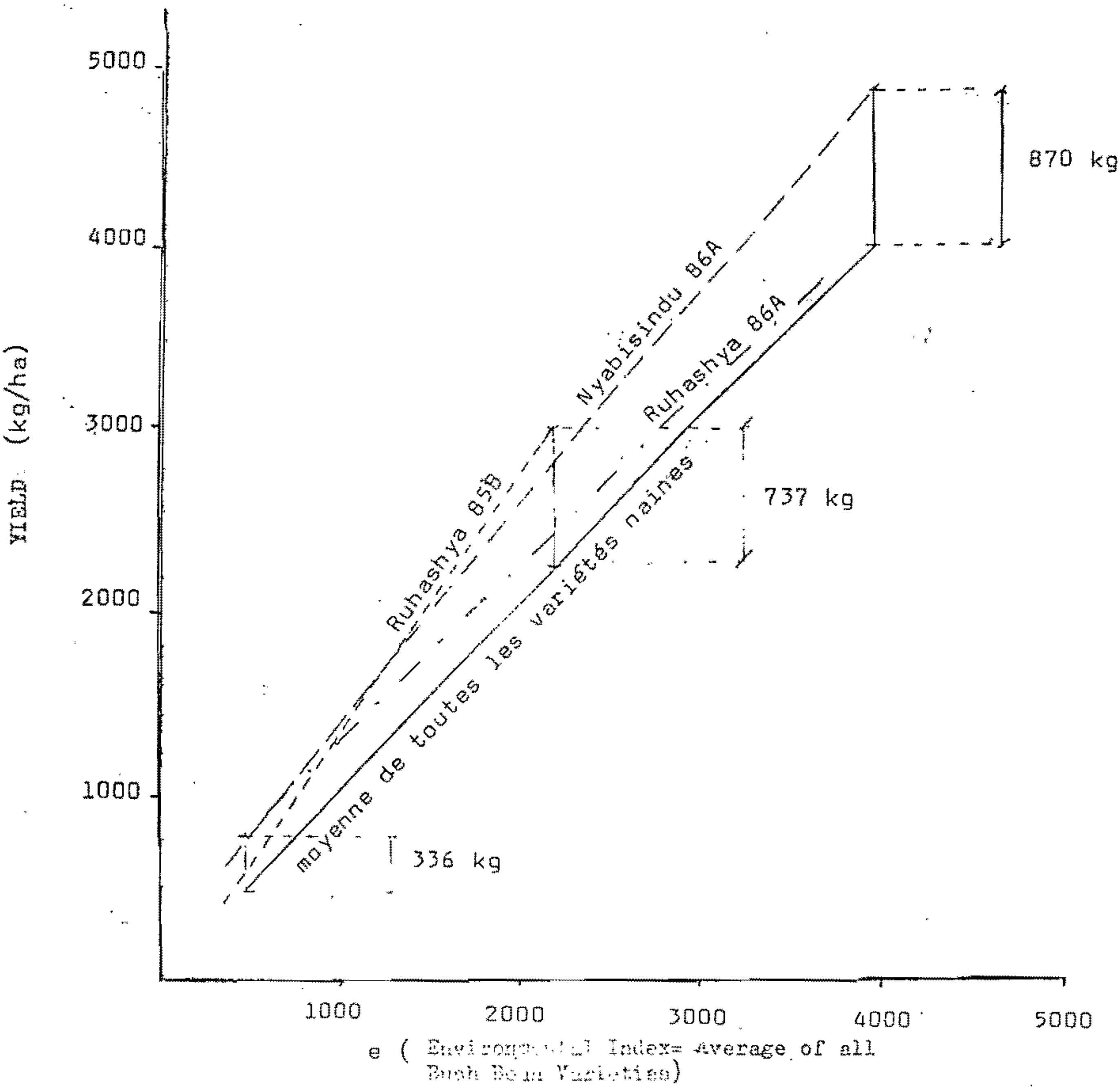
Table 5. Yield Comparison of Bush Beans and Staked Climbing Beans.

| Bush Beans | Climbing Beans |
|---|---|
| 1,665 kg/ha | 2,857 kg/ha |
| 1,246 kg/ha | 2,675 kg/ha |

Source: NYABYENDA, P. ISAR 1985 Synthése des Resultats de Recherche Sur le Haricot au Rwanda durant les 20 dernieres années.

Table 6

Difference in yield of Bush and Climbing Beans in On-Farm Trials (kg. dry weight/ha.




| place | region | season | intersection (a) | slope (b) | Corrélation |
|---|---|---|---|---|---|
| – – – – – – | Ruhashya | 85B | - 142,8 | 1,40 | 0,84 |
| —— · · —— · | Ruhashya | 86A | + 371 | 0,93 | 0,77 |
| —— —— —— — | Nyabisindu | 86A | + 190 | 1,17 | 0,82 |
| Formula: yield = a + be | | | | | |

Source: W. Graf ISAR [illegible]

Table 7. Comparison of Farmers' Evaluations of Climbing Bean Mixture + The Best Bush Bean, 1986a.

| Place | Climbing Beans | Rating | Bush Beans | Rating |
|---|---|---|---|---|
| Mugusa 1986A (Mayaga) | Climbing bean mixture | 2.8 | Best bush (Kilinmikwe) | 4.6 |
| Nyabisindu 1986A (Plateau Central) | Climbing bean mixture | 3.0 | Best bush (Kilinmikwe) | 4.8 |

The evaluation is calculated on the basis that 5 = Highly acceptable, 3 = Average and 1 = Very poor
Sample size 28 farmers

Table 8. Adopting Farmers' Ratings of Climbing Beans, Plateau Central 1986A.

| Excellent | Good | Fair | Poor | Very Poor |
|---|---|---|---|---|
| 83% | 13% | 2% | 2% | - |

Sample size 12 farmers

Table 9. Gisenyi Stake Production Survey

| Staking Material | | | Main Source of Material | | |
|---|---|---|---|---|---|
| Pennisetum | Bamboo | Wood | Anti-Erosion Hedges | Bamboo Grove | Wood Lot + Other |
| 95% | 22% | 12% | 68% | 13% | 19% |

Sample size 120 farmers

# The Advantages and Disadvantages of Promoting Expanded Dairy Production in Dual Purpose Herds: Evidence from Latin America

Carlos Seré
Libardo Rivas

## 1. Introduction

The last two decades have seen an unprecedented increase in the demand of animal protein in many developing countries, particularly in those achieving relatively high rates of economic growth such as oil exporting countries, several Far East countries and large areas of Latin America (SARMA and JEUNG, 1985). Policy makers in these countries are under pressure to face two broad options to expand the domestic supply of animal protein: following the pattern of most developed countries of expanding poultry, pork and intensive dairy production on the basis of modern feedgrain production (including cassava chips) or expanding ruminant production of beef and milk based mainly on pastures. This paper discusses some of the trade-offs involved for the specific case of dairy production in the tropical lowlands of Latin America.

## 2. Characteristics of dairy products demand in the Latin American tropics

Compared to other developing regions of the world, Latin America can be characterized by (Table 1):

- relatively low population density, ample land endowment
- intermediate growth rates of population
- basically urban societies
- per capita income levels significantly above other regions
- relatively high growth rates of per-capita incomes in the seventies with a drastic setback in the eighties
- a relatively ample supply of protein and calories with a particularly high share of animal protein
- ample supply of cattle in relation to population
- milk consumption levels are markedly higher than in other developing regions.

These are very broad generalizations appropriate to describe the general setting of dairy production. Nevertheless they mask substantial heterogeneity both between countries of the region and among income strata and regions within countries (see RIVAS y SERE, 1985; CIAT, 1986).

Latin America is a relatively recent livestock producing region. Cattle were introduced to the continent by the Spanish and Portuguese in the 16th country. Nevertheless they adapted very well and grew to a stock of presently 200 million head. Cattle fitted very well into the resource endowment of the continent. Ample land was available with limitations for crop production; labour supply was frequently limited leading to extensive low-output, low-cost systems. No major diseases impair production as occurs in Africa, where areas with good forage production potential are limited due to the presence of tse-tse flies, trypanosomiasis and several tick-borne diseases.

Table 1. Macroeconomic indicators for major developing regions[1]

| Indicator | Latin America | Africa | Near East | Far East |
|---|---|---|---|---|
| Population (1984): | | | | |
| Inhabitants (million) | 397.1 | 435.2 | 233.0 | 1351.0 |
| Density (inhabitants/km$^2$) | 19.7 | 18.7 | 19.4 | 162.4 |
| Growth rate (1970-84) (%) | 2.4 | 2.8 | 2.8 | 2.2 |
| Urbanization (%) | 68.4 | 35.6 | 48.0 | 38.2 |
| Per capita indicators: | | | | |
| Income (US$ 1983)[2 4] | 1054 | 692 | 3257 | 607 |
| Protein consumption (gms/day))[3] | 67.2 | 55.3 | 78.0 | 51.1 |
| Animal protein (%)[3] | 41.2 | 20.7 | 24.1 | 15.4 |
| Caloric intake (calories/day)[3] | 2634 | 2367 | 2849 | 2164 |
| Milk and dairy product consumption (kg/year)[3 4 5] | 102.1 | 30.7 | 72.9 | 33.7 |
| Head of cattle per inhabitant (1984) | 0.79 | 0.32 | 0.24 | 0.20 |
| Self sufficiency in milk and dairy products (%)[3 4] | 90.6 | 61.7 | 80.9 | 84.4 |

1/ Country groupings following FAO classification
2/ GNP per inhabitant
3/ Average 1979/1981
4/ Average weighted by population
5/ Fluid milk equivalent

Sources: FAO, (1984a)
FAO, (1984b)
IBRD (1985)

The favourable endowment for ruminant livestock production resulted in these products (mainly beef and milk) becoming major staples in the diets of Latin Americans as is documented by the per-capita consumption levels (Table 2). The high expenditure shares and income elasticities, even among low-income, urban strata of the population (Table 3), further document the importance of milk and dairy products in Latin American diets.

Table 2. Apparent per capita consumption of milk[1] in selected Latin American countries and regions. Average 1977/84

| Country | Apparent per capita consumption (kg/inhabitant/year) | Self sufficiency index (%) |
|---|---|---|
| Brazil | 88.1 | 98.2 |
| Mexico | 109.0 | 88.4 |
| Colombia | 99.5 | 95.4 |
| Venezuela | 139.5 | 62.0 |
| Central America and Panama | 84.5 | 84.1 |
| Caribbean | 39.3 | 24.1 |
| Tropical Latin America | 93.6 | 88.7 |
| Temperate Latin America | 171.0 | 98.6 |
| Latin America | 102.1 | 90.6 |

1/ Includes fresh, dry and condensed milk in terms of fresh milk.

Source: CIAT (1986)

Colombian data analyzed by CIAT (SANINT et al., 1985) document that milk is also an important protein source in rural areas, even though consumption levels are somewhat lower than in urban regions (Table 4).

A very similar pattern was documented for Panama by FRANKLIN, SHEARER and ARCIA (1984). In rural areas milk contributed 5.3% to the average protein intake and represented 5.5% of food expenditure; in urban areas values were higher (10.1% and 9.4% respectively).

Information on consumption of milk by dairy farming families is very scarce. One farm survey of small dairy farmers in the Andean Piedmont of Colombia documented that home consumption was 0.66 kg per capita per day (KLEEMANN et al., 1983; p.220). The authors calculated that on these farms milk was supplying 24% of the protein requirements

Table 3. Expenditure share and expenditure elasticity of milk and dairy products in the lowest and highest quartile of the population, selected cities of Latin America

| Country | City | Expenditure share of total food expenditure | | Expenditure elasticity | |
|---|---|---|---|---|---|
| | | Lowest quartile | Highest quartile | Lowest quartile | Highest quartile |
| BRAZIL | Sao Paulo | 10.5 | 10.4 | 0.87 | 0.40 |
| COLOMBIA | Bogotá | 9.6 | 10.6 | 0.91 | 0.52 |
| | Barranquilla | 10.4 | 11.0 | 0.99 | 0.32 |
| | Cali | 7.0 | 12.5 | 1.02 | 0.37 |
| | Medellín | 8.5 | 13.1 | 1.55 | 0.56 |
| CHILE | Santiago | 6.9 | 9.5 | 1.16 | 0.58 |
| ECUADOR | Quito | 8.7 | 13.7 | 0.87 | 0.51 |
| | Guayaquil | 8.9 | 12.5 | 0.78 | 0.33 |
| PARAGUAY | Asunción | 11.2 | 13.2 | 1.02 | 0.13 |
| VENEZUELA | Caracas | 13.1 | 12.7 | 1.06 | 0.46 |
| | Maracaibo | 18.6 | 17.9 | 1.12 | 0.32 |

Source: RUBINSTEIN and NORES (1980).

Table 4. Role of milk and dairy product consumption in rural and urban nutrition by income level. Colombia, 1981

| | Urban | | Rural | |
|---|---|---|---|---|
| | Quintile | | Quintile | |
| | lowest | highest | lowest | highest |
| Contribution to protein intake per adult equivalent (%) | 10.41 | 16.24 | 11.98 | 15.73 |
| Contribution to calorie intake per adult equivalent (%) | 3.99 | 7.63 | 4.23 | 6.61 |
| Food expenditure share (%) | 7.7 | 10.4 | 8.7 | 11.3 |

Source: SANINT ét al. (1985)

per adult person, 14% of the calories, 99% of the calcium and 76% of the phosphorous requirements. Due to the continuous supply of milk and the divisibility of the product, this pattern of ample home consumption of milk can be expected to be a general feature of dairy farming systems in the region.

Contrary to the situation of market saturation in developed countries, milk and dairy product demand is quite price-and income-elastic in Latin America. For the city of Cali, ANDERSEN et al. (1976) estimated price elasticities for a set of 22 commodities including milk by interviewing households twice (in 1969 and 1970). ANDERSEN and CAICEDO (1978) used the same dataset to estimate income elasticities by income quintile (Table 5). Income and price elasticity estimates for individual dairy products (Table 6) are available only for Chile (CORFO, 1985) a country not very representative of the consumption patterns. This type of information is critically needed for other countries in order to efficiently target dairy market interventions.

A pilot study of milk and dairy product consumption patterns is presently being undertaken for the city of Palmira, Colombia (RIVAS y SERE, in process). Initial results indicate very distinct patterns of consumption by families of different income levels (Table 7). Furthermore inter-household allocation also seems to differ markedly (Table 8).

Policies related to milk and dairy product consumption are generally determined by the wage-good character of this commodity group for urban consumers. Milk consumption by children is considered an essential ingredient of welfare and thus policies attempting to improve it are politically very attractive.

The most frequent policy package encountered across the countries of the region includes direct consumer price controls on pasteurized milk, no price controls for dairy products, special programs to distribute milk to children in schools. Dairy imports are generally administered by government; they are used to bridge the gap between domestic supply and demand at government controlled prices. This has been particularly attractive due to the low prices of milk powder on the world market. This is reflected by self sufficiency levels of well below 100 for most countries of the region. During the period 1977/84 only Uruguay and Argentina were net exporters. The average level of self sufficiency in milk (fresh, condensed, powdered) of tropical Latin America was 88.7% during the same period (CIAT, 1986).

The policy of controlling prices of fluid milk while letting the market operate in the sector of dairy products has contributed to induce the milk processing industry to shift resources from the pasteurization and distribution of milk to the processing of milk into dairy products. These products supply substantially higher cost protein (see Table 9) and consumption levels are very low in all but the highest income strata. Thus the dairy industry is trapped in low volume market catered for by a high-cost industry with limited growth potential. This has penalized low income consumers by diverting milk from fluid milk to higher priced dairy products and by inhibiting the growth of the

Table 5. Income and price elasticities of milk by income level. Cali, Colombia, 1969-1970

| Income level | Income elasticity | Price elasticity |
|---|---|---|
| 1 (lowest) | 1.83 | -1.788 |
| 2 | 1.65 | -1.621 |
| 3 | 1.13 | -1.121 |
| 4 | 0.63 | -0.642 |
| 5 | 0.20 | -0.201 |
| Average | 0.77 | -0.771 |

Sources: ANDERSEN et al. (1976)
ANDERSEN and CAICEDO (1978)

Table 6. Price and income elasticities of demand for individual dairy products. Chile.

| Product | Price elasticity | Income elasticity |
|---|---|---|
| Fluid milk | | |
| . fresh | -0.83 | 0.83 |
| . reconstituted | -1.56 | 0.96 |
| Dry milk | -1.88 | 0.90 |
| Condensed milk | -0.69 | 1.57 |
| Butter | -1.06 | 0.64 |
| Yogurt | -0.77 | 0.73 |
| Fresh cheese | -0.24 | 1.68 |
| Other cheese | -0.61 | 1.73 |

Source: CORFO (1985).

Table 7. Structure of milk and dairy products[1] consumption by income level. Palmira, Colombia, 1986 (kg/person/year)

| | Income Strata | | | | |
|---|---|---|---|---|---|
| Product | 1 (lowest) | 2 | 3 | 4 (highest) | Average[2] |
| Raw milk | 25.7 | 52.9 | 128.2 | 102.1 | 51.3 |
| Pasteurized milk | 34.4 | 35.3 | 43.1 | 65.3 | 35.8 |
| Dry milk | 28.9 | 23.9 | 7.3 | 3.7 | 23.9 |
| Subtotal | 89.0 | 112.1 | 178.6 | 171.1 | 111.0 |
| Cheese | 6.0 | 20.6 | 30.0 | 49.0 | 17.0 |
| Total | 95.0 | 132.7 | 208.6 | 220.1 | 128.0 |
| . Income index[4] | 100.0 | 226.5 | 391.8 | 556.5 | 206.6 |
| . Milk expenditure as percentage of food expenditure | 9.1 | 12.9 | 15.7 | 16.9 | 12.1 |
| . Households surveyed | 39 | 66 | 40 | 35 | 180 * |
| . Expansion factor | 26.3 | 66.2 | 6.9 | 0.6 | 100.0 * |

* Total
1/ In terms of fluid milk equivalent
2/ Average weighted by expansion factor
3/ Income level of household block as defined by city administration
4/ Mean income of of stratum 1=100

Source: RIVAS and SERE (in preparation)

Table 8. Per capita consumption of milk[1] by age group and income level. Palmira, Colombia, 1986 (kg/year)

| | Age group (years) | | | | |
|---|---|---|---|---|---|
| Income level | ñ18 | ñ7 and =¿18 | ñ3 and =¿7 | =¿3 | Index (5)/(2) |
| (1) | (2) | (3) | (4) | (5) | (6) |
| 1 (low) | 55.64 | 54.60 | 132.60 | 182.00 | 3.27 |
| 2 | 94.12 | 77.48 | 146.64 | 301.60 | 3.20 |
| 3 | 169.00 | 141.96 | 238.68 | 312.00 | 1.85 |
| 4 (high) | 175.76 | 164.84 | 185.64 | 306.80 | 1.75 |

1/ Includes raw, pasteurized, dry and baby milk in terms of equivalent fluid milk.
Source: RIVAS and SERE (in preparation)

Table 9. Cost (US$ per kg) of protein of alternative dairy products. Palmira, Colombia, 1986

| Product | Price per kg protein (US$) |
|---|---|
| "Costeño" cheese[1] | 6.94 |
| Raw milk | 8.79 |
| Pasteurized milk | 9.01 |
| Powdered milk | 14.97 |
| Parmesan cheese | 20.29 |
| Fresh cheese | 22.08 |
| Cottage cheese | 23.06 |
| Condensed milk | 25.91 |
| Yogurt | 43.92 |

1/ Very dry cheese of long shelf life used for cooking.

Source: RIVAS and SERE (in preparation)

industry into large companies capable of marketing efficiently fluid milk to consumers of all income strata.

Given the levels of domestic producer prices of most countries above international prices and the stated priority of most governments of expanding dairy production, there seems to be ample room for import substitution[1] and consumer price reductions if supply is expanded and marketing efficiency improved.

## 3. Dairy production systems in tropical Latin America

In the Latin American tropics two very distinct ecological regions are involved in dairy production: the highlands and the lowlands. The borderline is at an altitude of about 2000 m.a.s.l. at latitudes close to the Equator and gradually decreases as latitude increases.

1/ Latin America's net imports of milk and dairy products amounted to a total value of US$789 million in 1984 (FAO, 1985).

The highlands are characterized by the fact that C3 temperate grasses and legumes are the dominant forage sources and European breeds perform well under the prevailing environmental conditions. This has led to the development of specialized dairy operations using mainly Holstein Friesian or Brown Swiss cattle. These systems are important in Colombia and Ecuador but are also found in Central America, Venezuela and Peru.

Production technology is generally easily transferable from temperate regions. Major limitations for the expansion of these systems are the high opportunity cost of mechanizable land which has a range of alternative crop uses due to the high population density. Expansion on mountainous areas is limited due to the erosion hazard of intensive grazing systems, the high cost of pasture improvements due to impeded mechanization and the low productivity of unmechanized cut-and-carry systems. Intensification on presently utilized pasture land is to some extent possible through heavier fertilization, introduction of improved pastures, irrigation and use of concentrate.

The lowlands are characterized by high temperature and at least seasonally high moisture allowing the productive growth of the more efficient C4 tropical grasses. These produce large volumes of forage of low to intermediate quality. The environmental conditions, the presence of ticks and tick-borne diseases favour the use of adapted *Bos indicus* cattle as well as the Criollo cattle, descendent of the *Bos taurus* cattle introduced by the Spaniards and adapted to the environment by more than 400 years of mainly natural selection.

Two distinct milk production systems can be identified here: the traditional so-called dual purpose beef milk system, and the specialized milk production system similar to production systems in tropical highlands and temperate regions based on introduced *Bos* taurus cattle. A classification approach and case studies of individual systems were presented elsewhere (SERE, 1983), while biologic and economic performance of dual purpose systems as well as research trends and priorities were reviewed by SERE and VACCARO (1985). Here only a very brief description will be made of each system; emphasis will be placed on the advantages of each system from both the producers' and a national perspective.

The relative importance of both systems in different countries is shown in Table 10. Given the fact that statistics only report the total number of cows milked and average yield, proportions of cows and output by each system were calculated using production levels per cow considered representative of each system. Specialized systems include an important number of highland cows, thus in the lowlands the predominance of dual purpose cows is greater than shown by the national averages.

Specialized dairy systems can be described as an unstable equilibrium of European dairy cattle in an environment not suitable for them. Cows can achieve higher lactation yields than local cattle but require high inputs. Lack of tolerance of tick-borne diseases and sensitivity to high solar radiation imply that they have to be handled

Table 10. Importance of dual purpose milk production in the Latin American tropics. 1984

| Country | Dairy cows ('000) | Yield per cow (kg/year) | Dual-purpose cows as percentage dairy cows[1] (%) | Milk of dual-purpose cows as percentage of total[1] (%) |
|---|---|---|---|---|
| Bolivia | 56 | 1418 | 54 | 19 |
| Brazil | 14700 | 714 | 89 | 63 |
| Colombia | 2800 | 1000 | 75 | 38 |
| Ecuador | 720 | 1375 | 56 | 20 |
| Mexico | 8900 | 812 | 84 | 52 |
| Paraguay | 87 | 1897 | 30 | 8 |
| Peru | 675 | 1156 | 67 | 29 |
| Dominican Republic | 229 | 2009 | 25 | 6 |
| Venezuela | 1387 | 1072 | 82 | 57 |
| Central America: | | | | |
| Costa Rica | 270 | 1259 | 62 | 25 |
| El Salvador | 261 | 954 | 77 | 41 |
| Guatemala | 400 | 825 | 84 | 51 |
| Honduras | 430 | 651 | 92 | 71 |
| Nicaragua | 200 | 625 | 94 | 75 |
| Panama | 96 | 958 | 77 | 40 |

1/ Calculated by imputing an annual production of 2500 kg per specialized dairy cow and 500 kg per dual purpose cow (750 kg per dual purpose cow for Venezuela).

Source: Own calculations based on FAO (1985).

permanently stabled and forage has to be cut and carried. This implies heavy investments in buildings and agricultural machinery. The relatively low quality of tropical roughages, combined with the reduced voluntary intake and higher milk yield, creates the need for substantial supplementation with concentrates in order to achieve the required energy concentration in the diet. Additionally, serious health problems impair productivity and increase costs. Venezuela is the country with the largest experience of this production system. There VACCARO (1986) documented that 11.6% of dairy cattle imported as calves or heifers never reached parturition. Of the surviving animals 7.5% aborted and 8.6% had stillbirths. Of the female offspring born in Venezuela 17.7% died before reaching the age of 9-12 months and losses of 21% occurred between 9-12 months of age and first calving due to death and involuntary culling. For those calving, first lactation yields of 2605 kgs were estimated while crossbred heifers reared on the farm under the same conditions produced 2495 kg per lactation (VACCARO, CARDOZO and VACCARO, 1983). Results from Cuba under intensive feeding management similarly document lower reproductive efficiency of purebred Holstein cattle versus crossbreds (PRADA, 1979).

Similar information was obtained by WILKINS et al. (1979) in the Bolivian lowlands, clearly documenting the higher productivity of crossbreeds. WILKINS et al. conclude that production costs of systems based on purebred cattle are higher than the gross revenue under the Bolivian conditions and that milk yield similar to that achieved in temperate Great Britain would be needed to break even.

MADALENA (1986) reports a study from India by PATEL et al. (1976) where 350 small herds were monitored fortnightly to register inputs and outputs of herds of different genotypes. The general conclusion was that European Zebu crossbreeds had a better economic performance than purebreds and buffaloes.

MADALENA's own data from the Brazilian Cerrado, a somewhat less stressful environment than typical tropical lowlands, show the superiorty of 3/4 Holstein grade cattle over purebred Holstein Friesians. Additionally his data show a substantial genotype-environment interaction (MADALENA, personal communication).

On the other hand, dual purpose systems achieve substantially lower lactation yields, lower productivity per hectare, or man-day but achieve returns to capital making it a competitive system within the prevailing socioeconomic frame as documented by its predominance across the region (see Table 10). A detailed monitoring study of two years of operation of six dual purpose farms in the Central Provinces of Panama (CIAT, 1984a, 1984b, 1985) gives clues to the reasons for this performance.

Table 11 describes the average resource endowment. Farms are small- to medium-sized, operating on land that is marginal for crops due to a long dry season (4-6 months), poor soils, hilly topography. High input costs and small farm sizes causing high mechanization costs additionally limit crop options.

Family labour is used particularly for milking and livestock handling but hired labour supplies 2/3 of total man-days employed, especially for tasks like weeding and repairing fences which are frequently carried out by contract labour. Capital structure clearly reflects the extensiveness of the system and explains its resilience to unfavourable economic situations. Land and cattle are self perpetuating assets wich do not require regular maintenance and depreciation reserves. Land appreciates in value while cattle are a very easily marketable asset.

Biological performance indicators of dual purpose systems (Table 12) are substantially better in terms of reproductive efficiency than extensive cow-calf systems basically using the same resources, thus documenting the fact that through dual-purpose systems a more labour-intensive use of cattle and land resources is made and at the same time more calves are produced. This is due to the better feeding of cows which produce milk in addition to calves and more intensive management. Weaner weights are lower than those of beef cows but the additional value of the milk produced more than offsets this because the market does not penalize lighter weaners in direct proportion to the weight difference. This is explained by the extensive subsequent rearing of young stock and compensatory growth which imply that differences are not significant at slaughtering time. The narrow milk-beef price ratio prevailing in the tropics contributes substantially to the economics of this system.

Table 11. Resource endowment of dual purpose farms in the Central Provinces of Panama

| | | |
|---|---|---|
| Average farm size (ha) | | 69 |
| Paddocks (average number) | | 6.5 |
| Land use (%): | native pastures | 32.3 |
| | naturalized Hyparrhenia rufa | 42.1 |
| | sown pastures | 22.5 |
| | crop stubble | 1.8 |
| | crops | 1.3 |
| Soils: | pH | 5.1 - 5.9 |
| | $P_2O_5$ (parts per million) | 2.6 -12.2 |
| Cattle: | head (average) | 118 |
| | Animal units (average) | 102 |
| | cows (%) | 32.2 |
| | steers, ñ2 years (%) | 5 |
| Labour: | total man-day (average) | 542 |
| | family labour (%) | 33 |
| | man-days/hectare | 7.9 |
| | man-days/animal unit | 5.3 |
| Capital: | US$ (average) | 61,171 |
| | land (%) | 39 |
| | cattle (%) | 52 |
| | constructions, fences (%) | 8 |
| | small equipment (%) | 1 |

Source: CIAT (1984a)

Table 12. Biological performance of dual purpose farms in the Central Provinces of Panama

| Indicator (average) | Year 1 | Year 2 |
|---|---|---|
| Calving rate (%) | 73.1 | 64.4 |
| Adult mortality (%) | 3.3 | 3.5 |
| Calf mortality (%) | 19.5 | 7.6 |
| Age at first calving (months) | 37.5 | 41.0 |
| Weaner weight (kg) | 132.0 | 125.0 |
| Cow weight (kg) | 337.0 | 350.0 |
| Lactation length of milked cows (days) | 152 | 272 |
| Production per milked cow/year (kg) | 1156 | 1019 |
| Milk production per hectare (kg) | 276 | 336 |
| Beef production per animal unit (kg) | 46 | 47 |
| Stocking rate (AU) | 1.3 | 1.3 |

Source: CIAT (1985)

Structure of gross returns (Table 13) reveals that beef and milk both contribute in approximately similar proportions. This obviously varies with farm size and relative beef milk prices across countries. The major feature of the cost structure is the overriding importance of the labour component which has a heavy incidence in livestock handling, weed control and others. In this example pasture maintenance (fertilization and resowing of degraded parts) has an incidence above the regional average due to the fact that these farms were receiving agricultural credit with supervision. Thus dual purpose systems are very attractive in terms of the employment and income generated for the farmer family and twice as much for landless rural people. This calculation ignores employment generated in the milk carting sector, milk processing, etc. Using essentially the same domestic resources (marginal land, local cattle) dual purpose systems employ 5.3 man-days per animal unit while extensive cow-calf systems employ about 1.5 man-days per animal unit.

Productivity of the labour employed is somewhat above the wage rate (US$5/man-day) and return to capital is also in line with the fact that this is a very low risk system, with good cash flow and involving work considered more amenable than small-scale unmechanized crop production. Cash flow aspects are of particular importance to smallholders given their limited access to institutional credit, a general feature of rural credit in Latin America.

Table 13. Economic performance (US$) of dual purpose farms in the Central Provinces of Panama

| Indicator (average) | Year 1 | Year 2 |
|---|---|---|
| Gross return (average) | 8544 | 8218 |
| . milk (%) | 49.6 | 56.0 |
| . beef[1] (%) | 50.4 | 44.0 |
| Costs | 3117 | 3687 |
| . livestock handling (%) | 39 | 35 |
| . weed control (%) | 10 | 10 |
| . pasture renting (%) | 5 | 8 |
| . pasture maintenance (%) | 11 | 11 |
| . animal health and supplementation (%) | 12 | 9 |
| . other (%) | 23 | 27 |
| Return to family labour and total capital | 5472 | 4531 |
| Return to labour (man-day)[2]: | | |
| . family | 20.6 | 13.5 |
| . total | 10.1 | 4.8 |
| Return to capital (%)[3] | 7.6 | 5.8 |

1/ Net of changes in cattle inventory
2/ Inputing 3% interest on farm capital
3/ Inputing a wage of US$5 per man-day for unpaid family labour

Source: CIAT (1985)

Comparison between the data of the two years (Tables 12 and 13) indicates the flexibility of dual purpose systems. Year 2 was drier than year 1 and it was difficult to sell cattle. Due to the need of cash, farmers allocated forage preferentially to the milking cows and continued to milk cows producing very low levels of milk as documented by similar levels of production per cow with considerably longer lactations. At the same time calves were weaned lighter and heifers allocated less forage leading to higher ages at first calving.

Information from a cost of production survey for different livestock systems of Colombia (BALCAZAR, 1985) documents the similarity of the cost structure of dual purpose systems across countries and it pinpoints important differences with specialized systems of the highlands (Table 14). In Colombia specialized lowlands systems are virtually nonexistent. Lowland dual purpose systems make a markedly lower use of purchased inputs. Within the structure of purchased input highlands systems employ important levels of cereal-based concentrates, the Bogotá case presents important use of milk replacers and pastures are fertilized. On the other hand, the dual purpose systems' input structure includes herbicides but no fertilizers, some animal health and fence maintenance.

Table 14. Structure of production cost index for alternative milk production systems in Colombia

| | Specialized System | | Dual Purpose System | | |
|---|---|---|---|---|---|
| Region: Technology level | Bogotá (medium) | Antioquia (medium) | Atlántico (medium) | Tolima (medium) | Atlántico (low) |
| a) Labour | 33.00 | 30.97 | 47.00 | 55.20 | 68.78 |
| b) Inputs | 60.42 | 64.68 | 37.07 | 39.05 | 13.57 |
| .mineral feeds | 3.81 | 2.23 | 2.68 | 6.01 | 0.15 |
| .concentrates | 20.92 | 44.96 | 7.18 | 7.01 | 0 |
| .milk replacers | 3.25 | 0.28 | 0 | 0 | 0 |
| .animal health | 2.87 | 2.66 | 5.61 | 8.8 | 1.88 |
| .fertilizers | 16.93 | 10.07 | 0 | 0.58 | 0 |
| .herbicides | 0.14 | 0.39 | 7.38 | 5.71 | 3.55 |
| .seeds | 0.76 | 0 | 0.08 | 0 | 0 |
| .fence maint. | 0.58 | 0.42 | 1.72 | 2.42 | 1.87 |
| .Artificial inseminat. | 2.09 | 0.58 | 6.21 | 2.03 | 0 |
| .fuels | 1.53 | 1.31 | 5.54 | 4.03 | 6.11 |
| .pasture rent | 1.70 | 0 | 0 | 1.49 | 0 |
| .milk transport | 0 | 0.13 | 0 | 0 | 0 |
| .others | 5.84 | 1.65 | 0.67 | 0.97 | 0.01 |
| c) Depreciation machines and equipment | 6.33 | 4.34 | 15.61 | 5.74 | 17.65 |
| TOTAL. . . . . . | 100 | 100 | 100 | 100 | 100 |

Source: BALCAZAR (1984)

The competitive edge of tropical lowlands production over specialized highlands system is documented for the Colombian case by the growth of the participation of lowlands regions in national production. BEJARANO et al. (1984) report than the share of the North Coast, the main dual purpose region, grew from 29.5% in 1976 to 35.9% in 1983. In Brazil the participation of the temperate and subtropical Southern region has remained constant at about 22% of national production.

Within the Brazilian tropics, production is being gradually displaced from the Southeastern region, which includes the major cities (Rio, Sao Paulo) towards other zones, particularly the Cerrados (Central West region) which presents a growth rate twice the national average for the period 1968/81 (Table 15) reflecting the increased competitiveness of more distant regions as road infrastructure improves.

Table 15. Evolution of dairy production in Brazil by regions (1968/81)

| Region[1] | Share of national production (%) 1968 | 1981 | Average growth rate of production (1968/81) |
|---|---|---|---|
| North | 0.5 | 1.3 | 11.8 |
| Northeast | 11.9 | 13.4 | 4.8 |
| Southeast | 59.7 | 52.1 | 2.8 |
| South | 21.0 | 22.9 | 4.6 |
| Central-West | 6.9 | 10.3 | 7.1 |
| Brazil | 100.0 | 100.0 | 3.9 |

1/ North includes states of Rondonia, Acre, Amazonas, Roraima, Pará, Amapá.
Northeast includes states of Maranhao, Piauí, Ceará, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, Sergipe, Bahia.
Southeast includes states of Minas Gerais, Espírito Santo, Rio de Janeiro, Sao Paulo.
South includes states of Paraná, Santa Catarina, Rio Grande do Sul.
Central-West includes states of Mato Grosso do Sul, Mato Grosso, Goiás, Distrito Federal.

Source: IBGE (1971) and (1983).

Very few studies have analyzed the competitiveness of alternative dairy production systems in terms of their comparative advantage over imports. FORD (1979) studied alternatives for milk import substitution in Guyana within a domestic resource cost frame. He found that the intensification of existing, mainly dual purpose operations along the coast was more efficient than the development of large scale intensive operations in the savannas based on imported cattle. Domestic resource cost (DRC) coefficients for all alternatives were below the shadow exchange rate suggesting the rationale for the proposed import substitution strategy. Sensitivity analyses reducing the international price of milk 10% showed marked increases in the DRC coefficients reaching values close to the shadow exchange rate, thus indicating limited comparative advantage.

The situation of most other countries of the region (Colombia, Venezuela, Brazil) where adapted cow-calf systems are predominant implies that the marginal resources needed to expand dual purpose milk production are few thus making the system competitive. Rapid population growth and improving road infrastructure have induced migration into the tropical lowlands. This has contributed to shifting extensive beef systems into more labour-intensive dual purpose systems. Given the relatively high price of milk the dual purpose system can introduce a floor price for labour if there is a market for the milk. On the other hand, if labour becomes scarce, productivity can be increased through better feeding, milking of higher yielding cows, and even machine milking. This intensification process can be observed in Venezuela, where average milk yield per dual purpose cow is substantially higher than in neighbouring countries (BODISCO and RODRIGUEZ, 1985).

Dual purpose systems not only make efficient use of indigenous resources, but they also tend to have positive equity effects. A number of studies show that dual purpose farms tend to concentrate in the small to medium sized farm strata. In Brazil, DIAS (1986) reported that of 28000 milk producers supplying NESTLE 58% supplied between 1 and 50 liters of milk per day. Only 6% of the farmers supplied more than 200 l/day.

RIVAS (1974) surveyed a random sample of 476 cattle ranches of the Colombian North Coast. While 76% of the ranches of less than 200 ha milked cows, 53% of the farms between 201-500 ha milked, but only 14.9% of the farms of more than 500 ha produced milk. OTTE et al. (1985) suggest that for the Department of Córdoba, on the Colombian North Coast the number of herds of less than 30 animals is negligible. They estimate that 50% of the population of more than 30 animal herds is in herds of between 30 and 100 head, 25% in herds between 100 and 200 and 25% in herds of more than 300 head. On the other hand, the lumpiness of the investments needed to operate specialized lowlands systems (constructions, machinery, qualified management, access to credit) make small scale operations unviable. Due to its very capital-intensive nature, neither is it an attractive employment generation option.

For the lowlands a clear-cut case can be made for dual purpose systems of varying intensity vis-a-vis intensive specialized systems. On the other hand, highland production is contributing a substantial share of the market in many countries of the region, e.g. Ecuador, Colombia. Nevertheless the availability of suitable highlands is very variable between countries. At the same time empirical evidence documents an increasing role of dual purpose systems even in countries with highland areas such as Colombia.

## 4. Constraints and potential strategies for the development of dual purpose systems

Farm level data clearly show the rationale for milking cows even when of low productivity as long as labour and marketing facilities are available (VON OVEN, 1969).

Detailed farm monitoring studies of more intensive smallholder dual purpose systems show that these systems generate reasonable income levels, continuous cash flow, whilst they involve low production risks and make efficient use of domestic resources. A number of surveys and reviews (SERE y VACCARO, 1985; VACCARO, 1986) have documented the low productivity levels achieved per cow or per hectare and the limited use of improved technology. A vast range of technologies have been proposed (see PRESTON, 1983; SERE, 1986) and many development projects have attempted to implement innovation in the fields of artificial insemination for upgrading programs, extension, credit, etc., in general with only moderate success. On the other hand horizontal expansion of the system and some intensification has occurred in specific regions. These cases e.g. Brazilian Cerrados, Central Provinces of Panama, Cesar and Caqueta regions of Colombia, can be associated with public efforts in the road infrastructure sector and in the subsequent establishment of dairy processing facilities by private companies and in few cases dairy cooperatives. These developments have usually capitalized on public road infrastructure investments associated with other sectors such as petroleum, cotton, and forestry.

The central hypothesis of this paper is that development of lowland tropic milk production systems has been constrained by the lack of a coordinated investment strategy involving private on-farm investments, public infrastructure investment and private or public investment in milk collection, processing and marketing. This underinvestment is related to a lack of evolution in the urban segment of the dairy industry from small local companies to large efficient industries working nationally. This stagnation is related to government pricing policies which are supposed to benefit low income consumers.

The fact that farm-produced low quality cheese sells at a price below the price of fluid milk, as shown for the case of Palmira documents the fact that milk production based on extensive dual purpose systems in frequently competitive in situations of almost complete lack of infrastructure. Nevertheless, the lack of such infrastructure acts a deterrent for on-farm investments, because the profitability of intensifying production is very dependent on off-farm services. Semi-intensive dairying is an activity which is sensitive to off-farm support services such as roads, artificial insemination, milk collection and cooling, input supply, etc. It is a complex system with wide-ranging interactions. Thus a multitude of interrelated biologic and socio-economic constraints are operating as described in a more general manner for intensive livestock systems by FITZHUGH and DE BOER (1979).

Marketing of milk can certainly be identified as a particularly binding constraint in most situations. Milk is a perishable product of low unit value, thus farm gate price can be seriously affected by milk collection costs. Dual purpose farms tend to produce low volumes of milk and farms tend to be scattered over the region. Poor roads imply additional costs and risks to milk collectors. Poor infrastructure, high costs and consequent low margins imply a high marketing risk for producers and low profitability. These act as deterrents for on-farm investment by farmers.

Dairy production was initially developed in regions of intermediate to high altitude close to the urban markets and milk was to a large extent sold as raw milk to nearby urban consumers. In the course of the development process increased demand particularly for dairy products led to the installation of processing facilities close to these centers. In this situation dairy marketing was not considered a major bottleneck as stated by FRANKEL (1982) in his review of World Bank financed dairy projects.

The gradual development of road infrastructure in the lowlands created the potential to milk existing lowlands beef cows as well as to intensify towards more efficient dual purpose systems based on crossbred cows. The competitiveness of lowlands dairy production was further increased by the introduction of more adapted forage species and the delivery of minimum services to the livestock sector. All this has markedly altered the national dairy scenario.

Tropical dual purpose systems, particularly if European x Zebu crossbred cattle are managed on improved pastures, have a substantial potential to expand supply at low marginal costs in many cases with a marked seasonal pattern. This poses additional strains on the marketing system. A series of mechanisms such as differential dry and wet season prices, quota systems, etc. have been implemented by milk processors to induce off-season production. Nevertheless this is only possible at substantially higher marginal costs. This rise in marginal cost is not very marked in systems where ample use of concentrates is made year-round as is the case in the highlands systems, or in very extensive dual purpose systems grazing pastures of year round low quality. Poor nutritive condition of cows does not allow seasonal mating, a prerequisite for more efficient coordination of seasonal forage supply and demand. But technical innovations in the field of tropical pastures, such as legume-grass pastures, make it possible to achieve intermediate levels of production with almost exclusive use of pastures during wet season. The higher nutritive plane reduces the calving interval and makes seasonal mating possible, which was the major constraint for seasonal production in traditional systems. This process is similar to the development of New Zealand's dairy industry which adopted a seasonal production pattern to achieve low cost production. A similar process has to be envisaged for the tropical lowlands areas, if milk prices are to be reduced in order to expand consumption by low-income urban consumers.

Three complementary strategies seem feasible:

a) Seasonal importation of dry milk.
b) Integration of local seasonal markets at a national or regional level using the asynchronous weather patterns of individual regions.
c) Seasonal production and reconstitution of locally produced milk.

Most countries are net importers of dry milk. A targeted importation of marginal amounts needed to balance supply and demand can reconcile seasonal production and constant demand. Revenue from sale of reconstituted milk can to some extent support producer prices in the wet season.

Integration of regional markets into efficient industries requires structural changes in the milk processing and marketing industry as well as technical innovations in milk production, collection, processing and retailing. Particularly important are technological developments reducing the costs of collecting milk from dual purpose systems. These technologies will on the one hand induce horizontal expansion and on the other make intensification economic.

Promising technologies include:

a) Development of low-cost milk-cooling equipment for individual farmers or groups of farmers thus allowing less frequent milk transportation of larger volumes and in some cases twice daily milking.
b) Development of techniques to reduce volume of milk transported such as ultrafiltration.
c) Identification of milk additives to replace cooling for longer transportation routes.
d) Development of marketing systems for enhancing the value of less perishable products produced "on farm" e.g. melted cheese types.
e) Design of efficient systems to market milk and dairy products to low income urban consumers. Products such as UHT (long shelf-life) milk might play an important role.

These possibilities (lower-cost seasonally supplied milk, new technologies to process it, new urban low income markets to supply) could lead to changes in the industry structure size, number and location of plants, products, marketing channels, services to milk producers, etc. The costs and risks involved in it have led other countries to internalize these costs by creating large schemes of vertically integrated companies, frequently dairy cooperatives. This process has yet not been successful in tropical Latin America.

5. Policy implications

Policy implications of the above described situation and potentials are grouped under the following headings: research needs, foreign aid, pricing policies, institutional issues and infrastructure investment policy. Many issues naturally transcend individual headings.

a) Research needs

Within the socioeconomic field, marketing issues should be assigned the highest priority, particularly emphasizing the need to develop mechanisms to let low-income urban consumers have access to milk and dairy products. This research should include diagnosis of existing dairy industry, its structural adjustment problems, new technologies, new products. Given the high priority assigned by politicians and nutritionists to milk consumption by vulnerable population groups, costs and benefits of alternative interventions needs to be assessed. For Colombia, VILLAMIZAR (1986) has proposed a scheme to tax dairy product consumption to subsidize fluid milk. Income group specific demand parameters are needed to be able to assess the impact of such interventions.

On the production side, domestic resource cost studies of alternative production systems and supply expansion options (regions, systems, etc.) are needed. Particular microeconomic issues include the costs, benefits and risks of more intensive dual purpose systems and particularly the economics of seasonal milk production. At the industry level, efficiency of present structure, bottlenecks and options of structural adjustment have to be assessed.

Among biological research needed, the whole complex of cattle feeding (pastures, concentrates, non-traditional supplements, etc.) requires highest priority. Development of low cost strategies to improve feeding of cows is crucial to intensify the production efficiency at the farm level and consequently to induce the development of the whole dairy sector. Tropical pasture research has been successful in increasing productivity per hectare. Major efforts are needed to improve pasture quality (digestibility, protein content, voluntary intake) to increase production per cow. The potential merits of more seasonal production schemes should be assessed by means of bioeconomic modeling. If promising results are achieved, physical experiments should follow. Furthermore, the development of technologies to store milk on-farm, quality-test it, transport it, turn it into appropriate dairy products for local consumers could have a high pay-off.

b) The role of foreign aid

While past activity has mainly been to donate dairy products, developed economies could play a more targeted role in developing local milk production and demand. The Indian example of using revenue from the sale of reconstitued dry milk to support domestic producer prices and finance dairy infrastructure development shows one way (BRUMBY and GREESELS, 1985). Countries with higher self sufficiency levels of milk production will require more sophisticated schemes to avoid disincentivating domestic production. Cattle exports have also been extensively used as an aid mechanism. Empirical evidence from the lowlands tropics of Latin America shows that it has to be used carefully and targeted towards producing improved bulls for crossbreeding programs. In many cases artificial insemination will be a more cost-effective way to achieve the same result. Dairy-surplus developed countries have an industry producing equipment for processing, transporting, handling dairy products. Supply of those capital-intensive goods to enhance labour intensive local production seems to be an attractive option, subject to the fact that technology supplied should be "appropriate". The same countries have developed a research infrastructure of dairy science, milk technology, agricultural engineering. This stock of knowledge could contribute to the design of "appropriate" dairy products, technologies and to the training of developing country personnel to perform this research.

c) Pricing policies

Governments have tended to control fluid milk prices, while exerting less control over dairy products. In the long run this has diverted fluid milk from the market towards dairy products and did not increase milk consumption. More targeted measures could create incentives for developing an efficient fluid milk market while at the same time increasing intake by specific groups of the population.

d) Institutional policies

Dairy development tends to be associated with an increasing level of farmer organization. Particularly in developing country situations associated with fiscal limitations, public services to the sector are scarce. These services have to be internalized into the system. This normally requires collaborative activities between individuals. Dairy cooperatives have played a crucial role in this sense in most developed economies but have failed in DC's. On the other hand some private companies have achieved this vertical integration. Detailed studies of the institutional aspects of successes and failures of dairy service organizations (particularly dairy cooperatives) are needed to contribute to more efficient policy-making.

## 6. Concluding remarks

Yield increases were the major source of increased production in crops in Latin America during the seventies after a rapid area expansion in the sixties (PAULINO, 1986). In livestock production, increase in stock numbers is still a major source of output growth. During the period 1977/84 growth of beef output in tropical Latin America was due 100% to increases in stock numbers. In milk 47% of the output growth was due to yield per cow increases and 53% to increases in cow numbers (CIAT, 1986).

This comparison documents the different growth patterns of crop and ruminant animal production in Latin America. While deteriorating terms of trade particularly with respect to agricultural mechanization (basically a fixed cost per hectare independent of yield levels) make only higher yielding crop production economic, ruminant livestock production can make efficient use of frontier lands with low or zero opportunity cost. Milk production from dual purpose herds has intermediate levels of infrastructure requirements. The most outstanding feature of this production system is its flexibility to respond either by increasing yield levels or expanding horizontally according to market forces.

Joint efforts by foreign aid agencies and Latin Americans to develop appropriate technologies and policies for the dairy sector will not only foster a more equitable development of the region but will also be a valuable contribution to the identification of strategies for the development of Africa's livestock sector in the coming decades.

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# The Meat of the Matter:
# Cassava's Potential as a Feed Source in Tropical Latin America

John K. Lynam

Latin American economies have gone through a period of profound structural change in the post-war period, accompanied by a number of adjustment problems, as reflected in strains on urban services, high inflation rates, malnutrition among a significant portion of the urban population, a rising external debt, and high rates of unemployment. Virtually all of these adjustment problems have antecedents in or implications for the agricultural sector, a fact which has motivated a heavy policy intervention in this sector. The focus of these interventions was the grain and livestock sector, as governments strived to balance policies focused on low urban food prices with the maintenance of incentives to domestic farmers. The following discussion will review the interaction between changing demand conditions, policy interventions, and production response for meat and grains. This will then provide the context for an evaluation of the opportunities for cassava to play a more fundamental role in this sector. The arguments cover a wide terrain and are schematically presented in Figure 1.

## Meat as a Wage Good? The Legacy of a Land Surplus Economy

The structure of agricultural output in Latin America is heavily weighted towards livestock products, especially if compared to either Africa or Asia (Table 1). Livestock production is larger in value terms than the combined production of cereals and other starchy staples. In the livestock sector beef cattle form the largest component and in turn command significant land resources. In particular, permanent pastures in Latin America cover three times more area than the land devoted to annual and permanent crops (FAO, 1985). There are historical, structural and economic reasons for the preeminent role that cattle play in the Latin American agricultural economy. Moreover, this importance in the agricultural sector is translated into a dominant role for beef in food consumption patterns.

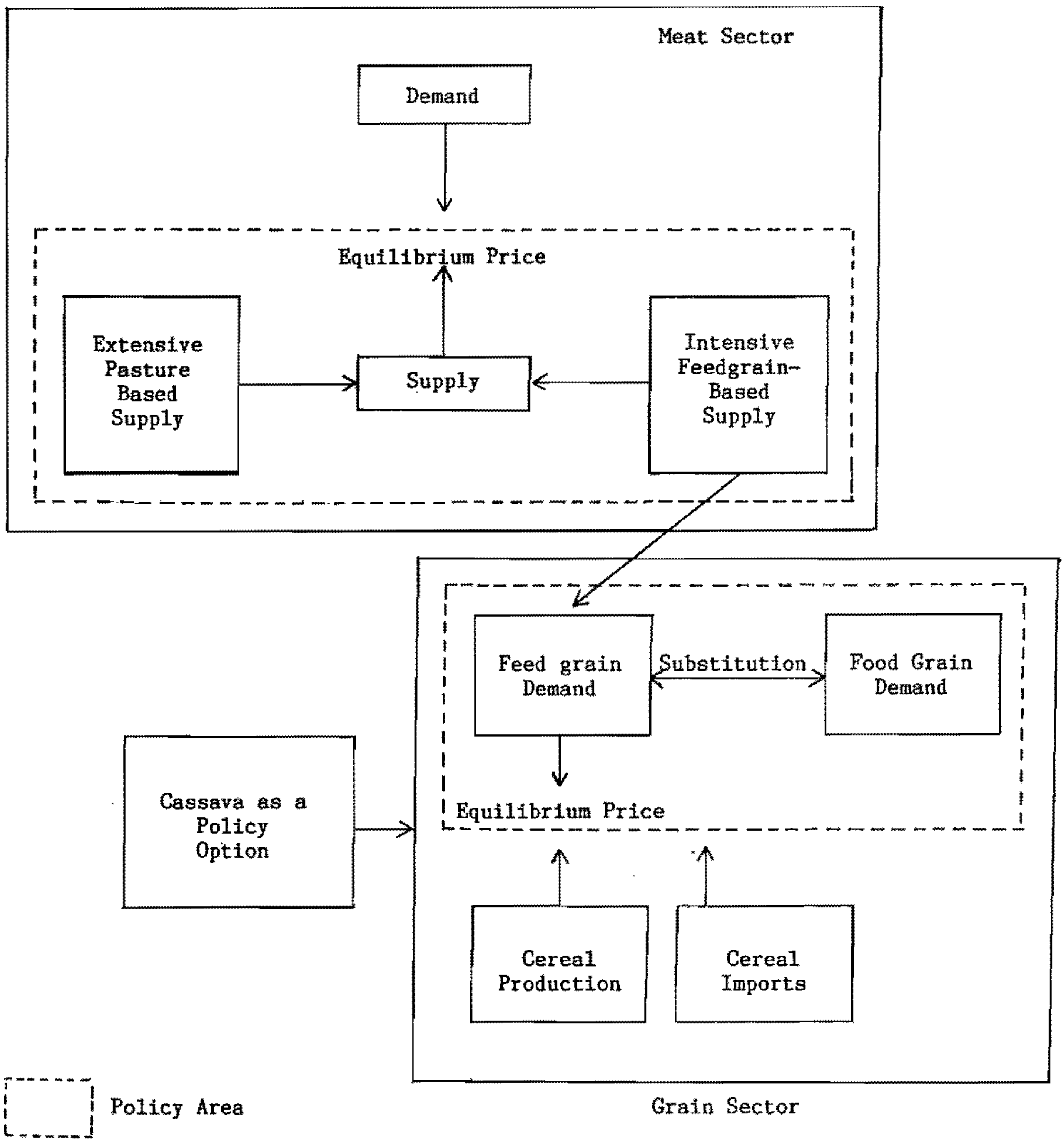
Cattle were one of the more important plant or animal introductions into Latin America by the early Spanish, and it was Christopher Columbus who made the first introduction into the continent by landing cattle on both Cuba and Hispanola (Rouse, 1973). In the development of the encomienda system in 16th century Spanish America, Keith (1980) points out that "stock raising was generally the first economic activity ... which was taken up by the encomenderos. (However), stock raising remained the primary sector of the colonial economy only where geography or the absence of nearby markets left no alternative. Elsewhere it was usually one element in a mixed agrarian system, an element which was valued less for the size of the profits derived from it than from their security." Stock raising in this period was in many ways a subsistence enterprise adapted to a land surplus agricultural economy. Markets, however, were needed for

TABLE 1. Structure of Agricultural Output by Region, 1976-80.

| Region | Cereals (%) | Other Staples (%) | Livestock (%) | Other Foods (%) | Nonfoods (%) |
|---|---|---|---|---|---|
| Latin America | 17 | 9 | 33 | 31 | 11 |
| South Asia | 45 | 9 | 13 | 27 | 7 |
| Southeast Asia | 44 | 10 | 12 | 26 | 8 |
| Africa | 17 | 27 | 18 | 25 | 14 |

Source: World Bank, 1982

Figure 1. Schematic of the Analysis of Cassava whithin the Latin America Grain-Livestock Sector.



cattle to achieve economic significance, and in many areas cattle were valued only for the hides.

Nevertheless, the 16th and 17th century did provide the structural features on which the future development of the livestock industry would be based, i.e. the hacienda which developed as a response to limited markets. As Grindle (1986) summarizes the point, the hacendados "often acquired land in order to limit production of commodities where prices might decline as a result of increased output, and to limit competition from other haciendas or from the Indian communities. Most centrally, monopoly over land made available a surplus labor force that served to subsidize low levels of production in a context of generally low prices for agricultural commodities." The resultant, skewed farm size distribution would be key to the future expansion of the livestock industry, when markets came to be established.

The market stimulus for livestock production came in the 18th century with the rise of the sugar plantation. Cattle were needed not only for draft power in field transport and to run the trapiches but also as a food source. In many of the large sugar cane growing areas such as Northeast Brazil, Cuba, and the Colombian Coast, the development of the sugar plantation coincided with the rise of large stock raising enterprizes. The greater requirements for draft power in turn led to the importation into Cuba in the 19th century of Zebu cattle from India, which in turn provided the basis for shipments to Colombia and Brazil. The Zebu stock would eventually supplant the original criollo cattle in much of lowland, tropical Latin America, and become the future basis for meat production.

Low-cost beef production required extensive amounts of land with a low opportunity cost. In Latin America this was provided by the abundant land available, which was in turn accentuated by the farm size distribution. Profitable beef production, however, required markets and these would have to wait, except for the export industry in the Southern Cone, for the rise of towns and major urban areas. Beef was not a major consumption item in rural areas. Most of the rural population lived on small-scale farms and depended on starchy staples. Because of the lack of storage or refrigeration, apart from the dried beef of Northeast Brazil, swine and poultry were a more appropriate meat source for farm families. A minimum population density was necessary to make possible beef consumption on a regular basis.

This feature of beef consumption is reflected in current expenditure and consumption patterns for meats (Tables 2 and 3). Expenditure on and consumption of beef is almost universally lower in rural areas than in urban areas. In the coastal areas of Ecuador and Colombia where the rural settlement pattern is based on villages, per capita consumption of beef is higher than in other parts of Latin America. In countries such as Brazil, consumption of pork is much higher in rural areas than in urban areas. Overall meat consumption is significantly higher in urban compared to rural areas in Latin America. This is possibly due to the generally higher

TABLE 2. Latin America: Shares of the Total Food Budget Spent on the Principal Caloric Staple (Highest Expenditure) and the Major Meats.

| Country | Caloric Staple Commodity | Caloric Staple Share (%) | Beef (%) | Pork (%) | Chicken (%) |
|---|---|---|---|---|---|
| Peru (1971-72) | | | | | |
| North Coast | | | | | |
| Cities | Wheat | 8.3 | 11.2 | 9.1 | 5.1 |
| Towns | Wheat | 7.8 | 13.6 | 9.1 | 3.3 |
| Rural | Wheat | 8.6 | 7.3 | 9.2 | 2.2 |
| Central Sierra | | | | | |
| Cities | Wheat | 12.5 | 12.8 | 10.8 | n.a. |
| Towns | Wheat | 11.4 | 3.0 | 9.8 | n.a. |
| Rural | Potato | 20.6 | 3.2 | 7.2 | n.a. |
| Low Jungle | | | | | |
| Cities | Wheat | 10.0 | 9.6 | 12.4 | 10.0 |
| Towns | Wheat | 8.6 | 8.6 | 9.0 | 7.5 |
| Rural | Cassava | 9.7 | 1.4 | 5.8 | 6.2 |
| Brazil (1975) | | | | | |
| South | | | | | |
| Cities | Wheat | 8.2 | 17.6 | 1.2 | 4.8 |
| Towns | Wheat | 9.7 | 14.0 | 2.3 | 5.3 |
| Rural | Rice | 9.7 | 6.6 | 4.7 | 4.8 |
| Sao Paulo | | | | | |
| Cities | Wheat | 7.6 | 13.0 | 2.1 | 5.1 |
| Towns | Rice | 9.4 | 12.4 | 3.2 | 4.8 |
| Rural | Rice | 16.7 | 7.2 | 3.8 | 4.7 |
| Northeast | | | | | |
| Cities | Wheat | 12.7 | 18.8 | 1.5 | 6.3 |
| Towns | Wheat | 11.3 | 19.1 | 4.0 | 3.8 |
| Rural | Cassava | 9.1 | 17.8 | 7.2 | 0.8 |
| Colombia (1981) | | | | | |
| Urban | Wheat | 5.9 | 17.7 | 1.1 | 1.6 |
| Rural | Rice | 7.2 | 14.3 | 0.5 | 0.8 |
| Panama (1980) | | | | | |
| Urban | Rice | 9.6 | 21.0 | 1.8 | 11.7[1] |
| Rural | Rice | 20.0 | 10.6 | 2.2 | 9.0[1] |

[1] Includes eggs

Source: Lizardo de las Casas Moya (1977); IBGE (1977); Sanint, Rivas, Duque and Sere (1985); Franklin, Shearer, Arcia (1984).

TABLE 3. Latin America. Per Capita Consumption of Meats Disaggregated by Region and Rural-urban Residence.

| Country | Beef (kg) | Pork (kg) | Chicken (kg) |
|---|---|---|---|
| Peru (1971-72) | | | |
| North Coast | | | |
| Cities | 12.8 | 20.2 | 6.4 |
| Towns | 15.7 | 20.3 | 3.7 |
| Rural | 6.7 | 17.3 | 1.9 |
| Central Sierra | | | |
| Cities | 15.7 | 19.1 | n.a. |
| Towns | 4.7 | 18.3 | n.a. |
| Rural | 2.7 | 10.4 | n.a. |
| Low Jungle | | | |
| Cities | 11.0 | 20.3 | 6.7 |
| Towns | 8.4 | 11.8 | 3.9 |
| Rural | 0.6 | 4.8 | 2.3 |
| Brazil (1975) | | | |
| South | | | |
| Cities | 31.1 | 1.8 | 10.8 |
| Towns | 21.0 | 3.8 | 9.8 |
| Rural | 7.8 | 7.1 | 10.9 |
| Sao Paulo | | | |
| Cities | 19.0 | 2.9 | 11.0 |
| Towns | 15.9 | 4.2 | 8.9 |
| Rural | 8.2 | 4.2 | 7.1 |
| Northeast | | | |
| Cities | 17.9 | 1.6 | 10.5 |
| Towns | 15.4 | 4.5 | 4.7 |
| Rural | 6.7 | 5.3 | 3.1 |
| Colombia (1981) | | | |
| Atlantic Coast | | | |
| Urban | 46.0 | 1.7 | 3.0 |
| Rural | 30.0 | 1.5 | 1.4 |
| Central Region | | | |
| Urban | 31.9 | 2.6 | 2.2 |
| Rural | 30.6 | 1.2 | 1.1 |
| Eastern Region | | | |
| Urban | 34.9 | 0.4 | 1.4 |
| Rural | 23.0 | 0.2 | 1.0 |

Source: Lizardo de las Casas Moya (1977); IBGE (1977); Sanint, Rivas, Duque and Sere, (1985).

income levels in urban areas but just as probable are the differences in refrigeration and meat retailing. In villages of Colombia consumers must wait for the red flag raised in the morning signifying that an animal has been slaughtered.

The importance of beef in tropical Latin American economies can thus be seen as a 20th century phenomenon, whose genesis lay in the economic history of the continent. Urbanization of Latin American economies provided the markets, and the skewed land distribution and historical accumulation of cattle stocks provided in a sense a latent capacity for livestock production that awaited only market development. Cheap beef found ready markets in urban Latin America and because of its relative price, it became a major item in the food budget. It is tempting to call it an urban staple, a wage good.

Beef is a staple with a significant difference from what that term normally implies. In general it is the major component in the food budget of urban consumers in Latin America. This gives it an important weight in consumer price indices and therefore makes it of political interest to governments trying to hold back inflation. The difficulty with beef as a staple, and therefore in a policy context, is that demand for beef is not highly inelastic with respect to either price or income. The point is made in Table 4, which shows beef consumption by income strata. Beef is important in the food budget of the poor, but, and the but should be emphasized, caloric staples such as rice in Brazil, Colombia, and the Dominican Republic, wheat in Brazil and Peru, and maize in Mexico are usually as important or more important. On the other hand, beef is far more important in the food budget of the rich. Beef is thus not a classic wage good; any benefits from interventions to control beef prices are directed principally at the higher income strata and moreover, because of the relatively higher price and income elasticity (Rivas, et. al., 1986) attempts at controlling prices will either be marginal or extraordinarily expensive. For policies focused on maintaining cheap urban staples, caloric sources have been and will continue to be the appropriate wage goods in a Latin American context.

Nevertheless, the weight that beef has in the Latin American diet, the relatively more elastic demand for the commodity, and the land extensive production systems translate into a significant command on the productive resources of the agricultural sector. Rising demand for beef could bid resources (both land and capital) away from staple commodities whose demand is much more inelastic. However, rising real prices for beef calls into question the potential for substitution in demand. If beef can be substituted for, then there is potential both for controlling meat prices and for intensifying meat production systems in general.

<u>A Chicken in Every Pot: The Poultry Revolution in Latin America</u>

The last quarter of a century has witnessed major divergences in the demand for and the actual consumption of beef (Table 5). Between 1960 and

TABLE 4. Latin America: Shares of the Food Budget Spent on the Principal Caloric Staple and Beef by Income Strata.

| Country | Caloric Staple | | |
|---|---|---|---|
| | Commodity | Share (%) | Beef (%) |
| Peru (1971-72) | | | |
| Lima | | | |
| Lowest decile | Wheat | 11.2 | 5.1 |
| Second decile | Wheat | 10.0 | 5.3 |
| Third decile | Wheat | 9.6 | 7.8 |
| Highest decile | Wheat | 10.3 | 15.7 |
| Brazil (1975) [1] | | | |
| Porto Alegre | | | |
| Lowest strata | Wheat | 10.6 | 14.0 |
| Second strata | Wheat | 11.2 | 13.2 |
| Third strata | Wheat | 10.1 | 14.5 |
| Highest strata | Wheat | 4.3 | 16.2 |
| Sao Paulo | | | |
| Lowest strata | Rice | 13.9 | 8.4 |
| Second strata | Rice | 12.6 | 11.6 |
| Third strata | Rice | 10.7 | 12.6 |
| Highest strata | Wheat | 4.5 | 13.5 |
| Recife | | | |
| Lowest strata | Wheat | 15.2 | 13.2 |
| Second strata | Wheat | 14.7 | 14.8 |
| Third strata | Wheat | 15.5 | 15.4 |
| Highest strata | Wheat | 9.3 | 19.6 |
| Colombia (1981) | | | |
| Urban | | | |
| Lowest quintile | Sugar | 12.0 | 14.2 |
| Highest quintile | Rice | 4.2 | 16.6 |
| Mexico (1977) | | | |
| National Level | | | |
| Lowest decile | Maize | 30.6 | 4.4 |
| Second decile | Maize | 24.3 | 5.6 |
| Third decile | Maize | 19.6 | 7.2 |

[1] Nine strata, are defined.

Source: Lizardo de las Casas Moya (1977); IBGE (1977); Sanint, Rivas, Duque and Sere (1985); Lustig (1980).

TABLE 5. Beef and Veal. Annual Growth Rates of Potential Domestic Demand and Production by Country. Average 1970/81.

| Region and Country | Annual Growth Rate Demand (%) | Production (%) |
|---|---|---|
| Tropical Latin America | 5.3 | 2.2 |
| Brazil | 6.1 | 1.5 |
| Mexico | 4.4 | 3.3 |
| Bolivia | 4.9 | 4.9 |
| Colombia | 4.9 | 3.5 |
| Ecuador | 8.9 | 5.3 |
| Paraguay | 4.4 | - 1.1 |
| Peru | 3.0 | - 1.3 |
| Venezuela | 4.2 | 5.4 |
| Cuba | 4.5 | - 2.6 |
| Dominican Rep. | 6.0 | 3.4 |
| Central America and Panama | 4.0 | 3.3 |
| Costa Rica | 4.8 | 6.3 |
| El Salvador | 3.9 | 3.4 |
| Guatemala | 5.2 | 3.9 |
| Honduras | 3.6 | 5.2 |
| Nicaragua | 1.6 | - 1.1 |
| Panama | 3.5 | 1.3 |
| Caribbean | 3.2 | 2.0 |
| Guyana | 1.5 | - 1.1 |
| Haiti | 4.5 | 2.7 |
| Jamaica | - 0.6 | 2.0 |
| Trinidad and Tobago | 5.1 | 2.3 |

Source: CIAT, 1985

1985 growth in beef production has slowed down and per capita consumption levels have declined in tropical Latin America. Given the respectable growth in per capita income levels, declining per capita availabilities has resulted in a widening divergence between growth in consumption and growth in demand, a situation that puts upward pressure on prices. Beef prices have in general increased, but not enough to explain the difference in demand growth (Table 6).

Price increases have occurred in a period when many governments have had a clear policy objective of controlling inflation. In most countries real beef prices have increased but at a lower rate than suggested by demand growth. In some cases governments have intervened in the beef market in order to control variability and increases in beef prices. This intervention is clearest in Brazil, where up to 1982 the government bought and stored refrigerated beef. On average 10% of annual beef production went into government controlled freezer storage (Rivas, et.al., 1986), a program which was very costly to operate and which in the end is counter productive within the context of beef cycles (Jarvis, 1986).

However, a far more dominant influence on beef prices over the past 25 years was the rapid rise in poultry production. Production of chicken meat has grown at a sustained rate of about 9% per year in tropical Latin America over the 1968/84 period. In Brazil poultry production -- or at least commercial production -- grew at an annual rate of 26% from 1960 through 1983. Such growth, even from a relatively small initial level, is rare and reflects the dynamism that can arise when technological change is linked to an expansive market. As a result per capita consumption of chicken meat in tropical Latin America increased from 4.8 kg. in the 1969/76 period to 8.2 kg. in the 1978/85 period, a level that is now well over half the per capita consumption level of beef (14.0 kg). Chicken meat thus allowed an expansion in total meat consumption, i.e. beef, pork, and chicken, increasing its relative share from 18% to 29%.

Increasing consumption at such rates was motivated by the declining real price of poultry meat, which in turn was possible because of declining costs due to technical change. Moreover, the price of chicken declined even more relative to the reference meat, beef (Table 7). In countries such as Brazil, Colombia and Peru chicken was more expensive than beef in the 1960's and in the early 1970's chicken became cheaper, with the price difference widening through the 1970's and 1980's. In other countries, such as Mexico, Venezuela, Jamaica and the Dominican Republic beef and chicken were similarly priced in the early 1960's. However, again the tendency was for chicken to become increasingly less expensive relative to beef. Declining prices and increased incomes certainly induced increased consumption levels of chicken. The question, however, is whether changing relative prices caused a substitution of beef by increased chicken consumption.

Income growth was not the dominant force influencing consumption trends in meats; rather, prices played a much more significant role. Based

TABLE 6. Latin America: Comparison between Growth in Excess Demand and Real Price[1] Increases for Beef, 1970-81.

| Country | Production Growth (%) | Demand Growth (%) | Growth in Excess Demand (%) | Growth in Real Prices (%) |
|---|---|---|---|---|
| Brazil | 1.5 | 6.1 | 4.6 | 3.0 |
| Colombia | 3.5 | 4.9 | 1.4 | - 0.7 |
| Ecuador | 5.3 | 8.9 | 3.6 | 3.0 |
| Paraguay | - 1.1 | 4.4 | 5.5 | - 0.4 |
| Peru | - 1.3 | 3.0 | 4.3 | 3.1 |
| Venezuela | 5.4 | 4.2 | - 1.2 | 6.7 |
| Dominican Republic | 3.4 | 6.0 | 2.6 | - 1.1[2] |
| Panama | 1.3 | 3.5 | 2.2 | 2.7 |

[1] Retail Prices [2] 1974-84.

Source: CIAT (1985) and national statistical (price) sources.

TABLE 7. Latin America. Growth Rates of Retail Prices for Meats, 1965-84.

| Country | Beef (%) | Chicken (%) |
|---|---|---|
| Colombia (1960-84) | - 0.4 | - 3.6 |
| Brazil (1960-82) | 2.4 | - 2.7 |
| Ecuador (1970-84) | 2.7 | - 0.1 |
| Peru (1966-83) | 2.3 | - 4.1 |
| Venezuela (1965-84) | 2.2 | - 2.4 |
| Panama (1960-84) | 1.7 | - 2.1 |
| Dominican Republic (1974-84) | - 1.1 | - 2.9 |

Source: CIAT data files derived from national statistical sources.

on the study by Rivas, et.al. (1986) the own price elasticity for beef varies between .05 and .78, with four of the seven countries having a price elasticity below .25 (Table 8). Beef consumption is moderately inelastic with respect to price, a finding that reflects the relatively high consumption levels for the meat. For chicken, on the other hand, the own price elasticity varies from .12 to 1.72 but with the elasticity being greater then .90 in four of the countries. Consumption of chicken meat is thus very responsive to price changes, a fact reflected in the declining price trends and the high growth rates in per capita consumption. However, what is particularly salient is that the cross-price elasticity, measuring the substitution of beef by chicken, is either similar to or in the case of Brazil significantly larger than the own price elasticity for beef [1/]. In general, a change in the chicken price will have as much influence on beef consumption as an equivalent change in the beef price itself. These cross-price elasticities vary between .4 and .74. Then considering the very significant rates of decline in chicken prices, the substitution effect plays a significant role in holding down beef prices -- this is clearest in Brazil (Table 9). Moreover, the total effect of price changes (both own-price and the substitution effects) has a more dominant influence on demand than income changes.

Consumer budget surveys from Peru and especially Brazil give a more detailed look at changes in meat consumption. What is apparent in major metropolitan areas of Brazil between 1960 and 1975 is the declining consumption of beef and the rising consumption of poultry. Consumption of chicken meat increased across all income strata, while that of beef tended to decline across all income strata (Figures 2 and 3). These trends again support the dominance of the price effect over the significant growth in income during the period.

The most significant substitution of chicken for beef was among the lower income strata. Chicken was rarely eaten by the urban poor in the 1960's. By 1975 chicken was virtually on a par with beef, as the principal meat eaten by the lower income strata. As significant, however, the total consumption of meat by the poor declined over the period in the Northeast of Brazil. Vergolino (1980) presents data for Recife to show the

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1/ In Jamaica, Venezuela and the Dominican Republic the cross-price elasticity was either not significant from zero or negative, the latter indicating complementarity, which is nevertheless doubtful. The cross-price elasticity of chicken consumption with respect to beef prices was in all cases positive. Such non-symmetry in sign is not possible. In all these countries the own-price elasticity for beef is not significant from zero and moreover, chicken is a large consumption item, with per capita consumption levels being higher than beef in Jamaica and the Dominican Republic. Under such circumstances the structural model was not able to distinguish between the effect of the two prices on meat consumption.

TABLE 8. Latin America: Estimates of Demand Elasticities for Beef and Chicken Meat.

| Country | Beef | | | Chicken | | |
|---|---|---|---|---|---|---|
| | Income | Own Price | Cross Price | Income | Own Price | Cross Price |
| Colombia | 0.72 | - 0.69 | 0.42 | 0.88 | - 0.46 | 0.61 |
| Peru | 0.85 | - 0.42 | 0.40 | 0.75 | - 1.19 | 0.66 |
| Venezuela | 0.37 | - 0.05[a] | - 0.33 | 1.09 | - 0.92 | 0.44 |
| Brazil | 0.32 | - 0.23 | 0.50 | 1.69 | - 1.26 | 0.03[a] |
| Mexico | 0.37 | - 0.78 | 0.74 | 0.74 | - 0.62 | 0.22 |
| Dominican Rep. | 0.77 | - 0.14[a] | - 1.12 | 0.00[a] | -0.12 | 0.19[a] |
| Jamaica | 0.67 | - 0.12[a] | -0.20[a] | 0.80 | -1.72 | 1.27 |

[a] The estimate is not significant at the 10% probability level.

Source: Rivas, Sere, Sanint and Cordeu (1986).

TABLE 9. Brazil: Disaggregation of Factors Influencing the Growth in Beef Demand, 1960-82.

| Demand Component | 1960-67 (%) | 1968-75 (%) | 1976-82 (%) | Average (%) |
|---|---|---|---|---|
| Actual Per Capita Consumption | - 1.2 | 1.3 | - 2.8 | 0.3 |
| Income Effect ($\epsilon$ = .32) | 0.8 | 2.7 | 0.8 | 2.0 |
| Growth in Excess Demand | 2.0 | 1.4 | 3.6 | 1.7 |
| Implied Price Change ($\epsilon$ = -.23) | 8.7 | 6.1 | 15.7 | 7.4 |
| Actual Change in Beef Price | 2.9 | 8.2 | 3.3 | 2.4 |
| Actual Change in Poultry Price | - 2.3 | - 0.6 | - 6.3 | - 2.7 |

Figure 2. Recife, Brazil: Comparison of Consumption of Beef and Chicken by Income Strata, 1960 and 1975.

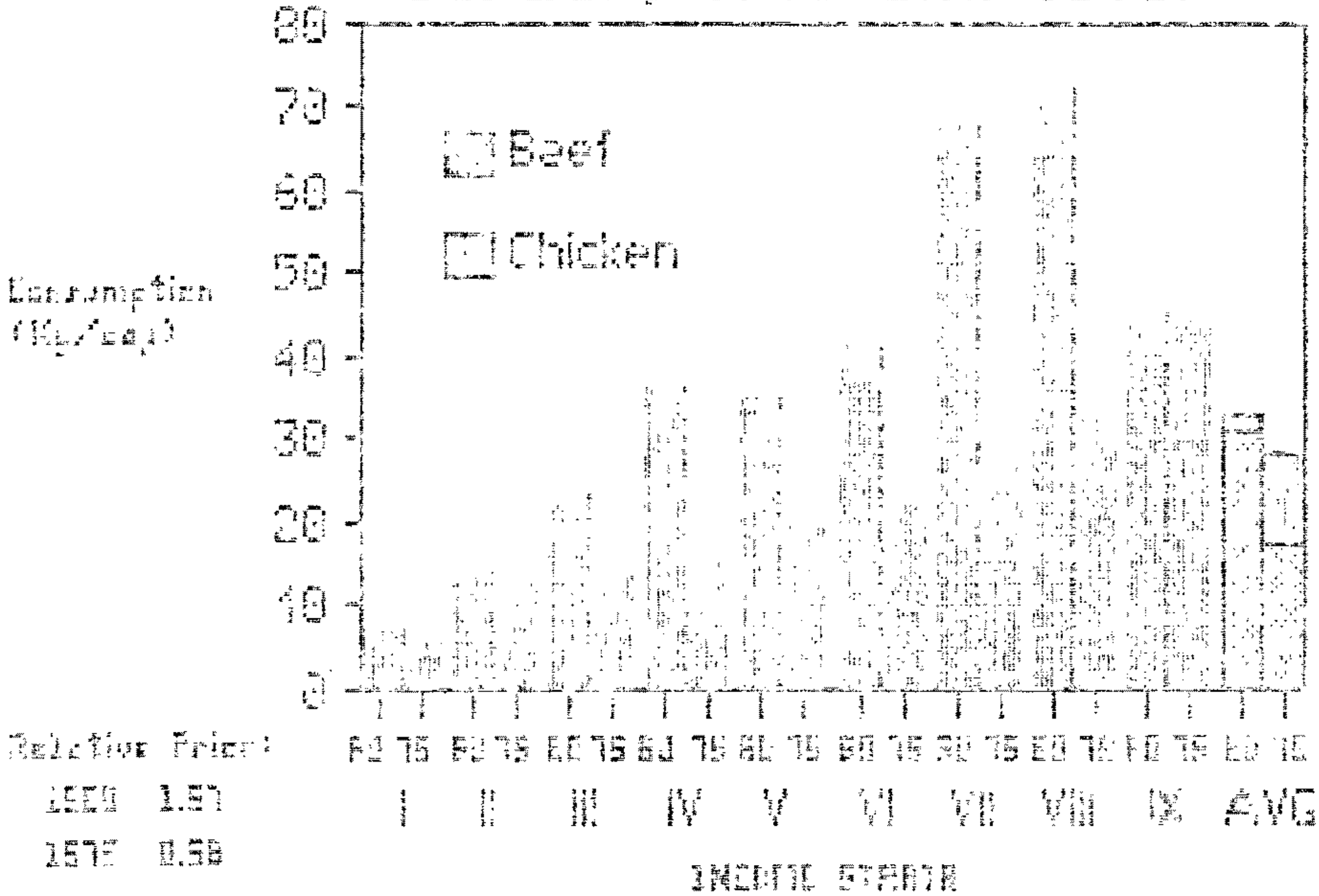
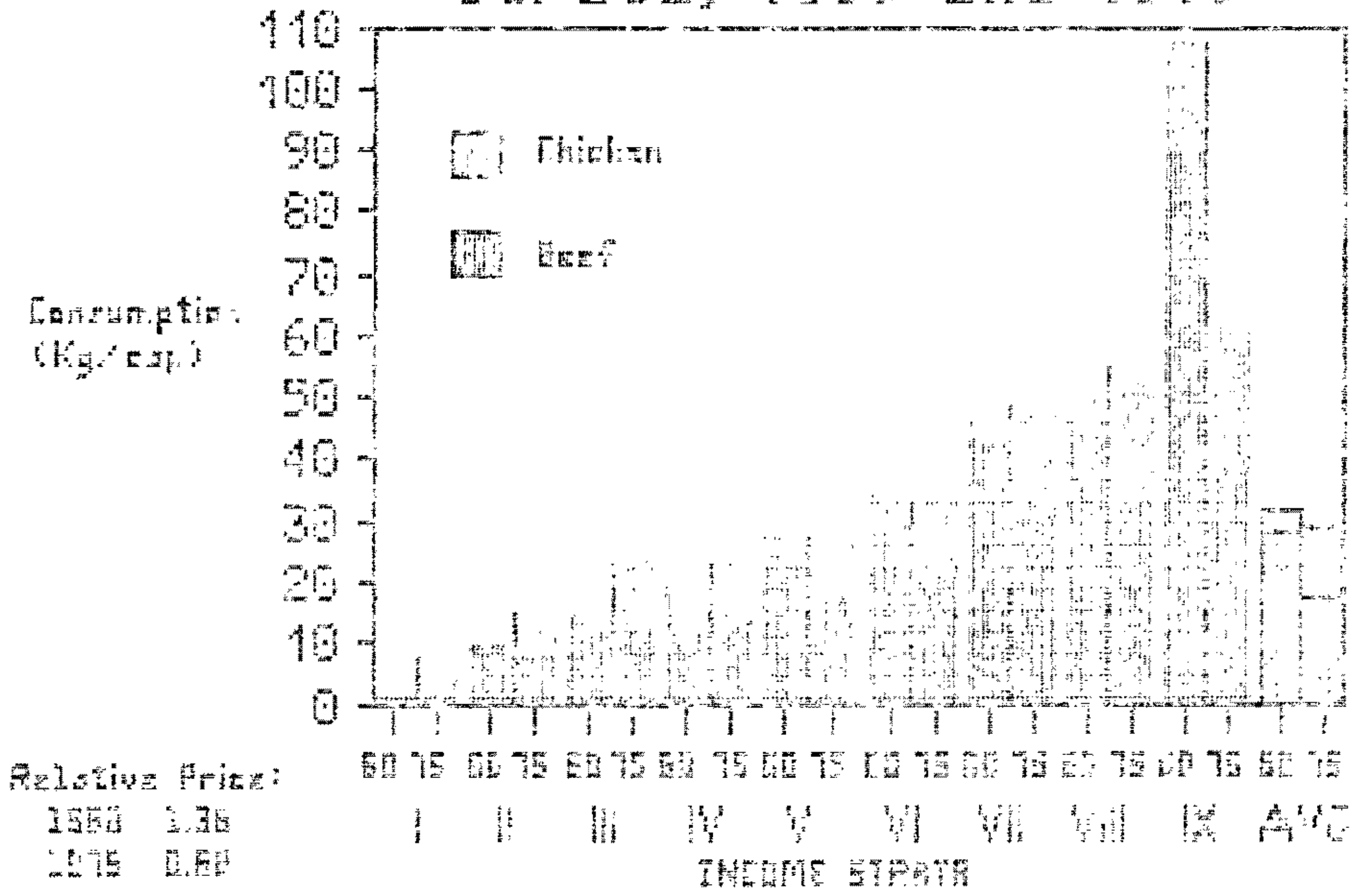


Figure 3. Sao Paulo, Brazil: Comparison of Consumption of Beef and Chicken by Income Strata, 1960 and 1975



consistency of this trend (Table 10). Rising beef prices were squeezing the meat consumption of the poor, even though there was a significant switch into chicken. Finally, the data for Peru (Table 11), suggest how rapidly substitution can take place when the change in relative prices is so marked.

Chicken is now the principal meat in the diet of every Caribbean country except Haiti and Cuba. In Peru also, chicken is the dominant meat. If current production trends in beef and poultry continue (obviously a big assumption), by the end of the century poultry will have passed beef as the major meat source in most of the other countries of tropical Latin America, apart from Colombia, Panama, Paraguay and Costa Rica. This represents a revolution of some magnitude and thus begs the question of whether these trends can continue, an issue which turns the analysis to an evaluation of the production side.

## The Intensive Versus the Extensive Frontier

Comparatively little meat moves in international trade. Transport costs are such that domestic production usually has an advantage over imports, even in the case of East Asia where the bulk of the feed ingredients must be imported. If the major portion of increasing demand for meat in Latin America is to be met by domestic production and if the different meats are substitutable to a relevant degree, then the policy question revolves around the production options open to meeting the increasing demand for meat. This leads naturally to a consideration of the potential for expanding and/or intensifying beef production systems versus the potential for expanding and/or intensifying swine or poultry production systems. The central question for Latin America is whether these two options are complementary to a relevant degree or whether at some point they become competitive.

Beef production systems in Latin America are land extensive. Some countries, such as those in the Caribbean which do not have the land resources or such as Peru which lacks extensive grasslands, have met rising meat demand by dependence on pork and poultry production. All the other countries of tropical Latin America have extensive grasslands. Growth in beef production in tropical Latin America to date has depended principally on increasing pasture area (Table 12), i.e. growth through expanding extensive production systems. Only Brazil and Venezuela have managed a consistent increase in the carrying capacity of its pastures. In these two cases there was a degree of excess capacity and a reliance (more so in the case of Venezuela) on natural savanna with a low carrying capacity. Only recently have both countries reached levels similar to other Latin American countries.

The potential for meeting the increasing demand for beef purely by horizontal expansion in most countries is limited. During the 1970's and 1980's countries such as the Caribbean countries, Mexico, Ecuador, El Salvador, Guatemala and Peru reached a situation where any expansion in

TABLE 10. Brazil: Trends in Annual Per Capita Consumption of Beef and Poultry in Recife.

| Year of Consumer Survey | Average Consumption | | Low Income Strata 1/ | |
|---|---|---|---|---|
| | Beef (kg) | Poultry (kg) | Beef (kg) | Poultry (kg) |
| 1961/62 | 31.6 | 1.3 | n.a. | n.a. |
| 1967/69 | 28.4 | 5.2 | 14.5 | 0.5 |
| 1973 | 23.0 | 13.0 | 8.9 | 3.7 |
| 1975 | 17.9 | 10.5 | 4.4 | 2.5 |

1/ Families with income less than one minimum salary

Source: Vergolino, 1980.

TABLE 11. Peru: Consumption Changes for Beef and Poultry by Income Strata in Lima, 1972-1979.

| Year | Consumption per Family | | | | Real Prices (1973 = 100) | |
|---|---|---|---|---|---|---|
| | Low Income Strata | | Medium Income Strata | | | |
| | Beef (g/day) | Poultry (g/day) | Beef (g/day) | Poultry (g/day) | Beef (Soles/kg) | Poultry (Soles/kg) |
| 1972 | 136 | 126 | 241 | 177 | 44.9 | 75.7 |
| 1976 | 56 | 318 | 75 | 425 | 65.3 | 45.9 |
| 1979 | 29 | 210 | 90 | 290 | 50.5 | 47.6 |

Source: Ministerio de Agricultura, 1985

TABLE 12. Latin America: Changes in Cattle Stocks, Pasture Area and Stocking Rate in Selected Producing Countries, 1950-1980.

| Country and Year | Cattle Stock (1000 head) | Pasture Area (1000 ha) | % Pasture Cultivated (%) | Stocking Rate (head/ha) | Pasture Area as % of Total Farm Area (%) |
|---|---|---|---|---|---|
| Brazil | | | | | |
| 1950 | 47,089 | 107,633 | 13.9 | .44 | 46.4 |
| 1960 | 57,102 | 122,335 | 16.4 | .47 | 49.0 |
| 1970 | 78,562 | 154,139 | 19.3 | .51 | 52.4 |
| 1975 | 101,674 | 165,652 | 24.0 | .61 | 51.1 |
| 1980 | 118,086 | 174,500 | 34.7 | .68 | 47.8 |
| Venezuela | | | | | |
| 1950 | 5,769 | 13,501 | 12.1 | .43 | 61.0 |
| 1961 | 6,519 | 16,608 | 16.6 | .39 | 63.9 |
| 1971 | 8,678 | 16,080 | 31.8 | .52 | 60.7 |
| 1980 | 10,791 | 17,471 | 32.4 | .62 | n.a. |
| Panama | | | | | |
| 1950 | 570 | 552 | 77.4 | 1.03 | 47.6 |
| 1961 | 763 | 818 | 83.5 | .93 | 45.3 |
| 1971 | 1,260 | 1,141 | 84.6 | 1.10 | 46.0 |
| 1980 | 1,345 | 1,296 | 78.4 | 1.04 | 57.4 |
| Costa Rica | | | | | |
| 1950 | 608 | 617 | 40.0 | .98 | 34.5 |
| 1963 | 1,051 | 937 | 42.7 | 1.12 | 35.1 |
| 1974 | 1,694 | 1,558 | 47.0 | 1.09 | 49.9 |
| Colombia | | | | | |
| 1960 | 14,781 | 14,606 | n.a. | .66 | 53.6 |
| 1971 | 19,808 | 17,930 | n.a. | .70 | 57.1 |

Source: Agricultural Censuses for the various countries; data for Colombia is from Hertford and Nores (1982).

pasture had to compete with cropland. These countries depended on quite significant rates of growth in poultry production to meet rising meat demand. There is some potential to bring additional land under grazing in the rest of Latin America but only in Brazil, Venezuela and Colombia does the potential exist to meet rising beef demand purely by horizontal expansion. In these countries the issue is more what factors will be responsible for inducing growth, especially when continued growth in poultry and, to a more limited extent, pork is also an option.

Technical change in beef production systems is critical to determining the future share that beef will have in overall meat consumption in tropical Latin America. This is a particularly complex issue on which volumes have been written, but what is relevant in the current context is some speculation about the overall determinants that will induce increased productivity in beef production systems and a delineation of the policy choices. Jarvis (1986) has recently reviewed many of these issues. Two principal points seem to come out of this analysis. First, technological change within beef production systems usually requires an interacting complex of changes within the overall production system [2/]. Although this conclusion is based on experience with livestock development projects in the Southern Cone, technical change in tropical beef systems as well must anticipate both an adoption sequence within an overall technological package and significant interactions between management and the return on the investment required in applying the technology.

Second, tropical beef systems, while implying a significant capital investment, are nevertheless low-input, low-productivity systems. Capital is the constraining factor in the system. Investment in new technology usually will be recouped by a future stream of benefits and therefore, will in general depend on an improved, initial cash flow. Incorporation of a cropping component or milking can be a critical element in developing the cash flow that will sustain the investment program. However, again this implies a significant increase in management resources devoted to the overall enterprise.

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2/ Jarvis (1986) makes the point thusly: "But more productive pastures (particularly the fertilized grass-legume mixes) mean increased variable costs and require more sophisticated management if they are to be profitable. Herd expansion is necessary to utilize fully the increased pasture production and to justify the increased expenses, and the additional animals must be purchased, for natural herd buildup takes several years, and to wait that long for increased production would sharply reduce the profitability of the investment. Because diseases are more damaging to profitability in a high-production operation, improved health practices are needed. Time-honored traditional practices must be discarded and others must be learned to obtain the productivity desired from the new package (p.132)."

These issues can be extended to a macro-scale by analyzing the case of Brazil. What is found in Brazil is a significant structural change in the location of beef production. There has been a basic shift in beef production out of the South and Southeast and into the Center-West and, to a lesser extent, the North (Table 13). Cattle herds in the Northeast increased at about the same rate as the overall rate in Brazil as a whole. There are two elements to this process. First, in the period there was a dynamic increase in crop area in the South and Southeast, especially soybeans and wheat in the South and sugarcane, citrus and soybeans in the Southeast. This put a brake on the expansion in pasture area in the two regions. Neither increasing productivity nor rising beef prices were sufficient to motivate a significant production response. This, in turn, opened a window for the expansion of beef systems into the cerrados of the Center-West. This expansion, however, depended on the sowing of pasture, given the low carrying capacity (0.2 animal units per hectare) of the natural savannas. This was supported by the very significant credit and transport subsidies given to first rice and then maize production in this region. Crop production during the period was a component of beef systems in the cerrados (Vera and Sere, 1985) and supported the sowing of pastures. Thus, a dynamic crop sector in traditional production zones and policy support (through crop subsidies) to pasture establishment in the cerrados, resulted in an overall shift in the locus of beef production to the Center-West.

Making future increases in beef production dependent on the cerrados and, to a more limited extent, the Northeast is a reasonable but riskier strategy. The risk arises in the dependence on technology for expansion of beef production in the cerrados and the underlying structural features of land settlement in these areas. The first factor lending instability to this expansion is the changes in crop policy. The recent policy emphasis in the rice sector is to shift production to the irrigated sector of the South and Northeast. Maize, on the other hand, is not well adapted to the soils typical of the region and requies significant inputs and a transport subsidy to remain competitive. The second factor is the management constraint as a determinant of the rate of sowing of improving pastures. This is portrayed in Table 14 which suggests that the increasing area in pastures in the Center-West is coming in farm sizes of 500 hectares and over and that there is a strict negative relationship between farm size and stocking rate (and implicitly the stringency of the management constraint in the effective utilization of the pasture resource, especially when it is noted that the percentage distribution of cultivated pasture is not significantly different between farm sizes). Moreover, milking declines in importance in this range of farm sizes. Since pasture technology is key to an increased growth in beef production in the Center-West, a principal issue is the limits farm size places on the adoption and effective utilization of that technology.

The case of Brazil brings into sharper focus then the determinants of increased growth in beef production in the rest of tropical Latin America. The cases of Brazil, Venezuela and Colombia are in one sense unique because

TABLE 13. Brazil: Changes in the Distribution of Cattle Stock and Pastures by Major Regions, 1970-80.

| Year and Region | Cattle Stock | | | | Pasture Area | | |
|---|---|---|---|---|---|---|---|
| | Beef (000 head) | Milk (000 head) | Dual Purpose (000 head) | Total (000 head) | Total (000 ha) | Percent Cultivated (%) | Stocking Rate (head/ha) |
| North | | | | | | | |
| 1970 | 1,346 | 131 | 206 | 1,706 | 4,428 | 14.4 | .39 |
| 1975 | 1,684 | 142 | 299 | 2,130 | 5,281 | 29.8 | .40 |
| 1980 | 3,555 | 307 | 123 | 3,989 | 7,722 | 48.8 | .52 |
| Northeast | | | | | | | |
| 1970 | 7,328 | 3,701 | 2,466 | 13,806 | 27,875 | 20.6 | .50 |
| 1975 | 11,307 | 3,507 | 3,012 | 18,041 | 30,624 | 22.3 | .59 |
| 1980 | 15,572 | 4,283 | 1,502 | 21,506 | 34,159 | 30.3 | .63 |
| Southeast | | | | | | | |
| 1970 | 10,431 | 13,148 | 2,995 | 26,845 | 44,739 | 23.8 | .60 |
| 1975 | 17,803 | 11,749 | 5,540 | 35,237 | 47,277 | 24.4 | .75 |
| 1980 | 20,199 | 11,633 | 2,949 | 34,835 | 43,639 | 37.1 | .80 |
| South | | | | | | | |
| 1970 | 11,694 | 5,506 | 1,545 | 18,953 | 21,613 | 16.8 | .88 |
| 1975 | 14,499 | 3,935 | 2,483 | 21,516 | 21,160 | 21.0 | 1.02 |
| 1980 | 18,721 | 4,710 | 909 | 24,495 | 21,313 | 26.4 | 1.15 |
| Center-West | | | | | | | |
| 1970 | 12,699 | 2,726 | 1,774 | 17,252 | 55,483 | 16.4 | .31 |
| 1975 | 20,446 | 1,622 | 2,669 | 24,750 | 61,310 | 24.9 | .37 |
| 1980 | 29,258 | 2,821 | 1,178 | 33,261 | 67,666 | 57.4 | .49 |
| Total | | | | | | | |
| 1970 | 43,498 | 25,213 | 8,986 | 78,562 | 154,139 | 19.3 | .51 |
| 1975 | 65,739 | 20,956 | 14,003 | 101,674 | 165,652 | 24.0 | .61 |
| 1980 | 87,306 | 23,754 | 6,661 | 118,086 | 174,500 | 34.7 | .68 |

Source: IBGE, 1974, 1979, 1984.

TABLE 14. Brazil: Distribution of Pasture Area and Cattle Stock by Farm Size and Selected Productivity Measures, 1980.

| Farm Size Strata (ha) | Pasture Area (1000 ha) | % Pasture Cultivated (%) | % Increase Pasture Area 1970-1980 (%) | Cattle Stock (1000 head) | % Cows Milked (%) | Stocking Rated (head/ha) |
|---|---|---|---|---|---|---|
| Less than 5 | 404 | 35.4 | 9.0 | 2,065 | 17.0 | 5.11 |
| 5-10 | 1,012 | 34.8 | 0.9 | 2,353 | 19.9 | 2.32 |
| 10-20 | 2,801 | 33.8 | 0.6 | 4,796 | 21.3 | 1.71 |
| 20-50 | 8,889 | 33.8 | 0.0 | 10,509 | 18.8 | 1.18 |
| 50-100 | 11,292 | 34.1 | 3.6 | 10,484 | 17.3 | .93 |
| 100-200 | 15,884 | 35.1 | 8.1 | 13,003 | 15.3 | .82 |
| 200-500 | 27,555 | 36.0 | 9.1 | 20,347 | 11.8 | .74 |
| 500-1000 | 22,654 | 38.2 | 12.5 | 15,316 | 7.7 | .68 |
| 1000-2000 | 21,715 | 37.3 | 17.5 | 13,633 | 4.9 | .63 |
| 2000-5000 | 24,404 | 37.9 | 16.2 | 12,954 | 2.9 | .53 |
| 5000-10,000 | 12,756 | 33.6 | 16.9 | 5,265 | 1.8 | .41 |
| More than 10,000 | 25,134 | 25.9 | 27.8 | 7,277 | 0.8 | .29 |
| Total | 174,500 | 34.7 | 12.3 | 118,086 | 10.5 | .68 |

Source: IBGE (1984)

of the extensive areas of underexploited savanna. Land rights in this "extensive frontier" have already been largely determined, being distributed in very large farms. Further sub-division of farms based on migration into these areas and buying of relatively cheap land is conditioned to a large degree by migration patterns in these countries. All have reached the demographic transition in which the rural population has started to decline absolutely and the urban centers have become principal poles for rural out-migration. As in Brazil, intensification of the llanos areas of Colombia and Venezuela will depend on the crop-livestock competition in the longer-settled agricultural regions. Venezuela has more recently developed price supports and input subsidies for expansion in maize, sorghum and rice production. However, since a crop component is instrumental to pasture establishment and improvement in beef production systems, the result of this has been to improve beef systems closer to markets (both crop and meat markets) rather than shift the comparative advantage to the further reaches of the llanos. In Colombia the same thing has happened to a more limited extent in the Atlantic Coast and Piedmont areas, with no shift in comparative advantage to the llanos. Outside these three countries crops and/or milking are becoming a more integrated feature of beef production systems as market pressures, a more manageable farm size and the complementarities between crop production and pasture extablishment contribute to increased productivity.

However, this expansion in feedgrain and, to a certain extent, oilseed production is a response to the even faster development of the "intensive frontier" in the tropical Latin American meat sector. Expansion of the intensive frontier is well represented by evolution of the poultry industry in tropical Latin America and the swine sector in the south of Brazil, in Venezuela and in parts of Mexico and Paraguay. In fact, the poultry revolution in Latin America, as in Asia, represented not so much an intensification of current production systems as a complete restructuring of the sector. The impetus was the rising demand for meat, aided by rising beef prices and urbanization. Whereas traditional production was oriented to rural consumption, the rise of large-scale broiler operations, often vertically linked to feed concentrate manufacturers, was oriented to the development of urban markets. Marketing of chicken followed the development of supermarkets as a major form of food retailing and the rise of "fast food" chicken restaurants. The whole poultry sector was transformed from retailing, through production and provision of feed sources. This restructuring allowed for significant gains through economies of scale at all levels.

Economies of scale were probably even more important in the decline of poultry prices than was technical change, which is not to diminish the role played by new technology. Balanced feed technology together with new breeds, often introduced from the United States, resulted in a significant decline in the amount of feed needed to produce a kilogram of meat. Mortality measures were reduced by antibiotics, the time to slaughter weight declined, and slaughtering technology allowed factory-scale operations. The impact was a significant reduction in per unit costs and as importantly an ability to adjust production levels very quickly to changes in profitability, whether due to output or feed price changes. For those governments concerned about the inflationary impact of meat prices, the poultry industry allowed much more control over market prices. As the weight of chicken meat increased in the consumers' budget, in some cases to a parity with beef, the supply responsiveness and weight in the consumer budget drew meat sector policies toward the poultry industry.

Feed is the dominate cost in the production of poultry meat, making up to 80% of the total (Table 15). It is this switch from land devoted to pasture to land planted to feed crops that forms the basis of the development of the intensive frontier. On average a hectare of land in Brazil can produce 1.8 tons of maize or 1.3 tons of soybean meal. With a conversion rate of 3.4 kg of feed for every 1 kg of chicken meat, a hectare of land can produce 490 kg of meat. By comparison the average annual production of beef per hectare in Brazil is 15 to 20 kg. Per hectare costs are obviously very different between beef and chicken and the quality of the land is often quite different, but the option is clear in those agricultural economies that have exhausted their agricultural frontier or for the other countries where the rate of expansion of pasture land is insufficient to accomodate rising meat demand. Moreover, the dynamics of the process suggest that the faster the expansion of the intensive frontier, the slower T 15 the rate of expansion at the extensive frontier (Upton, 1976) or the greater the need for technical change in the process of developing the extensive frontier.

The feed concentrate industry has in most instances been the lead sector in the development of the poultry industry. It is the growth node, with forward linkages to poultry producers and backward linkages to feed grain producers. The dynamism of the balanced feed industry establishes the limits on poultry expansion and establishes the market growth for feed ingredients. This industry has been dynamic indeed, with annual growth rates in almost all countries of well over 10% (Table 16). The major portion of feeds are directed to poultry but swine feeds form a significant component in countries such as Mexico and Venezuela. There has been little difficulty in drawing investment resources into the industry at rates sufficient to maintain growth rates. To date only government interventions have limited growth in the concentrate industry. Examples are the price controls on eggs and poultry meat in Mexico and Peru, often creating a cost-price squeeze, and the controls on imports of feed ingredients in Colombia and to a certain extent, Ecuador.

The expanding concentrate industry precipitated a rapid rise in the demand for feed components, especially carbohydrate sources. This resulted in significant demand-led growth in the feedgrain sector. In some countries, feedgrain demand was met by the expansion of an already existing maize production base; in other countries sorghum expanded rapidly as a new crop. In no tropical Latin American country, except for Paraguay, was the expansion in production always able to meet the increases in demand. All-these countries turned to imports of feedgrains, with import volumes

TABLE 15. Peru and Brazil: Cost Distribution (as a Percent of Total Production Costs) in the Production of Broilers.

| Cost Component | Minas Gerais, Brazil May 1978 (%) | Lima, Peru May 1986 (%) |
|---|---|---|
| Feed | 65.6 | 77.6 |
| Day-old Chicks | 19.5 | 15.6 |
| Vaccine | 0.5 | 1.5 |
| Litter | 0.2 | 0.7 |
| Disinfectant | 0.8 | 0.4 |
| Water | 0.9 | 2.2 |
| Labor | 3.8 | 0.9 |
| Other | 8.7 | 1.1 |
| Total (%) | 100.0 | 100.0 |
| (Cost/kg) | Cr$12.07 | 12.94 Intis |

Note: Costs for Brazil are based on a lot size of 5,000 birds; that for Peru is based on a lot size of 100,000 birds.

Source: Informe Agropecuario (1978) and Malarin (1986).

TABLE 16. Latin America: Characterization of the Mixed Feed Industry.

| Country | 1984 Production (000 t) | Percent Poultry (%) | 1970-84 Growth Rate (%) |
|---|---|---|---|
| Brazil | 10,824 | 67 | 11.0 |
| Colombia | 1,536 | 76 | 18.6 |
| Peru | 595 | 73 | 4.6 |
| Venezuela | 2,244 | 66 | 9.9 |
| Mexico | 8,500 | 53 | 5.8 |
| Jamaica | 227 | 62 | n.a. |

Source: Associations of Feed Manufactureres in the individual countries growing rapidly in all but a few cases. At this point the analysis turns to a closer evaluation of the determinants of the supply of carbohydrate components for animal feeds.

The Grain Divide: The Choice of Carbohydrate Source in Feed Demand

A rapidly expanding feed concentrate industry, led by the increasing demand for animal products, can create either a very dynamic domestic grain sector, rising real prices of grains or increasing grain imports. A dynamic grain sector creates obvious positive benefits but rising grain prices or imports can raise significant policy problems. Increasing demand for maize as a feed source, particularly, has significant implications for countries in Latin America where maize is a primary food source and which often intervene in maize markets to keep consumer prices low to poorer segments of the population. Yotopopoulos (1983) argues that the rising income of the middle income classes leads to rising demand for income elastic foods, particularly meat, which in turn can bid grain prices up; the latter obviously can have a negative effect on the nutrition of the poor, who depend on such grains as a primary calorie source in their diet. However, in Latin America governments have taken steps to minimize this competition, enhancing natural segmentation in grain markets based on price and quality factors.

Grains are virtually perfectly substitutable in balanced feed rations -- factors such as carotene, tannins, and amino acid content do result in price differentials but do not hinder substitution -- but this is definitely not the case in the human diet. Substitution between rice, wheat and maize does occur but only to a more limited degree and sorghum is not seen as a food except in very limited, rural areas of Central America and Haiti. What is also clear in Latin America is that food uses will always bid grains away from feed uses, not vise versa. Rice is rarely used in animal feeds and wheat only slightly less often in Latin America, principally because the nutrient content is too expensive relative to alternatives. Moreover, in countries where hard (dent or flint) maize is a major food source, sorghum is normally the principal grain used in feed rations. This is certainly the case in Mexico, Nicaragua, Venezuela and Colombia -- in the latter country maize is only of regional importance in human diets. There is a natural evolution to that grain which does not compete in the food economy, essentially because too often the foodgrain becomes too expensive or too scarce to sustain the animal feed industry.

In countries such as Brazil, Dominican Republic, Jamaica, Ecuador, Peru, and Panama maize is the principal grain in feed rations. In all these countries rice and/or wheat is the major foodgrain. In most of these countries root crops and plantains are also important calorie sources. In Ecuador and Peru soft or floury maize is a regionally important food source but this is a distinct commodity from the hard maize. In all these latter countries hard maize is a minor food consumption item with readily available supplies of more preferred grains. In such a food economy, changes in overall food demand for maize will have little impact on its price. Competition between the food and feed markets in these countries are thus minimized by the structure of grain preferences and relative prices.

The above would appear a workeable solution to food-feed competition were it not that many governments heavily subsidize the consumption of key grains -- eg. maize in Mexico or wheat in Brazil, Peru and Ecuador. In such cases food grains become price competitive in feed rations, and governments try to maintain the independence of the two markets through elaborate administrative rules on imports, domestic sales, and subsidy payments. In all cases a national grain marketing agency administers much of domestic marketing of the subsidized grain. Nevertheless, in all these countries there is evidence of some leakage of the subsidized foodgrain into use by feed compounders. The clearest case is wheat flour in Brazil (Table 17), where flour prices to the consumer were kept exceptionally low.

Intervention into foodgrain markets in many cases precipitated later interventions in feedgrain and poultry markets. The policy objectives varied somewhat but all major feedgrain producing countries, apart from Carribean countries, intervened to support farmer incomes and to provide sufficient incentive to increase production. How this was done varied depending on whether foodgrain consumption was subsidized. In countries such as Mexico, Venezuela, Peru, and Brazil, where foodgrains were subsidized, governments normally intervened with input subsidies, particularly fertilizer and credit, and attempted to keep output prices at around import prices (in many cases this failed due to a progressive overvaluation of the exchange rate and producer prices moved above import prices). On the other hand, countries such as Colombia and Panama did not subsidize food grain consumption and in turn maintained support prices for feedgrains well above import prices, through a government marketing agency and import controls. Through the 1970's most countries intervened to some degree in feedgrain markets, almost always to the advantage of feedgrain producers but only rarely neglecting the interest of the feed concentrate industry.

Striking a balance between the interests of feedgrain producers and feed concentrate manufacturers often required either subsidies or the strategic use of imports, often coming in under overvalued exchange rates. Each country managed incentives to the two groups through a state marketing agency. This agency maintained the producer support price by buying in the domestic market when necessary, also controlled the price and supplies to the feed compounding factories, and managed imports. In some cases, e.g. Peru and Venezuela, the marketing agency would sell to the factories at a lower price than the domestic price, in effect balancing the loss by imports that were even cheaper. Peru and Venezuela also eventually moved to a system of allocating import quotas at import prices to factories on the basis of purchases of domestic production at the higher support prices.

TABLE 17. Brazil: Difference between Wheat Flours Sold by Flour Mills and Actual Human Consumption, August 1974/July 1975.

| Region | Sales by Mills (t) | Flour Consumption (t) | Absolute Difference (t) |
|---|---|---|---|
| Rio de Janeiro | 447,244 | 292,113 | 155,131 |
| Sao Paulo | 1,005,645 | 584,951 | 470,694 |
| South | 721,556 | 769,365 | - 47,809 |
| Minas Gerais, Espirito Santo | 310,646 | 279,665 | 30,981 |
| Northeast | 676,660 | 511,943 | 164,717 |
| Federal District | 23,297 | 18,970 | 4,327 |
| North | 168,924 | 145,645 | 23,279 |
| Total | 3,353,972 | 2,552,652 | 801,320 |

Note: The major portion of the mixed feed industry is located in Sao Paulo. The consumption estimate is based on the national food budget survey.

Source: CFP (1981)

However, by far the more usual subsidy was for transport costs. In this case both support prices and sales prices to the factory were fixed at a single price for the whole country. This was little problem for a country such as the Dominican Republic or Panama but had profound implications for large countries such as Mexico, Peru and Brazil -- in Brazil the CFP would sell at market prices in the region but often with a transport subsidy. In all these countries surplus feedgrain production areas were often far removed from deficit demand areas. In Brazil and Peru this was a direct subsidy to foster feedgrain production in frontier areas, in Peru in the selva region and in Brazil in the center-west, cerrado areas. Transport subsidies in these cases were large and shifted comparative advantage to those areas where transport costs would often be prohibitive.

Brazil is a case where transport subsidies absorbed by CFP can shift comparative advantage away from local production. Table 18, showing the regional structure of maize production and demand, clearly highlights that maize must move from the south and center-west to the deficit areas of the northeast and southeast. The comparison of relative costs (Table 19) clearly shows the importance of transport costs in the supply of feedgrain markets in Brazil. Subsidies are often necessary to keep the center-west areas competitive in maize production, often at the expense of the development of production in the Northeast -- a point to which the discussion will return in discussing the potential for cassava in feed rations.

Feedgrain production has responded to the expanding markets and policy interventions, except in Panama and Peru (Table 20) -- in Peru maize supply has depended on the relative support price of maize to rice, with rice having a clear advantage upto 1985. Basic differences in technology between maize and sorghum bring into sharp focus how these production increases were achieved. In the case of sorghum, production increases were achieved by expanding area planted with an imported technology based on hybrid seed and mechanized production, from planting through harvesting. This technology was appropriate for expansion wholly on large farms. In maize, on the other hand, the production structure in most tropical Latin American countries has been skewed toward the small-scale producer. Moreover, the increase in production, especially in the last decade, has been due more to increasing yields, except in Paraguay, than increasing area. The implication, however, that small farmers were able to capture the major portion of the benefits of this expanding market are not supported by the limited data on the subject. In Ecuador the small-scale producer of floury maize in the Sierra remained isolated from the change in the market for yellow, dent maize. This was captured by large scale, mechanized producers on the Pacific coast. In Brazil (Table 21), both yields and area expanded in farms above fifty hectares, as both mechanical and yield increasing technologies were adopted by larger scale farmers. Those farmers with farms from 5 to 50 ha. in size, increased yields but with declining area planted to maize. Farms of 5 ha or less were effectively marginalized as yields remained static and area declined

TABLE 18. Brazil: Regional Surpluses (+) or Deficits (-) in the Production of Maize and Animal Feed, 1983.

| Region | Maize (000 t) | Animal Feed (000 t) |
|---|---|---|
| North | 19.3 | - 28.7 |
| Northeast | - 708.0 | - 199.3 |
| Southeast | - 1212.1 | - 139.9 |
| South | 600.1 | 346.6 |
| Center West | 1559.1 | 30.8 |
| | As a Percent of Total Consumption | |
| North | 7.4 | - 39.1 |
| Northeast | - 44.0 | - 22.1 |
| Southeast | - 16.6 | - 3.0 |
| South | 6.2 | 6.7 |
| Center West | 186.5 | 9.5 |

Sources: CFP and Sindicato da Industria de Racoes Balanceadas.

TABLE 19. Brazil: Private and Social Costs of Supplying Maize and Dried Cassava in the Northeast, 1986.

| Item | Private Costs | | Social Costs | |
|---|---|---|---|---|
| | Absolute (Cr$/t) | Cassava/Maize (%) | Absolute (Cr$/t) | Cassava/Maize (%) |
| Locally produced maize | 1517 | 86 | 1405 | 88 |
| Maize from South | 1616 | 81 | 1468 | 84 |
| Maize from Center West | 2494 | 52 | 2130 | 58 |
| Imported maize | 1705 | 77 | 1675 | 73 |
| Locally produced cassava | 1306 | | 1231 | |
| Maize price | 1690 | 77 | 1690 | 73 |

Source: CFP and CIAT - EMBRATER survey.

TABLE 20. Latin America: Characterization of the Feedgrain Sector, 1966-85.

| Country | Production | | | Net Imports | | |
|---|---|---|---|---|---|---|
| | Volume 1983-85 (1000 t) | Growth 1966/75 (%) | Growth 1975-85 (%) | Volume 1966-68 (1000 t) | Volume 1976-78 (1000 t) | Volume 1983-85 (1000 t) |
| <u>Sorghum</u> | | | | | | |
| Mexico | 5,557 | 10.0 | 4.0 | - 177 | 517 | 2,766 |
| Colombia | 574 | 19.8 | 4.6 | 1 | 60 | 127 |
| Venezuela | 475 | 10.7 | 15.3 | 1 | 513 | 546 |
| <u>Maize</u> | | | | | | |
| Brazil | 20,638 | 3.6 | 3.0 | - 760 | - 529 | - 72 |
| Dominican Republic | 97 | 2.2 | - 0.3 | 0 | 93 | 185 |
| Ecuador | 257 | 4.3 | 1.3 | - 1 | 20 | 10 |
| Paraguay | 473 | 5.8 | 4.3 | - 4 | - 8 | - 12 |
| Peru | 689 | 1.2 | 0.2 | 22 | 212 | 255 |
| Panama | 72 | - 5.7 | 0.3 | 1 | 4 | 29 |
| Jamaica | 4 | 9.6 | - 12.5 | 47 | 166 | 177 |

Source: FAO (1986).

TABLE 21. Brazil: Change in Area Planted and Yield of Maize by Farm Size During the Period 1970-1980.

| Farm Size Strata (ha) | 1980 | | % Increase 1970-1980 | |
|---|---|---|---|---|
| | Area (000 ha) | Yield (t/ha) | Area (%) | Yield (%) |
| Less than 5 | 979.6 | 0.93 | - 23.9 | 8.1 |
| 5-10 | 972.4 | 1.45 | - 18.9 | 21.8 |
| 10-20 | 1,638.8 | 1.63 | - 12.9 | 28.3 |
| 20-50 | 2,353.0 | 1.61 | - 9.5 | 27.8 |
| 50-100 | 1,275.6 | 1.52 | 5.9 | 27.7 |
| 100-200 | 1,026.0 | 1.54 | 19.3 | 28.3 |
| 200-500 | 1,005.1 | 1.62 | 19.4 | 29.6 |
| 500-1000 | 504.9 | 1.67 | 31.6 | 21.9 |
| More than 1000 | 583.2 | 1.64 | 41.5 | 15.5 |
| Total | 10,338.6 | 1.52 | - 3.1 | 26.7 |

Source: IBGE (1974) and IBGE (1984).

markedly. Large farmers have a clear advantage in being able to take advantage of both labor-saving and yield-increasing technologies, drawing on the technology developed in U.S. agriculture over the last 2 to 3 decades. In general the small farmer has lost the comparative advantage he had in management -- normally reflected in higher yields --, together with the fact that he often does not have the same access to the subsidized inputs and credit that have fueled this expansion in feedgrains.

Nevertheless, even rapid rates of growth in feedgrain production were not sufficient to meet expanding domestic demand. Imports (Table 20) were necessary both to meet deficits and in many cases to support price policies for grain supplies to feed manufacturers. The rising trend in feedgrain imports in many countries, however, was affected in the 1980's by the external debt crisis in Latin America. The ratio of debt servicing to exports rose significantly (Figure 4), precipitating major devaluations, fiscal stringency, and declines in domestic demand. Agricultural imports are a significant component of the import bill and were increasing as a percentage of total imports (Table 23). The devaluations and the need to cut back government spending, especially on subsidies, forced many countries to expand efforts to increase self-sufficiency in basic commodities. With recent changes in domestic price policies and (because of devaluations) the domestic price of feedgrain imports, a window opens on developing a more diversified strategy to meeting carbohydrate demand in the feed sector. In particular there is an incentive for governments to evaluate the potential of cassava to meet the expanding demand for feed sources.

## The Cassava Option in Meeting Feed Demand

The rapid expansion in the demand for feed components changes the whole dynamic of demand for (certain) starchy staples as an economy urbanizes and incomes increase. In general direct food demand for grains (and starchy staples in general) increases upto an income level of about $1000 (1978 prices) and then declines somewhat after that (Monke, 1983). However, at about that point derived demand for carbohydrate sources for animal feeds begins to grow. For commodities such as maize, sorghum and cassava (and occasionally soft wheats) this market transition provides an opportunity to maintain a significant elasticity in total demand for the commodity. Few agricultural commodities face such continual increases in demand throughout the growth process, and only flexibility in end uses and relatively cheap production costs allow a commodity such as cassava to move from being primarily a food staple to becoming a commercial crop supplying a growing industrial demand. Adapting to shifting end markets and changing market structure is key to a modernizing agriculture, where expanding marketable surpluses lead to increasing farmer incomes and thereby helps to moderate rural-urban migration.

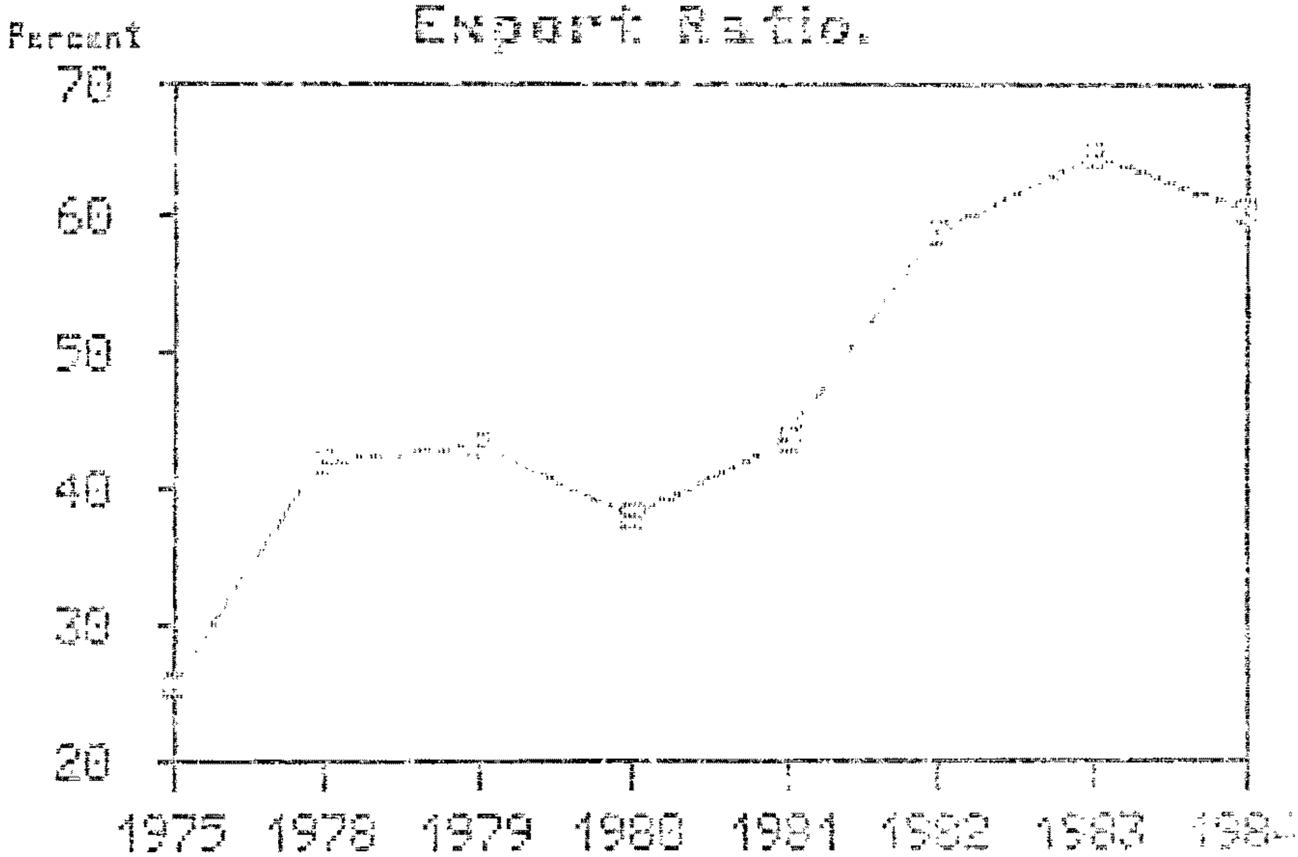
Cassava is basically a starch source, and since carbohydrate or energy sources are the principal component in balanced feeds, dried cassava has the potential for forming a significant percentage of the complete ration.

TABLE 23. Latin America: Agricultural Imports as a Percent of Total Imports.

| Country | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|
| Brazil | 9.9 | 9.1 | 8.5 | 8.7 | 11.0 |
| Mexico | 16.1 | 13.5 | 12.8 | 26.3 | 20.8 |
| Colombia | 11.5 | 9.5 | 10.3 | 10.9 | 8.3 |
| Ecuador | 8.1 | 7.8 | 9.1 | 14.9 | 12.1 |
| Peru | 20.4 | 20.4 | 18.0 | 17.5 | 15.7 |
| Venezuela | 16.2 | 17.0 | 15.2 | 11.6 | 20.7 |

Source: IDB (1986) and FAO (1986).

Figure 4. Latin America: Debt Service to Export Ratio.



Mixed feed technology allows the incorporation of high protein sources to compensate for cassava's lack of protein and least cost feed formulation models allow factories to produce a balanced ration with the lowest cost mix of ingredients. Experience with using cassava in Europe, especially the Netherlands, has shown cassava to have few negative nutritional characteristics. Aflatoxin is usually nonexistent because of cassava's low protein content. If properly dried, HCN toxicity is not a factor in animal nutrition. For poultry there is some concern with the energy density of the diet if cassava assumes a high percentage, but this can be overcome by pelleting and the addition of a small percentage of animal tallow or vegetable oil. In general cassava can fully replace grains in swine and dairy rations and can be used up to an inclusion level of 20 to 30% in poultry rations.

The movement to the use of balanced feeds in animal nutrition is also associated with structural change in animal production, with the locus of production shifting from integrated crop-livestock systems on individual farms to large-scale, specialized production units, normally close to major urban markets. This structural transformation is clearest in the case of broiler and egg production. In swine, on the other hand, farm production is often able to resist the movement to large integrated units, due essentially to lower cost feed sources and the diminished scale economies in swine production. For the farm operation, however, the difficulty is maintaining balanced nutrition of the animal from on-farm sources, especially adequate protein levels. Technical change in swine in Latin America (in a first phase) has taken the form of a shift in breeds to a leaner carcass, and the purchase of protein concentrates to mix with energy sources produced on the farm. In a second phase in a few countries, particularly Mexico and Venezuela, large scale specialized swine production systems have also developed.

Cassava as an animal feed in Latin America develops first as an on-farm feed source. All through tropical Latin America cassava is fed to animals raised within the farm. Normally this is not systematic. The cassava is often non-commercial (the roots being small or left in the ground far beyond the period of satisfactory quality) or is the surplus after a periodic harvest. Moreover, the swine or even poultry tend to scavenge for a large component of their feed needs. Animal productivity in these systems is low but costs are also low. Generally in such systems only a minor percentage of the total cassava crop is fed to the animal stock. The opportunity cost of the cassava is too high compared to the low weight gains by the animal; lack of protein tends to limit the effectiveness of the energy source. Such systems are quickly disappearing, being overtaken by more efficient production systems.

The key to more productive on-farm swine systems has been the availability of protein concentrates. In areas such as the south of Brazil, particularly Rio Grande do Sul and Santa Catarina, and parts of eastern Paraguay cassava has developed as a major on-farm feed source in intensive swine (and in Rio Grande do Sul, dairy) systems. Particularly, in Brazil the development has been quite dramatic over the past couple of decades. A coincidence of factors gave rise to this dominant role of cassava is on-farm feeding systems. Predominant among these was the demise of the farinha market in southern Brazil as a result of the wheat subsidy. Shrinking demand made cassava relatively cheap at a time when swine production systems were changing with the introduction of breeds with less fat (the market for lard declined with the rise of the soybean oil industry) and the improved availability of protein concentrates. However, the key was the low production costs for cassava compared to the principal competing energy source, maize (Table 24). At the farm level cassava is very competitive with grain sources as an energy source in the feeding of animals. The one restriction is that the varieties must be relatively low in HCN content, a factor that limits on-farm feeding to swine in the Northeast.

Developing a cassava production system that can supply a continuous supply of roots during the whole year and yet releases land at critical planting periods requires either an extensive land area or a storage system. In southern Mexico with the rise of large-scale swine production systems in the ejidos, large silos have been developed for ensiling cassava roots. The ensiled roots can be kept for an indefinite period of time and the roots can be assembled near the swine production units. The costs of such systems have been very price competitive with sorghum (Table 25), which must be imported into the region. The ensiled cassava is mixed with a protein concentrate and minerals and provides a perfectly balanced feed source. Ensiled cassava systems can be adapted to most any size of production system but investment in a permanent silo and a chipper requires a certain minimum size of swine operation.

Availability of protein concentrates, intensification and technical change in swine production systems, and organization of the cassava production system to provide continuity of supply are all necessary for the development of such integrated systems. They also require an obvious coincidence between cassava production areas and swine production, the latter which requires adequate access to urban markets. Besides southern Mexico, southern Brazil and Paraguay, there is also potential to develop such systems in the Dominican Republic and possibly in the selva region of Peru and the Santa Cruz area of Bolivia. However, to broaden the market for cassava as an animal feed source, especially to the poultry sector, requires the mixing of dried cassava in balanced feeds.

Cassava is just starting to participate in the market for feed components going into the rations industry. Spontaneous development of a feed market for dried cassava has developed in Asian countries, particularly Thailand and Malaysia, but in Latin America cassava has not easily made the transition away from on-farm uses and food markets. There are two questions to be asked in regard to cassava's emerging role in the feed market. First, can cassava compete price-wise with the principal feedgrains and potentially carve out a significant share of this expanding market. Second, if cassava is already profitable, why have dried cassava

TABLE 24. Brazil: Production Costs for Maize and Cassava (Dried Basis) in the South, 1986.

| Cost Item | Cassava (Cruzado/t) | Maize (Cruzado/t) |
|---|---|---|
| Variable Costs | 172.5 | 555.4 |
| Factor Costs | | |
| Labor | 131.2 | 330.0 |
| Capital | 17.6 | 32.2 |
| Input Cost | 23.7 | 193.2 |
| Fixed Costs | 139.3 | 331.6 |
| Factor Costs | | |
| Land | 58.3 | 220.0 |
| Labor | 27.9 | 27.5 |
| Capital | 13.3 | 27.5 |
| Input Cost | 39.8 | 56.6 |
| Total Costs | 311.8 | 888.7 |

Source: CIAT field data.

TABLE 25. Mexico: Comparison of Costs of Production of Ensiled Cassava Roots with Sorghum Price in Tabasco, 1986.

| Cost Component | Cost (Pesos/kg) |
|---|---|
| Variable Costs | |
| Root Price | 17.00 |
| Loading and Unloading | .80 |
| Transport | 4.00 |
| Chipping and Tamping | .85 |
| Plastic Cap | .20 |
| Working Capital | 2.29 |
| Sub-Total | 25.14 |
| Fixed Costs | |
| Silo Depreciation | .96 |
| Capital Costs | 1.60 |
| Sub-Total | 2.56 |
| Weight loss and Deterioration | 4.92 |
| Total Costs | 32.62 |
| Cassava Cost Dry Weight Basis | 77.67 |
| Sorghum Cost Dry Weight Basis | 93.49 |

Source: CIAT field data.

markets not spontaneously developed in Latin America. If cassava can compete, then an understanding of constraints on development of a cassava feed market will hopefully pinpoint mechanisms by which market linkages can be formed.

To generalize about the ability of cassava to compete with grains in animal feed rations is fraught with the problem of policy interventions in the marketing and pricing of feedgrains. A starting point is a comparison of costs of production and prices at the farm and factory level for dried cassava and the principal competing grain. As can be seen in Table 26 cassava competes favorably with feedgrains in terms of farm-level profitability. In all countries considered, dried cassava either now provides or could provide a reasonable return on farmer owned resources. Moreover, these farm-level prices are translated into prices at the rations factory that enter the least-cost feed formulation for swine and, in most cases, for poultry. At issue then is why these obvious profit incentives have not been translated into a rising production of dried cassava. To understand this requires an evaluation of grain pricing policy, on the one hand, and an understanding of pricing of alternative cassava products, especially in food markets, on the other hand.

Governments have intervened heavily in feedgrain markets in Latin America over the past two decades; on the other hand, there has been no direct intervention in cassava markets. Obviously, this policy support for grains has directly affected the private profitability of cassava. Policy intervention has taken many forms. In Mexico there were direct subsidies provided by the state trading company, CONASUPO, in which the sales price to factories were usually less than either the farmer purchase price or the import price (Table 27). Also, the sales price was fixed for any location in the country so that transport subsidies were also significant. In 1985 with the pressure to reduce the fiscal deficit, purchase and sales prices were brought into line and in 1986 sales prices started to reflect transport costs as different prices were now set for six different regions. Cassava produced in the south in 1986 could begin to compete with sorghum in regional markets.

In Peru and Venezuela cassava could compete with nationally produced grains on the basis of costs of production but it could not compete under existing policy arrangements. In Peru the state marketing agency buys and sells maize at one single price in the whole country. The whole marketing margin is absorbed by ENCI, the effect of which has been to shift comparative advantage from the high cost production on irrigated areas of the coast to the jungle areas in Eastern Peru. As can be seen in Table 28, maize production in the jungle region is much more profitable than on the coast under such a subsidy system. However, cassava cannot compete in coastal markets with subsidized maize if it must pay the transport costs. In 1986 dried cassava was brough under ENCI price support and purchasing operations.

TABLE 26. Latin America: Comparison of Production Costs for Dried Cassava and Prices for Cassava and the Principal Feedgrain, 1986

| | Production Cost [1] | Price [1] | | |
|---|---|---|---|---|
| Country | Cassava | Cassava | Grain | Cassava/ Grain |
| Sorghum: | | | | |
| Colombia | 17,044 | 25,600 | 32,000 | 80 |
| Mexico | 50,429 | 64,000 | 78,000 | 82 |
| Venezuela | 1,279 | 1,870 | 2,200 | 85 |
| Maize: | | | | |
| Peru | 994[2] | 2,475 | 3,300 | 75 |
| Panama | 170 | 180 | 230 | 78 |
| Paraguay | 32,406 | 56,000 | 70,000 | 75 |
| Brazil | 1,306 | 1,330 | 1,705[3] | 78 |

[1] Prices and costs in local currency per ton.
[2] Assumes cassava comes under ENCI purchasing system, in which case transport costs are not included.
[3] Maize import price,

TABLE 27. Mexico: Sorghum Prices Managed by CONASUPO, 1971-85.

| Year | Purchase Price (Pesos/ton) | Import Price (Pesos/ton) | Sales Price (Pesos/ton) |
|---|---|---|---|
| 1971 | 600 | 870 | 817 |
| 1972 | 729 | 760 | 810 |
| 1973 | 776 | - | 873 |
| 1974 | 1113 | 1849 | 1225 |
| 1975 | 1600 | 1457 | 1595 |
| 1976 | 1638 | - | 1739 |
| 1977 | 2016 | 2293 | 2011 |
| 1978 | 2030 | 2473 | 2127 |
| 1979 | 2033 | 2704 | 2231 |
| 1980 | 2891 | 3352 | 2672 |
| 1981 | 3927 | 4072 | 3439 |
| 1982 | 5093 | 8264 | 4746 |
| 1983 | 12388 | 16239 | 9150 |
| 1984 | 20478 | 22631 | 18861 |
| 1985 | 28705 | 26598 | 33720 |

Source: CONASUPO

TABLE 28. Peru: Cost and Price Comparison for Maize and Dried Cassava, 1986.

| Cost/Price | Maize | | Cassava |
|---|---|---|---|
| | Coast (Inti/t) | Jungle (Inti/t) | Jungle (Inti/t) |
| Production Costs | 2377 | 1810 | 994 |
| Transport Costs | 300 | 1500 | 1500 |
| Total Costs | 2677 | 3310 | 2494 |
| Price[1] | 3300 | 3300 | 2475 |

[1] ENCI purchase price

Source: Malarin (1986) and CIAT field data.

In Venezuela the policy has been to foster cheap feed but not at the expense of domestic grain producers. Domestic sorghum producers receive significant input subsidies, especially fertilizer and credit, and price supports ensure significant profit margins. Cassava is put under some disadvantage with the fertilizer subsidies but can still compete at sorghum support prices. The policy constraint, however, is that most sorghum is imported and it comes in under a preferential exchange rate (Table 29). In order to get the license to import, the feed manufacturer must purchase a certain amount of nationally produced sorghum at the ruling support price. There is no requirement that cassava be purchased in order to get an import license, meaning cassava must compete with this mix of domestic sorghum and imported sorghum at the preferential exchange rate. Under this policy cassava is made uncompetitive by an administrative rule which excludes cassava.

However, apart from Venezuela the 1982 debt crisis has forced a rationalization of both exchange rates and domestic pricing policies in tropical Latin America. This has created a price environment in which cassava now can begin to compete on a basis which more accurately reflects real production and marketing costs. In this environment cassava is in general cost competitive with domestic grains. Nevertheless, for countries such as Panama and Colombia, there have never been grain policies that have adversely affected the ability of cassava to compete in the mixed feed market. In these countries the second constraint on the development of the dried cassava market becomes apparent, i.e. the nature of price formation in existing cassava markets and the effect this has on incentives to invest in processing capacity for cassava chips.

In Panama and Colombia, and in the rest of Latin America except for Brazil, price formation in cassava markets is based on the human food market, which in turn is based on the marketing of fresh roots. The perishability and bulkiness of fresh roots creates several constraints on the development of a unified price structure for cassava. First, markets for fresh cassava are spatially fragmented. The perishability and high transport costs limit arbitrage between markets at any significant distance. Prices rather depend on local supply and demand conditions, resulting in quite significant differences in cassava prices in different markets.

Second, farm-level prices for cassava going into the fresh market are normally well above the costs of production for cassava that would go into processing. Prices set in the fresh market, therefore, give the illusion of higher costs of production than really predominate. The reasons for this divergence between prices and costs are due to risk and quality factors. A certain percentage of roots is discarded due to insufficient size. Normally, a relatively high starch content is required and factors such as insect attack or a rainfall after an extended dry period will reduce starch levels below commercial acceptance. Another risk is the rationing of market access that is found in fresh cassava markets. Farmers cannot normally sell when they want to but rather when they can. They will

TABLE 29. Venezuela: Comparison of Prices for Sorghum and Dried Cassava, 1985.

| Item | Price (Bs/ton) |
|---|---|
| Dried Cassava | |
| Production Costs | 1279 |
| Price | 1870 |
| Domestic Sorghum | 2200 |
| Imported Sorghum | |
| Free Exchange Rate | 2640 |
| Preferential Exchange Reate | 990 |

Source: CIAT field date.

often sell early, sacrificing yield, in order to gain access to markets. Janssen (1986) estimated for the Atlantic Coast of Colombia that farm prices for the fresh market could be discounted by 25% to reach a price at which selling to a processing market would be equally profitable.

Finally, spatially fragmented markets where volumes entering the market are small compared to the production capacity introduce significant year-to-year price variability -- significantly seasonal price variability is limited because of the seasonal storage possible by leaving cassava in the ground. This interplay of supply and demand results in prices in years of relative scarcity being far above what is needed for cassava to enter the animal feed market. A unified price structure is needed for development of multiple markets. However, a shift in either supply or demand conditions in the fresh market makes returns on capital invested in processing capacity very risky, due to the inability to operate in years of high prices.

This riskiness of capital returns on processing investment also affects Brazil, where farinha dominates in price formation in cassava markets. In this case an inelastic price elasticity, declining demand induced by the wheat subsidy, and variability in production due to the marginal climatic conditions of the northeast, create a situation of significant price variability (Figure 5). This creates an uncertain environment for both farmers and prospective investors in cassava chipping and drying. For farmers any expansion in planted area, especially in a year of above average rainfall, risks driving prices down to variable costs of production. On the other hand, investment in chipping and drying capacity runs the risk of coinciding with a year of poor rainfall, high prices and inability to compete with maize in the animal feed market. Incentives on the side of the farmer and the processor run counter to each other, even though costs of production suggest acceptable profit levels for both farmers and processors.

In the case of both the fresh urban market and the farinha market, price formation has inhibited the development of alternative markets for cassava. By comparison, grains are tradeable internationally, year to year price variability is dampened by storage, and markets are spatially integrated by relatively low transport costs. Grain prices are more stable and market integration ensures a more effective transmission of incentives. However, the fact that cassava could compete in the feed rations market suggests a market failure where intervention would lead to increased production and economic efficiency.

The basis for correcting that market failure is suggested in Figure 6. Development of an alternative market such as the animal feed market provides both growth prospects and a price floor to the food market. Reduced market risk provides the incentive for farmers to expand production -- see Janssen (1986) for an estimate of the response of farmers to the development of such a floor price. On the other hand, expansion in the production base drives prices in the food market down to the floor price,

Figure 5. Bahia, Brazil: Variation in the Wholesale Price of Farinha (at Constant 1977 Prices).

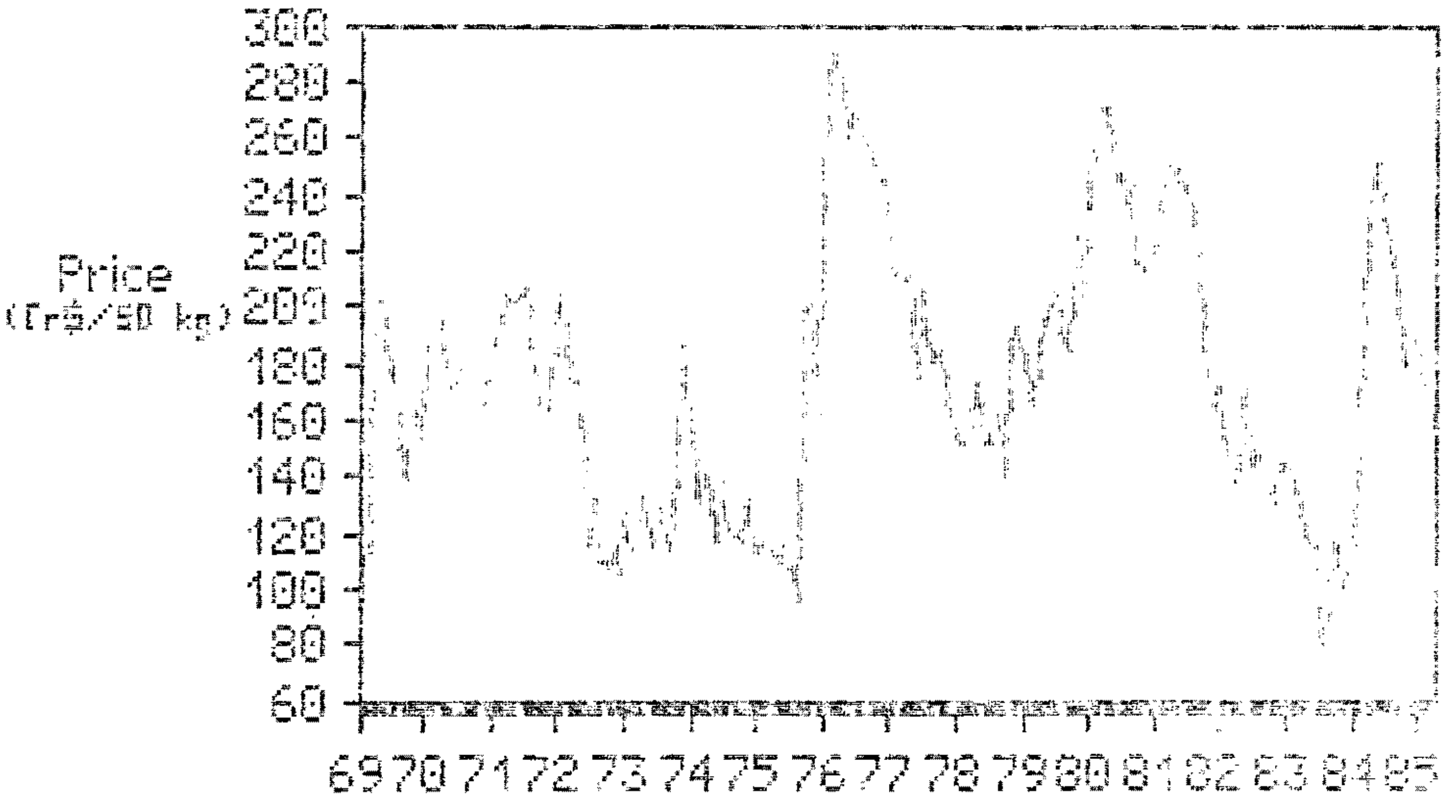
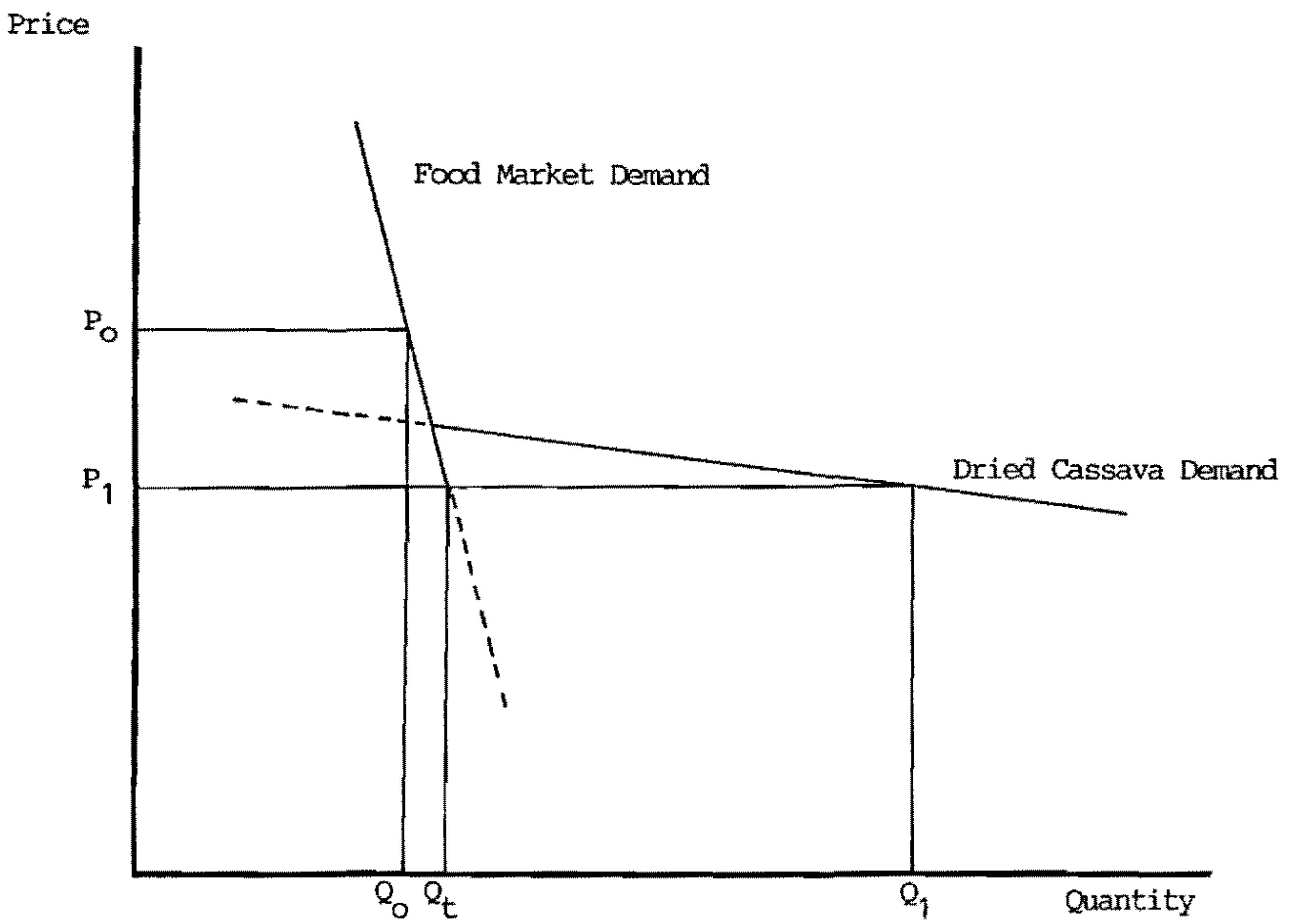


Figure 6. Representation of Linking Two Markets and the Effect of a Price Floor for the Food Market.



thereby both stabilizing prices -- with the attendant benefits for cassava consumers -- and unifying prices in both markets. The key, of course, to the whole process are the investments in processing capacity that allow production to expand upto that critical point where the cassava price has stabilized and is unified with the feedgrain price. There are options for how this might be accomplished and a discussion of those options requires a linkage to policy objectives.

## The Development Potential of Cassava in Latin America

Cassava's multiple uses allow the crop to adjust to changing market conditions as economies develop and in so doing to maintain a significant elasticity in demand. Most staple food crops at critical income levels actually face declining per capita consumption but by developing alternative markets, such as that for animal feed rations, cassava is able to maintain a continued growth in market demand. Development of cassava as a component in the mixed feed industry thus opens an opportunity to use cassava as a means of income generation in typical cassava production zones. These tend to be the more marginal, agricultural regions of Latin America and as a large World Bank study (Kutcher and Scandizzo, 1982) concluded for the Northeast of Brazil, such agricultural economies tend to be demand constrained in terms of their growth prospects. This seems somewhat paradoxical until it is realized what type of and number of cropping and livestock alternatives are available to farmers in such areas. These are limited and most crops face quite inelastic demand. The potential of developing cassava as a major cash crop in such areas is both real and to date overlooked in areas such as the Northeast of Brazil or the Atlantic Coast of Colombia.

The other principal characteristic of cassava in Latin America is its production by small-scale farmers. Cassava fits well into small farm systems. Its malleability in intercropping systems; the flexibility in planting and harvesting; and the lack of mechanization of principal cultural practices have contributed to its dominance in small farm systems. However, just as important to the dominance of small farmers in cassava production is the organization of fresh root marketing or of the supply of roots to small-scale farinha plants. Harvesting small lots on a relatively continuous basis under significant marketing risk is not compatible with the management resources or (probably) risk preferences of large scale farmers. Thus, cassava offers that rare combination of being a small-farmer crop, produced in marginal agricultural conditions, but with significant potential growth in overall demand. With these characteristics policy should be oriented to maximizing cassava's development potential in Latin America, especially as a source of increases in small farmer incomes.

Realizing cassava's development potential therefore depends on linking the small-scale producer to growth markets, particularly the feed component market. At issue then is how to motivate investment in processing capacity so as to maximize access of small-scale farmers to this market. Two design issues dominate in this regard, scale of the processing plant and ownership and management of the plant. Scale to a large extent will influence ownership options and both will influence the degree to which the cassava producer, himself, vertically integrates into processing and marketing of chips and pellets.

Small-scale agro-industry is rare in Latin America, especially when compared to Asia. Much of what small-scale processing is done in Latin America is done by the producer himself. Panela, cheese, farinha de mandioca, and chuno production are all cases where the farmer himself invests in processing capacity. The alternative in Latin America has been very large-scale processing plants, eg. rice-milling, sugar refining, milk and cheese processing, maize starch production and oilseed crushing. Rarely have intermediate-size, processing plants been a feature of the agricultural economy. Farinha production in parts of the Northeast of Brazil is one of the few examples of such intermediate processing plants. Two factors contributed to this development. First, Brazilian manufacturers designed intermediate processing machinery, such as hydraulic presses and mechanized roasting equipment. Second, cassava production itself reached a sufficient density to support specialization and economies of scale in processing. Improvements in transport infrastructure aided this process. By contrast, Northern Brazil still is characterized by farinha production at the farm level.

The farinha economy of the Brazilian Northeast provides the model for the prospective cassava chip industry of Latin America. However, this chip industry must pass through various stages to arrive at such a model. The initiation must focus on stabilizing market conditions for the cassava farmer and in turn motivating his expansion in cassava production. The initial production base must be built on an integration of the farmer himself in processing. The technology of solar drying of cassava is well adapted to such an integration and moreover, makes use of underemployed labor during the off-season. Moreover, the processing plant provides the mechanisms for operation of the price floor. The farmer can expand production (whether through area expansion or yield increases) and should prices in the food market rise, he is still better off, having the funds to cover the investment in the processing plant through sales to the fresh market. Independent processors do not have such flexibility in covering the capital costs of the plant. A certain critical density of production needs to be developed before there is any movement to specialization in processing, motivated by scale economies -- see my discussion of the evolution of the Thai cassava processing industry (Lynam, 1987). The operative factor here is a sufficient density to minimize transport costs for roots, on the one hand, and the effective price linkage of the cassava root and feedgrain markets, on the other. Otherwise, spatially separated, small-scale plants operated by producers will have the advantage.

Developing the market for cassava chips and pellets in Latin America requires key institutional interventions in order to overcome the particular kind of market failure inherent in lack of diversification in cassava markets. These interventions to date have been organized around pilot projects in key target regions. The initial interventions must demonstrate the economic and technical feasibility of the processing plants, create market channels to mixed feed factories, and develop plans for backstopping production increases. This process obviously requires an integrated, institutional approach in the initial stages, with institutional costs declining as the demonstration effect starts to take over. Key services are a line of credit for small-scale agro-industry, technical assistance in plant construction and management, extension services for production technology, and contract development between cassava drying plants and feed factories. Proper organization of these pilot projects can ensure that small-scale farmers are the primary beneficiaries of development of the dried cassava market (Lynam, Janssen, and Romanoff, 1986).

## Conclusions

Agricultural economies in tropical Latin America have undergone significant structural change in the post-war period. Changes on the production side -- massive mechanization, increased fertilizer and agro-chemical use, and the advent of improved varieties in some major crops -- were matched by quite significant changes in food demand, due principally to rising incomes, very rapid urbanization, and major changes in the organization of food wholesaling and retailing. Changing consumption patterns and rapid demand growth in income-elastic food commodities created significant growth markets and income generation potential for domestic producers. However, in many commodities production was not able to respond quickly enough to meet rising demand, resulting in either imports or upward pressure on prices. This rapid structural change created a complex set of issues for policy makers, especially how to best utilize changing domestic demand to modernize agricultural production and yet how to insure that food prices were kept in line to meet the needs of the burgeoning urban population and as a means of controlling inflation.

Nowhere were these issues more pronounced than in the feed-livestock sector in tropical Latin America. Expenditure on meat formed a large component of the consumer's total budget. Moreover, the relatively high income elasticity resulted in a significant growth in demand. However, growth in the supply of beef, the predominant meat in the diet of tropical Latin America, did not respond sufficiently to meet the growing demand. In part this was due to biological limits on the rate of growth in beef production and in part it was due to the reliance on extensive systems. The area in pastures expanded more or less in line with growth in cattle stock. Only in Brazil and Venezuela were there major increases in stocking rate, and even there these increases started from very low levels.

This gap between the supply and demand for beef was met, not by beef imports, but by increases in the production of alternative meats, especially poultry. Poultry production expanded at a very rapid rate in the last two decades in tropical Latin America, as production systems became more intensive and marketing systems for poultry were able to achieve significant scale economies. Real prices of poultry fell in most countries, while the price relative to beef fell even further. The poultry sector was the solution to the overall price inflation in the meat sector. First, supply was very responsive to profit incentives and meat supplies in the short-run were not constrained by biological or reproductive limits. Second, substitution between beef and poultry was significant, with the falling price of poultry putting a lid on rising beef prices. The poultry sector made the whole meat sector more manageable and more responsive to short-run shifts in demand.

The rapid increase in poultry production resulted in numerous backward linkages to other sectors in the agricultural economy. The derived demand for feed components, especially carbohydrate sources, increased dramatically. Not all countries have exploited the opportunity created by this market to develop feedgrain production (and income generation potential for feedgrain producers); moreover, all tropical Latin American countries except Paraguay have become net importers of feedgrains, as production has not been able to keep up with demand. As with the diversification in meat production, one of the means to increase supplies of carbohydrate sources for the feed industry is by diversifying sources of supply. Some countries such as Colombia and Mexico have been particularly successful in developing sorghum production. Dried cassava offers another distinct, and yet unexploited, alternative for increasing supplies of feed components. Cassava will not completely replace maize or sorghum but there is a potential niche in most agricultural sectors in tropical Latin America where cassava can be competitively produced to compete with feedgrains in mixed feed rations.

Latin America is at a stage in its development where diversification should be occurring in cassava markets. However, Latin America lags well behind Asia in this regard. There are many reasons for this lag but the principal factor has been that prices in cassava food markets have not been an efficient indicator of the relative profitability of investing in cassava processing capacity and price variability increased the risks of entrepreneur investment in these new markets. Linking price formation in cassava markets to feedgrain markets will provide the basis for cassava to begin to take part in the development process in Latin America. However, in Latin America this requires an initial institutional intervention to form these market linkages. Moreover, cassava can be a policy tool for in turn making that development process more equitable. Cassava is principally produced by small-scale farmers, usually in more marginal agro-climatic zones -- the agricultural niche where cassava has a comparative advantage. Linking these farms, which are characterized by both underemployed labor and land resources, to a growth market, such as exists for dried cassava, can achieve increased income in a stratum which has been increasingly marginalized in the recent growth process in Latin America.

The economic climate in tropical Latin America is now appropriate to bring cassava into the agricultural policy process. The 1982 debt crisis has resulted in major realignments in foreign exchange rates, reductions or elimination of subsidies, and a renewed emphasis on increasing domestic production and reducing imports. Except for Venezuela, cassava is now competitive with feedgrains under existing grain pricing policies. Demonstrating that cassava can be a vehicle for raising labor and land productivity in marginal agricultural zones, in increasing small farmer incomes, and in reducing feedgrain imports will insure in the future that cassava will be a component in overall agricultural planning. Cassava adds flexibility to this planning process and it provides a cropping alternative especially adapted to tropical conditions. The niche is there; it remains only to be exploited.

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# Rice in Colombia: Trends in Production and Consumption and Present Constraints

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In 1983-85 Colombia exhibited the highest yields in rice production in Latin America with over 5.0 tons/ha at the national average (FAO). This was the result of widespread adoption of improved seeds and rapid modernization in production practices that started in the late fifties and intensified in the sixties. As stated by Pulver and Weber, "Colombia occupies a critical position in the region not only because it is a major rice producer but also because it is seen as a leader in technology adoption".

Over the past two decades (1966-85) yields increased at an annual 4.2% and area harvested expanded at 2.0% per year. (See FAO data on rice trends in the Appendix). However, average rates of growth for the period mask the stagnation in rice production after 1978. While production grew at an annual 9.3% in 1966-78, in the next period, 1978-85, it decreased at 0.6% per year. Yields exploded at an annual rate of growth of 8.9% in 1966-75 well above that of other countries while area cultivated expanded at a more modest 1.3% per year.

This paper examines the characteristics of rice in Colombia: its consumption, its evolution in the past two decades and the present constraints that have led to a halt in the expansion of its production.

A brief summary of agricultural policies and its influence on resource allocation between the agricultural sector and the rest of the economy and on the specific adjustments within the agricultural sector during the past two decades is presented. Emphasis is placed upon the discrimination that those policies have created against agriculture and specifically those affecting agricultural exportables (like rice). Despite the set of compensatory policies designed for rice (price supports, credit, research expenditures), there has been a lack of protection for the crop since 1975.

The role of rice in Colombian diets is explored both in a time series framework (its evolution in the past 25 years) and by means of cross sectional data obtained at the national level in 1981 by DANE/DRI in a household expenditures and nutritional survey. The importance of rice at the lower income levels emerges quite clearly from the analysis.

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Projected demand is confronted with production levels of 1985 and the magnitude of the deficits is examined under two different scenarios for per capita consumption levels.

Then, the paper concentrates on the issue of economic efficiency in rice production in Colombia, an issue that has gained increasing public concern and that led to the formulation of the National Agronomy Plan in 1986. The Plan was conceived after a series of meetings between FEDEARROZ (Federacion Nacional de Arroceros), ICA and CIAT, in 1984-85.

To explore the issue of economic efficiency, a stochastic frontier production function is adjusted (Ramirez, 1986). The analysis is carried out in an ex-post, static and partial equilibrium setting from a set of 71 questionnaires administered to rice producers under varying production environments in 1981.

The methodology employed allows to measure technical inefficiency as reflected by the deviation of producers from the revenue maximizing input combination of existing resources. The discrepancy between observed and "optimal" input combinations arises from aversion to risk as well as from the crop management approach. Particularly relevant are factors like poor managerial skills, failures to use the right resources at the right time and in the correct fashion, low hired labor productivity, material hindrance to progress and damaged output among others. These are all factors controllable by the producer.

The analysis concludes that by eliminating technical inefficiencies, total revenues could be increased by 17.3%. Eliminating allocative inefficiencies (which arise when resources are not only used in the wrong amounts but also in the wrong combinations) costs of production (and consequently, economic inefficiency) could be reduced at least by 30%. These results are very much in line with numbers estimated in the National Agronomy Plan. The paper concludes with the need to implement an integrated crop management approach and enumerates some of the activities formulated in the National Plan to improve yields and production. Fundamentally, the Plan has been designed to give confidence (reduce uncertainty) to both farmers and technical assistants about the proposed cost-reducing practices.

<u>Recent Agricultural Policies in Colombia.</u>

In 1978 a slow down of the economy started, linked to the world recession and the after shock of the coffee bonanza. In per capita terms, GDP and agricultural GDP increased at 0.5% and -0.1% per year in 1978-85, respectively (Table 1). Area harvested decreased from 4.3 million hectares in 1978 to 3.8 million hectares in 1984 (MAG). Terms of trade for agriculture, as measured by the ratio of sectoral deflators for value added were much lower in 1983 than in 1970, but they increased until 1977 and decreased thereafter (Table 2).

The slow down of agriculture is the result of a number of biases that affect agricultural production. At first glance, there has been a policy of protection in effect for most agricultural products in Colombia. The internal price of most products has been higher than the international price; nominal protection indexes are positive (Garcia). However, to be able to conclude that there was effective protection, one has to bring several other factors into the picture. The most relevant of these, for recent times in Colombia, has been the overvaluation of the peso. If the nominal protection is higher than the overvaluation, the product was probably protected. In this sense, Garcia concludes that only products like powder milk, oils and fats, and wheat would be truly importables, since they have been effectively protected even after making the adjustment for the overvaluation. Rice, coffee and cotton, for example, have been discriminated against in this sense for the past two decades.

The modernization of agriculture made it more dependent on imported inputs, whose trade has been restricted. Agricultural credit reduced its participation in total credit from 31% in 1970 to 17% in 1981, input costs (labor, machinery, fertilizer, seed, etc.) grew faster than output prices (cost-price squeeze), public investment in research in relation to agricultural GDP,went from 0.46% in 1972 to 0.20% in 1982, public expenditures in agriculture went from 25% of the total in 1970 to 7.6% in 1981 (Prieto et al.). After 1978, use of fertilizer has decreased (Balcazar en Machado, SAC Sep.'85), supply of real agricultural credit stagnated, the overvaluation of the Peso became more marked and rural instability kept high, all making Colombian agriculture less competitive. Illegal, parallel and black markets continued to be important, with the subsequent impact on resource cost and allocation, particularly on wages and land.

The consensus is that the resulting biases from the macroeconomic and trade policies have been so strong that agriculture (and particularly exportables like coffee and rice) has had to pay more than half of the industrialization costs (Valdes) with a loss of competitiveness that made necessary the implementation of compensatory policies mainly price, commercialization and credit policies (Sanint, 1987). But in the end, there was no effective protection for these crops, for they had to support the effects of protectionism through higher input prices and worse terms of trade for agriculture. The compensatory policies to stimulate their production were not enough to neutralize the adverse effect of general policies. The result has been a net flow of resources from agriculture to the other sectors.

From the viewpoint of Colombian producers, output prices are too low and yet they are not competitive in the world market (with the exception of coffee, bananas and a few minor export crops). This general perception is particularly obvious in the case of rice, where internal costs of production under irrigation reached US$283 per ton of paddy rice in 1984 while the international price (fob Thailand) for white rice was around US$258 per ton (IRRI). The cost-price squeeze in rice production is quite evident from data in Table 3. The price of paddy rice in 1984 was too low to ensure profits and yet too high to enter the world market, yet yields were high. As we will see later, the lack of protection is only one aspect of the problem. Serious inefficiencies have been occurring in the production of rice.

Historical Developments in Production and Consumption.

By the mid-sixties, the newly expanded rice research program of the Colombian Agricultural Institute (ICA) introduced new dwarf varieties based on the genetic material available at the International Rice Research Institute (IRRI) and in collaboration with CIAT has continued to provide advanced genetic material (IR8, IR22, CICA4, CICA6, CICA8 and Oryzicas are among the most well known).

The new dwarf varieties, now accounting for 100% of the seed used in the country caused a shift in the location of production of rice from rainfed areas to irrigated and swampland areas. Present yields in 1984 were 5.6 tons/ha under irrigated conditions and 4.1 tons/ha in favored upland (FEDEARROZ, un gremio...).

When expanded rice production, mostly based on higher yields (Table 4), caused the retail price of rice to fall both in real terms and relative to the other staples, consumers increased rice consumption at a rapid pace.

Consumption of Rice in Colombia.

During the impressive technological innovation that took place in rice production in Colombia in the 1960-84 period, per capita rice consumption more than doubled from about 30 kilos of paddy equivalent to over 60 kilos, growing at an annual rate of 4.1%, which is the highest among the group of major carbohydrate foods (Table 5 and 6). At the same time its real retail price, in 1970 pesos, went from close to $6 per kilo to just over $3 per kilo of white rice, decreasing at an annual rate of 3.4%, also the most marked favorable change among the group considered (Table 7).

The reduction in price and the simultaneous growth in real per capita income help to explain the rapid expansion in consumption. Own-price and income elasticities for rice were estimated at -0.43 and 0.65 respectively for that period. These values are similar to previous estimates for other periods (Sanint, 1983).

It is important to note that the reduction in the consumer's price of rice had a negative impact on demand of wheat, corn, and cassava (with cross-price elasticities of 0.35, 0.23 and 0.09 respectively) while demand for plantains was not affected and potato consumption was positively affected (i.e., showed a complementarity effect, with a cross-price elasticity of -0.26).

In other words, rice displaced other major carbohydrates to achieve higher levels of demand by means of a significant reduction in its own-price.

However, for the past 7 years production has stagnated, after it reached in 1978 the level of 1.9 million tons of paddy rice and consumption reached the level of 68.9 kilos per capita (Tables 4 and 5). Since then, per capita consumption of rice (paddy equivalent) has been decreasing due to population growth, to reach 63.5 kilos in 1985.

Rice constitutes a basic staple to the urban and rural poor throughout the country. According to the DANE/DRI nutritional household survey of 1981, Colombians consumed 39.6 kilos per capita of white rice that year (Sanint et al.). Both urban and rural consumption were around that value which indicates that the cereal is a major staple at the country side as well as in the cities. There are important fluctuations around that value, however.

Data from the survey were analyzed dividing the country in 45 basic cells, that result from 4 regions with two zones each (rural and urban) one region with an urban zone only (Bogota D.E.) and 5 income groups (quintiles). Additional cells were provided to include mean values for regions, zones, strata and grand total groups.

Among the five regions, the highest average annual consumption appears in the Atlantic Coast with 61.1 kilos per capita while the Eastern region has the lowest individual consumption with 27.9 kilos per year (Table 8).

The highest annual per capita consumption among the 45 cells occurs in the Atlantic region (70.8 kilos of white rice in the rural upper-middle income quintile) while the lowest intake is found in the Eastern region (16.4 kilos in the lowest income quintile of the rural sector).

By income groups, the upper-middle class has the highest per capita consumption of rice per year with 44.9 kilos, while the lowest income stratum has also the most reduced annual intake of the cereal, with 32.0 kilos per capita.

However, for the country as a whole, rice takes the biggest share in total food expenditures at the lowest level of income with 9.5%. The rural poor of the Atlantic Coast devote as much as 18.1% of their food expenditures to rice. On the other hand, that share is lowest among the upper income level in Bogota, D.E. (3.3%). By regions, the Atlantic and the Pacific exhibit the highest participation of rice in household food expenditures with 8.7% and 7.2% respectively, which are considerably higher than those of the other three regions (Table 9).

Being rice a rich source of energy and protein, it constitutes a basic nutritional staple in Colombian diets. Nationally, rice contributes 14.5% and 12.7% to total energy and protein intake. There are no marked differences between the urban and the rural shares. Rice is of paramount importance among the poor in the Atlantic region (both in the urban and rural areas) since they obtain almost one-third of their calorie and protein intake from this cereal (Tables 10 and 11).

It is important to note, looking at the 45 cells, that although per capita quantities consumed increase with income, to reach a peak in the fourth quintile (upper-middle class) in all cases but one (Eastern urban), the contribution of rice to food expenditures, and to calorie and protein intake is highest at the lowest income levels and decreases thereafter. By zones (urban and rural) within regions, there are no sifnificant differences except perhaps in the Atlantic Coast.

Demand elasticities calculated from these data are longer term parameters than those calculated from time series data. Therefore, they are slightly higher than the latter. They support the hypothesis that rice consumption is quite sensitive to changes in its own retail price and in income. For income elasticities, the highest values appear among low income groups and the value of the elasticity generally decreases as income rises, as expected from economic theory. But this is not the case for price elasticities where a more random configuration appears associated with income changes (Table 12).

The fact that rice is grown throughout the country and has good marketing channels (Montes et al.) explains the existence of a uniform retail price for the cereal among the five different regions examined. By income levels, there are significant differences. Rice is cheaper among the poor (which most likely consume qualities of rice with a high percentge of broken grains) than among rich consumers (Table 13).

Regional differences in rice consumption, then, are probably closely related to prices and availability of other carbohydrates. In the Atlantic Coast, for example, where rice demand is highest, consumption of cassava and yams is high while bread and wheat products, maize and potatoes are used in levels considerably below the national average figures (Sanint et al.).

Available evidence indicates that there exists ample demand for rice in Colombia in all regions and by consumers with varying levels of income. Demand was enough to absorb the shifts in supply brought about in the past two decades by the incorporation of the new improved practices and varieties.

Given the obvious basic role that rice plays particularly among low income consumers in the country, i.e. among those considered at nutritional risk, it is crucial to maintain prices of rice at present levels or even lower and keep supplies abundant if the government intends to improve the nutritional situation of the absolute poor.

However, per capita consumption of white rice in 1985 went back to the same level that it was in 1976 (about 65 kilos) after it peaked in 1981 with 72.1 kilos due to stagnation in rice production. Costs of production went from around US$155 per ton in 1976 to about US$300 per ton in 1984 as a result of the more rapid rise in costs compared to the rate of devaluation. (FEDEARROZ p. 69).

If per capita consumption stays at the level of 1985 (63.25 kilos), by the year 2000 Colombia would require a supply of 2.31 million tons, or 513,300 tons above 1985 production levels, which implies an annual growth of 1.7%. If we assume a growth in real per capita incomes of 1.5% per year (lower than the 1.9% of 1960-84) and an annual reduction of 1.0% in the real price of rice, per capita consumption would rise to 76.0 kilos by the year 2000. Needs would amount to 2.69 million tons, or 892,500 tons above the 1985 amount of production (a 50% increase). Alternative strategies for meeting this demand are discussed in the following section.

Production

Rice is grown mainly in three areas of the country: Central, Atlantic Coast and Eastern Plains, with 34%, 33% and 21% of the area, respectively. The rest (12%) is found in Valle del Cauca and the Santanderes (Table 14).

The Central region, where rice is exclusively grown under irrigation, yields reach the level of 6.0 tons/ha. In the Coast and the Eastern Plains, where irrigated and mechanized upland systems are found, yields are 4.6 tons/ha and 4.4 tons/ha respectively. About 87% of production comes from irrigated systems. These systems have a good potential for expansion in the Coastal region.

In spite of the high yields, costs of production per hectare are so high that unit costs per ton make Colombia a non-competitive country by international prices.

Two alternatives are viable to increase rice production in Colombia: (i) Expand and improve cultivated areas, (ii) Obtain even higher yields. Yields are already high and significant changes are not likely to occur in the near future. Given current trends in Colombian agriculture, area expansion is unlikely to occur unless the relative profitability of rice with respect to other crops improves markedly. This improvement can result from two different sources: (i) Favorable government policies that will permit the reduction of costs of production or increase the price of rice relative to other crops and/or (ii) Reduce costs of production by means of higher efficiency. Of these alternatives, the second seems to be the most plausible. Improvements in infrastructure (irrigation) and more favorable government policies are out of reach to farmers; the prevalent bias against agriculture does not permit anticipating major changes in policies either. Consequently, higher efficiency is a must to reactivate rice production. But, is it possible?

While the tendency to higher costs have a macroeconomic component stemming from the set of discriminatory policies against agriculture and, particularly, against exportables like rice (see Garcia), it also has a microeconomic component that originates in management practices which are not optimal from the agronomic and, consequently, from the economic point of view.

For a number of producers, researchers, extensionists and observers it became evident that managerial approaches have been the key issue (Ramirez, 1979; Pulver 1985; National Agronomy Plan 1986). "Under irrigated conditions, farmers in Tolima (Central region), the Coast and Meta (Eastern Plains) need to harvest at least 5.9 tons, 4.6 tons, and 4.7 tons/ha, respectively, just to meet their production costs. In comparison, average production costs in Latin America for irrigated rice are only 3.4 tons/ha... Costs for plant protection, including weed, disease and insect control reach 1.3 tons/ha in Tolima, 1 ton/ha in the Valle and in the Coast and 0.8 tons/ha in Meta. This is about double the amount spent on an average in Latin America on plant protection in rice. These items, which result in especially high costs in Colombia, required further analysis in order to reveal the agronomic practices behind them and in order to search for cost-effective alternatives" (Pulver and Weber, p.3).

Given the high cost structure in which Colombian agriculture is locked-in, the only viable alternative at present to increase rice production is by means of higher economic efficiency. Economic efficiency encompasses both technical and allocative efficiency.

Technical (or agronomic), efficiency is achievement of the maximum possible output with a given quantity of inputs. It implies using the right amounts of available inputs to attain maximum output, such that no more output could be obtained from the input mix. Allocative efficiency refers to the ability of farmers to produce a given level of output at minimum cost. That is to combine inputs in right proportions such that the same output level could not be produced with a lower level of expenditures.

The crucial distinction between agronomic and economic efficiency lies in the fact that the first deals with physical input-output relationships while the latter incorporates input and output prices. For example, while a producer that obtains the highest possible yields of rice per hectare is efficient from the agronomic view he will be using amounts of inputs that are beyond the point of economic efficiency given a set of positive prices for his inputs and for rice.

The theory of production economics asserts that technical inefficiency is due to an excessive input usage. In turn, allocative inefficiency results from using inputs in the wrong proportions. Both kinds of inefficiencies are costly to producers, so that the observed level of expenditures is higher than the minimum cost associated with a particular level of output. Since cost is not minimized net revenue or profit is not maximized and the observed level of profit is lower than the profit maximizing level.

Under conditions of perfect competition in input and output markets (the simplest case) and within a static framework, an income maximizing farmer is assumed to use each input up to the point where its marginal value product (MVP) equals the input price. In real world situations the profit maximizing output level (economic optimum) is lower than the total physical product maximizing level (physical optimum).

Posada illustrates this point with a simple example of nitrogen use in rice production (Table 15). Clearly, maximum profit (economic efficiency) is achieved at a different application of nitrogen (120 kg/ha) than the amount of nitrogen (160 kgs/ha) that yields the maximum production.

The conditions applied in the proceeding example can be synthesized for any given input i as folows:

MPPi * Price of Rice = Price of i,
where MPPi refers to the Marginal Physical Productivity of the input i; (a monotonically decreasing function).

In simple words, let us look at fertilizer applications. The farmer should use additional units of fertilizer until its contribution to additional revenue (i.e., added tons of rice per kilo of fertilizer used times the price of rice) is equal to what the farmer paid for that unit of fertilizer. If he applies even more fertilizer, he may produce more rice (up to a point), but the expense is not going to be compensated by the expenditure and he will waste resources.

The issue of efficiency in the agronomic (or technical) and economic sense is addressed now using a methodology that has been applied by Afriat (1972) and Aigner, Lovell and Schmidt (1977). The results of applying this economic methodology are then compared with recommended practices from the National Agronomy Plant that are based on agronomists observations, field trials and evaluations.

Data used in the model were collected from a 1981 random survey involving the interviewing respondents method. The questionnaire contained detailed information on farm resource endowments, production technology, input-output relationships and financial markets.

The maximum likelihood estimates of the stochastic revenue function were used to compute the mean efficiency of rice farms in several scenarios (Ramirez).

Taking the sample as a whole, the analysis reveals that total output could be increased by 17.3% above current levels if technical inefficiencies were eliminated. Also, assuming that rice producers would use inputs in the right proportions (allocative efficiency), costs of production could be reduced by 15.8%. If both inefficiencies are corrected, total costs of production could be reduced by more than 30%.

These results assume profit maximization as the only objective of the producer. They mask the impact of other criteria involved in determining the farmer's optimal strategy. Factors like risk, uncertainty, and liquidity management decisions will interfere with the profit maximizing input combination.

Under conditions of risk and uncertainty, as is the actual case in rice production, and assuming that technical efficiency is being already achieved, the general hypothesis is that rice producers who are risk averters will not stop at that profit maximizing point in determining input use, because they are willing to pay a risk premium. Their condition for an economic optimum would be given by:

MPPi * Price of Rice = Price of i + Ra * Ir where
Ra * Ir = Risk adjustment, and
Ra = Risk aversion coefficient,
Ir = Marginal contribution of risk to additional input use.

It is well known that Ir is negative for plant protection inputs. Thus, the higher a farmer's expectations about total crop losses, the more chemical inputs are sprayed over the crop. The higher the risk associated with weed incidence the higher will be the amounts of seed planted, labor hired to fight weeds and machine-hours spent on land cultivtion. If farmers are uncertain about the consequences of reducing input usage by any amount, the observed input usage may, eventually, exceed that level of input that achieves an economic optimum or even a physical optimum.

The additional output value that farmers are actually giving up as extra expenditures on inputs portray a risk premium to insure against risk and uncertainity. Empirical evidence supports the idea that a risk averter is willing to pay higher insurance against adverse events with unknown probabilities (uncertain events) than if they would otherwise know this probability. Therefore, in the case of rice, it is crucial to have demonstration parcels with the management packages proposed by the National Rice Plan to reduce uncertainty on the part of farmers.

It is postulated that rice producers could pay a lower rate of insurance if they were fairly acquainted with the nature and magnitude of the risks involved in a particular management strategy. They must be convinced that their net returns can increase, even if current input levels are reduced. By doing so, economic efficiency can be enhanced and costs of production can be reduced significantly, leading to higher supplies.

Integrated Crop Management Activities.

Several practices have been evaluated and demonstration plots exist for transferring knowledge and confidence to farmers and technical assistants where they can verify that the management strategy proposed works in the field. Costs of production have been reduced by about 23% in all areas (Coast, Central, and Eastern Planins) (FEDEARROZ-ICA-CIAT). These results are very much in line with those emerging from our analysis and validate the possibility of increasing efficiency and reducing costs per hectare without sacrificing revenues.

An interesting point implicit in the integrated crop management approach suggested by the National Rice Plan is that optimal resource use should be based on more technical supervision (to minimize the risk of crop failures) in substitution of imported chemical inputs (Posada), thus increasing the national value added in production.

Recommendations of the Plan include reduction of seed densities from 250 plus kilos per ha. to 100-150 kilos per ha, careful timing in weed control, implementation of an integrated pest management approach allowing beneficial insects to carry out their action, adequate seed selection and treatment among others.

The current stagnation in production will imply higher prices for rice with lower levels of individual consumption in the near future. If the Government decides to keep consumption at present levels, imports are likely to occur. Both alternatives appear to be quite costly and socially unattractive.

However, should the results presented here be extrapolated to all producers, rice production could be expanded easily to accomodate for the additional demand brought by the lower prices. Field trial results are very encouraging in this respect. An additional point for research constitutes the fact that if efficiency is rapidly improved excedents may be generated. The possibilities for new market outlets (internal and external) should be carefully evaluated now.

Finally, the area of commercialization has been overlooked in this paper, but undoubtedly there is room for improvement also. In Colombia, between 1977 and 1983, the wholesale price index for food increased annualy 4.8 percentage points more rapidly than the farm gate price index. This suggests that reducing the costs of marketing is a key target in improving food supplies since they have grown much faster than production costs.

According to SAC, rice production in Colombia has comparative advantage at the farm level even under the present circumstances described here. However, the advantage is eroded due to a set of inefficiencies in milling, handling and transportation of white rice. To rely on rice as a basic staple and ensure an adequate use of domestic resources the inefficiencies in production and marketing should (and can) be reduced in the near future.

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Table 1. Colombia, Gross Domestic Product - Total and Agriculture in Constant Prices 1970 Pesos (Millions).

| | Total GDP | Agriculture GDP | Percent Agric |
|---|---|---|---|
| 1960 | 71,902 | 24,305 | 33.8% |
| 1965 | 90,351 | 27,834 | 30.8% |
| 1970 | 119,797 | 34,245 | 28.6% |
| 1975 | 163,399 | 44,066 | 27.0% |
| 1976 | 170,227 | 44,905 | 26.4% |
| 1977 | 178,326 | 46,097 | 25.8% |
| 1978 | 194,818 | 50,575 | 26.0% |
| 1979 | 203,664 | 52,618 | 25.8% |
| 1980 | 211,930 | 53,954 | 25.5% |
| 1981 | 217,228 | 55,580 | 25.6% |
| 1982 | 219.183 | 54,622 | 24.9% |
| 1983 | 221,375 | 55,606 | 25.1% |
| 1984 | 228,459 | 56,940 | 24.9% |
| 1985 | 234,956 | 58,591 | 24.9% |
| Annual Growth Rates | GDP | Agriculture | Population |
| 1960-67 | 4.6% | 2.9% | 3.1 |
| 1967-78 | 6.0% | 4.5% | 2.2 |
| 1978-85 | 2.4% | 1.8% | 1.9 |
| 1981-85 | 2.0% | 1.5% | 1.8 |

Source: IDB Economic and Social Progress in Latin America Several Issues.

Table 2. Measures of the Internal Terms of Trade for Agriculture, 1970-83.

| Year | Ratio of Sectoral Value Added Deflators (agriculture to non-agriculture) | Wholesale Price Ratio: Agriculture to All Consumer Goods | Ratio of Agricultural Producer Price to: Consumer Price Index | Ratio of Agricultural Producer Price to: Wholesale Index for Consumer Goods |
|---|---|---|---|---|
| 1970 | 0.966 | 0.885 | 0.846 | 1.056 |
| 1971 | 0.955 | 0.872 | 0.856 | 1.018 |
| 1972 | 0.991 | 0.863 | 0.879 | 0.994 |
| 1973 | 1.051 | 0.925 | 0.939 | 1.036 |
| 1974 | 1.067 | 0.983 | 0.938 | 1.009 |
| 1975 | 1.000 | 1.000 | 1.000 | 1.000 |
| 1976 | 1.006 | 1.021 | 1.046 | 1.035 |
| 1977 | 1.099 | 1.022 | 1.103 | 1.039 |
| 1978 | 0.978 | 1.055 | 0.905 | 0.855 |
| 1979 | 0.896 | 1.033 | 0.886 | 0.802 |
| 1980 | 0.806 | 0.975 | 0.871 | 0.765 |
| 1981 | 0.788 | 0.933 | 0.841 | 0.731 |
| 1982 | 0.786 | 0.952 | 0.850 | 0.693 |
| 1983 | 0.775 | 0.954 | 0.868 | 0.684 |
| Rates of change (%) | | | | |
| 1970-75 | 0.69 | 2.47 | 3.40 | -1.08 |
| 1975-80 | -4.22 | -0.51 | -2.72 | -5.22 |
| 1980-83 | -1.30 | -0.72 | -0.11 | -2.21 |

Source: World Bank, Rural Financial Markets Sector Study.

TABLE 3. Colombia, Irrigated Rice. Costs of Production and Price of Paddy Rice.

| | Yield tons/ha | Production Cost $/ha | Production Cost $/ton | Price Paddy $/ton | Margins $/ton | Margins $/ha |
|---|---|---|---|---|---|---|
| 1977 B | 5.40 | $31.786 | $5,886 | $7,841 | $1,955 | $10,555 |
| 1984 A | 5.55 | $131,235 | $23,646 | $23,851 | $205 | $1,138 |

Source: Fedearroz.

TABLE 4. Area, Production and Yield of Rice in Colombia, 1961-1984.

| Y e a r | Area 000 Has | Production 000 Tons | Yield Ton / Ha |
|---|---|---|---|
| 1961 | 237.10 | 473.60 | 2.00 |
| 1962 | 279.50 | 585.00 | 2.09 |
| 1963 | 254.00 | 550.00 | 2.17 |
| 1964 | 302.50 | 600.00 | 1.98 |
| 1965 | 374.50 | 672.00 | 1.79 |
| 1966 | 350.00 | 680.00 | 1.94 |
| 1967 | 290.70 | 661.50 | 2.28 |
| 1968 | 277.10 | 786.30 | 2.84 |
| 1969 | 250.40 | 694.50 | 2.77 |
| 1970 | 233.20 | 752.60 | 3.23 |
| 1971 | 253.50 | 904.30 | 3.57 |
| 1972 | 273.80 | 1.043.30 | 3.81 |
| 1973 | 290.90 | 1.175.80 | 4.04 |
| 1974 | 368.50 | 1.569.90 | 4.26 |
| 1975 | 381.40 | 1.622.20 | 4.25 |
| 1976 | 355.60 | 1.480.70 | 4.16 |
| 1977 | 337.20 | 1.401.60 | 4.16 |
| 1978 | 434.30 | 1.878.00 | 4.32 |
| 1979 | 430.60 | 1.829.80 | 4.25 |
| 1980 | 414.20 | 1.784.10 | 4.31 |
| 1981 | 439.00 | 1.877.70 | 4.28 |
| 1982 | 473.90 | 2.023.60 | 4.27 |
| 1983 | 425.40 | 1.813.50 | 4.26 |
| 1984 | 370.20 | 1.725.10 | 4.66 |

Source: Fedearroz.

TABLE 5. Rice in Colombia, Availability and Per Capita Consumption, 1960-85.

| | Production | Exports | Stocks | Availability | Human Population | Per Capita Consumption Paddy | Per Capita Consumption White Rice |
|---|---|---|---|---|---|---|---|
| | Thousand Metric Tons | | | | Millions | Kilos | |
| 1960 | 450 | 0 | na | 450.0 | 15.7 | 28.8 | 19.3 |
| 1961 | 474 | 0 | na | 474.0 | 16.2 | 29.3 | 19.6 |
| 1962 | 585 | (1) | na | 586.0 | 16.7 | 35.0 | 23.5 |
| 1963 | 550 | (3) | na | 553.0 | 17.3 | 31.9 | 21.4 |
| 1964 | 600 | 0 | na | 600.0 | 17.9 | 33.5 | 22.5 |
| 1965 | 672 | 0 | na | 672.0 | 18.4 | 36.6 | 24.5 |
| 1966 | 680 | 0 | na | 680.0 | 18.9 | 35.9 | 24.1 |
| 1967 | 622 | 0 | na | 622.0 | 19.5 | 31.9 | 21.4 |
| 1968 | 786 | 0 | na | 786.0 | 20.1 | 39.1 | 26.2 |
| 1969 | 689 | (16) | na | 705.0 | 20.7 | 34.1 | 22.9 |
| 1970 | 753 | 8 | 183 | 745.4 | 21.1 | 35.3 | 23.6 |
| 1971 | 905 | 0 | 248 | 840.3 | 21.6 | 38.9 | 26.0 |
| 1972 | 1,043 | 5 | 270 | 1,016.1 | 22.1 | 46.0 | 30.8 |
| 1973 | 1,176 | 31 | 147 | 1,267.9 | 22.6 | 56.2 | 37.6 |
| 1974 | 1,570 | 2 | 344 | 1,370.7 | 23.0 | 59.5 | 39.9 |
| 1975 | 1,622 | 116 | 306 | 1,544.5 | 23.5 | 65.7 | 44.0 |
| 1976 | 1,481 | 120 | 195 | 1,471.4 | 24.0 | 61.4 | 41.1 |
| 1977 | 1,402 | 31 | 118 | 1,448.4 | 24.4 | 59.3 | 39.7 |
| 1978 | 1,878 | 1 | 279 | 1,717.4 | 24.9 | 68.9 | 46.2 |
| 1979 | 1,830 | 38 | 346 | 1,724.9 | 25.4 | 68.0 | 45.5 |
| 1980 | 1,784 | 60 | 282 | 1,787.1 | 25.9 | 69.0 | 46.2 |
| 1981 | 1,878 | 33 | 222 | 1,904.9 | 26.4 | 72.1 | 48.3 |
| 1982 | 2,024 | 0 | 378 | 1,867.7 | 27.0 | 69.3 | 46.4 |
| 1983 | 1,814 | 35 | 346 | 1,811.2 | 27.5 | 66.0 | 44.2 |
| 1984 | 1,725 | 40 | 264 | 1,766.4 | 27.9 | 63.2 | 42.4 |
| 1985 | 1,798 | 52 | 161 | 1,848.7 | 28.3 | 65.3 | 43.7 |

na: not available

Sources: For Production, Fedearroz: Un Gremio al Servicio de Colombia.
For Exports and Population, DANE
For Stocks, IDEMA, Division de Comercializacion.
Other, Own calculations

TABLE 6. Colombia. Per Capita Consumption of Carbohydrates, Kgs.

| Year | Cassava | Potatoes | Corn | Wheat | Plantains |
|---|---|---|---|---|---|
| 1960 | 43.5 | 41.7 | 47.4 | 18.2 | 80.2 |
| 1961 | 40.2 | 34.1 | 38.0 | 18.8 | 78.8 |
| 1962 | 46.6 | 51.2 | 34.0 | 19.2 | 77.2 |
| 1963 | 46.2 | 33.1 | 32.6 | 15.0 | 75.6 |
| 1964 | 39.1 | 38.4 | 45.1 | 15.0 | 75.2 |
| 1965 | 43.6 | 41.5 | 37.3 | 16.2 | 75.4 |
| 1966 | 44.4 | 40.1 | 35.8 | 18.1 | 75.2 |
| 1967 | 43.6 | 41.0 | 33.5 | 13.5 | 81.5 |
| 1968 | 44.8 | 47.3 | 31.6 | 18.6 | 79.6 |
| 1969 | 48.4 | 41.2 | 34.7 | 13.4 | 79.4 |
| 1970 | 92.6 | 43.2 | 35.5 | 16.2 | 79.5 |
| 1971 | 92.0 | 40.2 | 27.6 | 18.9 | 79.7 |
| 1972 | 90.9 | 37.2 | 31.0 | 22.2 | 76.9 |
| 1973 | 88.5 | 45.2 | 21.3 | 18.5 | 77.6 |
| 1974 | 92.3 | 43.9 | 25.6 | 23.0 | 78.3 |
| 1975 | 86.0 | 56.2 | 27.0 | 15.7 | 76.2 |
| 1976 | 77.0 | 63.2 | 30.1 | 15.1 | 77.3 |
| 1977 | 80.2 | 65.8 | 20.4 | 20.9 | 75.5 |
| 1978 | 82.1 | 80.1 | 28.2 | 19.3 | 88.0 |
| 1979 | 75.2 | 81.4 | 25.1 | 20.5 | 88.1 |
| 1980 | 83.0 | 66.7 | 30.1 | 21.3 | 90.7 |
| 1981 | 81.3 | 79.6 | 25.8 | 22.6 | 90.8 |
| 1982 | 57.6 | 79.7 | 26.4 | 24.3 | 73.9 |
| 1983 | 58.8 | 79.7 | 23.2 | 25.1 | 81.9 |
| 1984 | 59.9 | 88.1 | 20.6 | 25.2 | 76.7 |
| 1985 | 59.8 | 67.1 | 26.9 | 24.9 | 77.1 |

Source: Ministerio de Agricultura, Own calculations.

TABLE 7. Colombia. Gross Domestic Product (GDP) and Real Retail Prices of Major Carbohydrate Staples, $/Kg. (1970 Pesos).

| Year | Cassava | Potatoes | Rice | Corn | Wheat | Plantains | Real Per Capita G D P ($1000) |
|---|---|---|---|---|---|---|---|
| 1960 | 1.52 | 1.85 | 5.74 | 3.46 | 6.14 | 1.23 | 42.79 |
| 1961 | 1.97 | 1.94 | 6.53 | 5.07 | 6.16 | 1.40 | 47.39 |
| 1962 | 1.77 | 1.67 | 6.05 | 4.74 | 5.59 | 1.72 | 47.06 |
| 1963 | 1.50 | 2.18 | 4.69 | 3.48 | 5.17 | 1.63 | 40.95 |
| 1964 | 1.90 | 2.79 | 4.93 | 4.47 | 5.49 | 2.10 | 45.00 |
| 1965 | 2.02 | 1.61 | 5.64 | 3.65 | 5.63 | 1.78 | 42.65 |
| 1966 | 1.76 | 2.27 | 5.55 | 3.62 | 5.27 | 1.81 | 44.69 |
| 1967 | 1.89 | 2.01 | 5.37 | 3.65 | 5.10 | 1.66 | 46.53 |
| 1968 | 2.11 | 2.00 | 5.25 | 3.63 | 5.15 | 1.82 | 49.20 |
| 1969 | 3.42 | 1.81 | 4.67 | 3.48 | 4.67 | 1.77 | 50.83 |
| 1970 | 2.04 | 1.73 | 4.46 | 3.5 | 4.43 | 1.78 | 55.46 |
| 1971 | 2.24 | 1.82 | 4.30 | 3.22 | 3.88 | 1.84 | 55.23 |
| 1972 | 2.66 | 1.98 | 3.77 | 3.29 | 3.40 | 1.82 | 57.07 |
| 1973 | 1.89 | 2.05 | 3.51 | 3.70 | 3.62 | 1.77 | 56.16 |
| 1974 | 2.13 | 1.83 | 4.21 | 3.41 | 3.79 | 1.59 | 57.05 |
| 1975 | 2.81 | 3.23 | 3.79 | 3.56 | 5.46 | 2.17 | 59.98 |
| 1976 | 2.19 | 1.74 | 3.05 | 2.93 | 4.93 | 1.93 | 57.85 |
| 1977 | 1.71 | 1.80 | 3.47 | 3.25 | 4.03 | 2.17 | 56.93 |
| 1978 | 2.45 | 1.70 | 3.81 | 3.55 | 3.64 | 1.93 | 62.41 |
| 1979 | 2.49 | 1.73 | 3.17 | 3.13 | 3.30 | 1.66 | 60.50 |
| 1980 | 2.14 | 2.09 | 2.27 | 3.51 | 3.30 | 1.68 | 62.14 |
| 1981 | 2.17 | 1.79 | 3.50 | 3.42 | 3.11 | 1.72 | 62.03 |
| 1982 | 3.13 | 1.88 | 3.48 | 3.09 | 2.77 | 1.88 | 64.04 |
| 1983 | 2.98 | 1.74 | 3.12 | 3.04 | 2.46 | 1.94 | 64.27 |
| 1984 | 2.59 | 1.40 | 3.11 | 3.00 | 2.61 | 1.95 | 65.81 |

Source: Ministerio de Agricultura, DANE. Own calculations.

TABLE 8. Colombia. White Rice, Per Capita Consumption by Region, Zone and Quintile. DANE/DRI Survey, 1981.

| Region / Income Quintile | Low Income 1 | 2 | 3 | 4 | High Income 5 | Average |
|---|---|---|---|---|---|---|
| Atlantic | | | | | | |
| Urban | 57.6 | 59.2 | 59.4 | 62.3 | 54.0 | 58.5 |
| Rural | 60.9 | 62.7 | 69.5 | 70.8 | 64.3 | 65.1 |
| Total | 59.6 | 61.1 | 63.8 | 64.4 | 55.7 | 61.1 |
| Eastern | | | | | | |
| Urban | 23.0 | 26.7 | 32.8 | 32.7 | 34.0 | 30.1 |
| Rural | 16.4 | 25.9 | 30.0 | 38.1 | 32.1 | 26.0 |
| Total | 18.5 | 26.2 | 31.5 | 34.8 | 33.3 | 27.9 |
| Bogotá D.E. | 27.5 | 32.6 | 33.5 | 36.8 | 33.2 | 33.5 |
| Central | | | | | | |
| Urban | 25.2 | 32.3 | 35.6 | 37.7 | 28.8 | 32.0 |
| Rural | 22.3 | 34.0 | 33.9 | 36.6 | 33.6 | 31.1 |
| Total | 23.9 | 33.0 | 35.0 | 37.4 | 29.6 | 31.7 |
| Pacific | | | | | | |
| Urban | 40.4 | 50.1 | 49.4 | 51.9 | 50.4 | 49.2 |
| Rural | 35.4 | 44.7 | 50.7 | 57.8 | 50.1 | 43.7 |
| Total | 37.2 | 47.3 | 49.9 | 53.1 | 50.4 | 47.1 |
| Total | | | | | | |
| Urban | 32.3 | 38.2 | 41.2 | 44.0 | 39.4 | 39.6 |
| Rural | 31.6 | 39.4 | 45.2 | 47.8 | 41.9 | 39.5 |
| Total | 32.0 | 38.8 | 42.6 | 44.9 | 39.7 | 39.6 |

Source: Own calculations. Data refer to annual kilos consumed per adult equivalent.

TABLE 9. Colombia. White Rice. Percent in total Food Expenditures. DRI/PAN Household Survey, 1981.

| Region / Income Quintile | Low Income 1 | 2 | 3 | 4 | High Income 5 | Average |
|---|---|---|---|---|---|---|
| **Atlantic** | | | | | | |
| Urban | 14.87 | 10.24 | 8.39 | 7.35 | 5.27 | 7.44 |
| Rural | 18.06 | 13.03 | 9.77 | 8.29 | 7.98 | 11.31 |
| Total | 15.76 | 11.74 | 8.98 | 7.58 | 5.65 | 8.71 |
| **Eastern** | | | | | | |
| Urban | 7.07 | 5.31 | 5.01 | 4.10 | 3.75 | 4.70 |
| Rural | 4.69 | 4.45 | 4.40 | 4.93 | 4.24 | 4.56 |
| Total | 5.45 | 4.76 | 4.72 | 4.42 | 3.92 | 4.63 |
| **Bogotá D.E.** | 8.88 | 6.80 | 5.40 | 4.54 | 3.32 | 4.47 |
| **Central** | | | | | | |
| Urban | 8.21 | 6.65 | 5.49 | 4.56 | 3.75 | 5.15 |
| Rural | 6.69 | 5.46 | 5.29 | 4.78 | 4.63 | 5.66 |
| Total | 7.50 | 6.56 | 5.41 | 4.62 | 3.90 | 5.31 |
| **Pacific** | | | | | | |
| Urban | 11.62 | 9.74 | 7.69 | 6.28 | 5.19 | 6.66 |
| Rural | 10.95 | 8.31 | 7.35 | 8.56 | 6.94 | 8.69 |
| Total | 11.20 | 9.02 | 7.55 | 6.74 | 5.29 | 7.22 |
| **T o t a l** | | | | | | |
| Urban | 9.75 | 7.52 | 6.29 | 5.37 | 4.23 | 5.65 |
| Rural | 9.36 | 7.48 | 6.64 | 6.24 | 5.63 | 7.17 |
| Total | 9.54 | 7.50 | 6.41 | 5.56 | 4.39 | 6.09 |

TABLE 10. Colombia. White Rice. Percent Share of Total Calorie intake. DRI/PAN, Household Survey, 1981.

| Region / Income Quintile | Low Income 1 | 2 | 3 | 4 | High Income 5 | Average |
|---|---|---|---|---|---|---|
| Atlantic | | | | | | |
| Urban | 31.3 | 25.9 | 21.8 | 19.9 | 16.4 | 20.8 |
| Rural | 32.3 | 26.0 | 21.5 | 20.2 | 19.0 | 24.3 |
| Total | 31.9 | 25.9 | 21.7 | 20.0 | 16.8 | 22.2 |
| Eastern | | | | | | |
| Urban | 13.3 | 11.9 | 11.7 | 10.7 | 10.9 | 11.5 |
| Rural | 7.6 | 8.9 | 8.8 | 11.1 | 9.7 | 9.0 |
| Total | 9.1 | 9.9 | 10.2 | 10.9 | 10.4 | 10.1 |
| Bogotá D.E. | 18.8 | 16.3 | 13.7 | 13.5 | 11.3 | 13.2 |
| Central | | | | | | |
| Urban | 15.0 | 13.8 | 13.2 | 11.8 | 10.9 | 12.6 |
| Rural | 10.8 | 11.3 | 10.0 | 10.0 | 9.5 | 10.5 |
| Total | 12.9 | 12.5 | 11.9 | 11.3 | 10.6 | 11.8 |
| Pacific | | | | | | |
| Urban | 20.6 | 19.4 | 16.2 | 15.3 | 14.0 | 15.9 |
| Rural | 17.6 | 15.9 | 14.2 | 16.6 | 14.4 | 16.0 |
| Total | 18.6 | 17.5 | 15.3 | 15.7 | 14.0 | 15.9 |
| Total | | | | | | |
| Urban | 18.8 | 16.7 | 15.2 | 14.3 | 12.8 | 14.7 |
| Rural | 15.5 | 14.2 | 13.4 | 13.7 | 12.3 | 14.0 |
| Total | 16.9 | 15.4 | 14.5 | 14.1 | 12.7 | 14.5 |

TABLE 11. Colombia. White Rice. Percent share in total protein intake. DRI/PAN Household Survey, 1981.

| Region / Income Quintile | Low Income 1 | 2 | 3 | 4 | High Income 5 | Average |
|---|---|---|---|---|---|---|
| Atlantic | | | | | | |
| Urban | 30.0 | 21.6 | 17.8 | 16.3 | 12.9 | 17.0 |
| Rural | 33.2 | 23.7 | 18.6 | 17.7 | 15.4 | 21.9 |
| Total | 32.0 | 22.8 | 18.2 | 16.6 | 13.3 | 18.8 |
| Eastern | | | | | | |
| Urban | 12.3 | 10.2 | 9.3 | 8.3 | 8.3 | 9.3 |
| Rural | 7.6 | 8.2 | 7.9 | 9.4 | 8.7 | 8.3 |
| Total | 9.0 | 8.9 | 8.6 | 8.8 | 8.5 | 8.8 |
| Bogotá D.E. | 17.5 | 14.4 | 11.2 | 10.6 | 8.3 | 10.4 |
| Central | | | | | | |
| Urban | 14.7 | 12.3 | 11.0 | 9.8 | 8.8 | 10.7 |
| Rural | 11.8 | 11.4 | 9.6 | 9.7 | 8.7 | 10.4 |
| Total | 13.3 | 11.9 | 10.5 | 9.8 | 8.8 | 10.6 |
| Pacific | | | | | | |
| Urban | 21.6 | 18.6 | 14.4 | 14.3 | 11.6 | 13.9 |
| Rural | 20.2 | 16.4 | 14.2 | 16.9 | 13.9 | 16.8 |
| Total | 20.7 | 17.5 | 14.3 | 14.1 | 11.7 | 14.8 |
| T o t a l | | | | | | |
| Urban | 18.3 | 14.8 | 12.6 | 11.7 | 10.0 | 12.2 |
| Rural | 16.6 | 13.8 | 12.4 | 12.5 | 10.9 | 13.5 |
| Total | 17.3 | 14.3 | 12.5 | 11.8 | 10.1 | 12.6 |

TABLE 12. White Rice: Income and Price Elasticities of Demand. Colombia. DANE/DRI Survey 1981. By region, area and quintile.

| Region / Quintile | Area | Atlantic | | Eastern | | Bogotá | Central | | Pacific | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Urban | Rural | Urban | Rural | Urban | Urban | Rural | Urban | Rural |
| Income Elast. | 1 | 0.88 | 0.68 | 0.96 | 0.87 | 0.79 | 0.79 | 0.96 | 1.00 | 0.78 |
| | 2 | 0.84 | 0.76 | 0.74 | 0.96 | 0.74 | 0.83 | 0.74 | 0.97 | 0.77 |
| | 3 | 0.92 | 1.04 | 0.96 | 0.54 | 0.69 | 0.67 | 0.82 | 0.83 | 0.80 |
| | 4 | 0.56 | 0.62 | 0.78 | 0.86 | 0.67 | 0.59 | 0.59 | 0.67 | 0.44 |
| | 5 | 0.17 | 0.68 | 0.55 | 0.14 | 0.19 | 0.26 | 0.49 | 0.23 | 0.60 |
| Price Elast. | 1 | -0.98 | -0.96 | -0.87 | -0.22 | -0.58 | -0.83 | -0.85 | -0.88 | 0.55 |
| | 2 | -0.93 | -0.53 | -0.88 | -0.88 | -0.87 | -0.85 | -0.85 | -0.97 | -0.95 |
| | 3 | -0.90 | -1.03 | -0.52 | -0.86 | -0.93 | -0.77 | -0.83 | -0.15 | -0.86 |
| | 4 | -0.34 | -0.58 | -0.93 | -0.81 | -0.87 | -0.92 | -0.86 | -0.17 | -0.29 |
| | 5 | -1.02 | -0.50 | -0.90 | -0.63 | -0.58 | -0.66 | -0.86 | -0.96 | -1.11 |

Source: Own-calculations.

TABLE 13. Duncan's Multiple Range Test for the Retail Price of Rice by Regions and Income Levels. Colombia, DANE/DRI Survey, 1981.

| Region | Price $/Kg. | Grouping | |
|---|---|---|---|
| Atlantic | 38.85 | A | |
| Central | 38.67 | A | |
| Bogota, D.E. | 38.46 | A | |
| Pacific | 38.42 | A | |
| Eastern | 37.72 | A | |

| Quintile | Price | Grouping | |
|---|---|---|---|
| 5 (High) | 39.71 | A | |
| 4 | 38.87 | A | B |
| 3 | 38.13 | A | B |
| 2 | 37.90 | C | B |
| 1 (Low) | 37.04 | C | |

Note: Groups with same letter have means that are not significantly different at the 10% level.

Source: Own calculations.

TABLE 14. Rice Sector: Regional Analysis, 1977-1984. Colombia.

AREA 000 HAS.

| Zone | Mean | % | Coefficient of variation | Growth Rate |
|---|---|---|---|---|
| CENTRAL[1] | 111.5 | 34 | 7.1 | 1.0 |
| COAST[2] | 106.2 | 33 | 15.0 | 0.5 |
| EASTERN PLAINS[3] | 67.8 | 21 | 22.0 | 7.0 |
| TOTAL[4] | 324.9 | 100 | 11.2 | 2.4 |

PRODUCTION 000 TONS.

| Zone | Mean | % | Coefficient of variation | Growth Rate |
|---|---|---|---|---|
| CENTRAL[1] | 665.2 | 40 | 6.8 | 1.0 |
| COAST[2] | 489.5 | 30 | 12.0 | 1.9 |
| EASTERN PLAINS[3] | 298.7 | 18 | 21.6 | 8.0 |
| TOTAL[4] | 1.654.9 | 100 | 10.0 | 2.4 |

YIELDS TONS/HA.

| Zone | Average | Growth Rate |
|---|---|---|
| CENTRAL[1] | 6.0 | 0.0 |
| COAST[2] | 4.6 | 1.4 |
| EASTERN PLAINS[3] | 4.4 | 1.0 |
| TOTAL[4] | 5.1 | 0.0 |

1 Huila, Tolima, Caldas, Cundinamarca, Boyaca.
2 Antioquia, Cordoba, Sucre, Bolivar, Magdalena, Cesar, Guajira.
3 Meta, Casanare.
4 Irrigated and mechanized upland.

Source: Fedearroz.

TABLE 15. Colombia. An Example of the Technical versus the Economic Efficiency. The Use of Nitrogen in Rice Production.

| Dosis Kg. N/Ha | Cost | Yield in Kgs. of Paddy Rice | Profit |
|---|---|---|---|
| 88 | 4.957 | 6.995 | 2.838 |
| 120 | 5.074 | 7.301 | 2.227 |
| 160 | 5.131 | 7.327 | 2.136 |
| 200 | 5.308 | 6.747 | 1.439 |

Source: Posada.

# Recent Evolution of the Livestock Sector in Latin America

Carlos Seré and Libardo Rivas

## Introduction

Structural adjustment continues to be the dominant issue in Latin American economic development. After rapid growth in the seventies, fostered by high prices for oil and other commodities and the ample availability of international credit, the eighties have been characterized by a very marked recession, a price drop in most commodity markets, high interest rates and widespread debt repayment difficulties.

This has led to substantial reductions in per capita income across the region as shown in Table 1. Given the high income elasticity of beef and milk this has triggered a general reduction in domestic demand and prices. Difficulties compounded particularly for agricultural exporters due to ever increasing protectionism and the disposal of structural surpluses of developed countries on the international markets.

This has been of benefit to importing countries, but poses a dilemma regarding the extent to which these low prices will persist in order to make decisions of redimensioning individual sectors.

The drop in interest rates over the past two years has eased somewhat the external debt problems; for the case of Venezuela savings amount to US 1 billion in 1986 (SINTESIS ECONOMICA, 1986).

Several countries have attempted to develop policy packages as alternatives to the conventional IMF/WORLD BANK supported structural adjustment package, including currency devaluation, public expenditure reduction, opening the economy to international markets, etc.

These alternative packages are geared to increasing domestic demand via price controls and salary increases and, in the case of Peru, limiting foreign debt payment to 10% of export revenue. These policies resulted in short term economic growth, as reflected in 1986 GNP growth rates of 8% in Brazil and 5.5% in Argentina (CEPAL, 1986). This resulted in substantial increases in domestic demand of products with high income elasticities, as will be elaborated for the case of beef and milk.

Table 1. Evolution of real GDP per capita in selected Latin American countries. 1981/86

| Country | 1981 | 1982 | 1983 | 1984 | 1985 | 1986[1] |
|---|---|---|---|---|---|---|
| Argentina | -8.2 | -7.8 | 1.4 | 0.6 | -5.9 | 3.9 |
| Brazil | -4.2 | -0.8 | -4.8 | 2.6 | 5.9 | 5.7 |
| Colombia | 0.1 | -1.1 | -0.3 | 1.4 | 0.4 | 3.0 |
| México | 5.4 | -2.6 | -7.6 | 0.9 | 0.1 | -6.3 |
| Perú | 1.3 | -2.5 | -14.2 | 1.2 | -1.0 | 5.9 |
| Venezuela | -3.9 | -4.1 | -8.2 | -3.7 | -3.2 | -1.0 |
| Latin America [2] | -1.9 | -3.7 | -4.7 | 0.9 | 0.4 | 1.2 |

1/ Preliminary estimates
2/ Excluding Cuba.

Source: CEPAL (1986)

Such policies nevertheless contributed to the reduction in exports and exacerbated the foreign debt problem. More than one third of the export revenues of the region were used to pay interest on the foreign debt in 1986. The most critical situations are encountered in Argentina, Brazil, Mexico and Chile, countries for which 1986 interest payments represent 52%, 38%, 40% and 39% of their respective export earnings.

In spite of the slight recovery of the world economy and the drop in interest rates, the debt problem has not been solved, as shown by the unilateral decision of Brazil in early 1987 to stop payments of interest and principal on its foreign debt. Several other countries are discussing similar steps. Thus foreign debt remains the central issue in the Latin American economic policy discussion.

## The beef sector

Changes in productivity in the beef sector cannot be analyzed for short periods of time due to the masking effect of cyclical changes. Therefore in this analysis averages for the periods 1970/77 and 1978/85 are emphasized.

The performance of the beef sector during the latter period reflects very closely the performance of the whole regional economy. Its main features were as follows:

- Production decreased at a rate of -0.7% p.a. That of Tropical Latin America grew at a low rate (0.4% p.a.) while that of the temperate region decreased at a rate of -2.2% p.a., due mainly to strong contraction of the Argentinian beef sector.

- Production per head in stock decreased both in tropical (-2.1%) and temperate Latin America (-1.3%).

- Production per capita dropped at a rate of -3.0% p.a. This trend is quite consistent across countries and regions, with particularly large negative rates in Central America.

- Apparent consumption per capita has decreased from 20.0 kg of beef and veal during the period 1970/77 to 19.7 kg in the period 1978/85.

- The structure of the beef trade shows increases in the share of processed meats and changes in the volumes traded (Argentina and Paraguay reducing exports, Brazil becomming a major exporter).

- A drop occurred in the export price of beef, particularly from countries with FMD, a fact particularly affecting South American exporters (Table 2)

Table 2. Growth rates of real beef prices* of international significance. 1975/80 and 1980/86

| Country | Growth rates (percentage) | |
|---|---|---|
| | 1975/80 | 1980/86 |
| USA (Omaha) | 2.7 | -3.9 |
| Argentina (Buenos Aires) | 17.1 | -12.2 |
| EEC | 1.6 | -7.5 |
| Australia (Brisbane) | 18.1 | -6.0 |

* Prices in 1980 US$

Source: FAO, Monthly Bulletin of Statistics (several years)

The beef economy of the period 78/85 can be characterized by the process of a reduction in domestic demand as a consequence of reduced purchasing power of domestic consumers, and reduced export demand due to the global recession and the agricultural policies of developed countries which have generated vast structural surpluses disposed of in the international market.

During 1977/85 this led to a substantially lower growth rate of domestic prices than during the period 1970/77. Data for Argentina, Brazil and Colombia (Table 3) show the clear link between growth of prices and stocks of cattle as well as beef production. This evidence clearly supports the existence of a large positive long term supply elasticity as has been shown in the seventies by several authors (YVER, 1972; BARROS, 1973; JARVIS, 1974; LATTIMORE, 1974).

Table 3. Growth rates of beef production, prices and stocks in selected countries of Latin America. Means 1970/77 and 1978/85

| | 1970/1977 | | | | 1977/1985 | | | |
|---|---|---|---|---|---|---|---|---|
| Country | Production | Stocks | Price[1] | Real GDP per cápita[2] | Production | Stocks | Price[1] | Real GDP per cápita[3] |
| Argentina | 3.3 | 3.2 | 1.1 | 0.7 | -3.2 | -0.8 | -3.7 | -3.8 |
| Brazil | 3.6 | 4.9 | 11.1 | 5.6 | -0.1 | 3.2 | -5.3 | -0.7 |
| Colombia | 3.5 | 2.6 | 12.1 | 2.2 | 1.6 | -1.3 | 2.5 | 0.8 |

1/ Prices per kg liveweight, in US4 at oficial exchange rate.
2/ Period 1970/80.
3/ Period 1980/85.

Sources: FAO-Tape, FGV (several years), JUNTA NACIONAL DE CARNES (several years) y FADEGAN (several years).

Contrasting with the long-term nature of supply response in beef, demand reacts very rapidly to changes in income, thus generating great volatility in the market. This is highlighted by the recent developments in the Brazilian beef market. During the early eighties the reduction in per capita incomes made it possible for Brazil to export increasing volumes of beef (reaching 426.000 tons in 1985). The increase in purchasing power created by the Cruzado Plan in 1986 is indicated by the fact that the official monthly minimum wage expressed in terms of kg of beef increased from 25 to 34.3 kg between February and March (AGROANALISIS, 1986). Internal demand grew to an extent which led to a prohibition of beef exports and to imports from the US, the EEC and neighboring countries. Early in 1986 Brazilian authorities had expected beef exports to reach 500.000 tons by the end of 1986.

The increase in beef prices in Brazil was compounded by a reduction in cow slaughterings due to expectations of further increases in beef prices. The recent political changes in Brazil, where basically price controls have been abolished will probably imply a reduction in consumer purchasing power and consequently a marked change in the beef scenario.

Taking a longer-term perspective, productivity per head in stock has essentially remained stagnant or decreased in many countries. This seems to be related to the fact that beef production is being displaced to increasingly marginal lands. This process is particularly evident in Brazil.

On the other hand, the increasing interdependence of the world economy is imposing large short-term fluctuations on Latin American economies. There is empirical evidence to support the contention that beef price variability has increased significantly on the international market from countries with FMD from the early seventies onwards (Table 4). This puts sectors with lengthy production processes (such as cattle production) at an increasing risk, a fact which helps to explain the displacement of livestock to marginal areas. Given the resource endowment of many regions of Latin America, where cattle production is particularly favoured, it seems a high priority to develop strategies to cope with this increasing risk.

Table 4. Variability of beef prices of international significance (in 1980 US$ per ton)

| | United States[1] | | | Argentina[2] | | |
|---|---|---|---|---|---|---|
| Period | Mean ($\bar{X}$) | Variance ($S^2$) | Coefficient of variation (CV) | Mean ($\bar{X}$) | Variance ($S^2$) | Coefficient of variation (CV) |
| 1960/72 | 2607.1 | 242518 | 18.9 | 1535 | 175777 | 27.3 |
| 1972/85 | 2545.2 | 371709 | 24.0 | 1769 | 498582 | 39.9 |
| $F_{12,13}$ | | 1.53 | | | 2.84 | |
| Critical $F_{12,13,.10}$ value | | | 2.10 | | | |

1/ All origins, US$ ports
2/ Frozen beef

Source: IMF (several years)

Livestock owners are already indicating an ability to diversify, such as the increasing interest in the milking of beef cows to insure better cash flow, the integration of the cattle operations with crops, etc.

Other options might include the development of futures markets for cattle, the implementation of stabilization funds, the expansion of inter-regional trade, and the availability of short-term credit to improve cash flow in years of low prices.

The dairy sector

The Latin American dairy sector has evolved along a very similar pattern to the beef sector during the last eight years. The main features are:

- Production has grown at markedly lower rates than in the previous period (1.1% v 3.9%). Particularly high growth rates were achieved in Colombia (6.1% p.a.), Trinidad & Tobago (9.3% p.a.), Dominican Republic (5.2% p.a) and Bolivia (3.6% p.a.). Except for the case of Colombia, these countries are minor producers.

- Production per cow increased only slightly (0.22% p.a. for the period 1969/85), reaching a level of 962 kg per milking cow in 1985. The most remarkable case is Mexico with a growth rate of 3.07% p.a. over the same period.

- Per capita consumption has increased slightly a the regional level (from 99.4 to 102.1 kg p.a.). Haiti still ranges lowest with only 11 kg followed by Bolivia with 23 kg. At the other end of the range the Southern Cone countries consume an average of 170 kg p.a.

- Net imports have increased substantially (52%), leading to self sufficiency levels decreasing from 92.4% to 90.7%.

While the dominant picture is one of stagnation, several countries show dynamic growth in production e.g. Colombia, Bolivia, Venezuela, Dominican Republic and Trinidad & Tobago. On the other hand, Brazil, the largest producer (contributing 40% of regional production) achieved only very low growth rates. Nicaragua's dairy sector has deteriorated very drastically leading to lower consumption levels and the country shifting from being a net exporter to a net importer with a self sufficiency degree of 81%.

Pricing policies for beef and milk differ widely. While beef prices are generally left to be determined by the market, milk prices are generally imposed either directly or through the milk powder importation regime. This has tended to penalize the dairy sector, reducing the incentives to investment and to the adoption of improved technologies. Brazil is a good case in point. During the period 1970/77 production grew at an annual rate of 5.9% while real prices grew at a rate of 6.6% p.a. During the period 1978/85 production grew only at 0.4%, while the real producer price dropped at a rate of -5.7% p.a. (see AGROANALISIS, 1986). This documents the high, short-, and medium- term supply elasticities of milk production.

Such policies of controlled prices and importation of milk powder are feasible because surpluses from developed countries have been available at low prices, thus making importation an attractive option, particularly if the time horizon for making such a decision is short, thereby reducing the burden of the potential long-term effects of shrinking the domestic dairy sector in a situation of high world market prices.

Outlook

The outlook for livestock products is closely related to general economic growth. The general picture of serious problems of balance of payments does not seem to support expectations of rapidly increasing per capita incomes throughout the region.

On the other hand, the low prices of most export commodities will tend to foster currency devaluations and thus make import substitution more attractive. This might induce an expansion in dairy production in countries with low self-sufficiency levels. Such a move might be assisted by increasing international prices of dairy products if the policy measures enacted by the US and the EEC to reduce dairy surpluses are effective.

Poultry and pig production have been expanding rapidly in the region due to technical change, changing consumption patterns and, in many cases, the availability of grains at low prices due to overvalued currencies. The outlook for this process continuing is dependent mainly on the evolution of feedgrain prices on the world market and exchange rate policies.

The overall outlook will be influenced mainly by the evolution of the economy of the developed countries. Economic growth in that part of the world could lead to increased prices of raw materials (including oil), and in developing countries this could thus generate income, the driving force of the livestock sector.

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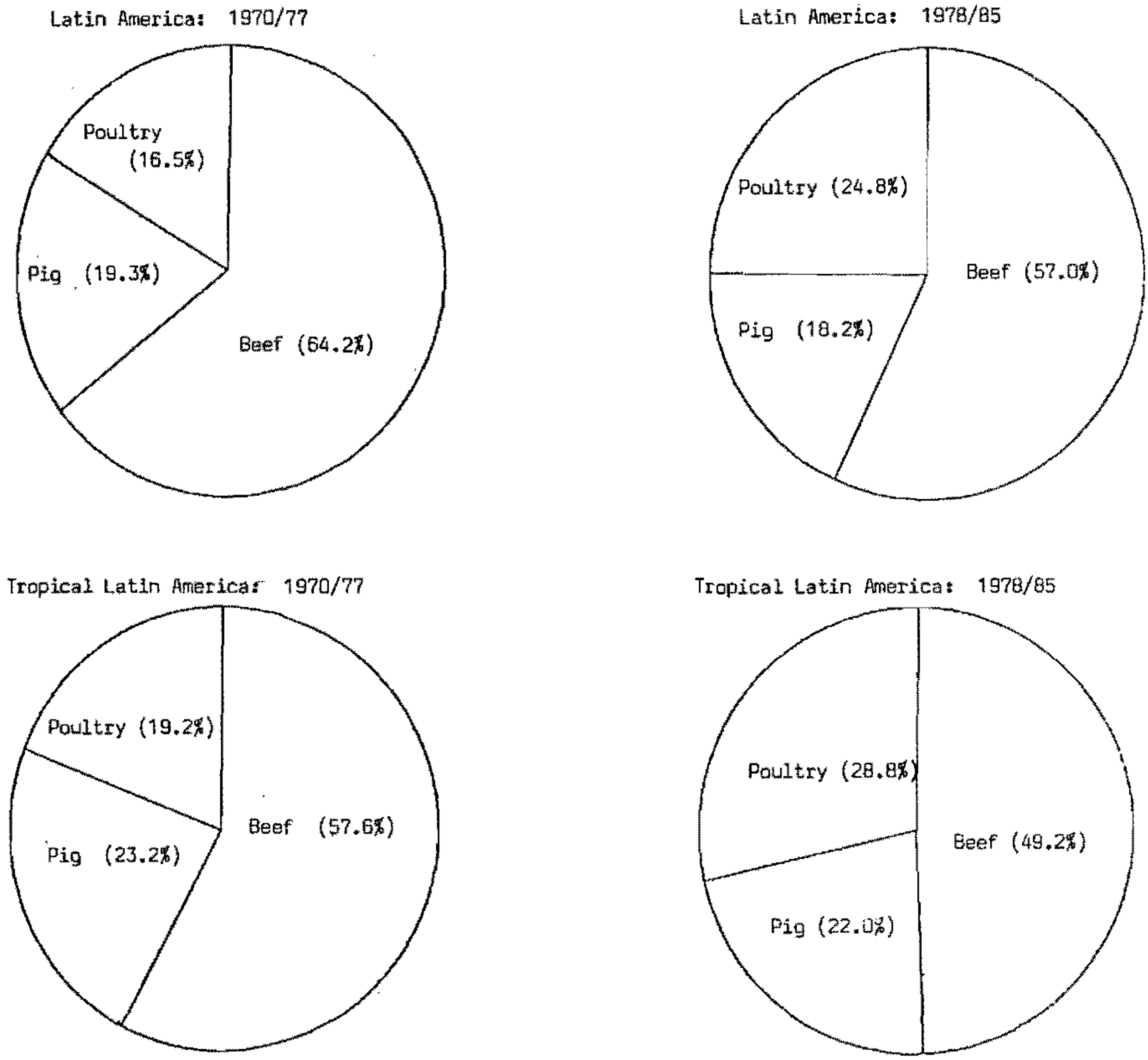



STRUCTURE OF MEAT CONSUMPTION IN LATIN AMERICA
(Averages 1970/77 and 1978/85)

BEEF AND VEAL : STOCKS AND PRODUCTION FOR SELECTED REGIONS
1985

| Region and Country | Production Total 000mt | % | Stocks Total 000heads | % |
|---|---|---|---|---|
| WORLD | 46072 | 100.0 | 1268934 | 100.0 |
| UNITED STATES | 10994 | 23.9 | 109749 | 8.6 |
| EUROPE | 10990 | 23.9 | 132179 | 10.4 |
| LATIN AMERICA | 8004 | 17.4 | 317610 | 25.0 |
| TROPICAL L.A. | 4774 | 10.4 | 249462 | 19.7 |
| Brazil | 2136 | 4.6 | 134500 | 10.6 |
| Colombia | 643 | 1.4 | 21935 | 1.7 |
| Venezuela | 320 | 0.7 | 12486 | 1.0 |
| TEMPERATE L.A. | 3230 | 7.0 | 68148 | 5.4 |
| Argentina | 2700 | 5.9 | 54800 | 4.3 |
| ASIA | 2796 | 6.1 | 368738 | 29.1 |
| AFRICA | 3140 | 6.8 | 176598 | 13.9 |
| OCEANIA | 1768 | 3.8 | 31273 | 2.5 |

BEEF AND VEAL PRODUCTION, RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS

| COUNTRY | PRODUCTION 1000 MT 1969/76 | 1977/84 | 1985 | PERCENTAGE OF TOTAL % 1985 | PER CAPITA PRODUCTION KG 1985 |
|---|---|---|---|---|---|
| BRAZIL | 2027 | 2242 | 2136 | 26.83 | 16 |
| MEXICO | 475 | 619 | 665 | 8.35 | 9 |
| | 2502 | 2861 | 2801 | 35.18 | 13 |
| BOLIVIA | 59 | 86 | 94 | 1.18 | 15 |
| COLOMBIA | 443 | 599 | 643 | 8.07 | 23 |
| CUBA | 164 | 146 | 145 | 1.82 | 15 |
| DOMINICAN RP | 36 | 50 | 58 | 0.73 | 10 |
| ECUADOR | 60 | 88 | 115 | 1.44 | 13 |
| PARAGUAY | 116 | 106 | 100 | 1.26 | 28 |
| PERU | 91 | 93 | 101 | 1.26 | 5 |
| VENEZUELA | 229 | 323 | 320 | 4.02 | 19 |
| TROPICAL SOUTH AMERICA | 1197 | 1490 | 1575 | 19.78 | 16 |
| COSTA RICA | 54 | 75 | 62 | 0.78 | 25 |
| EL SALVADOR | 25 | 30 | 32 | 0.40 | 6 |
| GUATEMALA | 59 | 74 | 57 | 0.72 | 7 |
| HONDURAS | 37 | 50 | 39 | 0.49 | 9 |
| NICARAGUA | 62 | 64 | 59 | 0.74 | 19 |
| PANAMA | 40 | 48 | 54 | 0.68 | 25 |
| CENTRAL AMERICA PANAMA | 276 | 340 | 303 | 3.81 | 12 |
| BARBADOS | 0 | 0 | 0 | 0.00 | 1 |
| GUYANA | 4 | 2 | 2 | 0.03 | 2 |
| HAITI | 20 | 27 | 33 | 0.42 | 5 |
| JAMAICA | 11 | 13 | 16 | 0.20 | 7 |
| TRINIDAD TOB | 1 | 2 | 1 | 0.02 | 1 |
| CARIBBEAN | 37 | 44 | 53 | 0.67 | 5 |
| TROPICAL LATIN AMERICA | 4012 | 4735 | 4733 | 59.44 | 14 |
| ARGENTINA | 2408 | 2798 | 2700 | 33.91 | 90 |
| CHILE | 161 | 182 | 180 | 2.26 | 15 |
| URUGUAY | 334 | 357 | 350 | 4.40 | 117 |
| TEMPERATE SOUTH AMERICA | 2903 | 3337 | 3230 | 40.56 | 72 |
| LATIN AMERICA | 6916 | 8072 | 7963 | 100.00 | 20 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

BEEF CATTLE STOCK,RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA STOCK LEVELS

| COUNTRY | STOCK 1000 HEADS 1969/76 | | 1985 | PERCENTAGE OF TOTAL % 1985 | STOCK PER CAPITA HEADS 1985 |
|---|---|---|---|---|---|
| | 1969/76 | 1977/84 | 1985 | | |
| BRAZIL | 85010 | 118081 | 134500 | 42.47 | 0.99 |
| MEXICO | 26652 | 34984 | 37450 | 11.83 | 0.47 |
| | 111662 | 153065 | 171950 | 54.30 | 0.80 |
| BOLIVIA | 2732 | 4774 | 5851 | 1.85 | 0.92 |
| COLOMBIA | 21718 | 24023 | 21935 | 6.93 | 0.76 |
| CUBA | 5701 | 5993 | 6400 | 2.02 | 0.64 |
| DOMINICAN RP | 1517 | 1998 | 2420 | 0.76 | 0.39 |
| ECUADOR | 2418 | 3023 | 3378 | 1.07 | 0.36 |
| PARAGUAY | 4757 | 5902 | 6400 | 2.02 | 1.74 |
| PERU | 4114 | 4013 | 3900 | 1.23 | 0.20 |
| VENEZUELA | 8686 | 10878 | 12486 | 3.94 | 0.72 |
| TROPICAL SOUTH AMERICA | 51643 | 60603 | 62771 | 19.82 | 0.62 |
| COSTA RICA | 1661 | 2208 | 2553 | 0.81 | 0.98 |
| EL SALVADOR | 1113 | 1198 | 929 | 0.29 | 0.17 |
| GUATEMALA | 1565 | 1940 | 2587 | 0.82 | 0.32 |
| HONDURAS | 1681 | 2034 | 2508 | 0.79 | 0.57 |
| NICARAGUA | 2388 | 2396 | 1890 | 0.60 | 0.58 |
| PANAMA | 1281 | 1425 | 1423 | 0.45 | 0.65 |
| CENTRAL AMERICA PANAMA | 9688 | 11200 | 11890 | 3.75 | 0.46 |
| BARBADOS | 19 | 19 | 18 | 0.01 | 0.07 |
| GUYANA | 264 | 184 | 140 | 0.04 | 0.15 |
| HAITI | 884 | 1075 | 1350 | 0.43 | 0.21 |
| JAMAICA | 270 | 287 | 321 | 0.10 | 0.14 |
| TRINIDAD TOB | 68 | 76 | 77 | 0.02 | 0.06 |
| CARIBBEAN | 1506 | 1640 | 1906 | 0.60 | 0.17 |
| TROPICAL LATIN AMERICA | 174499 | 226508 | 248516 | 78.48 | 0.70 |
| ARGENTINA | 52979 | 55861 | 54800 | 17.31 | 1.79 |
| CHILE | 3197 | 3652 | 3400 | 1.07 | 0.28 |
| URUGUAY | 9775 | 10430 | 9948 | 3.14 | 3.30 |
| TEMPERATE SOUTH AMERICA | 65951 | 69942 | 68148 | 21.52 | 1.49 |
| LATIN AMERICA | 240450 | 296450 | 316664 | 100.00 | 0.79 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

AREA IN ANNUAL AND PERMANET CROPS AND PERMANENT PASTURES

| COUNTRY | PERMANENT PASTURES 1968/75 | PERMANENT PASTURES 1976/83 | PERMANENT PASTURES 1984 | ANNUAL AND PERMANENT CROPS 1968/75 | ANNUAL AND PERMANENT CROPS 1976/83 | ANNUAL AND PERMANENT CROPS 1984 |
|---|---|---|---|---|---|---|
| | 000 HA | | | | | |
| BRAZIL | 147367 | 160500 | 165000 | 56189 | 69595 | 75250 |
| MEXICO | 74499 | 74499 | 74500 | 23426 | 24419 | 24700 |
| | 221866 | 234999 | 239500 | 79615 | 94014 | 99950 |
| BOLIVIA | 27475 | 27050 | 26900 | 2586 | 3350 | 3385 |
| COLOMBIA | 30000 | 30000 | 30000 | 5130 | 5597 | 5695 |
| CUBA | 2534 | 2568 | 2480 | 2763 | 3182 | 3236 |
| DOMINICAN RP | 1893 | 2092 | 2092 | 1169 | 1395 | 1470 |
| ECUADOR | 2414 | 3844 | 4700 | 2569 | 2507 | 2510 |
| PARAGUAY | 14681 | 15475 | 15500 | 1002 | 1755 | 1940 |
| PERU | 27120 | 27120 | 27120 | 2968 | 3426 | 3517 |
| VENEZUELA | 16543 | 17167 | 17400 | 3523 | 3701 | 3758 |
| TROPICAL SOUTH AMERICA | 122659 | 125316 | 126192 | 21710 | 24912 | 25511 |
| COSTA RICA | 1427 | 1967 | 2167 | 494 | 587 | 637 |
| EL SALVADOR | 610 | 610 | 610 | 642 | 709 | 725 |
| GUATEMALA | 1128 | 1234 | 1334 | 1582 | 1744 | 1815 |
| HONDURAS | 3400 | 3400 | 3400 | 1568 | 1749 | 1777 |
| NICARAGUA | 4202 | 4849 | 5100 | 1271 | 1245 | 1267 |
| PANAMA | 1140 | 1161 | 1161 | 545 | 554 | 564 |
| CENTRAL AMERICA PANAMA | 11908 | 13220 | 13772 | 6101 | 6587 | 6785 |
| BARBADOS | 4 | 4 | 4 | 33 | 33 | 33 |
| GUYANA | 999 | 1178 | 1230 | 373 | 473 | 495 |
| HAITI | 617 | 512 | 500 | 824 | 686 | 904 |
| JAMAICA | 230 | 208 | 200 | 251 | 266 | 269 |
| TRINIDAD TOB | 11 | 11 | 11 | 144 | 158 | 160 |
| CARIBBEAN | 1861 | 1913 | 1945 | 1626 | 1816 | 1861 |
| TROPICAL LATIN AMERICA | 358294 | 375448 | 381409 | 109052 | 127330 | 134107 |
| ARGENTINA | 144262 | 143250 | 142800 | 33789 | 35265 | 35600 |
| CHILE | 11242 | 11838 | 11900 | 4999 | 5488 | 5528 |
| URUGUAY | 13635 | 13632 | 13632 | 1531 | 1449 | 1446 |
| TEMPERATE SOUTH AMERICA | 169139 | 168719 | 168332 | 40318 | 42202 | 42574 |
| LATIN AMERICA | 527433 | 544167 | 549741 | 149370 | 169532 | 176681 |

BEEF AND VEAL PRODUCTION PER CAPITA 1969/85

| COUNTRY | ANNUAL GROWTH RATE 1969/85 % | AVERAGE 1969/76 | AVERAGE 1977/84 | 1985 |
|---|---|---|---|---|
| | | KG/YEAR | | |
| BRAZIL | -1.29*** | 19.9 | 18.3 | 15.8 |
| MEXICO | 0.02 | 8.5 | 8.8 | 8.4 |
| | -1.11*** | 15.9 | 14.9 | 13.1 |
| BOLIVIA | 1.77*** | 12.8 | 15.1 | 14.7 |
| COLOMBIA | 1.22*** | 20.1 | 23.0 | 22.4 |
| CUBA | -2.61*** | 18.4 | 14.9 | 14.4 |
| DOMINICAN RP | 1.64*** | 7.8 | 8.8 | 9.3 |
| ECUADOR | 1.47*** | 9.2 | 10.7 | 12.3 |
| PARAGUAY | -4.93*** | 47.2 | 33.5 | 27.2 |
| PERU | -2.17*** | 6.4 | 5.3 | 5.1 |
| VENEZUELA | 0.37 | 19.6 | 21.3 | 18.5 |
| TROPICAL SOUTH AMERICA | -0.15 | 16.0 | 16.3 | 15.5 |
| COSTA RICA | 0.55 | 29.0 | 32.7 | 23.9 |
| SALVADOR | 0.00 | 6.3 | 6.2 | 5.8 |
| GUATEMALA | -1.26* | 10.5 | 10.6 | 7.2 |
| HONDURAS | -1.30 | 12.9 | 13.4 | 8.9 |
| NICARAGUA | -3.47*** | 27.9 | 22.8 | 18.0 |
| PANAMA | 0.42 | 24.3 | 24.0 | 24.8 |
| CENTRAL AMERICA PANAMA | -0.96* | 15.2 | 15.0 | 11.7 |
| BARBADOS | -3.47* | 1.7 | 1.3 | 1.1 |
| GUYANA | -8.38*** | 5.6 | 2.7 | 2.1 |
| HAITI | 1.53*** | 4.1 | 4.5 | 5.1 |
| JAMAICA | 0.60 | 5.8 | 5.8 | 6.8 |
| TRINIDAD ETC | -1.02 | 1.5 | 1.5 | 1.2 |
| CARIBBEAN | 0.44 | 4.2 | 4.2 | 4.7 |
| TROPICAL LATIN AMERICA | -0.77*** | 15.5 | 14.9 | 13.4 |
| ARGENTINA | -0.73 | 96.6 | 98.7 | 88.3 |
| CHILE | 0.29 | 16.3 | 16.1 | 15.0 |
| URUGUAY | 0.64 | 118.6 | 122.0 | 116.2 |
| TEMPERATE SOUTH AMERICA | -0.56 | 77.2 | 78.5 | 70.8 |
| LATIN AMERICA | -0.99*** | 23.3 | 22.5 | 20.0 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

BEEF AND VEAL ANNUAL GROWTH RATES OF PRODUCTION,POPULATION AND PRODUCTION PER CAPITA. 1970/85

| | PRODUCTION | | POPULATION | | PRODUCTION PER CAPITA | |
|---|---|---|---|---|---|---|
| | 1970/77 | 1978/85 | 1970/77 | 1978/85 | 1970/77 | 1978/85 |
| BRAZIL | 3.6*** | -0.1 | 2.4*** | 2.2*** | 1.2 | -2.4* |
| MEXICO | 4.0*** | 1.9 | 3.2*** | 2.6*** | 0.8 | -0.8 |
| | 3.6*** | 0.3 | 2.7*** | 2.4*** | 1.0 | -2.1* |
| BOLIVIA | 5.2*** | 2.5*** | 2.5*** | 2.7*** | 2.8*** | -0.2 |
| COLOMBIA | 3.5** | 1.6*** | 2.2*** | 2.1*** | 1.4 | -0.6 |
| CUBA | -7.8*** | 0.6 | 1.6*** | 0.6*** | -9.3*** | 0.0 |
| DOMINICAN RP | 3.4*** | 4.0*** | 2.8*** | 2.3*** | 0.6 | 1.7*** |
| ECUADOR | 3.7** | 2.1 | 3.0*** | 2.9*** | 0.7 | -0.8 |
| PARAGUAY | -2.9* | -3.7** | 3.2*** | 3.1*** | -6.1*** | -6.7*** |
| PERU | -1.9*** | 3.1** | 2.8*** | 2.6*** | -4.7*** | 0.5 |
| VENEZUELA | 4.8*** | -0.4 | 3.5*** | 3.0*** | 1.3 | -3.4*** |
| TROPICAL SOUTH AMERICA | 1.4 | 1.0** | 2.6*** | 2.4*** | -1.2 | -1.4*** |
| COSTA RICA | 9.2*** | -3.2* | 2.6*** | 2.7*** | 6.6*** | -5.9*** |
| SALVADOR | 6.4*** | 0.5 | 2.9*** | 2.9*** | 3.5* | -2.4** |
| GUATEMALA | 2.0 | -3.8 | 2.8*** | 2.8*** | -0.8 | -6.6** |
| HONDURAS | 3.1* | -7.8** | 3.3*** | 3.4*** | -0.1 | -11.2*** |
| NICARAGUA | 2.6 | -3.5 | 3.1*** | 3.2*** | -0.5 | -6.8* |
| PANAMA | 4.5*** | 6.0*** | 2.6*** | 2.2*** | 2.0** | 3.8** |
| CENTRAL AMERICA PANAMA | 4.5*** | -2.4*** | 2.9*** | 2.9*** | 1.6 | -5.3*** |
| BARBADOS | -20.3*** | -3.0 | 0.5*** | 0.3*** | -20.8*** | -3.3 |
| GUYANA | -3.0* | -4.8 | 1.9*** | 2.0*** | -4.9** | -6.8* |
| HAITI | 2.2*** | 6.5*** | 2.3*** | 2.5*** | -0.1 | 4.0*** |
| JAMAICA | 3.6*** | 5.4*** | 1.7*** | 1.4*** | 1.9* | 4.0*** |
| TRINIDAD ETC | -3.2** | -3.7 | 1.2*** | 1.6*** | -4.4*** | -5.3** |
| CARIBBEAN | 1.7*** | 5.1*** | 2.0*** | 2.1*** | -0.3 | 3.1*** |
| TROPICAL LATIN AMERICA | 3.0*** | 0.4 | 2.6*** | 2.4*** | 0.4 | -2.0*** |
| ARGENTINA | 3.3 | -3.2** | 1.7*** | 1.6*** | 1.6 | -4.8*** |
| CHILE | 4.4 | 2.6** | 1.7*** | 1.6*** | 2.7 | 1.1 |
| URUGUAY | 1.9 | 3.8* | 0.2*** | 0.7*** | 1.7 | 3.1 |
| TEMPERATE SOUTH AMERICA | 3.2 | -2.2** | 1.6*** | 1.5*** | 1.6 | -3.7*** |
| LATIN AMERICA | 3.0** | -0.7* | 2.5*** | 2.3*** | 0.5 | -3.0*** |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 * P<0.05

BEFF AND VEAL PRODUCTION PER HEAD IN STOCK 1969/85

| COUNTRY | ANNUAL GROWTH RATE 1969/85 % | AVERAGE 1969/76 | AVERAGE 1977/84 | 1985 |
|---|---|---|---|---|
| | | KG/HEAD | | |
| BRAZIL | -2.92*** | 23.9 | 19.1 | 15.9 |
| MEXICO | -0.21 | 17.8 | 17.7 | 17.8 |
| | -2.34*** | 22.5 | 18.8 | 16.3 |
| BOLIVIA | -2.34*** | 21.8 | 18.1 | 16.0 |
| COLOMBIA | 2.44*** | 20.4 | 25.0 | 29.3 |
| CUBA | -2.08*** | 28.5 | 24.3 | 22.7 |
| DOMINICAN RP | -0.15 | 24.6 | 24.9 | 24.0 |
| ECUADOR | 1.84*** | 24.8 | 29.2 | 34.0 |
| PARAGUAY | -4.33*** | 24.7 | 18.2 | 15.6 |
| PERU | 0.69 | 22.1 | 23.1 | 25.8 |
| VENEZUELA | 0.84* | 26.3 | 29.8 | 25.6 |
| TROPICAL SOUTH AMERICA | 0.45* | 23.2 | 24.6 | 25.1 |
| COSTA RICA | -0.26 | 32.3 | 34.3 | 24.4 |
| SALVADOR | 3.65*** | 22.5 | 25.8 | 34.5 |
| GUATEMALA | -1.79 | 38.2 | 39.6 | 22.0 |
| HONDURAS | -0.58 | 22.0 | 24.7 | 15.6 |
| NICARAGUA | 0.38 | 25.9 | 26.5 | 31.2 |
| PANAMA | 1.55*** | 31.0 | 33.4 | 37.9 |
| CENTRAL AMERICA PANAMA | 0.24 | 28.4 | 30.4 | 25.5 |
| BARBADOS | -2.80 | 21.9 | 17.9 | 15.6 |
| GUYANA | -1.65*** | 15.7 | 12.8 | 14.3 |
| HAITI | 1.06*** | 22.7 | 24.9 | 24.7 |
| JAMAICA | 1.01** | 42.2 | 44.2 | 49.8 |
| TRINIDAD ETC | -1.07 | 21.6 | 21.3 | 18.2 |
| CARIBBEAN | 0.91*** | 24.9 | 26.6 | 27.8 |
| TROPICAL LATIN AMERICA | -1.36*** | 23.0 | 21.0 | 19.0 |
| ARGENTINA | 0.33 | 45.7 | 50.1 | 49.3 |
| CHILE | 0.39 | 50.4 | 49.6 | 52.9 |
| URUGUAY | 0.22 | 34.5 | 34.3 | 35.2 |
| TEMPERATE SOUTH AMERICA | 0.32 | 44.3 | 47.7 | 47.4 |
| LATIN AMERICA | -1.09*** | 28.9 | 27.3 | 25.1 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

BEEF AND VEAL ANNUAL GROWTH RATES OF PRODUCTION,STOCKS AND PRODUCTION/HEAD IN STOCK, 1970/85

| COUNTRY | PRODUCTION 1970/77 | 1978/85 | STOCK 1970/77 | 1978/85 | PRODUCTION/HEAD IN STOCK 1970/77 | 1978/85 |
|---|---|---|---|---|---|---|
| BRAZIL | 3.6*** | -0.1 | 4.9*** | 3.2*** | -1.4 | -3.4** |
| MEXICO | 4.0*** | 1.9 | 3.2*** | 2.2*** | 0.7 | -0.4 |
| | 3.6*** | 0.3 | 4.5*** | 3.0*** | -0.9 | -2.7** |
| BOLIVIA | 5.2*** | 2.5*** | 6.8*** | 5.0*** | -1.5 | -2.6*** |
| COLOMBIA | 3.5** | 1.6*** | 2.6*** | -1.3** | 0.9 | 2.9*** |
| CUBA | -7.8*** | 0.6 | -0.9 | 1.8*** | -6.9*** | -1.2** |
| DOMINICAN RP | 3.4*** | 4.0*** | 8.2*** | 3.7*** | -4.8*** | 0.4 |
| ECUADOR | 3.7** | 2.1 | 1.6** | 3.0*** | 2.1** | -0.9 |
| PARAGUAY | -2.9* | -3.7** | 4.1*** | 2.6*** | -7.0*** | -6.2*** |
| PERU | -1.9*** | 3.1** | 0.0 | -0.5 | -2.0** | 3.6*** |
| VENEZUELA | 4.8*** | -0.4 | 2.0*** | 3.1*** | 2.8*** | -3.5*** |
| TROPICAL SOUTH AMERICA | 1.4 | 1.0** | 2.4*** | 1.2*** | -1.0 | -0.2 |
| COSTA RICA | 9.2*** | -3.2* | 3.3*** | 3.5*** | 5.9** | -6.7*** |
| SALVADOR | 6.4*** | 0.5 | -0.0 | -6.8*** | 6.4* | 7.3*** |
| GUATEMALA | 2.0 | -3.8 | -1.6 | 7.9*** | 3.6 | -11.7*** |
| HONDURAS | 3.1* | -7.8** | 2.7*** | 3.9*** | 0.4 | -11.7*** |
| NICARAGUA | 2.6 | -3.5 | 2.8** | -4.8*** | -0.2 | 1.3 |
| PANAMA | 4.5*** | 6.0*** | 1.9*** | 0.4 | 2.7*** | 5.6*** |
| CENTRAL AMERICA PANAMA | 4.5*** | -2.4*** | 1.7*** | 1.2*** | 2.7** | -3.7*** |
| BARBADOS | -20.3*** | -3.0 | -0.6 | -0.8 | -19.7*** | -2.2 |
| GUYANA | -3.0* | -4.8 | 0.8* | -6.7* | -3.8** | 2.0** |
| HAITI | 2.2*** | 6.5*** | -1.6** | 6.8*** | 3.8*** | -0.4 |
| JAMAICA | 3.6*** | 5.4*** | 0.7*** | 2.6*** | 2.9** | 2.8*** |
| TRINIDAD ETC | -3.2** | -3.7 | 2.3*** | 0.2 | -5.5*** | -3.9 |
| CARIBBEAN | 1.7*** | 5.1*** | -0.6* | 4.2*** | 2.2*** | 0.9*** |
| TROPICAL LATIN AMERICA | 3.0*** | 0.4 | 3.7*** | 2.4*** | -0.7* | -2.1** |
| ARGENTINA | 3.3 | -3.2** | 3.2*** | -0.8* | 0.1 | -2.4** |
| CHILE | 4.4 | 2.6** | 2.7** | 0.1 | 1.7 | 2.5*** |
| URUGUAY | 1.9 | 3.8* | 3.3** | -1.1 | -1.4 | 4.8** |
| TEMPERATE SOUTH AMERICA | 3.2 | -2.2** | 3.2*** | -0.8*** | 0.0 | -1.3* |
| LATIN AMERICA | 3.0** | -0.7* | 3.6*** | 1.7*** | -0.5 | -2.4*** |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 * P<0.05

BEEF AND VEAL* SUMMARY OF LATIN AMERICA TRADE(THOUSAND TONS )

| REGION | EXPORT | | | IMPORT | | | +IMPORT-EXPORT | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1969/76 | 1977/84 | 1985 | 1969/76 | 1977/84 | 1985 | 1969/76 | 1977/84 | 1985 |
| BRAZIL | 70 | 53 | 141 | 14 | 57 | 49 | -56 | 4 | -92 |
| MEXICO | 27 | 14 | 2 | 1 | 3 | 8 | -26 | -11 | 6 |
| | 97 | 67 | 143 | 15 | 60 | 57 | -82 | -7 | -86 |
| BOLIVIA | 1 | 1 | 0 | 0 | 0 | 0 | -1 | -1 | 0 |
| COLOMBIA | 19 | 16 | 4 | 1 | 1 | 1 | -18 | -15 | -3 |
| CUBA | 1 | 0 | 0 | 0 | 1 | 0 | -1 | 1 | 0 |
| DOMINICAN REP. | 6 | 2 | 9 | 1 | 1 | 0 | -5 | -1 | -9 |
| ECUADOR | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1 | 0 |
| PARAGUAY | 10 | 3 | 0 | 0 | 0 | 0 | -10 | -3 | 0 |
| PERU | 0 | 1 | 0 | 7 | 9 | 11 | 7 | 8 | 11 |
| VENEZUELA | 0 | 1 | 0 | 3 | 15 | 2 | 3 | 14 | 2 |
| TROPICAL SOUTH AMERICA | 37 | 25 | 13 | 12 | 27 | 14 | -25 | 2 | 1 |
| COSTA RICA | 24 | 28 | 25 | 1 | 1 | 0 | -23 | -27 | -25 |
| SALVADOR | 2 | 3 | 2 | 1 | 1 | 0 | -1 | -2 | -2 |
| GUATEMALA | 14 | 14 | 14 | 1 | 1 | 1 | -13 | -13 | -13 |
| HONDURAS | 16 | 22 | 10 | 1 | 1 | 0 | -15 | -21 | -10 |
| NICARAGUA | 24 | 21 | 7 | 1 | 1 | 0 | -23 | -20 | -7 |
| PANAMA | 2 | 2 | 1 | 1 | 1 | 0 | -1 | -1 | -1 |
| CENTRAL AMERICA PANAMA | 82 | 90 | 59 | 6 | 6 | 1 | -76 | -84 | -58 |
| BARBADOS | 1 | 1 | 0 | 3 | 3 | 3 | 2 | 2 | 3 |
| GUYANA | 1 | 1 | 0 | 1 | 0 | 0 | 0 | -1 | 0 |
| HAITI | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| JAMAICA | 1 | 0 | 0 | 5 | 3 | 1 | 4 | 3 | 1 |
| TRINIDAD | 1 | 1 | 1 | 4 | 8 | 10 | 3 | 7 | 9 |
| CARIBBEAN | 5 | 4 | 2 | 14 | 15 | 15 | 9 | 11 | 13 |
| TROPICAL LATIN AMERICA | 221 | 186 | 217 | 47 | 108 | 87 | -174 | -78 | -130 |
| ARGENTINA | 259 | 225 | 75 | 0 | 0 | 0 | -259 | -225 | -75 |
| CHILE | 1 | 1 | 0 | 19 | 6 | 7 | 18 | 5 | 7 |
| URUGUAY | 106 | 108 | 85 | 0 | 0 | 0 | -106 | -108 | -85 |
| TEMPERATE SOUTH AMERICA | 366 | 334 | 160 | 19 | 6 | 7 | -347 | -328 | -153 |
| LATIN AMERICA | 587 | 520 | 377 | 66 | 114 | 94 | -521 | -406 | -283 |

*FRESH,CHILLED OR FROZEN

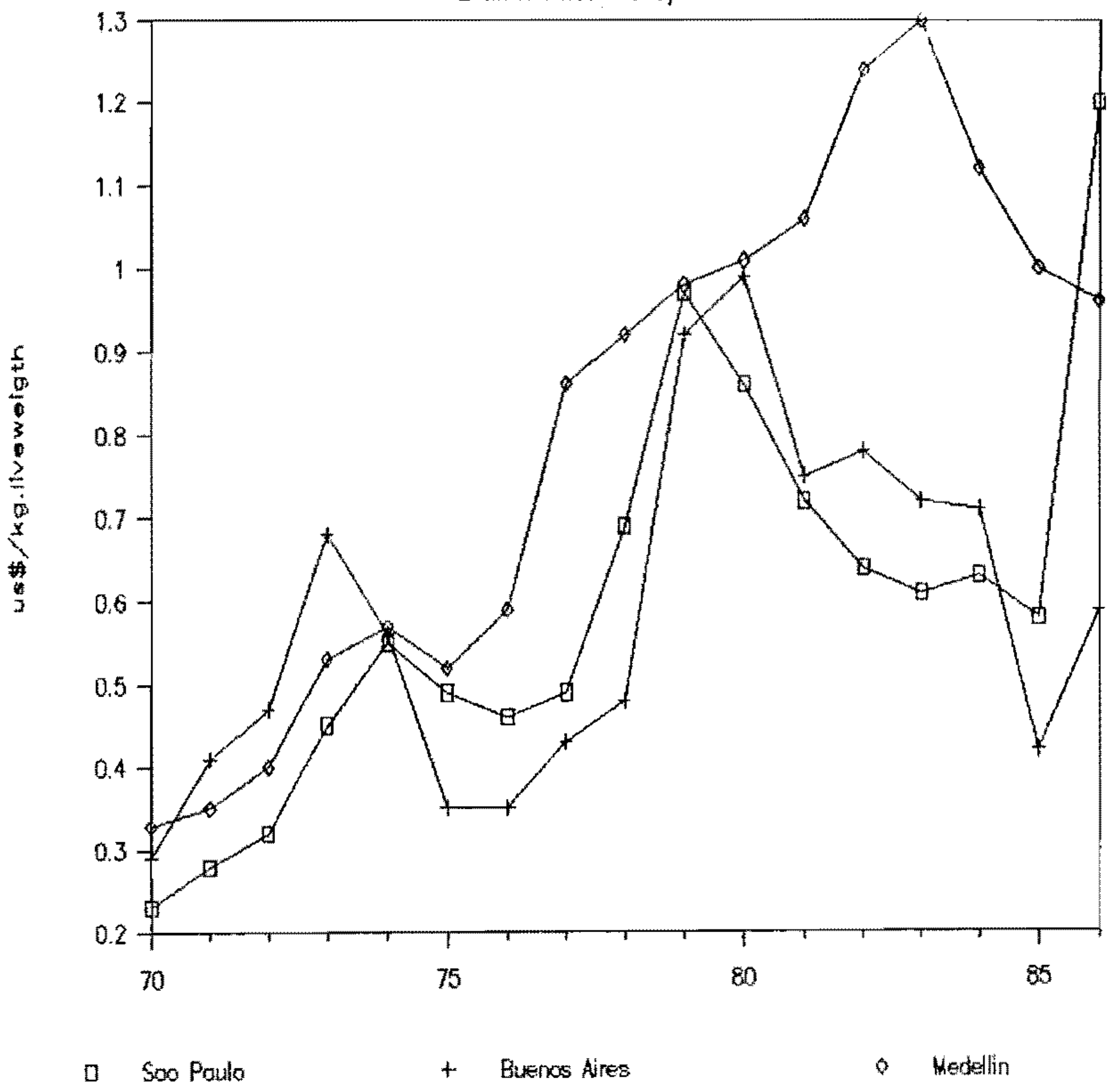
BEEF AND VEAL* PRODUCTION,TRADE AND APPARENT CONSUMPTION

| COUNTRY | 1970/77 PRODUCTION | +IMPORT -EXPORT | APPARENT CONSUMPTION | APPARENT PER CAPITA CONSUMPTION | SELF SUFFICIENCY INDEX | 1978/85 PRODUCTION | +IMPORT -EXPORT | APPARENT CONSUMPTION | APPARENT PER CAPITA CONSUMPTION | SELF SUFFICIENCY INDEX |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1000 MT | | | KG | | 1000 MT | | | KG | |
| BRAZIL | 2104.4 | -151.3 | 1953.0 | 18.7 | 107.7 | 2203.4 | -259.1 | 1944.2 | 15.5 | 113.3 |
| MEXICO | 491.5 | -22.8 | 468.7 | 8.2 | 104.9 | 629.1 | -2.2 | 626.8 | 8.7 | 100.4 |
| | 2595.9 | -174.1 | 2421.8 | 14.9 | 107.2 | 2832.4 | -261.4 | 2571 | 13.0 | 110.2 |
| BOLIVIA | 62.2 | -0.7 | 61.6 | 13.0 | 101.1 | 88.0 | 0.3 | 88.3 | 15.2 | 99.6 |
| COLOMBIA | 461.3 | -19.8 | 441.5 | 19.7 | 104.5 | 611.9 | -12.9 | 599.0 | 22.5 | 102.1 |
| CUBA | 154.1 | 73.8 | 227.9 | 25.1 | 67.6 | 147.6 | 95.2 | 242.8 | 24.7 | 60.8 |
| DOMINICAN RP | 37.1 | -3.9 | 33.3 | 7.0 | 111.7 | 52.1 | -2.7 | 49.5 | 8.6 | 105.4 |
| ECUADOR | 62.6 | 0.1 | 62.7 | 9.3 | 99.9 | 93.1 | 0.1 | 93.2 | 11.0 | 99.9 |
| PARAGUAY | 117.1 | -38.2 | 78.8 | 30.7 | 148.5 | 103.6 | -8.4 | 95.2 | 28.7 | 108.9 |
| PERU | 90.2 | 7.3 | 97.5 | 6.7 | 92.5 | 94.5 | 9.9 | 104.5 | 5.8 | 90.5 |
| VENEZUELA | 236.9 | 5.9 | 242.8 | 20.2 | 97.6 | 328.3 | 15.3 | 343.6 | 21.9 | 95.5 |
| TROPICAL SOUTH AMERICA | 1221.7 | 24.4 | 1246.1 | 16.2 | 98.0 | 1519.3 | 96.9 | 1616.2 | 17.3 | 94.00 |
| COSTA RICA | 59.0 | -25.2 | 33.8 | 17.8 | 174.6 | 72.7 | -27.2 | 45.5 | 19.2 | 159.8 |
| EL SALVADOR | 25.8 | -0.5 | 25.3 | 6.4 | 102.1 | 30.6 | 1.0 | 31.6 | 6.3 | 97.0 |
| GUATEMALA | 60.8 | -17.6 | 43.2 | 7.5 | 140.8 | 72.3 | -21.1 | 51.1 | 7.1 | 141.4 |
| HONDURAS | 38.5 | -15.3 | 23.2 | 7.8 | 166.2 | 49.3 | -17.3 | 32.0 | 8.2 | 154.1 |
| NICARAGUA | 65.0 | -23.4 | 41.5 | 18.1 | 156.4 | 61.1 | -15.2 | 45.9 | 15.7 | 133.1 |
| PANAMA | 41.6 | 5.0 | 46.7 | 27.8 | 89.2 | 48.5 | 4.9 | 53.4 | 26.4 | 90.9 |
| CENTRAL AMERICA PANAMA | 290.7 | -77.1 | 213.7 | 12.8 | 136.1 | 334.5 | -75.0 | 259.5 | 12.3 | 128.9 |
| BARBADOS | 0.4 | 6.8 | 7.2 | 29.6 | 5.1 | 0.3 | 4.7 | 5.0 | 20.1 | 6.9 |
| GUYANA | 4.0 | 0.6 | 4.6 | 6.1 | 86.6 | 2.2 | 0.0 | 2.2 | 2.5 | 99.3 |
| HAITI | 20.4 | -0.2 | 20.2 | 4.0 | 101.2 | 28.2 | 0.0 | 28.2 | 4.7 | 99.9 |
| JAMAICA | 11.5 | 11.7 | 23.2 | 11.7 | 49.5 | 13.2 | 8.1 | 21.3 | 9.6 | 61.9 |
| TRINIDAD TOB | 1.4 | 6.8 | 8.3 | 8.3 | 17.3 | 1.6 | 14.4 | 16.0 | 14.3 | 10.1 |
| CARIBBEAN | 37.7 | 25.8 | 63.6 | 7.1 | 59.4 | 45.6 | 27.2 | 72.8 | 6.9 | 62.6 |
| TROPICAL LATIN AMERICA | 4146.0 | -201.0 | 3945.0 | 14.9 | 105.1 | 4731.8 | -212.3 | 4519.5 | 14.0 | 104.7 |
| ARGENTINA | 2411.4 | -479.5 | 1932.0 | 76.0 | 124.8 | 2771.8 | -449.3 | 2322.5 | 80.3 | 119.3 |
| CHILE | 162.2 | 19.2 | 181.4 | 18.0 | 89.4 | 182.3 | 7.5 | 189.8 | 16.6 | 96.1 |
| URUGUAY | 333.9 | -109.2 | 224.7 | 79.5 | 148.6 | 357.7 | -112.6 | 245.1 | 83.4 | 146.0 |
| TEMPERATE SOUTH AMERIC | 2907.5 | -569.5 | 2338.0 | 61.0 | 124.4 | 3311.9 | -554.5 | 2757.3 | 63.7 | 120.1 |
| LATIN AMERICA | 7053.5 | -770.4 | 6283.0 | 20.6 | 112.3 | 8043.6 | -766.8 | 7276.8 | 19.7 | 110.5 |

* FRESH,CHILLED OR FROZEN AND CANNED MEAT IN CARCASS WEIGHT EQUIVALENT

# Domestic Prices of Beef

Latin America 1970/86

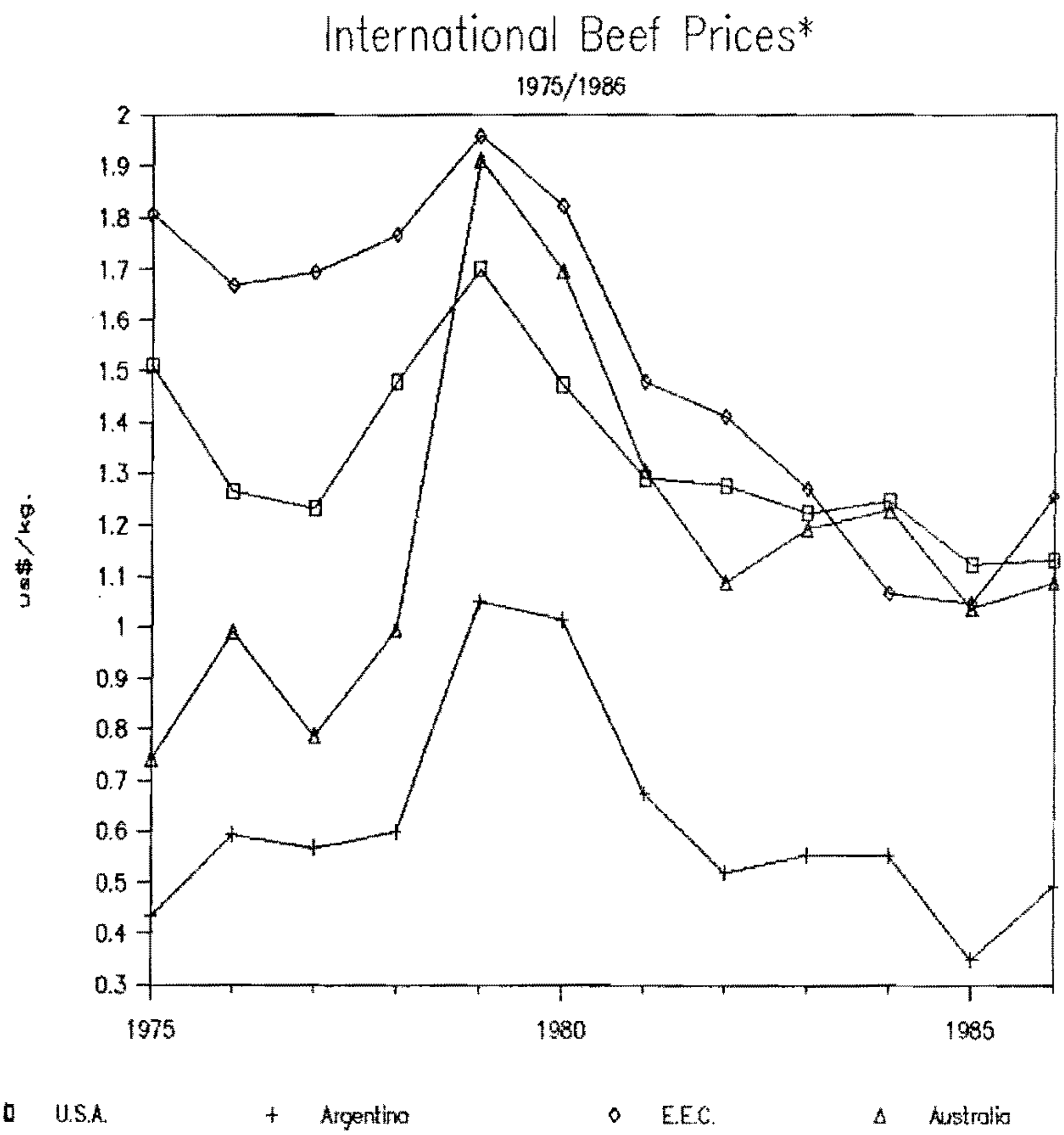



SOURCES:

BRAZIL - IBG, <u>Precos Recebidos pelos Agricultores</u> (several issues)

COLOMBIA - FADEGAN and Public Services Company of Medellín

ARGENTINA - JUNTA NACIONAL DE CARNES, <u>Boletín Semanal</u> (several issues)




* In real terms, deflacted by US wholesale index 1980=100

| | |
|---|---|
| Australia: | Wholesale, Brisbane, Oxen 301=320 kg, slaught. W.T. |
| Argentina: | Buenos Aires, wholesale liniers, young bulls, liveweight |
| EEC: | Wholesale, adult, weighted average liveweight |
| USA: | Wholesale Omaha. Steers 900-1100 lb liveweight. |

SOURCE: FAO (several issues)

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 CCCCCCC    OOOOOOO   WW      WW             M       M   IIIIII    LL          KK      KK
CCCCCCCCC  OOOOOOOOO  WW      WW             MM     MM   IIIIII    LL          KK     KK
CC     CC  OO     OO  WW      WW             MMM   MMM     II      LL          KK    KK
CC         OO     OO  WW      WW             MMMM MMMM     II      LL          KK   KK
CC         OO     OO  WW      WW             MM MMM MM     II      LL          KKKK
CC         OO     OO  WW      WW             MM  M  MM     II      LL          KKKK
CC         OO     OO  WW  W   WW             MM     MM     II      LL          KK   KK
CC     CC  OO     OO  WW.WWW WW              MM     MM     II      LL          KK    KK
CCCCCCCCC  OOOOOOOOO   WWW WWW               MM     MM   IIIIII    LLLLLLLLL   KK     KK
 CCCCCCC    OOOOOOO     W   W                MM     MM   IIIIII    LLLLLLLLL   KK      KK
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COW MILK: STOCKS AND PRODUCTION FOR SELECTED REGIONS
1985

| Region and Country | Production Total 000mt | % | Stocks Total 000heads | % |
|---|---|---|---|---|
| WORLD | 458023 | 100.0 | 222423 | 100.0 |
| UNITED STATES | 64954 | 14.2 | 11115 | 5.0 |
| EUROPE | 183828 | 40.1 | 49889 | 22.4 |
| LATIN AMERICA | 35023 | 7.6 | 36242 | 16.3 |
| TROPICAL L.A. | 27533 | 6.0 | 32102 | 14.4 |
| Brazil | 10722 | 2.3 | 14700 | 6.6 |
| Colombia | 2800 | 0.6 | 2850 | 1.3 |
| Venezuela | 1532 | 0.3 | 1410 | 0.6 |
| TEMPERATE L.A. | 7490 | 1.6 | 4140 | 1.9 |
| Argentina | 5600 | 1.2 | 2950 | 1.3 |
| ASIA | 42351 | 9.2 | 51977 | 23.4 |
| AFRICA | 11716 | 2.6 | 23935 | 10.8 |
| OCEANIA | 14186 | 3.1 | 4044 | 1.8 |

COW MILK PRODUCTION,RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS

| COUNTRY | PRODUCTION -1000 MT- 1969/76 | 1977/84 | 1985 | PERCENTAGE OF TOTAL % 1985 | PER CAPITA PRODUCTION KG 1985 |
|---|---|---|---|---|---|
| BRAZIL | 8337 | 10923 | 10722 | 30.99 | 81 |
| MEXICO | 4375 | 6820 | 6920 | 20.00 | 90 |
| | 12712 | 17743 | 17642 | 50.99 | 84 |
| BOLIVIA | 45 | 71 | 80 | 0.23 | 13 |
| COLOMBIA | 2237 | 2338 | 2800 | 8.09 | 100 |
| CUBA | 747 | 1032 | 1000 | 2.89 | 100 |
| DOMINICAN RP | 312 | 423 | 498 | 1.44 | 82 |
| ECUADOR | 746 | 923 | 988 | 2.85 | 108 |
| PARAGUAY | 101 | 160 | 170 | 0.49 | 48 |
| PERU | 819 | 796 | 809 | 2.34 | 42 |
| VENEZUELA | 1067 | 1376 | 1532 | 4.43 | 91 |
| TROPICAL SOUTH AMERICA | 6074 | 7118 | 7876 | 22.76 | 79 |
| COSTA RICA | 225 | 317 | 371 | 1.07 | 146 |
| EL SALVADOR | 199 | 273 | 288 | 0.83 | 53 |
| GUATEMALA | 282 | 318 | 333 | 0.96 | 43 |
| HONDURAS | 210 | 270 | 280 | 0.81 | 66 |
| NICARAGUA | 398 | 247 | 125 | 0.36 | 40 |
| PANAMA | 72 | 92 | 90 | 0.26 | 42 |
| CENTRAL AMERICA PANAMA | 1386 | 1516 | 1486 | 4.30 | 59 |
| BARBADOS | 6 | 7 | 9 | 0.03 | 37 |
| GUYANA | 16 | 14 | 15 | 0.04 | 16 |
| HAITI | 20 | 21 | 22 | 0.06 | 3 |
| JAMAICA | 48 | 48 | 50 | 0.14 | 22 |
| TRINIDAD TOB | 8 | 7 | 10 | 0.03 | 9 |
| CARIBBEAN | 97 | 98 | 106 | 0.31 | 10 |
| TROPICAL LATIN AMERICA | 20269 | 26475 | 27111 | 78.35 | 79 |
| ARGENTINA | 5116 | 5392 | 5600 | 16.18 | 186 |
| CHILE | 981 | 1014 | 1040 | 3.01 | 88 |
| URUGUAY | 732 | 809 | 850 | 2.46 | 284 |
| TEMPERATE SOUTH AMERICA | 6829 | 7215 | 7490 | 21.65 | 167 |
| LATIN AMERICA | 27098 | 33690 | 34601 | 100.00 | 89 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

COW MILK — STOCK, RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA STOCK LEVELS

| COUNTRY | S T O C K ---1000 HEADS--- 1969/76 | 1977/84 | 1985 | PERCENTAGE OF TOTAL % 1985 | STOCK PER CAPITA HEADS 1985 |
|---|---|---|---|---|---|
| BRAZIL | 10553 | 15444 | 14700 | 40.86 | 0.11 |
| MEXICO | 7498 | 8708 | 8500 | 23.63 | 0.11 |
| | 18051 | 24152 | 23200 | 64.49 | 0.11 |
| BOLIVIA | 34 | 51 | 56 | 0.16 | 0.01 |
| COLOMBIA | 2436 | 2414 | 2850 | 7.92 | 0.10 |
| CUBA | 586 | 708 | 680 | 1.89 | 0.07 |
| DOMINICAN RP | 217 | 237 | 249 | 0.69 | 0.04 |
| ECUADOR | 560 | 657 | 720 | 2.00 | 0.08 |
| PARAGUAY | 53 | 84 | 90 | 0.25 | 0.02 |
| PERU | 636 | 712 | 690 | 1.92 | 0.04 |
| VENEZUELA | 1012 | 1192 | 1410 | 3.92 | 0.08 |
| TROPICAL SOUTH AMERICA | 5534 | 6054 | 6745 | 18.75 | 0.07 |
| COSTA RICA | 228 | 286 | 290 | 0.81 | 0.11 |
| EL SALVADOR | 233 | 284 | 300 | 0.83 | 0.05 |
| GUATEMALA | 312 | 373 | 404 | 1.12 | 0.05 |
| HONDURAS | 330 | 415 | 430 | 1.20 | 0.10 |
| NICARAGUA | 357 | 303 | 200 | 0.56 | 0.06 |
| PANAMA | 74 | 93 | 90 | 0.25 | 0.04 |
| CENTRAL AMERICA PANAMA | 1535 | 1754 | 1714 | 4.76 | 0.07 |
| BARBADOS | 5 | 6 | 7 | 0.02 | 0.03 |
| GUYANA | 20 | 18 | 20 | 0.06 | 0.02 |
| HAITI | 97 | 91 | 93 | 0.26 | 0.01 |
| JAMAICA | 48 | 48 | 50 | 0.14 | 0.02 |
| TRINIDAD TOB | 5 | 4 | 6 | 0.02 | 0.01 |
| CARIBBEAN | 175 | 167 | 175 | 0.49 | 0.02 |
| TROPICAL LATIN AMERICA | 25296 | 32128 | 31834 | 88.49 | 0.09 |
| ARGENTINA | 2687 | 2940 | 2950 | 8.20 | 0.10 |
| CHILE | 744 | 702 | 660 | 1.83 | 0.05 |
| URUGUAY | 458 | 504 | 530 | 1.47 | 0.18 |
| TEMPERATE SOUTH AMERICA | 3889 | 4146 | 4140 | 11.51 | 0.09 |
| LATIN AMERICA | 29185 | 36273 | 35974 | 100.00 | 0.09 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

COW MILK PRODUCTION PER CAPITA 1969/85

| COUNTRY | ANNUAL GROWTH RATE 1969/85 % | AVERAGE 1969/76 | AVERAGE 1977/84 | 1985 |
|---|---|---|---|---|
| | | -KG/YEAR- | | |
| BRAZIL | 0.85* | 81.5 | 89.0 | 79.1 |
| MEXICO | 1.84*** | 78.5 | 96.9 | 87.6 |
| | 1.22*** | 80.4 | 91.9 | 82.2 |
| BOLIVIA | 3.00*** | 9.8 | 12.5 | 12.6 |
| COLOMBIA | -1.05* | 102.2 | 89.3 | 97.5 |
| CUBA | 2.45*** | 83.4 | 105.7 | 99.6 |
| DOMINICAN RP | 1.44*** | 67.1 | 74.9 | 79.8 |
| ECUADOR | -0.51*** | 114.4 | 111.9 | 105.3 |
| PARAGUAY | 1.87*** | 40.5 | 49.6 | 46.2 |
| PERU | -2.94*** | 57.9 | 45.6 | 41.1 |
| VENEZUELA | 0.01 | 91.3 | 90.4 | 88.5 |
| TROPICAL SOUTH AMERICA | -0.38** | 81.0 | 77.8 | 77.6 |
| COSTA RICA | 1.40*** | 121.0 | 137.4 | 142.7 |
| SALVADOR | 1.10** | 51.2 | 56.0 | 51.8 |
| GUATEMALA | -1.25*** | 50.0 | 45.3 | 41.8 |
| HONDURAS | -0.42 | 73.2 | 72.0 | 64.0 |
| NICARAGUA | -11.87*** | 179.2 | 91.0 | 38.2 |
| PANAMA | -0.45 | 44.6 | 46.4 | 41.3 |
| CENTRAL AMERICA PANAMA | -1.97*** | 76.6 | 67.1 | 57.3 |
| BARBADOS | 3.13*** | 22.9 | 29.8 | 36.9 |
| GUYANA | -3.42*** | 21.3 | 15.6 | 15.9 |
| HAITI | -1.70*** | 4.1 | 3.6 | 3.3 |
| JAMAICA | -1.07*** | 24.4 | 22.1 | 21.2 |
| TRINIDAD ETC | -1.47 | 8.4 | 6.6 | 8.8 |
| CARIBBEAN | -1.68*** | 11.1 | 9.5 | 9.4 |
| TROPICAL LATIN AMERICA | 0.56** | 78.0 | 83.4 | 76.7 |
| ARGENTINA | -0.58 | 204.3 | 189.5 | 183.2 |
| CHILE | -1.49*** | 99.5 | 90.5 | 86.4 |
| URUGUAY | 0.76*** | 259.6 | 277.1 | 282.2 |
| TEMPERATE SOUTH AMERICA | -0.62** | 181.0 | 169.4 | 164.2 |
| LATIN AMERICA | 0.18 | 91.1 | 93.6 | 86.7 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

COW MILK ANNUAL GROWTH RATES OF PRODUCTION,POPULATION AND PRODUCTION PER CAPITA. 1970/85

| | PRODUCTION | | POPULATION | | PRODUCTION PER CAPITA | |
|---|---|---|---|---|---|---|
| | 1970/77 | 1978/85 | 1970/77 | 1978/85 | 1970/77 | 1978/85 |
| BRAZIL | 5.9*** | 0.4 | 2.4*** | 2.2*** | 3.6** | -1.9 |
| MEXICO | 5.5*** | 1.1* | 3.2*** | 2.6*** | 2.3*** | -1.6** |
| | 5.8*** | 0.7 | 2.7*** | 2.4*** | 3.1*** | -1.7* |
| BOLIVIA | 7.6*** | 3.6*** | 2.5*** | 2.7*** | 5.1*** | 1.0 |
| COLOMBIA | -0.7 | 6.1*** | 2.2*** | 2.1*** | -2.8** | 3.9*** |
| CUBA | 3.3*** | 1.5 | 1.6*** | 0.6*** | 1.8*** | 0.9 |
| DOMINICAN RP | 3.3*** | 5.2*** | 2.8*** | 2.3*** | 0.5 | 2.9** |
| ECUADOR | 2.5*** | 1.6*** | 3.0*** | 2.9*** | -0.5* | -1.3*** |
| PARAGUAY | 6.9*** | 1.1 | 3.2*** | 3.1*** | 3.7*** | -2.0** |
| PERU | -0.6 | -0.6 | 2.8*** | 2.6*** | -3.3*** | -3.2*** |
| VENEZUELA | 3.8*** | 3.0*** | 3.5*** | 3.0*** | 0.3 | 0.1 |
| TROPICAL SOUTH AMERICA | 1.4*** | 3.3*** | 2.6*** | 2.4*** | -1.2** | 1.0** |
| COSTA RICA | 6.3*** | 2.1** | 2.6*** | 2.7*** | 3.8*** | -0.7 |
| SALVADOR | 7.5*** | 1.5** | 2.9*** | 2.9*** | 4.6** | -1.4** |
| GUATEMALA | 2.4*** | 1.0*** | 2.8*** | 2.8*** | -0.4 | -1.8*** |
| HONDURAS | 3.6*** | 1.1*** | 3.3*** | 3.4*** | 0.4* | -2.3*** |
| NICARAGUA | 3.7*** | -18.7** | 3.1*** | 3.2*** | 0.6 | -21.9*** |
| PANAMA | 1.2 | -0.6* | 2.6*** | 2.2*** | -1.4 | -2.8*** |
| CENTRAL AMERICA PANAMA | 4.3*** | -1.8* | 2.9*** | 2.9*** | 1.4** | -4.8*** |
| BARBADOS | 3.8*** | 3.2** | 0.5*** | 0.3*** | 3.2*** | 2.9** |
| GUYANA | -7.5*** | 3.1*** | 1.9*** | 2.0*** | -9.4*** | 1.1 |
| HAITI | 3.4*** | 0.7 | 2.3*** | 2.5*** | 1.1*** | -1.8 |
| JAMAICA | 0.8* | 0.2 | 1.7*** | 1.4*** | -0.9* | -1.2** |
| TRINIDAD ETC | -4.4* | 9.3*** | 1.2*** | 1.6*** | -5.7** | 7.7*** |
| CARIBBEAN | -0.2 | 1.7** | 2.0*** | 2.1*** | -2.1*** | -0.4 |
| TROPICAL LATIN AMERICA | 4.4*** | 1.2* | 2.6*** | 2.4*** | 1.7*** | -1.2* |
| ARGENTINA | 3.2** | 0.8 | 1.7*** | 1.6*** | 1.6 | -0.8 |
| CHILE | 0.3 | -1.0 | 1.7*** | 1.6*** | -1.4 | -2.6 |
| URUGUAY | 0.3 | 1.7*** | 0.2*** | 0.7*** | 0.1 | 1.0** |
| TEMPERATE SOUTH AMERICA | 2.4** | 0.6 | 1.6*** | 1.5*** | 0.9 | -0.9 |
| LATIN AMERICA | 3.9*** | 1.1* | 2.5*** | 2.3*** | 1.4** | -1.2* |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005   ** P<0.01   * P<0.05

COW MILK PRODUCTION PER HEAD IN STOCK 1969/85

| COUNTRY | ANNUAL GROWTH RATE 1969/85 % | AVERAGE 1969/76 | AVERAGE 1977/84 | 1985 |
|---|---|---|---|---|
| | | | KG/HEAD | |
| BRAZIL | -0.74** | 787.4 | 706.9 | 729.4 |
| MEXICO | 3.07*** | 582.0 | 782.3 | 814.1 |
| | 0.72*** | 701.5 | 734.2 | 760.4 |
| BOLIVIA | 0.76*** | 1327.3 | 1406.3 | 1418.4 |
| COLOMBIA | 0.64*** | 919.1 | 967.5 | 982.5 |
| CUBA | 1.66*** | 1275.4 | 1456.7 | 1470.6 |
| DOMINICAN RP | 2.64*** | 1434.9 | 1782.2 | 2000.0 |
| ECUADOR | 0.33* | 1331.3 | 1407.2 | 1371.7 |
| PARAGUAY | -0.01 | 1904.7 | 1905.2 | 1888.9 |
| PERU | -1.14*** | 1287.1 | 1118.9 | 1172.2 |
| VENEZUELA | 0.83** | 1052.9 | 1158.6 | 1086.5 |
| TROPICAL SOUTH AMERICA | 0.76*** | 1097.2 | 1175.5 | 1167.7 |
| COSTA RICA | 1.84*** | 982.3 | 1112.1 | 1279.3 |
| SALVADOR | 1.60*** | 847.2 | 959.3 | 958.3 |
| GUATEMALA | -0.68*** | 903.7 | 853.3 | 825.0 |
| HONDURAS | 0.38 | 635.1 | 651.0 | 651.2 |
| NICARAGUA | -4.40*** | 1111.9 | 761.2 | 625.0 |
| PANAMA | 0.09 | 973.1 | 989.3 | 1000.0 |
| CENTRAL AMERICA PANAMA | -0.27 | 900.6 | 863.6 | 867.5 |
| BARBADOS | 1.85*** | 1060.1 | 1271.8 | 1296.0 |
| GUYANA | -0.28** | 777.3 | 749.1 | 760.0 |
| HAITI | 1.30*** | 208.3 | 231.9 | 237.8 |
| JAMAICA | 0.00 | 999.9 | 999.7 | 1000.0 |
| TRINIDAD ETC | -0.18*** | 1737.4 | 1709.4 | 1704.9 |
| CARIBBEAN | 0.63*** | 556.8 | 584.5 | 607.1 |
| TROPICAL LATIN AMERICA | 0.52*** | 799.5 | 823.7 | 851.6 |
| ARGENTINA | -0.37* | 1904.2 | 1838.4 | 1898.3 |
| CHILE | 0.88* | 1320.1 | 1443.6 | 1575.8 |
| URUGUAY | 0.21 | 1600.6 | 1607.6 | 1603.8 |
| TEMPERATE SOUTH AMERICA | -0.04 | 1755.3 | 1742.5 | 1809.2 |
| LATIN AMERICA | 0.22** | 927.0 | 928.7 | 961.8 |

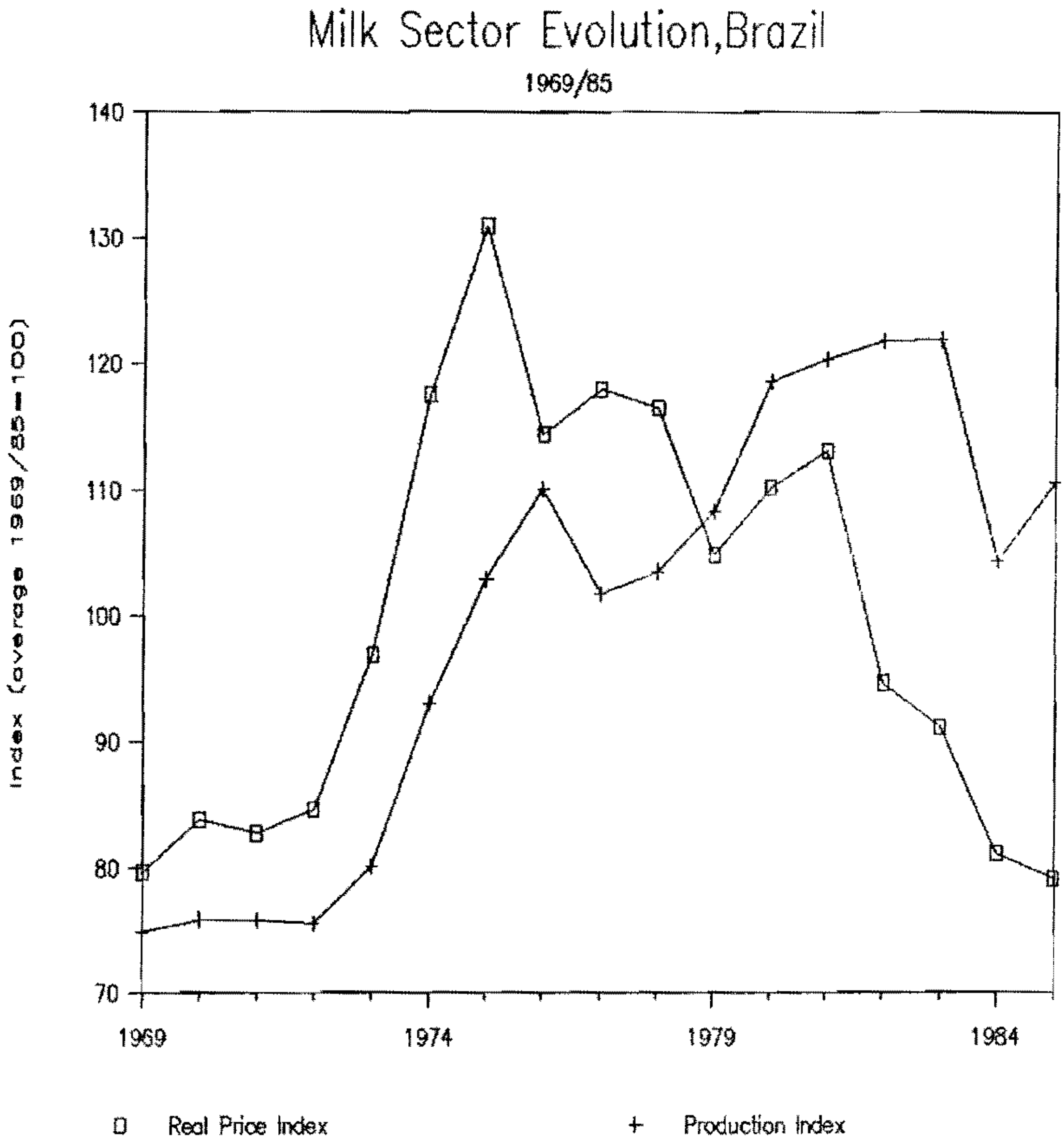
LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

COW MILK*

PRODUCTION, TRADE AND APPARENT CONSUMPTION

| COUNTRY | 1970/77 PRODUCTION | 1970/77 +IMPORT -EXPORT | 1970/77 APPARENT CONSUMPTION | 1970/77 APPARENT PER CAPITA CONSUMPTION | 1970/77 SELF SUFFICIENCY INDEX | 1978/85 PRODUCTION | 1978/85 +IMPORT -EXPORT | 1978/85 APPARENT CONSUMPTION | 1978/85 APPARENT PER CAPITA CONSUMPTION | 1978/85 SELF SUFFICIENCY INDEX |
|---|---|---|---|---|---|---|---|---|---|---|
| | ---1000 MT--- | | | ---KG--- | | ---1000 MT--- | | | ---KG--- | |
| BRAZIL | 8663.3 | 217.9 | 8881.2 | 85.1 | 97.5 | 11031 | 188.7 | 11219 | 89.3 | 98.3 |
| MEXICO | 4622.6 | 477.1 | 5099.6 | 88.8 | 90.6 | 6968.6 | 979.7 | 7948.3 | 110.0 | 87.7 |
| | 13286 | 695.0 | 13981 | 86.4 | 95.0 | 17999 | 1168.3 | 19168 | 96.9 | 93.9 |
| BOLIVIA | 48.1 | 41.6 | 89.7 | 19.0 | 53.6 | 73.8 | 59.7 | 133.5 | 23.0 | 55.3 |
| COLOMBIA | 2255.3 | 71.1 | 2326.4 | 103.6 | 96.9 | 2400.3 | 97.4 | 2497.7 | 93.6 | 96.1 |
| CUBA | 774.1 | 479.2 | 1253.3 | 138.0 | 61.8 | 1048.3 | 352.7 | 1400.9 | 142.7 | 74.8 |
| DOMINICAN RP | 326.8 | 33.5 | 360.3 | 76.0 | 90.7 | 437.3 | 70.5 | 507.8 | 88.1 | 86.1 |
| ECUADOR | 765.3 | 18.5 | 783.8 | 116.4 | 97.6 | 940.0 | 47.6 | 987.6 | 116.2 | 95.2 |
| PARAGUAY | 107.4 | 5.7 | 113.1 | 44.0 | 94.9 | 163.8 | 8.2 | 172.0 | 51.8 | 95.2 |
| PERU | 826.2 | 219.2 | 1045.4 | 71.8 | 79.0 | 794.7 | 195.9 | 990.5 | 55.0 | 80.2 |
| VENEZUELA | 1110.9 | 328.8 | 1439.7 | 119.6 | 77.2 | 1411.6 | 786.2 | 2197.8 | 140.2 | 64.2 |
| TROPICAL SOUTH AMERICA | 6214.2 | 1197.5 | 7411.7 | 96.4 | 83.8 | 7269.6 | 1618.2 | 8887.8 | 95.0 | 81.8 |
| COSTA RICA | 239.0 | 15.3 | 254.3 | 133.8 | 94.0 | 325.6 | 19.0 | 344.6 | 145.2 | 94.5 |
| EL SALVADOR | 208.9 | 48.2 | 257.0 | 64.7 | 81.3 | 278.3 | 83.3 | 361.6 | 72.0 | 77.0 |
| GUATEMALA | 289.7 | 22.3 | 312.0 | 53.9 | 92.8 | 320.0 | 73.8 | 393.8 | 54.5 | 81.3 |
| HONDURAS | 220.4 | 25.5 | 245.9 | 83.1 | 89.6 | 274.0 | 47.5 | 321.5 | 82.5 | 85.2 |
| NICARAGUA | 411.0 | -15.2 | 395.8 | 172.3 | 103.8 | 204.9 | 48.1 | 252.9 | 86.5 | 81.0 |
| PANAMA | 73.2 | 20.8 | 94.0 | 55.9 | 77.9 | 92.1 | 27.6 | 119.8 | 59.2 | 76.9 |
| CENTRAL AMERICA PANAMA | 1442.2 | 116.8 | 1559 | 93.4 | 92.5 | 1494.9 | 299.3 | 1794.2 | 85.1 | 83.3 |
| BARBADOS | 5.7 | 17.5 | 23.2 | 95.1 | 24.5 | 7.8 | 11.3 | 19.1 | 76.4 | 40.7 |
| GUYANA | 14.8 | 28.6 | 43.3 | 57.1 | 34.0 | 14.0 | 38.5 | 52.4 | 53.8 | 26.6 |
| HAITI | 21.0 | 18.3 | 39.3 | 7.9 | 53.4 | 20.8 | 48.2 | 69.1 | 11.4 | 30.2 |
| JAMAICA | 48.2 | 90.5 | 138.7 | 69.8 | 34.8 | 48.6 | 95.6 | 144.2 | 64.8 | 33.7 |
| TRINIDAD TOB | 7.8 | 81.9 | 89.6 | 90.1 | 8.7 | 7.8 | 122.9 | 130.7 | 116.5 | 6.0 |
| CARIBBEAN | 97.4 | 236.7 | 334.1 | 37.2 | 29.2 | 99.0 | 316.5 | 415.5 | 39.5 | 23.8 |
| TROPICAL LATIN AMERICA | 21040 | 2246.0 | 23286 | 88.1 | 90.4 | 26863 | 3402.3 | 30265 | 93.7 | 88.8 |
| ARGENTINA | 5210.2 | -72.1 | 5138.0 | 202.1 | 101.4 | 5428.2 | -7.4 | 5420.9 | 187.3 | 100.1 |
| CHILE | 983.6 | 121.3 | 1105.0 | 109.8 | 89.0 | 1014.7 | 121.1 | 1135.8 | 99.6 | 89.3 |
| URUGUAY | 727.9 | 3.2 | 731.1 | 258.8 | 99.6 | 824.5 | -13.5 | 811.0 | 275.9 | 101.7 |
| TEMPERATE SOUTH AMERICA | 6921.7 | 52.4 | 6974.0 | 182.1 | 99.2 | 7267.4 | 100.2 | 7367.7 | 170.2 | 98.6 |
| LATIN AMERICA | 27961 | 2298.4 | 30260 | 99.4 | 92.4 | 34130 | 3502.5 | 37633 | 102.1 | 90.7 |

*INCLUDES FRESH, DRY AND CONDENSED MILK IN TERMS OF FRESH MILK




Source: Production - FAO, Production Yearbook (several issues)
Price - Agroanalysis, Vol.10, No.1 (1986)

COW MILK    ANNUAL GROWTH RATES OF PRODUCTION, STOCKS AND PRODUCTION/MILKING COW

| COUNTRY | PRODUCTION 1970/77 | PRODUCTION 1978/85 | STOCK 1970/77 | STOCK 1978/85 | PRODUCTION/HEAD IN STOCK 1970/77 | PRODUCTION/HEAD IN STOCK 1978/85 |
|---|---|---|---|---|---|---|
| BRAZIL | 5.9*** | 0.4 | 5.7*** | 0.2 | 0.2 | 0.2 |
| MEXICO | 5.5*** | 1.1* | 2.2*** | 0.3 | 3.3*** | 0.8*** |
| | 5.8*** | 0.7 | 4.3*** | 0.2 | 1.5* | 0.5* |
| BOLIVIA | 7.6*** | 3.6*** | 5.9*** | 3.4*** | 1.7*** | 0.2 |
| COLOMBIA | -0.7 | 6.1*** | -1.9* | 5.5*** | 1.3*** | 0.6** |
| CUBA | 3.3*** | 1.5 | 1.9*** | 0.7 | 1.5* | 0.9 |
| DOMINICAN RP | 3.3*** | 5.2*** | 1.7*** | 0.1 | 1.6 | 5.1*** |
| ECUADOR | 2.5*** | 1.6*** | 2.0*** | 2.9*** | 0.5 | -1.3** |
| PARAGUAY | 6.9*** | 1.1 | 7.0*** | 1.3* | -0.1 | -0.2*** |
| PERU | -0.6 | -0.6 | 1.1 | -1.4** | -1.7** | 0.9* |
| VENEZUELA | 3.8*** | 3.0*** | 1.1 | 4.3*** | 2.7*** | -1.2 |
| TROPICAL SOUTH AMERICA | 1.4*** | 3.3*** | 0.1 | 3.3*** | 1.4*** | -0.0 |
| COSTA RICA | 6.3*** | 2.1** | 4.6*** | -1.3 | 1.6** | 3.3*** |
| SALVADOR | 7.5*** | 1.5** | 2.9*** | 1.5** | 4.7** | -0.02** |
| GUATEMALA | 2.4*** | 1.0*** | 2.5*** | 2.4*** | -0.1 | -1.4** |
| HONDURAS | 3.6*** | 1.1*** | 3.6*** | 1.2*** | 0.0 | -0.1 |
| NICARAGUA | 3.7*** | -18.7** | 2.9** | -12.9** | 0.8 | -5.8*** |
| PANAMA | 1.2 | -0.6* | 1.9 | -0.8** | -0.7 | 0.2 |
| CENTRAL AMERICA PANAMA | 4.3*** | -1.8* | 3.2*** | -1.6* | 1.1** | -0.3 |
| BARBADOS | 3.8*** | 3.2** | 2.4*** | 2.7** | 1.4*** | 0.5* |
| GUYANA | -7.5*** | 3.1*** | -7.5** | 2.6*** | -0.0 | 0.4 |
| HAITI | 3.4*** | 0.7 | 0.6*** | 0.1 | 2.7*** | 0.6*** |
| JAMAICA | 0.8* | 0.2 | 0.8* | 0.2 | 0.0 | 0.0 |
| TRINIDAD ETC | -4.4* | 9.3*** | -4.3* | 9.3*** | -0.2 | -0.1 |
| CARIBBEAN | -0.2 | 1.7** | -0.3 | 0.7 | 0.1 | 0.9*** |
| TROPICAL LATIN AMERICA | 4.4*** | 1.2* | 3.3*** | 0.7 | 1.1** | 0.5*** |
| ARGENTINA | 3.2** | 0.8 | 3.3** | 1.0 | -0.1 | -0.2 |
| CHILE | 0.3 | -1.0 | -0.8 | -1.5** | 1.1 | 0.5 |
| URUGUAY | 0.3 | 1.7*** | -1.0 | 2.0** | 1.3 | -0.3 |
| TEMPERATE SOUTH AMERICA | 2.4** | 0.6 | 2.0** | 0.7 | 0.5* | -0.0 |
| LATIN AMERICA | 3.9*** | 1.1* | 3.1*** | 0.7 | 0.8* | 0.4 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005    ** P<0.01    * P<0.05

DRY MILK SUMMARY OF LATIN AMERICA TRADE(THOUSAND TONS )

| REGION | EXPORT | | | IMPORT | | | +IMPORT-EXPORT | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1969/76 | 1977/84 | 1985 | 1969/76 | 1977/84 | 1985 | 1969/76 | 1977/84 | 1985 |
| BRAZIL | 1 | 1 | 0 | 22 | 25 | 32 | 21 | 24 | 32 |
| MEXICO | 1 | 1 | 0 | 48 | 96 | 162 | 47 | 95 | 162 |
| | 2 | 2 | 0 | 70 | 121 | 194 | 68 | 119 | 194 |
| BOLIVIA | 0 | 0 | 0 | 4 | 6 | 7 | 4 | 6 | 7 |
| COLOMBIA | 1 | 0 | 0 | 8 | 13 | 4 | 7 | 13 | 4 |
| CUBA | 0 | 0 | 0 | 51 | 36 | 39 | 51 | 36 | 39 |
| DOMINICAN REP | 1 | 1 | 0 | 4 | 8 | 8 | 3 | 7 | 8 |
| ECUADOR | 0 | 0 | 0 | 2 | 5 | 11 | 2 | 5 | 11 |
| PARAGUAY | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| PERU | 0 | 0 | 0 | 24 | 25 | 22 | 24 | 25 | 22 |
| VENEZUELA | 1 | 1 | 0 | 26 | 98 | 79 | 25 | 97 | 79 |
| TROPICAL SOUTH AMERICA | 3 | 2 | 0 | 120 | 192 | 171 | 117 | 190 | 171 |
| COSTA RICA | 1 | 1 | 0 | 1 | 3 | 0 | 0 | 2 | 0 |
| SALVADOR | 1 | 1 | 0 | 6 | 11 | 5 | 5 | 10 | 5 |
| GUATEMALA | 1 | 1 | 0 | 3 | 9 | 10 | 2 | 8 | 10 |
| HONDURAS | 0 | 1 | 0 | 3 | 5 | 8 | 3 | 4 | 8 |
| NICARAGUA | 3 | 2 | 0 | 1 | 6 | 9 | -2 | 4 | 9 |
| PANAMA | 0 | 0 | 0 | 3 | 4 | 5 | 3 | 4 | 5 |
| CENTRAL AMERICA PANAMA | 6 | 6 | 0 | 17 | 38 | 37 | 11 | 32 | 37 |
| BARBADOS | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 1 | 2 |
| GUYANA | 0 | 0 | 0 | 2 | 3 | 2 | 2 | 3 | 2 |
| HAITI | 0 | 0 | 0 | 1 | 4 | 7 | 1 | 4 | 7 |
| JAMAICA | 1 | 1 | 0 | 11 | 12 | 10 | 10 | 11 | 10 |
| TRINIDAD | 1 | 1 | 1 | 9 | 12 | 12 | 8 | 11 | 11 |
| CARIBBEAN | 3 | 3 | 1 | 25 | 33 | 33 | 22 | 30 | 32 |
| TROPICAL LATIN AMERICA | 14 | 13 | 1 | 232 | 384 | 435 | 218 | 371 | 434 |
| ARGENTINA | 9 | 9 | 0 | 2 | 8 | 1 | -7 | -1 | 1 |
| CHILE | 1 | 1 | 0 | 15 | 15 | 4 | 14 | 14 | 4 |
| URUGUAY | 0 | 2 | 3 | 1 | 1 | 1 | 1 | -1 | -2 |
| TEMPERATE SOUTH AMERICA | 10 | 12 | 3 | 18 | 24 | 6 | 8 | 12 | 3 |
| LATIN AMERICA | 24 | 25 | 4 | 250 | 408 | 441 | 226 | 383 | 437 |

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PPPPPPPP    IIIIII     GGGGGGG              M       M  EEEEEEEEE     AAA     TTTTTTTT
PPPPPPPPP   IIIIII    GGGGGGGGG             MM     MM  EEEEEEEEE    AAAAA    TTTTTTTT
PP     PP     II      GG     GG             MMM   MMM  EE          AA   AA      TT
PP     PP     II      GG                    MMMM MMMM  EE         AA     AA     TT
PPPPPPPPP     II      GG                    MM MMM MM  EEEEEE     AA     AA     TT
PPPPPPPP      II      GG   GGGG             MM  M  MM  EEEEEE     AAAAAAAAA     TT
PP            II      GG   GGGG             MM     MM  EE         AAAAAAAAA     TT
PP            II      GG     GG             MM     MM  EE         AA     AA     TT
PP          IIIIII    GGGGGGGGG             MM     MM  EEEEEEEEE  AA     AA     TT
PP          IIIIII     GGGGGGG              MM     MM  EEEEEEEEE  AA     AA     TT
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PIGMEAT: STOCKS AND PRODUCTION FOR SELECTED REGIONS
1985

| Region and Country | Production Total 000mt | % | Stocks Total 0000 head | % |
|---|---|---|---|---|
| WORLD | 58142 | 100.0 | 791471 | 100.0 |
| UNITED STATES | 6715 | 11.5 | 54073 | 6.8 |
| EUROPE | 20068 | 34.5 | 179919 | 22.7 |
| LATIN AMERICA | 2478 | 4.3 | 76975 | 9.7 |
| TROPICAL L.A. | 2162 | 3.7 | 71625 | 9.0 |
| Brazil | 900 | 1.5 | 30000 | 3.8 |
| Colombia | 114 | 0.2 | 2378 | 0.3 |
| Venezuela | 104 | 0.2 | 3152 | 0.4 |
| TEMPERATE L.A. | 316 | 0.5 | 5350 | 0.7 |
| Argentina | 240 | 0.4 | 3800 | 0.5 |
| ASIA | 21327 | 36.7 | 375954 | 47.5 |
| AFRICA | 428 | 0.7 | 10985 | 1.4 |
| OCEANIA | 343 | 0.6 | 4870 | 0.6 |

PIGMEAT PRODUCTION,RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS

| COUNTRY | PRODUCTION 1000 MT 1969/76 | 1977/84 | 1985/85 | PERCENTAGE OF TOTAL % 1985/85 | PER CAPITA PRODUCTION KG 1985/85 |
|---|---|---|---|---|---|
| BRAZIL | 754 | 916 | 900 | 37.31 | 7 |
| MEXICO | 313 | 449 | 500 | 20.73 | 6 |
| | 1066 | 1364 | 1400 | 58.03 | 7 |
| BOLIVIA | 20 | 31 | 35 | 1.44 | 6 |
| COLOMBIA | 80 | 103 | 114 | 4.73 | 4 |
| CUBA | 37 | 66 | 85 | 3.52 | 9 |
| DOMINICAN RP | 16 | 11 | 39 | 1.60 | 6 |
| ECUADOR | 34 | 56 | 65 | 2.69 | 7 |
| PARAGUAY | 48 | 79 | 90 | 3.73 | 25 |
| PERU | 68 | 72 | 70 | 2.88 | 4 |
| VENEZUELA | 61 | 83 | 104 | 4.31 | 6 |
| TROPICAL SOUTH AMERICA | 365 | 501 | 600 | 24.89 | 6 |
| COSTA RICA | 8 | 9 | 8 | 0.33 | 3 |
| EL SALVADOR | 12 | 14 | 13 | 0.54 | 2 |
| GUATEMALA | 13 | 15 | 16 | 0.65 | 2 |
| HONDURAS | 10 | 10 | 10 | 0.40 | 2 |
| NICARAGUA | 16 | 16 | 14 | 0.57 | 4 |
| PANAMA | 5 | 8 | 9 | 0.39 | 4 |
| CENTRAL AMERICA PANAMA | 64 | 72 | 69 | 2.88 | 3 |
| BARBADOS | 4 | 6 | 6 | 0.25 | 24 |
| GUYANA | 1 | 1 | 1 | 0.04 | 1 |
| HAITI | 26 | 19 | 9 | 0.37 | 1 |
| JAMAICA | 6 | 7 | 7 | 0.30 | 3 |
| TRINIDAD TOB | 3 | 3 | 4 | 0.15 | 3 |
| CARIBBEAN | 40 | 36 | 27 | 1.11 | 2 |
| TROPICAL LATIN AMERICA | 1536 | 1973 | 2097 | 86.92 | 6 |
| ARGENTINA | 236 | 238 | 240 | 9.95 | 8 |
| CHILE | 42 | 48 | 60 | 2.49 | 5 |
| URUGUAY | 23 | 19 | 16 | 0.64 | 5 |
| TEMPERATE SOUTH AMERICA | 302 | 306 | 316 | 13.08 | 7 |
| LATIN AMERICA | 1837 | 2279 | 2412 | 100.00 | 6 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

PIGS STOCK,RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA STOCK LEVELS

| COUNTRY | STOCK 1000 HEADS 1969/76 | STOCK 1000 HEADS 1977/84 | STOCK 1000 HEADS 1985 | PERCENTAGE OF TOTAL % 1985 | STOCK PER CAPITA HEADS 1985 |
|---|---|---|---|---|---|
| BRAZIL | 32781 | 33174 | 30000 | 39.20 | 0.22 |
| MEXICO | 11690 | 17338 | 19000 | 24.83 | 0.24 |
| | 44471 | 50512 | 49000 | 64.03 | 0.23 |
| BOLIVIA | 1030 | 1374 | 1112 | 1.45 | 0.17 |
| COLOMBIA | 1655 | 2070 | 2378 | 3.11 | 0.08 |
| CUBA | 1464 | 1945 | 2400 | 3.14 | 0.24 |
| DOMINICAN RP | 723 | 474 | 1850 | 2.42 | 0.30 |
| ECUADOR | 2206 | 3450 | 4230 | 5.53 | 0.45 |
| PARAGUAY | 758 | 1286 | 1400 | 1.83 | 0.38 |
| PERU | 2023 | 2065 | 2050 | 2.68 | 0.10 |
| VENEZUELA | 1658 | 2289 | 3152 | 4.12 | 0.18 |
| TROPICAL SOUTH AMERICA | 11517 | 14953 | 18572 | 24.27 | 0.18 |
| COSTA RICA | 213 | 225 | 220 | 0.29 | 0.08 |
| EL SALVADOR | 438 | 445 | 375 | 0.49 | 0.07 |
| GUATEMALA | 752 | 746 | 832 | 1.09 | 0.10 |
| HONDURAS | 647 | 442 | 410 | 0.54 | 0.09 |
| NICARAGUA | 614 | 592 | 540 | 0.71 | 0.17 |
| PANAMA | 176 | 203 | 215 | 0.28 | 0.10 |
| CENTRAL AMERICA PANAMA | 2841 | 2654 | 2592 | 3.39 | 0.10 |
| BARBADOS | 34 | 46 | 49 | 0.06 | 0.19 |
| GUYANA | 98 | 137 | 148 | 0.19 | 0.16 |
| HAITI | 1658 | 1238 | 500 | 0.65 | 0.08 |
| JAMAICA | 195 | 214 | 238 | 0.31 | 0.10 |
| TRINIDAD TOB | 53 | 63 | 83 | 0.11 | 0.07 |
| CARIBBEAN | 2038 | 1698 | 1018 | 1.33 | 0.09 |
| TROPICAL LATIN AMERICA | 60867 | 69817 | 71182 | 93.01 | 0.20 |
| ARGENTINA | 4419 | 3738 | 3800 | 4.97 | 0.12 |
| CHILE | 955 | 1053 | 1100 | 1.44 | 0.09 |
| URUGUAY | 414 | 436 | 450 | 0.59 | 0.15 |
| TEMPERATE SOUTH AMERICA | 5788 | 5228 | 5350 | 6.99 | 0.12 |
| LATIN AMERICA | 66655 | 75045 | 76532 | 100.00 | 0.19 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

PIGMEAT PRODUCTION PER CAPITA 1969/85

| COUNTRY | ANNUAL GROWTH RATE 1969/85 % | AVERAGE 1969/76 | AVERAGE 1977/84 | 1985 |
|---|---|---|---|---|
| | | KG/YEAR | | |
| BRAZIL | -0.52 | 7.4 | 7.5 | 6.6 |
| MEXICO | 1.89*** | 5.6 | 6.4 | 6.3 |
| | 0.16 | 6.8 | 7.1 | 6.5 |
| BOLIVIA | 2.79*** | 4.4 | 5.6 | 5.4 |
| COLOMBIA | 1.12*** | 3.6 | 3.9 | 4.0 |
| CUBA | 5.29*** | 4.1 | 6.8 | 8.5 |
| DOMINICAN RP | -12.08* | 3.4 | 2.0 | 6.2 |
| ECUADOR | 2.59*** | 5.2 | 6.7 | 6.9 |
| PARAGUAY | 2.44*** | 19.4 | 24.5 | 24.4 |
| PERU | -1.81*** | 4.8 | 4.1 | 3.5 |
| VENEZUELA | 1.57** | 5.2 | 5.4 | 6.0 |
| TROPICAL SOUTH AMERICA | 1.62*** | 4.8 | 5.5 | 5.9 |
| COSTA RICA | -1.43** | 4.2 | 4.1 | 3.0 |
| SALVADOR | -1.78*** | 3.2 | 2.9 | 2.3 |
| GUATEMALA | -0.97 | 2.4 | 2.2 | 2.0 |
| HONDURAS | -3.41*** | 3.4 | 2.6 | 2.2 |
| NICARAGUA | -3.89*** | 7.1 | 5.7 | 4.2 |
| PANAMA | 3.24*** | 2.9 | 3.8 | 4.3 |
| CENTRAL AMERICA PANAMA | -1.76*** | 3.5 | 3.2 | 2.7 |
| BARBADOS | 4.16*** | 16.4 | 22.5 | 23.8 |
| GUYANA | -3.80** | 1.9 | 1.7 | 1.0 |
| HAITI | -9.83*** | 5.4 | 3.3 | 1.4 |
| JAMAICA | 0.49 | 3.0 | 3.3 | 3.1 |
| TRINIDAD ETC | 0.29 | 2.7 | 2.6 | 3.0 |
| CARIBBEAN | -4.54*** | 4.6 | 3.5 | 2.4 |
| TROPICAL LATIN AMERICA | 0.36** | 5.9 | 6.2 | 5.9 |
| ARGENTINA | -1.28*** | 9.4 | 8.4 | 7.9 |
| CHILE | 0.48 | 4.3 | 4.3 | 5.0 |
| URUGUAY | -3.31*** | 8.3 | 6.5 | 5.1 |
| TEMPERATE SOUTH AMERICA | -1.11*** | 8.0 | 7.2 | 6.9 |
| LATIN AMERICA | 0.11 | 6.2 | 6.3 | 6.0 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

PIGMEAT ANNUAL GROWTH RATES OF PRODUCTION,POPULATION AND PRODUCTION PER CAPITA. 1970/85

| | PRODUCTION | | POPULATION | | PRODUCTION PER CAPITA | |
|---|---|---|---|---|---|---|
| | 1970/77 | 1978/85 | 1970/77 | 1978/85 | 1970/77 | 1978/85 |
| BRAZIL | 0.6 | 0.1 | 2.4*** | 2.2*** | -1.8* | -2.2* |
| MEXICO | 8.2*** | 3.3*** | 3.2*** | 2.6*** | 5.0*** | 0.7 |
| | 2.7*** | 1.2 | 2.7*** | 2.4*** | 0.1 | -1.2* |
| BOLIVIA | 7.8*** | 2.8*** | 2.5*** | 2.7*** | 5.3*** | 0.1 |
| COLOMBIA | 6.2*** | 2.3** | 2.2*** | 2.1*** | 4.0*** | 0.1 |
| CUBA | 4.9* | 5.3*** | 1.6*** | 0.6*** | 3.4 | 4.7*** |
| DOMINICAN RP | 9.1*** | -10.4 | 2.8*** | 2.3*** | 6.3*** | -12.7 |
| ECUADOR | 6.2*** | 2.3* | 3.0*** | 2.9*** | 3.2*** | -0.6 |
| PARAGUAY | 5.5*** | 3.5*** | 3.2*** | 3.1*** | 2.3*** | 0.5 |
| PERU | 1.5* | 0.5 | 2.8*** | 2.6*** | -1.3* | -2.1** |
| VENEZUELA | 9.8*** | 4.7*** | 3.5*** | 3.0*** | 6.3** | 1.7 |
| TROPICAL SOUTH AMERICA | 5.9*** | 2.9*** | 2.6*** | 2.4*** | 3.4*** | 0.6 |
| COSTA RICA | 2.3* | -3.6*** | 2.6*** | 2.7*** | -0.3 | -6.4*** |
| SALVADOR | 3.8*** | -2.6** | 2.9*** | 2.9*** | 0.8 | -5.5*** |
| GUATEMALA | -3.2** | 0.9 | 2.8*** | 2.8*** | -6.0*** | -1.9 |
| HONDURAS | -3.4*** | -0.1 | 3.3*** | 3.4*** | -6.7*** | -3.5* |
| NICARAGUA | 4.4* | -4.3 | 3.1*** | 3.2*** | 1.3 | -7.5* |
| PANAMA | 4.8** | 5.7*** | 2.6*** | 2.2*** | 2.2 | 3.6*** |
| CENTRAL AMERICA PANAMA | 1.5*** | -1.3* | 2.9*** | 2.9*** | -1.4*** | -4.2*** |
| BARBADOS | 5.0*** | 1.3 | 0.5*** | 0.3*** | 4.5*** | 1.0 |
| GUYANA | 7.3* | -10.2*** | 1.9*** | 2.0*** | 5.4 | -12.2*** |
| HAITI | 2.9*** | -22.1*** | 2.3*** | 2.5*** | 0.6 | -24.6*** |
| JAMAICA | 2.0 | 0.2 | 1.7*** | 1.4*** | 0.4 | -1.2 |
| TRINIDAD ETC | 2.5*** | 5.7** | 1.2*** | 1.6*** | 1.3** | 4.1* |
| CARIBBEAN | 3.1*** | -10.1*** | 2.0*** | 2.1*** | 1.2** | -12.2*** |
| TROPICAL LATIN AMERICA | 3.5*** | 1.4*** | 2.6*** | 2.4*** | 0.8*** | -1.1** |
| ARGENTINA | 1.9 | -0.5 | 1.7*** | 1.6*** | 0.2 | -2.1 |
| CHILE | -9.0** | 7.4*** | 1.7*** | 1.6*** | -10.7** | 5.9** |
| URUGUAY | 2.1* | -5.3** | 0.2*** | 0.7*** | 1.9 | -6.0*** |
| TEMPERATE SOUTH AMERICA | 0.6 | 0.5 | 1.6*** | 1.5*** | -1.0 | -1.0 |
| LATIN AMERICA | 3.0*** | 1.2*** | 2.5*** | 2.3*** | 0.5** | -1.1** |

0

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 * P<0.05

PIGMEAT PRODUCTION PER HEAD IN STOCK 1969/85

| COUNTRY | ANNUAL GROWTH RATE 1969/85 % | AVERAGE 1969/76 | AVERAGE 1977/84 | 1985 |
|---|---|---|---|---|
| | | --KG/HEAD-- | | |
| BRAZIL | 1.85*** | 23.1 | 27.7 | 30.0 |
| MEXICO | 0.18 | 26.5 | 25.9 | 26.3 |
| | 1.28*** | 24.0 | 27.0 | 28.6 |
| BOLIVIA | 2.86*** | 19.6 | 23.3 | 31.2 |
| COLOMBIA | 0.19 | 48.4 | 49.9 | 47.9 |
| CUBA | 3.05*** | 25.3 | 34.2 | 35.4 |
| DOMINICAN RP | -4.32 | 21.9 | 21.8 | 20.8 |
| ECUADOR | 0.19 | 15.5 | 16.2 | 15.3 |
| PARAGUAY | -0.58 | 65.7 | 61.2 | 64.3 |
| PERU | 0.33* | 33.5 | 34.8 | 33.9 |
| VENEZUELA | 0.63 | 36.8 | 36.3 | 33.0 |
| TROPICAL SOUTH AMERICA | 0.70*** | 31.6 | 33.6 | 32.3 |
| COSTA RICA | 0.57 | 36.7 | 41.7 | 35.9 |
| SALVADOR | 1.88*** | 28.1 | 31.8 | 34.7 |
| GUATEMALA | 1.77** | 18.0 | 20.6 | 18.9 |
| HONDURAS | 4.24*** | 15.2 | 22.3 | 23.4 |
| NICARAGUA | 0.16 | 25.8 | 26.4 | 25.6 |
| PANAMA | 4.38*** | 27.0 | 37.8 | 43.7 |
| CENTRAL AMERICA PANAMA | 2.16*** | 22.5 | 27.1 | 26.8 |
| BARBADOS | 0.87 | 117.8 | 121.0 | 122.8 |
| GUYANA | -5.93*** | 15.0 | 10.7 | 6.6 |
| HAITI | 0.16 | 16.0 | 15.1 | 18.0 |
| JAMAICA | 0.36 | 30.2 | 33.9 | 30.7 |
| TRINIDAD ETC | -1.10** | 50.8 | 46.0 | 43.4 |
| CARIBBEAN | 1.81*** | 19.8 | 21.9 | 26.4 |
| TROPICAL LATIN AMERICA | 1.28*** | 25.2 | 28.3 | 29.5 |
| ARGENTINA | 1.73*** | 53.7 | 63.9 | 63.2 |
| CHILE | 1.18 | 44.0 | 45.4 | 54.5 |
| URUGUAY | -3.69*** | 56.8 | 43.6 | 34.4 |
| TEMPERATE SOUTH AMERICA | 1.22*** | 52.3 | 58.5 | 59.0 |
| LATIN AMERICA | 1.11*** | 27.5 | 30.4 | 31.5 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

PIGMEAT ANNUAL GROWTH RATES OF PRODUCTION,STOCKS AND PRODUCTION/HEAD IN STOCK. 1970/85

| COUNTRY | PRODUCTION 1970/77 | PRODUCTION 1978/85 | STOCK 1970/77 | STOCK 1978/85 | PRODUCTION/HEAD IN STOCK 1970/77 | PRODUCTION/HEAD IN STOCK 1978/85 |
|---|---|---|---|---|---|---|
| BRAZIL | 0.6 | 0.1 | 2.0*** | -2.2*** | -1.4 | 2.3** |
| MEXICO | 8.2*** | 3.3*** | 5.3*** | 3.4*** | 2.9* | -0.1 |
| | 2.7*** | 1.2 | 2.9*** | -0.2 | -0.1 | 1.4** |
| BOLIVIA | 7.8*** | 2.8*** | 5.0*** | -4.1* | 2.8*** | 6.9*** |
| COLOMBIA | 6.2*** | 2.3** | 4.0*** | 3.5*** | 2.2** | -1.2 |
| CUBA | 4.9* | 5.3*** | 0.1 | 3.8*** | 4.8** | 1.5 |
| DOMINICAN RP | 9.1*** | -10.4 | -0.1 | 12.6 | 9.1*** | -23.0* |
| ECUADOR | 6.2*** | 2.3* | 6.3*** | 3.7*** | -0.1** | -1.4** |
| PARAGUAY | 5.5*** | 3.5*** | 11.4*** | 1.8*** | -5.9*** | 1.7*** |
| PERU | 1.5* | 0.5 | 1.1* | 0.6 | 0.4 | -0.1 |
| VENEZUELA | 9.8*** | 4.7*** | 1.9 | 6.5*** | 7.9** | -1.7** |
| TROPICAL SOUTH AMERICA | 5.9*** | 2.9*** | 3.5*** | 3.5*** | 2.4*** | -0.5 |
| COSTA RICA | 2.3* | -3.6*** | 0.8 | 0.9 | 1.5 | -4.5*** |
| SALVADOR | 3.8*** | -2.6** | 1.4 | -4.9** | 2.4 | 2.3 |
| GUATEMALA | -3.2** | 0.9 | -6.2** | 2.3*** | 3.0 | -1.5 |
| HONDURAS | -3.4*** | -0.1 | -8.2*** | -2.5* | 4.8*** | 2.4 |
| NICARAGUA | 4.4* | -4.3 | 1.8** | -3.7 | 2.6 | -0.6 |
| PANAMA | 4.8** | 5.7*** | 1.3 | 0.3 | 3.5** | 5.5*** |
| CENTRAL AMERICA PANAMA | 1.5*** | -1.3* | -2.6** | -1.3 | 4.1*** | 0.1 |
| BARBADOS | 5.0*** | 1.3 | 4.1*** | 1.1 | 0.9 | 0.1 |
| GUYANA | 7.3* | -10.2*** | 7.6*** | 1.9*** | -0.3 | -12.1*** |
| HAITI | 2.9*** | -22.1*** | 0.7 | -24.0*** | 2.2 | 1.9 |
| JAMAICA | 2.0 | 0.2 | 1.3* | 3.2*** | 0.7 | -3.0** |
| TRINIDAD ETC | 2.5*** | 5.7** | 1.0* | 5.9*** | 1.5** | -0.1 |
| CARIBBEAN | 3.1*** | -10.1*** | 1.2 | -15.0*** | 2.0** | 4.8*** |
| TROPICAL LATIN AMERICA | 3.5*** | 1.4*** | 2.7*** | 0.2 | 0.8** | 1.1** |
| ARGENTINA | 1.9 | -0.5 | -3.3** | 0.9 | 5.2*** | -1.3 |
| CHILE | -9.0** | 7.4*** | -2.2** | 1.3* | -6.8* | 6.1*** |
| URUGUAY | 2.1* | -5.3** | 2.4* | 1.4** | -0.2 | -6.7** |
| TEMPERATE SOUTH AMERICA | 0.6 | 0.5 | -2.7** | 1.0* | 3.2*** | -0.5 |
| LATIN AMERICA | 3.0*** | 1.2*** | 2.3*** | 0.3 | 0.8** | 0.9** |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 * P<0.05

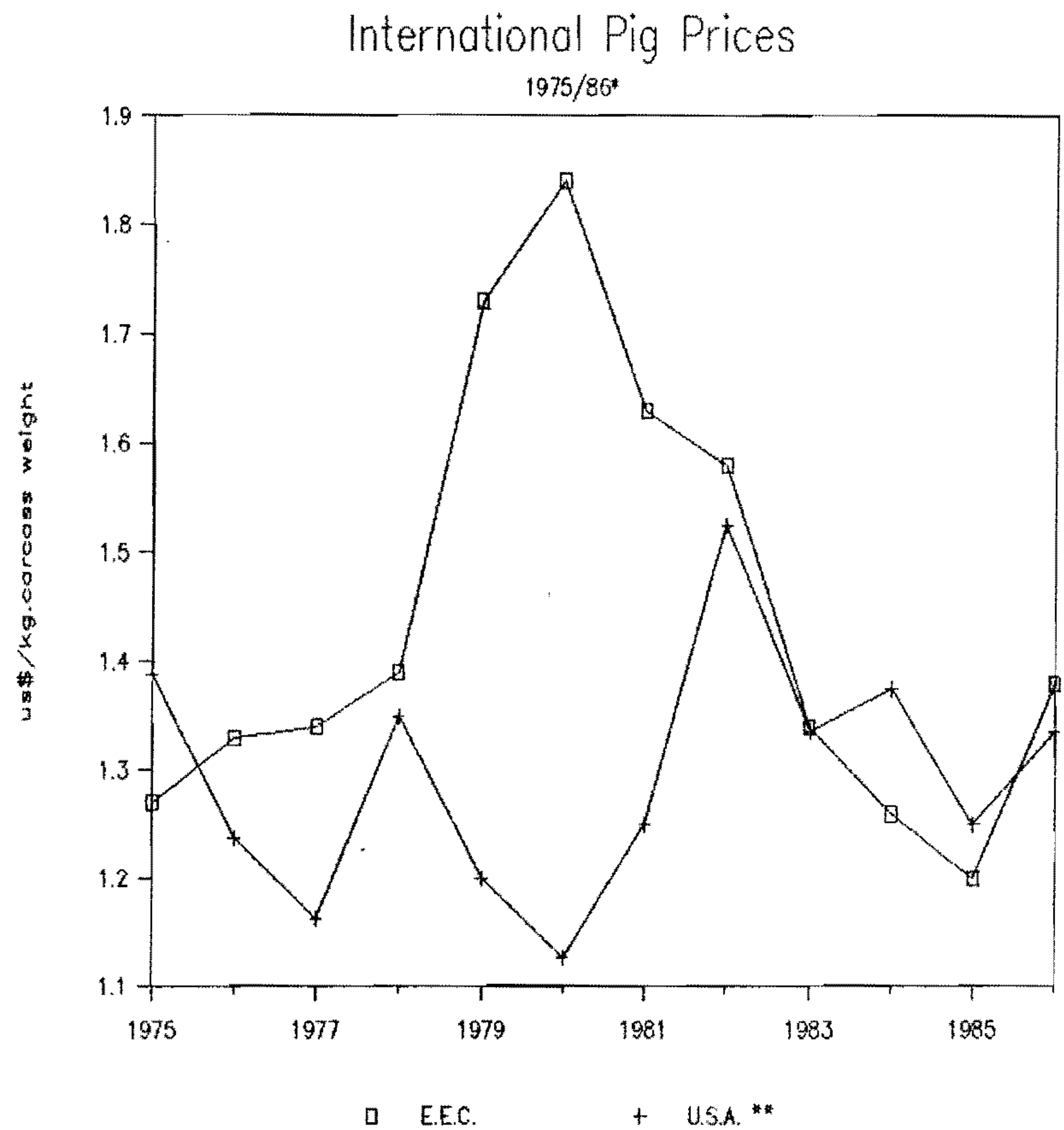
PIGMEAT* SUMMARY OF LATIN AMERICA TRADE(THOUSAND TONS )

| REGION | EXPORT | | | IMPORT | | | +IMPORT-EXPORT | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1969/76 | 1977/84 | 1985 | 1969/76 | 1977/84 | 1985 | 1969/76 | 1977/84 | 1985 |
| BRAZIL | 4 | 4 | 4 | 1 | 0 | 3 | -3 | -4 | -1 |
| MEXICO | 1 | 1 | 0 | 1 | 0 | 0 | 0 | -1 | 0 |
| | 5 | 5 | 4 | 2 | 0 | 3 | -3 | -5 | -1 |
| BOLIVIA | 1 | 0 | 0 | 0 | 1 | 0 | -1 | 1 | 0 |
| COLOMBIA | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| CUBA | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| DOMINICA REP. | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 1 |
| PERU | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| VENEZUELA | 0 | 1 | 3 | 1 | 6 | 0 | 1 | 5 | -3 |
| TROPICAL SOUTH AMERICA | 1 | 1 | 3 | 2 | 12 | 2 | 1 | 11 | -1 |
| COSTA RICA | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| SALVADOR | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| GUATEMALA | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| HONDURAS | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| NICARAGUA | 1 | 1 | 0 | 1 | 0 | 0 | 0 | -1 | 0 |
| PANAMA | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| CENTRAL AMERICA PANAMA | 3 | 3 | 0 | 6 | 5 | 0 | 3 | 2 | 0 |
| BARBADOS | 1 | 1 | 0 | 1 | 1 | 2 | 0 | 0 | 2 |
| GUYANA | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| HAITI | 0 | 0 | 0 | 1 | 1 | 2 | 1 | 1 | 2 |
| JAMAICA | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| TRINIDAD | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| CARIBBEAN | 4 | 3 | 1 | 5 | 4 | 6 | 1 | 1 | 5 |
| TROPICAL LATIN AMERICA | 13 | 12 | 8 | 15 | 21 | 11 | 2 | 9 | 3 |
| ARGENTINA | 5 | 2 | 1 | 0 | 1 | 0 | -5 | -1 | -1 |
| CHILE | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 1 | 1 |
| URUGUAY | 1 | 0 | 0 | 0 | 1 | 1 | -1 | 1 | 1 |
| TEMPERATE SOUTH AMERICA | 6 | 2 | 1 | 2 | 3 | 2 | -4 | 1 | 1 |
| LATIN AMERICA | 19 | 14 | 9 | 17 | 24 | 13 | -2 | 10 | 4 |

*FRESH,CHILLED OR FROZEN

PIGMEAT PRODUCTION,TRADE AND APPARENT CONSUMPTION

| COUNTRY | 1970/77 PRODUCTION | +IMPORT -EXPORT | APPARENT CONSUMPTION | APPARENT PER CAPITA CONSUMPTION | SELF SUFFICIENCY INDEX | 1978/85 PRODUCTION | +IMPORT -EXPORT | APPARENT CONSUMPTION | APPARENT PER CAPITA CONSUMPTION | SELF SUFFICIENCY INDEX |
|---|---|---|---|---|---|---|---|---|---|---|
| | ------------1000 MT | | ----------- | -----KG---- | | ------------1000 MT | | ----------- | -----KG---- | |
| BRAZIL | 767.8 | -4.8 | 763.0 | 7.3 | 100.6 | 923.8 | -2.3 | 921.5 | 7.3 | 100.2 |
| MEXICO | 335.3 | -0.8 | 334.5 | 5.8 | 100.2 | 460.2 | -0.4 | 459.8 | 6.4 | 100.1 |
| | 1103.2 | -5.6 | 1097.6 | 6.8 | 100.5 | 1384 | -2.7 | 1381.2 | 7.0 | 100.2 |
| BOLIVIA | 21.9 | -0.0 | 21.9 | 4.6 | 100.0 | 32.4 | 0.0 | 32.4 | 5.6 | 100.0 |
| COLOMBIA | 84.6 | 0.0 | 84.6 | 3.8 | 100.0 | 104.7 | 0.1 | 104.9 | 3.9 | 99.9 |
| CUBA | 40.3 | 0.0 | 40.3 | 4.4 | 100.0 | 69.7 | 0.1 | 69.8 | 7.1 | 99.8 |
| DOMINICAN RP | 17.3 | 0.0 | 17.3 | 3.7 | 100.0 | 13.1 | 2.9 | 16.0 | 2.8 | 81.7 |
| ECUADOR | 36.1 | 0.0 | 36.1 | 5.4 | 100.0 | 58.2 | 0.0 | 58.2 | 6.9 | 100.0 |
| PARAGUAY | 51.2 | 0.0 | 51.2 | 19.9 | 100.0 | 82.5 | 0.0 | 82.5 | 24.8 | 100.0 |
| PERU | 68.9 | 0.0 | 68.9 | 4.7 | 100.0 | 71.9 | 0.0 | 71.9 | 4.0 | 100.0 |
| VENEZUELA | 65.6 | 1.0 | 66.7 | 5.5 | 98.4 | 86.0 | 4.8 | 90.8 | 5.8 | 94.7 |
| TROPICAL SOUTH AMERICA | 385.9 | 1.0 | 387.0 | 5.0 | 99.7 | 518.5 | 8.0 | 526.4 | 5.6 | 98.5 |
| COSTA RICA | 8.4 | 0.0 | 8.4 | 4.4 | 99.5 | 9.1 | 0.1 | 9.2 | 3.9 | 99.2 |
| EL SALVADOR | 12.7 | 0.0 | 12.7 | 3.2 | 100.0 | 13.9 | 0.0 | 13.9 | 2.8 | 99.7 |
| GUATEMALA | 13.0 | 0.0 | 13.0 | 2.2 | 99.8 | 16.1 | 0.1 | 16.2 | 2.2 | 99.5 |
| HONDURAS | 9.4 | 0.0 | 9.4 | 3.2 | 100.0 | 9.9 | 0.1 | 9.9 | 2.5 | 99.5 |
| NICARAGUA | 16.8 | -0.1 | 16.8 | 7.3 | 100.5 | 14.9 | -0.0 | 14.9 | 5.1 | 100.1 |
| PANAMA | 4.9 | 0.0 | 4.9 | 2.9 | 99.6 | 8.1 | 0.0 | 8.1 | 4.0 | 100.0 |
| CENTRAL AMERICA PANAMA | 65.2 | 0.01 | 65.2 | 3.9 | 99.9 | 71.8 | 0.2 | 72.1 | 3.4 | 99.7 |
| BARBADOS | 4.3 | 0.0 | 4.4 | 18.0 | 99.0 | 5.7 | 0.6 | 6.3 | 25.4 | 90.4 |
| GUYANA | 1.6 | -0.0 | 1.6 | 2.1 | 100.2 | 1.3 | 0.0 | 1.3 | 1.4 | 100.0 |
| HAITI | 27.0 | 0.0 | 27.1 | 5.4 | 99.9 | 16.3 | 0.4 | 16.7 | 2.8 | 97.7 |
| JAMAICA | 6.2 | 0.3 | 6.5 | 3.3 | 95.5 | 7.1 | 0.1 | 7.2 | 3.2 | 99.3 |
| TRINIDAD TOB | 2.8 | 0.5 | 3.3 | 3.3 | 85.7 | 3.0 | 0.8 | 3.7 | 3.3 | 79.8 |
| CARIBBEAN | 42.0 | 0.8 | 42.8 | 4.8 | 98.1 | 33.5 | 1.8 | 35.3 | 3.4 | 94.9 |
| TROPICAL LATIN AMERICA | 1596.3 | -3.7 | 1592.5 | 6.0 | 100.2 | 2007.7 | 7.3 | 2015.0 | 6.2 | 99.6 |
| ARGENTINA | 240.8 | -4.8 | 236.0 | 9.3 | 102.0 | 238.3 | 0.3 | 238.5 | 8.2 | 99.9 |
| CHILE | 40.5 | 1.5 | 41.9 | 4.2 | 96.5 | 52.3 | 0.5 | 52.8 | 4.6 | 99.0 |
| URUGUAY | 23.4 | -0.0 | 23.4 | 8.3 | 100.1 | 17.9 | 0.1 | 18.0 | 6.1 | 99.5 |
| TEMPERATE SOUTH AMERIC | 304.7 | -3.4 | 301.4 | 7.9 | 101.1 | 308.4 | 0.9 | 309.3 | 7.1 | 99.7 |
| LATIN AMERICA | 1901.0 | -7.1 | 1893.9 | 6.2 | 100.4 | 2316.1 | 8.2 | 2324.3 | 6.3 | 99.6 |




* Current US$/kg carcass weight

** Conversion factor from liveweight to carcass: 0.80

SOURCE: FAO, Boletín Mensual de Estadísticas (several issues)

# POULTRY MEAT

POULTRY MEAT : STOCKS AND PRODUCTION FOR SELECTED REGIONS
1985

| Region and Country | Production Total 000mt | Production % | Stocks Total millons heads | Stocks % |
|---|---|---|---|---|
| WORLD | 30954 | 100.0 | 8287 | 100.0 |
| UNITED STATES | 7829 | 25.3 | 1050 | 12.7 |
| EUROPE | 7508 | 24.3 | 1236 | 14.9 |
| LATIN AMERICA | 3775 | 12.2 | 1030 | 12.4 |
| TROPICAL L.A. | 3196 | 10.3 | 963 | 11.6 |
| Brazil | 1536 | 5.0 | 450 | 5.4 |
| Colombia | 133 | 0.4 | 35 | 0.4 |
| Venezuela | 311 | 1.0 | 43 | 0.5 |
| TEMPERATE L.A. | 579 | 1.9 | 67 | 0.8 |
| Argentina | 482 | 1.6 | 42 | 0.5 |
| ASIA | 6461 | 20.9 | 2965 | 35.8 |
| AFRICA | 1604 | 5.2 | 752 | 9.1 |
| OCEANIA | 395 | 1.3 | 68 | 0.8 |

POULTRY MEAT PRODUCTION, RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS

| COUNTRY | PRODUCTION 1000 MT 1969/76 | 1977/84 | 1985 | PERCENTAGE OF TOTAL % 1985 | PER CAPITA PRODUCTION KG 1985 |
|---|---|---|---|---|---|
| BRAZIL | 467 | 1294 | 1536 | 41.34 | 12 |
| MEXICO | 261 | 437 | 515 | 13.85 | 7 |
| | 728 | 1730 | 2051 | 55.19 | 10 |
| BOLIVIA | 5 | 10 | 12 | 0.31 | 2 |
| COLOMBIA | 53 | 109 | 133 | 3.58 | 5 |
| CUBA | 46 | 76 | 106 | 2.85 | 11 |
| DOMINICAN RP | 31 | 60 | 74 | 1.98 | 12 |
| ECUADOR | 11 | 24 | 30 | 0.81 | 3 |
| PARAGUAY | 9 | 14 | 17 | 0.45 | 5 |
| PERU | 89 | 162 | 201 | 5.41 | 10 |
| VENEZUELA | 127 | 257 | 311 | 8.37 | 18 |
| TROPICAL SOUTH AMERICA | 371 | 711 | 883 | 23.76 | 9 |
| COSTA RICA | 3 | 5 | 5 | 0.14 | 2 |
| EL SALVADOR | 5 | 15 | 20 | 0.54 | 4 |
| GUATEMALA | 11 | 43 | 55 | 1.48 | 7 |
| HONDURAS | 5 | 10 | 13 | 0.36 | 3 |
| NICARAGUA | 7 | 9 | 10 | 0.28 | 3 |
| PANAMA | 8 | 13 | 14 | 0.37 | 6 |
| CENTRAL AMERICA PANAMA | 40 | 96 | 118 | 3.17 | 5 |
| BARBADOS | 2 | 5 | 6 | 0.17 | 25 |
| GUYANA | 8 | 13 | 15 | 0.40 | 16 |
| HAITI | 4 | 7 | 9 | 0.24 | 1 |
| JAMAICA | 20 | 31 | 35 | 0.93 | 15 |
| TRINIDAD TOB | 16 | 21 | 21 | 0.57 | 18 |
| CARIBBEAN | 50 | 77 | 86 | 2.31 | 8 |
| TROPICAL LATIN AMERICA | 1190 | 2614 | 3138 | 84.43 | 9 |
| ARGENTINA | 222 | 402 | 482 | 12.97 | 16 |
| CHILE | 51 | 77 | 75 | 2.02 | 6 |
| URUGUAY | 16 | 19 | 22 | 0.58 | 7 |
| TEMPERATE SOUTH AMERICA | 289 | 498 | 579 | 15.57 | 13 |
| LATIN AMERICA | 1479 | 3112 | 3717 | 100.00 | 10 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

CHICKEN — STOCK, RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA STOCK LEVELS

| COUNTRY | STOCK ---1000 HEADS--- 1969/76 | 1977/84 | 1985 | PERCENTAGE OF TOTAL % 1985 | STOCK PER CAPITA HEADS 1985 |
|---|---|---|---|---|---|
| BRAZIL | 256737 | 415875 | 450000 | 44.30 | 3.32 |
| MEXICO | 136189 | 176895 | 200000 | 19.69 | 2.53 |
| | 392926 | 592770 | 650000 | 63.99 | 3.03 |
| BOLIVIA | 5087 | 8815 | 10000 | 0.98 | 1.57 |
| COLOMBIA | 19232 | 30571 | 35000 | 3.45 | 1.22 |
| CUBA | 15367 | 23762 | 26024 | 2.56 | 2.59 |
| DOMINICAN RP | 7049 | 8163 | 8500 | 0.84 | 1.36 |
| ECUADOR | 10267 | 33569 | 43000 | 4.23 | 4.59 |
| PARAGUAY | 7562 | 12683 | 14500 | 1.43 | 3.94 |
| PERU | 25776 | 38250 | 41000 | 4.04 | 2.08 |
| VENEZUELA | 22661 | 39508 | 43000 | 4.23 | 2.48 |
| TROPICAL SOUTH AMERICA | 113000 | 195320 | 221024 | 21.76 | 2.18 |
| COSTA RICA | 4346 | 5450 | 5600 | 0.55 | 2.15 |
| EL SALVADOR | 2478 | 4699 | 4200 | 0.41 | 0.76 |
| GUATEMALA | 10115 | 13803 | 15100 | 1.49 | 1.90 |
| HONDURAS | 3306 | 4722 | 5200 | 0.51 | 1.19 |
| NICARAGUA | 3427 | 4711 | 5300 | 0.52 | 1.62 |
| PANAMA | 3607 | 5041 | 6000 | 0.59 | 2.75 |
| CENTRAL AMERICA PANAMA | 27278 | 38426 | 41400 | 4.08 | 1.60 |
| BARBADOS | 392 | 809 | 1000 | 0.10 | 3.95 |
| GUYANA | 8091 | 12725 | 14500 | 1.43 | 15.22 |
| HAITI | 3999 | 5600 | 7500 | 0.74 | 1.14 |
| JAMAICA | 3442 | 4938 | 5200 | 0.51 | 2.23 |
| TRINIDAD TOB | 5705 | 7388 | 7900 | 0.78 | 6.67 |
| CARIBBEAN | 21629 | 31459 | 36100 | 3.55 | 3.19 |
| TROPICAL LATIN AMERICA | 554833 | 857974 | 948524 | 93.37 | 2.69 |
| ARGENTINA | 33075 | 38075 | 42000 | 4.13 | 1.37 |
| CHILE | 15375 | 18413 | 19000 | 1.87 | 1.58 |
| URUGUAY | 5365 | 5947 | 6300 | 0.62 | 2.09 |
| TEMPERATE SOUTH AMERICA | 53815 | 62435 | 67300 | 6.63 | 1.48 |
| LATIN AMERICA | 608648 | 920408 | 1015824 | 100.00 | 2.55 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

POULTRY MEAT PRODUCTION PER CAPITA 1969/85

| COUNTRY | ANNUAL GROWTH RATE 1969/85 % | AVERAGE 1969/76 | AVERAGE 1977/84 | 1985 |
|---|---|---|---|---|
| | | | -KG/YEAR- | |
| BRAZIL | 9.01*** | 4.6 | 10.4 | 11.3 |
| MEXICO | 3.16*** | 4.7 | 6.2 | 6.5 |
| | 7.20*** | 4.6 | 8.9 | 9.6 |
| BOLIVIA | 5.75*** | 1.1 | 1.7 | 1.8 |
| COLOMBIA | 6.00*** | 2.4 | 4.1 | 4.6 |
| CUBA | 5.26*** | 5.1 | 7.7 | 10.6 |
| DOMINICAN RP | 4.88*** | 6.7 | 10.5 | 11.8 |
| ECUADOR | 5.69*** | 1.7 | 2.9 | 3.2 |
| PARAGUAY | 2.80*** | 3.5 | 4.4 | 4.5 |
| PERU | 5.84*** | 6.1 | 9.2 | 10.2 |
| VENEZUELA | 5.53*** | 10.8 | 16.7 | 18.0 |
| TROPICAL SOUTH AMERICA | 5.65*** | 4.9 | 7.7 | 8.7 |
| COSTA RICA | 1.74* | 1.7 | 2.2 | 2.1 |
| SALVADOR | 8.84*** | 1.3 | 3.1 | 3.6 |
| GUATEMALA | 11.74*** | 2.0 | 6.1 | 6.9 |
| HONDURAS | 3.99*** | 1.9 | 2.6 | 3.0 |
| NICARAGUA | 1.18 | 3.2 | 3.2 | 3.1 |
| PANAMA | 2.74*** | 5.0 | 6.6 | 6.3 |
| CENTRAL AMERICA PANAMA | 6.77*** | 2.2 | 4.2 | 4.5 |
| BARBADOS | 15.37*** | 7.3 | 22.0 | 24.7 |
| GUYANA | 3.97*** | 10.7 | 14.5 | 15.6 |
| HAITI | 3.77*** | 0.9 | 1.1 | 1.3 |
| JAMAICA | 4.05*** | 10.0 | 14.0 | 14.8 |
| TRINIDAD ETC | 1.61** | 16.2 | 19.3 | 17.9 |
| CARIBBEAN | 3.30*** | 5.6 | 7.4 | 7.6 |
| TROPICAL LATIN AMERICA | 6.59*** | 4.5 | 8.2 | 8.9 |
| ARGENTINA | 5.61*** | 8.9 | 14.0 | 15.8 |
| CHILE | 2.29* | 5.1 | 6.8 | 6.2 |
| URUGUAY | 2.36*** | 5.7 | 6.5 | 7.2 |
| TEMPERATE SOUTH AMERICA | 4.89*** | 7.6 | 11.6 | 12.7 |
| LATIN AMERICA | 6.23*** | 4.9 | 8.6 | 9.3 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

POULTRY MEAT        ANNUAL GROWTH RATES OF PRODUCTION,POPULATION AND PRODUCTION PER CAPITA. 1970/85

| | PRODUCTION | | POPULATION | | PRODUCTION PER CAPITA | |
|---|---|---|---|---|---|---|
| | 1970/77 | 1978/85 | 1970/77 | 1978/85 | 1970/77 | 1978/85 |
| BRAZIL | 9.2*** | 7.2** | 2.4*** | 2.2*** | 6.8*** | 4.9* |
| MEXICO | 7.0*** | 4.1*** | 3.2*** | 2.6*** | 3.9*** | 1.5* |
| | 8.4*** | 6.3** | 2.7*** | 2.4*** | 5.7*** | 4.0* |
| BOLIVIA | 12.3*** | 4.9*** | 2.5*** | 2.7*** | 9.8*** | 2.2*** |
| COLOMBIA | 8.7*** | 5.3*** | 2.2*** | 2.1*** | 6.5*** | 3.1*** |
| CUBA | 3.2** | 8.3*** | 1.6*** | 0.6*** | 1.6 | 7.7*** |
| DOMINICAN RP | 4.5*** | 5.9*** | 2.8*** | 2.3*** | 1.8* | 3.6** |
| ECUADOR | 8.6*** | 7.0*** | 3.0*** | 2.9*** | 5.6*** | 4.2*** |
| PARAGUAY | 7.7*** | 3.6*** | 3.2*** | 3.1*** | 4.5*** | 0.6 |
| PERU | 14.4*** | 8.4*** | 2.8*** | 2.6*** | 11.7*** | 5.8** |
| VENEZUELA | 10.6*** | 7.5*** | 3.5*** | 3.0*** | 7.1*** | 4.5** |
| TROPICAL SOUTH AMERICA | 9.7*** | 7.2*** | 2.6*** | 2.4*** | 7.2*** | 4.8*** |
| COSTA RICA | 9.9*** | -0.9 | 2.6*** | 2.7*** | 7.3** | -3.6 |
| SALVADOR | 14.0** | 4.9* | 2.9*** | 2.9*** | 11.1** | 1.9 |
| GUATEMALA | 11.1*** | 5.5* | 2.8*** | 2.8*** | 8.3*** | 2.7 |
| HONDURAS | 5.0*** | 8.5*** | 3.3*** | 3.4*** | 1.7 | 5.0*** |
| NICARAGUA | 12.5*** | 5.3** | 3.1*** | 3.2*** | 9.4*** | 2.1 |
| PANAMA | 4.8*** | 1.6 | 2.6*** | 2.2*** | 2.2 | -0.6 |
| CENTRAL AMERICA PANAMA | 9.7*** | 4.7*** | 2.9*** | 2.9*** | 6.8*** | 1.7* |
| BARBADOS | 26.7*** | 5.2*** | 0.5*** | 0.3*** | 26.2*** | 4.9** |
| GUYANA | 8.6*** | 4.4*** | 1.9*** | 2.0*** | 6.7*** | 2.4*** |
| HAITI | 4.5*** | 7.7*** | 2.3*** | 2.5*** | 2.2*** | 5.3*** |
| JAMAICA | 9.3*** | 1.6 | 1.7*** | 1.4*** | 7.6*** | 0.2 |
| TRINIDAD ETC | 6.8*** | -0.2 | 1.2*** | 1.6*** | 5.6** | -1.8 |
| CARIBBEAN | 8.4*** | 2.3*** | 2.0*** | 2.1*** | 6.5*** | 0.3 |
| TROPICAL LATIN AMERICA | 8.9*** | 6.4*** | 2.6*** | 2.4*** | 6.2*** | 4.0** |
| ARGENTINA | 6.5*** | 5.8** | 1.7*** | 1.6*** | 4.8** | 4.2** |
| CHILE | -4.0 | 2.4 | 1.7*** | 1.6*** | -5.7** | 0.9 |
| URUGUAY | 2.3 | 3.3*** | 0.2*** | 0.7*** | 2.1 | 2.6*** |
| TEMPERATE SOUTH AMERICA | 4.6*** | 5.2** | 1.6*** | 1.5*** | 3.0** | 3.7* |
| LATIN AMERICA | 8.0*** | 6.2*** | 2.5*** | 2.3*** | 5.5*** | 3.9** |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005    ** P<0.01    * P<0.05

POULTRY MEAT PRODUCTION PER HEAD IN STOCK 1969/85

| COUNTRY | ANNUAL GROWTH RATE 1969/85 % | AVERAGE 1969/76 | AVERAGE 1977/84 | 1985 |
|---|---|---|---|---|
| | | | KG/HEAD | |
| BRAZIL | 5.47*** | 1.8 | 3.1 | 3.4 |
| MEXICO | 3.02*** | 1.9 | 2.5 | 2.6 |
| | 4.84*** | 1.8 | 2.9 | 3.2 |
| BOLIVIA | 1.77*** | 1.0 | 1.1 | 1.2 |
| COLOMBIA | 2.62*** | 2.8 | 3.6 | 3.8 |
| CUBA | 1.20 | 3.0 | 3.2 | 4.1 |
| DOMINICAN RP | 5.59*** | 4.4 | 7.3 | 8.6 |
| ECUADOR | -5.05*** | 1.2 | 0.7 | 0.7 |
| PARAGUAY | -0.06 | 1.2 | 1.1 | 1.1 |
| PERU | 3.33*** | 3.4 | 4.2 | 4.9 |
| VENEZUELA | 2.44*** | 5.5 | 6.4 | 7.2 |
| TROPICAL SOUTH AMERICA | 1.62*** | 3.3 | 3.6 | 4.0 |
| COSTA RICA | 1.91** | 0.7 | 0.9 | 1.0 |
| SALVADOR | 5.91*** | 2.0 | 3.3 | 4.8 |
| GUATEMALA | 11.07*** | 1.1 | 3.1 | 3.6 |
| HONDURAS | 3.14*** | 1.6 | 2.1 | 2.6 |
| NICARAGUA | 0.25 | 2.1 | 1.9 | 1.9 |
| PANAMA | 1.01* | 2.3 | 2.6 | 2.3 |
| CENTRAL AMERICA PANAMA | 5.87*** | 1.5 | 2.5 | 2.8 |
| BARBADOS | 7.51*** | 4.3 | 6.8 | 6.3 |
| GUYANA | 0.40* | 1.0 | 1.0 | 1.0 |
| HAITI | 1.51*** | 1.0 | 1.2 | 1.2 |
| JAMAICA | 1.74*** | 5.7 | 6.2 | 6.6 |
| TRINIDAD ETC | -0.24 | 2.8 | 2.9 | 2.7 |
| CARIBBEAN | 0.71** | 2.3 | 2.4 | 2.4 |
| TROPICAL LATIN AMERICA | 3.95*** | 2.1 | 3.0 | 3.3 |
| ARGENTINA | 5.27*** | 6.7 | 10.5 | 11.5 |
| CHILE | 1.88* | 3.3 | 4.1 | 3.9 |
| URUGUAY | 1.51** | 3.0 | 3.2 | 3.4 |
| TEMPERATE SOUTH AMERICA | 4.51*** | 5.4 | 7.9 | 8.6 |
| LATIN AMERICA | 3.73*** | 2.4 | 3.3 | 3.7 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

POULTRY MEAT ANNUAL GROWTH RATES OF PRODUCTION, STOCKS AND PRODUCTION/HEAD IN STOCK. 1970/85

| COUNTRY | PRODUCTION 1970/77 | PRODUCTION 1978/85 | STOCK 1970/77 | STOCK 1978/85 | PRODUCTION/HEAD IN STOCK 1970/77 | PRODUCTION/HEAD IN STOCK 1978/85 |
|---|---|---|---|---|---|---|
| BRAZIL | 9.2*** | 7.2** | 7.8*** | 3.2** | 1.4 | 4.0** |
| MEXICO | 7.0*** | 4.1*** | 1.8** | 3.7*** | 5.2*** | 0.4 |
| | 8.4*** | 6.3** | 5.7*** | 3.4** | 2.7*** | 3.0** |
| BOLIVIA | 12.3*** | 4.9*** | 9.7*** | 3.2*** | 2.6* | 1.6** |
| COLOMBIA | 8.7*** | 5.3*** | 8.2*** | 5.2*** | 0.5 | 0.1 |
| CUBA | 3.2** | 8.3*** | 6.6*** | 2.0** | -3.4* | 6.3*** |
| DOMINICAN RP | 4.5*** | 5.9*** | 1.5*** | 1.2*** | 3.0*** | 4.7*** |
| ECUADOR | 8.6*** | 7.0*** | 14.9*** | 8.8*** | -6.3** | -1.7 |
| PARAGUAY | 7.7*** | 3.6*** | 7.7*** | 2.9*** | -0.0 | 0.7*** |
| PERU | 14.4*** | 8.4*** | 10.2*** | 1.9*** | 4.2*** | 6.4** |
| VENEZUELA | 10.6*** | 7.5*** | 8.9*** | 3.3** | 1.7 | 4.2** |
| TROPICAL SOUTH AMERICA | 9.7*** | 7.2*** | 8.8*** | 4.0*** | 0.9 | 3.2*** |
| COSTA RICA | 9.9*** | -0.9 | 4.1*** | 0.2 | 5.8* | -1.1 |
| SALVADOR | 14.0** | 4.9* | 9.4*** | -4.0*** | 4.6* | 8.8*** |
| GUATEMALA | 11.1*** | 5.5* | 1.9 | 1.4*** | 9.2*** | 4.1 |
| HONDURAS | 5.0*** | 8.5*** | 4.7*** | 2.8*** | 0.2 | 5.6*** |
| NICARAGUA | 12.5*** | 5.3** | 5.3*** | 4.3*** | 7.2*** | 1.0 |
| PANAMA | 4.8*** | 1.6 | 4.2** | 3.4** | 0.6 | -1.8 |
| CENTRAL AMERICA PANAMA | 9.7*** | 4.7*** | 4.1*** | 1.4*** | 5.6*** | 3.3*** |
| BARBADOS | 26.7*** | 5.2*** | 7.8*** | 6.0*** | 18.9*** | -0.9 |
| GUYANA | 8.6*** | 4.4*** | 7.0*** | 3.5*** | 1.6*** | 0.9 |
| HAITI | 4.5*** | 7.7*** | 3.2*** | 8.2*** | 1.3*** | -0.4 |
| JAMAICA | 9.3*** | 1.6 | 3.6 | -0.8 | 5.7** | 2.5** |
| TRINIDAD ETC | 6.8*** | -0.2 | 4.4*** | 1.6*** | 2.4 | -1.9 |
| CARIBBEAN | 8.4*** | 2.3*** | 5.1*** | 3.3*** | 3.3*** | -1.0 |
| TROPICAL LATIN AMERICA | 8.9*** | 6.4*** | 6.3*** | 3.4*** | 2.6*** | 3.0*** |
| ARGENTINA | 6.5*** | 5.8** | 0.0 | 3.7*** | 6.5*** | 2.1* |
| CHILE | -4.0 | 2.4 | 1.9*** | 1.8 | -5.9** | 0.6 |
| URUGUAY | 2.3 | 3.3*** | 0.9*** | 1.5*** | 1.4 | 1.8*** |
| TEMPERATE SOUTH AMERICA | 4.6*** | 5.2** | 0.7 | 2.9** | 3.9*** | 2.3 |
| LATIN AMERICA | 8.0*** | 6.2*** | 5.8*** | 3.4*** | 2.3*** | 2.8*** |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 * P<0.05

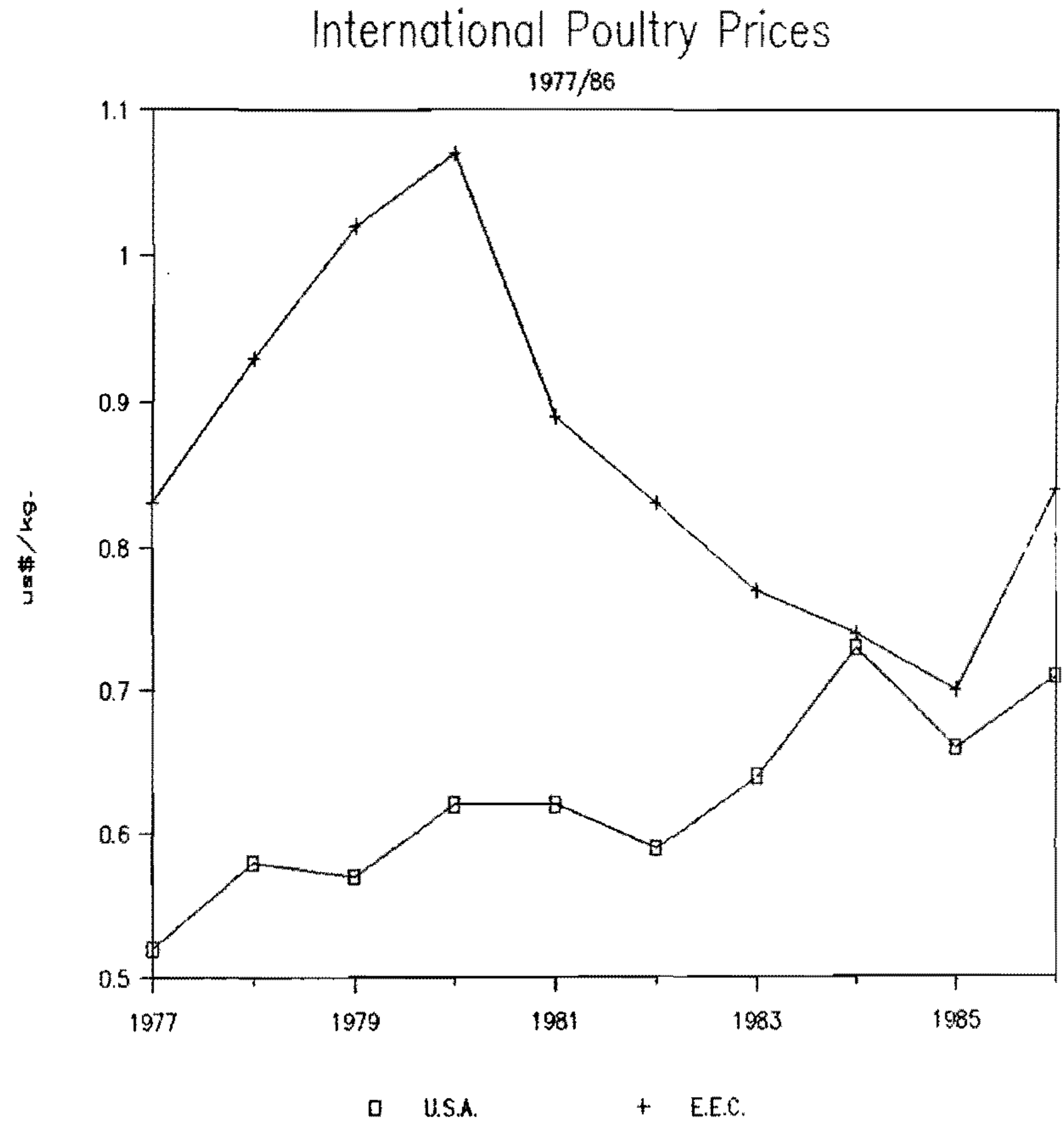
MEAT POULTRY * SUMMARY OF LATIN AMERICA TRADE(THOUSAND TONS )

| REGION | EXPORT | | | IMPORT | | | +IMPORT-EXPORT | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1969/76 | 1977/84 | 1985 | 1969/76 | 1977/84 | 1985 | 1969/76 | 1977/84 | 1985 |
| BRAZIL | 3 | 188 | 279 | 1 | 0 | 0 | -2 | -188 | -279 |
| MEXICO | 1 | 1 | 0 | 1 | 7 | 19 | 0 | 6 | 19 |
| | 4 | 189 | 279 | 2 | 7 | 19 | -2 | -182 | -260 |
| BOLIVIA | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| COLOMBIA | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| CUBA | 0 | 0 | 0 | 5 | 17 | 25 | 5 | 17 | 25 |
| DOMINICAN REP | 0 | 0 | 0 | 1 | 2 | 1 | 1 | 2 | 1 |
| PERU | 0 | 1 | 11 | 0 | 1 | 0 | 0 | 0 | -11 |
| VENEZUELA | 1 | 1 | 3 | 1 | 16 | 1 | 0 | 15 | -2 |
| TROPICAL SOUTH AMERICA | 2 | 3 | 14 | 8 | 38 | 28 | 6 | 35 | 14 |
| COSTA RICA | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| SALVADOR | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | -1 |
| GUATEMALA | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| HONDURAS | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| NICARAGUA | 1 | 0 | 0 | 1 | 2 | 0 | 0 | 2 | 0 |
| PANAMA | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 |
| CENTRAL AMERICA PANAMA | 6 | 5 | 3 | 6 | 7 | 3 | 0 | 2 | 0 |
| BARBADOS | 1 | 1 | 0 | 3 | 3 | 3 | 2 | 2 | 3 |
| GUYANA | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| HAITI | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| JAMAICA | 1 | 0 | 0 | 10 | 22 | 21 | 9 | 22 | 21 |
| TRINIDAD | 1 | 1 | 1 | 1 | 3 | 2 | 0 | 2 | 1 |
| CARIBBEAN | 4 | 2 | 1 | 16 | 30 | 27 | 12 | 28 | 26 |
| TROPICAL LATIN AMERICA | 16 | 199 | 297 | 32 | 82 | 77 | 16 | -117 | -220 |
| ARGENTINA | 1 | 2 | 0 | 1 | 6 | 0 | 0 | 4 | 0 |
| CHILE | 1 | 0 | 0 | 3 | 2 | 1 | 2 | 2 | 1 |
| URUGUAY | 1 | 4 | 2 | 0 | 1 | 0 | -1 | -3 | -2 |
| TEMPERATE SOUTH AMERICA | 3 | 6 | 2 | 4 | 9 | 1 | 1 | 3 | -1 |
| LATIN AMERICA | 19 | 205 | 299 | 36 | 91 | 78 | 17 | -114 | -221 |

*FRESH,CHILLED OR FROZEN

POULTRY MEAT — PRODUCTION, TRADE AND APPARENT CONSUMPTION

| COUNTRY | 1970/77 PRODUCTION | 1970/77 +IMPORT -EXPORT | 1970/77 APPARENT CONSUMPTION | 1970/77 APPARENT PER CAPITA CONSUMPTION | 1970/77 SELF SUFFICIENCY INDEX | 1978/85 PRODUCTION | 1978/85 +IMPORT -EXPORT | 1978/85 APPARENT CONSUMPTION | 1978/85 APPARENT PER CAPITA CONSUMPTION | 1978/85 SELF SUFFICIENCY INDEX |
|---|---|---|---|---|---|---|---|---|---|---|
| | ---1000 MT--- | | | ---KG--- | | ---1000 MT--- | | | ---KG--- | |
| BRAZIL | 514.8 | -6.6 | 508.2 | 4.9 | 101.3 | 1396.8 | -218.1 | 1178.7 | 9.4 | 118.5 |
| MEXICO | 277.5 | 0.5 | 278.0 | 4.8 | 99.8 | 457.5 | 8.4 | 465.9 | 6.4 | 98.2 |
| | 792.3 | -6.1 | 786.2 | 4.9 | 100.8 | 1854.3 | -209.7 | 1644.6 | 8.3 | 112.8 |
| BOLIVIA | 5.5 | 0.0 | 5.5 | 1.2 | 100.0 | 10.1 | 0.0 | 10.1 | 1.7 | 100.0 |
| COLOMBIA | 57.4 | -0.0 | 57.4 | 2.6 | 100.0 | 115.4 | 0.4 | 115.7 | 4.3 | 99.7 |
| CUBA | 47.5 | 5.7 | 53.2 | 5.9 | 89.4 | 82.3 | 19.3 | 101.6 | 10.3 | 81.0 |
| DOMINICAN RP | 32.9 | 0.1 | 33.0 | 7.0 | 99.6 | 64.0 | 1.5 | 65.5 | 11.4 | 97.7 |
| ECUADOR | 12.8 | 0.0 | 12.8 | 1.9 | 100.0 | 25.4 | 0.0 | 25.4 | 3.0 | 100.0 |
| PARAGUAY | 9.4 | 0.0 | 9.4 | 3.7 | 100.0 | 15.0 | 0.0 | 15.0 | 4.5 | 100.0 |
| PERU | 100.2 | -0.0 | 100.1 | 6.9 | 100.0 | 169.6 | -1.4 | 168.2 | 9.3 | 100.8 |
| VENEZUELA | 140.0 | 1.4 | 141.4 | 11.7 | 99.0 | 272.6 | 13.8 | 286.3 | 18.3 | 95.2 |
| TROPICAL SOUTH AMERICA | 405.7 | 7.2 | 412.9 | 5.4 | 98.3 | 754.3 | 33.6 | 787.9 | 8.4 | 95.7 |
| COSTA RICA | 3.6 | 0.0 | 3.6 | 1.9 | 99.9 | 4.9 | 0.0 | 4.9 | 2.1 | 99.8 |
| EL SALVADOR | 6.1 | -0.0 | 6.1 | 1.5 | 100.3 | 16.2 | -0.0 | 16.2 | 3.2 | 100.1 |
| GUATEMALA | 12.7 | -0.2 | 12.4 | 2.1 | 101.7 | 47.7 | -0.1 | 47.6 | 6.6 | 100.2 |
| HONDURAS | 5.6 | -0.0 | 5.6 | 1.9 | 100.0 | 10.8 | 0.1 | 10.9 | 2.8 | 99.5 |
| NICARAGUA | 8.0 | 0.3 | 8.2 | 3.6 | 96.8 | 9.1 | 1.1 | 10.2 | 3.5 | 89.2 |
| PANAMA | 8.7 | 0.1 | 8.8 | 5.2 | 99.0 | 13.5 | 0.3 | 13.8 | 6.8 | 98.1 |
| CENTRAL AMERICA PANAMA | 44.6 | 0.1 | 44.8 | 2.7 | 99.7 | 102.3 | 1.3 | 103.6 | 4.9 | 98.7 |
| BARBADOS | 2.2 | 2.7 | 4.9 | 20.1 | 44.4 | 5.8 | 2.8 | 8.6 | 34.3 | 67.6 |
| GUYANA | 8.7 | 0.0 | 8.7 | 11.5 | 100.0 | 13.2 | 0.0 | 13.2 | 14.8 | 99.8 |
| HAITI | 4.4 | 0.0 | 4.4 | 0.9 | 99.4 | 7.2 | 0.2 | 7.5 | 1.2 | 96.7 |
| JAMAICA | 21.9 | 11.5 | 33.4 | 16.8 | 65.6 | 31.2 | 21.9 | 53.2 | 23.9 | 58.8 |
| TRINIDAD TOB | 17.5 | 0.2 | 17.6 | 17.7 | 99.0 | 20.9 | 2.2 | 23.1 | 20.6 | 90.5 |
| CARIBBEAN | 54.7 | 14.4 | 69.1 | 7.7 | 79.1 | 78.3 | 27.2 | 105.5 | 10.0 | 74.2 |
| TROPICAL LATIN AMERICA | 1297.3 | 15.6 | 1312.9 | 5.0 | 98.8 | 2789.2 | -147.6 | 2641.6 | 8.2 | 105.6 |
| ARGENTINA | 240.9 | -1.9 | 239.0 | 9.4 | 100.8 | 425.4 | 4.9 | 430.3 | 14.9 | 98.9 |
| CHILE | 49.3 | 2.7 | 52.0 | 5.2 | 94.8 | 80.7 | 1.6 | 82.2 | 7.2 | 98.1 |
| URUGUAY | 16.7 | -0.3 | 16.5 | 5.8 | 101.7 | 19.7 | -3.1 | 16.5 | 5.6 | 118.9 |
| TEMPERATE SOUTH AMERIC | 306.9 | 0.5 | 307.5 | 8.0 | 99.8 | 525.7 | 3.4 | 529.1 | 12.2 | 99.4 |
| LATIN AMERICA | 1604.2 | 16.1 | 1620.3 | 5.3 | 99.0 | 3314.9 | -144.3 | 3170.7 | 8.6 | 104.6 |




At farm, broilers liveweight

SOURCE: FAO, Boletín Mensual de Estadísticas (several issues)

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RRRRRRRR    IIIIII    CCCCCCC   EEEEEEEEE
RRRRRRRRR   IIIIII   CCCCCCCCC  EEEEEEEEE
RR     RR     II     CC     CC  EE
RR     RR     II     CC         EE
RRRRRRRRR     II     CC         EEEEEE
RRRRRRRR      II     CC         EEEEEE
RR  RR        II     CC         EE
RR   RR       II     CC     CC  EE
RR    RR    IIIIII   CCCCCCCCC  EEEEEEEEE
RR     RR   IIIIII    CCCCCCC   EEEEEEEEE
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RICE, PADDY — PRODUCTION, RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS

| COUNTRY | PRODUCTION 1000 MT 1966/68 | 1976/78 | 1983/85 | PERCENTAGE OF TOTAL % 1983/85 | PER CAPITA PRODUCTION KG 1983/85 |
|---|---|---|---|---|---|
| BRAZIL | 6415 | 8682 | 8596 | 53.755 | 65 |
| MEXICO | 379 | 478 | 638 | 3.991 | 8 |
| | 6795 | 9160 | 9234 | 57.746 | 44 |
| BOLIVIA | 61 | 108 | 147 | 0.917 | 24 |
| COLOMBIA | 707 | 1527 | 1716 | 10.733 | 61 |
| CUBA | 98 | 455 | 532 | 3.328 | 53 |
| DOMINICAN RP | 176 | 324 | 482 | 3.014 | 79 |
| ECUADOR | 222 | 303 | 328 | 2.051 | 36 |
| PARAGUAY | 16 | 61 | 70 | 0.438 | 20 |
| PERU | 374 | 544 | 975 | 6.100 | 51 |
| VENEZUELA | 221 | 401 | 443 | 2.771 | 26 |
| TROPICAL SOUTH AMERICA | 1874 | 3723 | 4694 | 29.351 | 47 |
| COSTA RICA | 97 | 172 | 241 | 1.507 | 95 |
| EL SALVADOR | 69 | 40 | 58 | 0.366 | 11 |
| GUATEMALA | 20 | 25 | 51 | 0.318 | 7 |
| HONDURAS | 12 | 28 | 52 | 0.324 | 12 |
| NICARAGUA | 73 | 73 | 163 | 1.017 | 51 |
| PANAMA | 151 | 164 | 191 | 1.194 | 89 |
| CENTRAL AMERICA,PANAMA | 423 | 502 | 756 | 4.727 | 30 |
| GUYANA | 226 | 278 | 286 | 1.788 | 306 |
| HAITI | 77 | 112 | 121 | 0.755 | 19 |
| JAMAICA | 1 | 2 | 5 | 0.029 | 2 |
| TRINIDAD TOB | 10 | 19 | 4 | 0.023 | 3 |
| CARIBBEAN | 314 | 410 | 415 | 2.596 | 37 |
| TROPICAL LATIN AMERICA | 9406 | 13795 | 15099 | 94.421 | 44 |
| ARGENTINA | 222 | 313 | 384 | 2.404 | 13 |
| CHILE | 85 | 107 | 146 | 0.911 | 12 |
| URUGUAY | 101 | 223 | 362 | 2.264 | 121 |
| TEMPERATE SOUTH AMERICA | 408 | 644 | 892 | 5.579 | 20 |
| LATIN AMERICA | 9813 | 14439 | 15991 | 100.000 | 41 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

RICE, PADDY ANNUAL GROWTH RATES

| COUNTRY | PRODUCTION 1966/75 | 1975/85 | AREA 1966/75 | 1975/85 | YIELD 1966/75 | 1975/85 |
|---|---|---|---|---|---|---|
| BRASIL | 1.8** | 0.6 | 2.0*** | -1.5 | -0.2 | 2.1** |
| MEXICO | 5.0** | 1.6 | 3.2* | 0.1 | 1.8** | 1.6** |
| | 2.0** | 0.7** | 2.1*** | -1.4 | -0.1 | 2.1** |
| BOLIVIA | 6.9*** | 2.0 | 7.1*** | 2.7 | -0.2 | -0.6 |
| COLOMBIA | 10.2*** | 1.6 | 1.3 | -0.6 | 8.9*** | 2.2*** |
| CUBA | 20.2*** | 2.1*** | 18.0*** | -1.1* | 2.2 | 3.2*** |
| DOMINICAN RP | 3.8*** | 6.7*** | -1.3 | 1.1 | 5.1** | 5.6*** |
| ECUADOR | 2.6 | 0.4 | -1.0 | 0.6 | 3.6 | -0.2 |
| PARAGUAY | 16.5*** | 1.7 | 17.9*** | 1.3 | -1.4 | 0.5 |
| PERU | 4.0* | 7.3*** | 3.1 | 6.9*** | 0.9* | 0.4 |
| VENEZUELA | 4.3 | 3.9 | -0.9 | 4.9 | 5.2** | -1.1 |
| TROPICAL SOUTH AMERICA | 7.8*** | 3.2*** | 3.0*** | 1.6*** | 4.8*** | 1.6*** |
| COSTA RICA | 5.4** | 2.8 | 3.0 | -0.8 | 2.4 | 3.6* |
| SALVADOR | -4.9 | 2.6 | -7.8* | 0.0 | 2.8* | 2.6* |
| GUATEMALA | 4.9 | 8.6*** | 5.7** | 1.8 | -0.8 | 6.8** |
| HONDURAS | 10.3*** | 6.6*** | 7.1*** | 4.1* | 3.2*** | 2.5 |
| NICARAGUA | 2.4** | 10.2*** | 0.6 | 6.4*** | 1.8* | 3.8*** |
| PANAMA | 1.7 | 1.5 | -2.2 | -1.3* | 4.0*** | 2.8** |
| CENTRAL AMERICA,PANAMA | 2.6 | 4.4 | -0.1 | 0.5 | 2.6** | 3.9*** |
| GUYANA | 0.7 | 1.4 | -1.5 | -3.8** | 2.2 | 5.1*** |
| HAITI | 5.3*** | 1.1 | 1.8*** | 3.2*** | 3.5*** | -2.0* |
| JAMAICA | -6.0 | 8.7* | -8.5 | 4.6 | 2.6*** | 4.2*** |
| TRINIDAD ETC | 7.1*** | -22.5*** | 5.4** | -25.3*** | 1.7** | 2.9*** |
| CARIBBEAN | 2.2 | 0.6 | -0.4 | -2.0* | 2.7** | 2.6*** |
| TROPICAL LATIN AMERICA | 3.5*** | 1.5*** | 2.1*** | -0.9 | 1.4*** | 2.4*** |
| ARGENTINA | 4.9* | 2.3 | 4.9** | 2.3 | 0.0 | 0.0 |
| CHILE | -4.0 | 4.9** | -7.1** | 3.0 | 3.2* | 1.9 |
| URUGUAY | 6.4*** | 7.6*** | 3.4** | 5.1*** | 3.0** | 2.5** |
| TEMPERATE SOUTH AMERICA | 3.9** | 4.7** | 2.1* | 3.3*** | 1.9** | 1.4* |
| LATIN AMERICA | 3.5*** | 1.7*** | 2.1*** | -0.8 | 1.4*** | 2.5*** |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 * P<0.05

RICE, PADDY TRENDS IN YIELD LEVEL BY COUNTRY 1966/85

| COUNTRY | ANNUAL GROWTH RATE IN YIELD 1966/85 % | AVERAGE YIELD 1966/68 | AVERAGE YIELD 1976/78 | AVERAGE YIELD 1983/85 |
|---|---|---|---|---|
| | | KG/HA | | |
| BRASIL | 0.542* | 1507.8 | 1421.4 | 1700.2 |
| MEXICO | 2.052*** | 2474.7 | 3120.9 | 3322.5 |
| | 0.612* | 1541.4 | 1462.8 | 1759.5 |
| BOLIVIA | -0.476 | 1757.1 | 1579.9 | 1520.6 |
| COLOMBIA | 4.170*** | 2383.4 | 4172.8 | 5051.3 |
| CUBA | 4.328*** | 1947.0 | 2927.7 | 3499.6 |
| DOMINICAN RP | 3.526*** | 2159.3 | 2964.9 | 4154.1 |
| ECUADOR | 1.601** | 1980.4 | 2823.0 | 2813.7 |
| PARAGUAY | -0.468 | 2306.7 | 1964.9 | 2141.5 |
| PERU | 0.646*** | 3997.7 | 4266.0 | 4397.5 |
| VENEZUELA | 2.938*** | 1948.9 | 3031.7 | 2874.3 |
| TROPICAL SOUTH AMERICA | 2.861*** | 2354.1 | 3390.6 | 3815.6 |
| COSTA RICA | 3.367*** | 1669.8 | 2284.3 | 3145.8 |
| SALVADOR | 1.264** | 2751.0 | 2958.8 | 3851.8 |
| GUATEMALA | 2.474** | 2004.2 | 1879.6 | 3096.5 |
| HONDURAS | 2.515*** | 1231.4 | 1489.8 | 1993.2 |
| NICARAGUA | 2.308*** | 2602.6 | 2943.8 | 3880.4 |
| PANAMA | 2.662*** | 1166.2 | 1504.0 | 1881.3 |
| CENTRAL AMERICA,PANAMA | 2.914*** | 1615.2 | 1962.6 | 2707.2 |
| GUYANA | 3.894*** | 1825.4 | 2348.7 | 3256.8 |
| HAITI | 0.430 | 2035.6 | 2578.3 | 2202.0 |
| JAMAICA | 3.893*** | 1512.5 | 2058.8 | 2779.4 |
| TRINIDAD ETC | 1.896*** | 2394.1 | 2804.3 | 3349.8 |
| CARIBBEAN | 2.741*** | 1889.3 | 2435.3 | 2852.6 |
| TROPICAL LATIN AMERICA | 1.473*** | 1670.6 | 1775.5 | 2185.4 |
| ARGENTINA | -0.507* | 3679.3 | 3445.3 | 3506.5 |
| CHILE | 2.508*** | 2501.1 | 3336.7 | 4000.6 |
| URUGUAY | 2.255*** | 3182.0 | 4006.4 | 4634.2 |
| TEMPERATE SOUTH AMERICA | 1.065*** | 3225.0 | 3600.6 | 3990.5 |
| LATIN AMERICA | 1.492*** | 1704.7 | 1816.7 | 2241.5 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

WHITE RICE    SUMMARY OF LATIN AMERICA TRADE(THOUSAND TONS)

| REGION | EXPORT | | | IMPORT | | | +IMPORT-EXPORT | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1966/68 | 1976/78 | 1983/85 | 1966/68 | 1976/78 | 1983/85 | 1966/68 | 1976/78 | 1983/85 |
| BRAZIL | 160 | 222 | 4 | 1 | 16 | 219 | -159 | -206 | 215 |
| MEXICO | 16 | 22 | 0 | 5 | 1 | 112 | -11 | -21 | 112 |
| | 176 | 244 | 4 | 6 | 17 | 331 | -170 | -227 | 327 |
| BOLIVIA | 0 | 5 | 0 | 1 | 1 | 21 | 1 | -4 | 21 |
| COLOMBIA | 1 | 53 | 27 | 1 | 13 | 1 | 0 | -40 | -26 |
| CUBA | 0 | 0 | 0 | 161 | 165 | 212 | 161 | 165 | 212 |
| DOMINICAN RP | 0 | 2 | 0 | 5 | 45 | 17 | 5 | 43 | 17 |
| ECUADOR | 8 | 9 | 0 | 2 | 1 | 18 | -6 | -8 | 18 |
| PARAGUAY | 1 | 1 | 0 | 0 | 1 | 0 | -1 | 0 | 0 |
| PERU | 0 | 0 | 0 | 40 | 37 | 56 | 40 | 37 | 56 |
| VENEZUELA | 49 | 1 | 4 | 3 | 1 | 1 | -46 | 0 | -3 |
| TROPICAL SOUTH AMERICA | 59 | 71 | 31 | 213 | 264 | 326 | 154 | 193 | 295 |
| COSTA RICA | 1 | 24 | 39 | 7 | 1 | 14 | 6 | -23 | -25 |
| EL SALVADOR | 15 | 1 | 1 | 4 | 1 | 13 | -11 | 0 | 12 |
| GUATEMALA | 2 | 1 | 1 | 3 | 4 | 2 | 1 | 3 | 1 |
| HONDURAS | 1 | 0 | 0 | 8 | 6 | 3 | 7 | 6 | 3 |
| NICARAGUA | 2 | 2 | 1 | 14 | 1 | 19 | 12 | -1 | 18 |
| PANAMA | 1 | 5 | 3 | 1 | 1 | 1 | 0 | -4 | -2 |
| CENTRAL AMERICA,PANAMA | 22 | 33 | 45 | 37 | 14 | 52 | 15 | -19 | 7 |
| BARBADOS | 1 | 0 | 0 | 8 | 7 | 5 | 7 | 7 | 5 |
| GUYANA | 106 | 90 | 42 | 1 | 0 | 0 | -105 | -90 | -42 |
| HAITI | 0 | 0 | 0 | 1 | 26 | 9 | 1 | 26 | 9 |
| JAMAICA | 1 | 1 | 0 | 29 | 40 | 53 | 28 | 39 | 53 |
| TRINIDAD TOB | 1 | 1 | 1 | 30 | 33 | 45 | 29 | 32 | 44 |
| CARIBBEAN | 109 | 92 | 43 | 69 | 106 | 112 | -40 | 14 | 69 |
| TROPICAL LATIN AMERICA | 366 | 440 | 123 | 325 | 401 | 821 | -41 | -39 | 698 |
| ARGENTINA | 54 | 139 | 88 | 1 | 3 | 1 | -53 | -136 | -87 |
| CHILE | 0 | 7 | 0 | 22 | 18 | 15 | 22 | 11 | 15 |
| URUGUAY | 35 | 111 | 190 | 1 | 3 | 0 | -34 | -108 | -190 |
| TEMPERATE SOUTH AMERICA | 89 | 257 | 278 | 24 | 24 | 16 | -65 | -233 | -262 |
| LATIN AMERICA | 455 | 697 | 401 | 349 | 425 | 837 | -106 | -272 | 436 |

WHITE RICE — PRODUCTION,TRADE AND APPARENT CONSUMPTION

| COUNTRY | 1976/78 PRODUCTION | +IMPORT -EXPORT | APPARENT CONSUMPTION | APPARENT PER CAPITA CONSUMPTION | SELF SUFFICIENCY INDEX | 1983/85 PRODUCTION | +IMPORT -EXPORT | APPARENT CONSUMPTION | APPARENT PER CAPITA CONSUMPTION | SELF SUFFICIENCY INDEX |
|---|---|---|---|---|---|---|---|---|---|---|
| | ----1000 MT---- | | | ---KG--- | | ----1000 MT---- | | | ---KG--- | |
| BRAZIL | 5643 | -207 | 5437 | 48 | 103.80 | 5587 | 215 | 5802 | 44 | 96.30 |
| MEXICO | 310 | -21 | 289 | 5 | 107.25 | 415 | 112 | 527 | 7 | 78.76 |
| | 5954 | -228 | 5726 | 32 | 103.97 | 6002 | 327 | 6329 | 30 | 94.84 |
| BOLIVIA | 70 | -4 | 66 | 13 | 106.24 | 95 | 21 | 116 | 19 | 82.19 |
| COLOMBIA | 993 | -39 | 953 | 39 | 104.14 | 1116 | -26 | 1090 | 39 | 102.39 |
| CUBA | 296 | 165 | 460 | 48 | 64.22 | 346 | 211 | 557 | 56 | 62.11 |
| DOMINICAN RP | 210 | 43 | 253 | 49 | 83.02 | 313 | 16 | 330 | 54 | 95.02 |
| ECUADOR | 197 | -9 | 188 | 25 | 104.52 | 213 | 18 | 231 | 25 | 92.34 |
| PARAGUAY | 40 | -1 | 39 | 14 | 101.29 | 45 | 0 | 45 | 13 | 100.00 |
| PERU | 354 | 36 | 390 | 24 | 90.74 | 634 | 56 | 690 | 36 | 91.94 |
| VENEZUELA | 261 | -1 | 260 | 19 | 100.25 | 288 | -3 | 285 | 17 | 101.12 |
| TROPICAL SOUTH AMERICA | 2420 | 191 | 2611 | 31 | 92.70 | 3051 | 292 | 3343 | 34 | 91.26 |
| COSTA RICA | 112 | -24 | 88 | 42 | 126.66 | 157 | -26 | 131 | 52 | 119.48 |
| EL SALVADOR | 26 | 0 | 26 | 6 | 99.65 | 38 | 13 | 51 | 9 | 75.20 |
| GUATEMALA | 16 | 3 | 20 | 3 | 82.80 | 33 | 1 | 34 | 4 | 97.84 |
| HONDURAS | 18 | 5 | 24 | 7 | 76.85 | 34 | 2 | 36 | 8 | 94.22 |
| NICARAGUA | 47 | -2 | 46 | 18 | 103.70 | 106 | 18 | 124 | 39 | 85.14 |
| PANAMA | 107 | -5 | 102 | 56 | 104.47 | 124 | -2 | 122 | 57 | 101.64 |
| CENTRAL AMERICA,PANAMA | 326 | -21 | 305 | 17 | 106.83 | 491 | 6 | 498 | 22 | 98.75 |
| BARBADOS | 0 | 7 | 7 | 27 | 0.00 | 0 | 5 | 5 | 19 | 0.00 |
| GUYANA | 180 | -89 | 91 | 112 | 197.79 | 186 | -41 | 144 | 154 | 128.65 |
| HAITI | 73 | 26 | 98 | 18 | 73.71 | 79 | 9 | 88 | 14 | 89.72 |
| JAMAICA | 1 | 40 | 41 | 20 | 3.00 | 3 | 52 | 55 | 24 | 5.47 |
| TRINIDAD TOB | 12 | 33 | 45 | 43 | 27.34 | 2 | 44 | 46 | 40 | 5.24 |
| CARIBBEAN | 267 | 16 | 283 | 29 | 94.34 | 270 | 68 | 338 | 31 | 79.78 |
| TROPICAL LATIN AMERICA | 8967 | -42 | 8925 | 31 | 100.47 | 9814 | 693 | 10508 | 31 | 93.40 |
| ARGENTINA | 203 | -137 | 67 | 2 | 304.10 | 250 | -87 | 162 | 5 | 153.86 |
| CHILE | 70 | 11 | 81 | 8 | 86.39 | 95 | 14 | 109 | 9 | 87.05 |
| URUGUAY | 145 | -107 | 38 | 13 | 383.99 | 235 | -189 | 46 | 15 | 510.77 |
| TEMPERATE SOUTH AMERIC | 419 | -233 | 186 | 5 | 225.53 | 580 | -263 | 317 | 7 | 182.77 |
| LATIN AMERICA | 9385 | -275 | 9111 | 27 | 103.02 | 10394 | 431 | 10825 | 28 | 96.02 |

RICE, PADDY     TRENDS IN AREA LEVEL BY COUNTRY 1966/85

| COUNTRY | ANNUAL GROWTH RATE IN AREA 1966/85 % | AVERAGE AREA 1966/68 | AVERAGE AREA 1976/78 | AVERAGE AREA 1983/85 |
|---|---|---|---|---|
| | | --------1000 HA-------- | | |
| BRASIL | 1.521*** | 4251.6 | 6090.7 | 5070.5 |
| MEXICO | 0.627 | 153.2 | 153.7 | 188.5 |
| | 1.505*** | 4404.9 | 6244.4 | 5259.1 |
| BOLIVIA | 4.119*** | 34.4 | 68.1 | 94.7 |
| COLOMBIA | 2.012*** | 302.3 | 365.4 | 342.7 |
| CUBA | 3.994** | 53.1 | 155.6 | 152.1 |
| DOMINICAN RP | 2.621*** | 81.6 | 109.8 | 115.9 |
| ECUADOR | 1.487* | 112.0 | 107.7 | 116.4 |
| PARAGUAY | 7.964*** | 7.1 | 31.2 | 32.7 |
| PERU | 3.694*** | 92.8 | 127.3 | 220.7 |
| VENEZUELA | 3.490*** | 113.2 | 132.9 | 154.5 |
| TROPICAL SOUTH AMERICA | 2.787*** | 796.5 | 1097.9 | 1229.7 |
| COSTA RICA | 2.754*** | 58.2 | 75.6 | 76.6 |
| EL SALVADOR | -1.265 | 25.0 | 13.4 | 15.1 |
| GUATEMALA | 2.984*** | 10.5 | 14.1 | 16.9 |
| HONDURAS | 5.965*** | 9.7 | 19.3 | 27.6 |
| NICARAGUA | 2.824*** | 27.8 | 24.6 | 41.9 |
| PANAMA | -1.051*** | 129.9 | 110.5 | 101.5 |
| CENTRAL AMERICA,PANAMA | 1.024** | 261.1 | 257.5 | 279.5 |
| GUYANA | -1.571** | 123.0 | 116.0 | 87.7 |
| HAITI | 2.359*** | 37.7 | 43.9 | 55.0 |
| JAMAICA | 7.456** | 0.6 | 0.9 | 1.7 |
| TRINIDAD ETC | -7.814*** | 4.3 | 6.7 | 1.1 |
| CARIBBEAN | -0.438 | 165.6 | 167.6 | 145.5 |
| TROPICAL LATIN AMERICA | 1.641*** | 5628.1 | 7767.3 | 6913.7 |
| ARGENTINA | 2.728*** | 59.8 | 91.0 | 109.1 |
| CHILE | 2.253* | 34.1 | 32.2 | 36.3 |
| URUGUAY | 5.748*** | 31.7 | 55.8 | 78.0 |
| TEMPERATE SOUTH AMERICA | 3.402*** | 125.7 | 179.0 | 223.4 |
| LATIN AMERICA | 1.688*** | 5753.8 | 7946.4 | 7137.1 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005   ** P<0.01   * P<0.05

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 CCCCCCC     AAA     SSSSSSS   SSSSSSS    AAA    VV     VV    AAA
CCCCCCCCC   AAAAA   SSSSSSSSS SSSSSSSSS  AAAAA   VV     VV   AAAAA
CC     CC  AA   AA  SS     SS SS     SS AA   AA  VV     VV  AA   AA
CC        AA     AA SS        SS       AA     AA VV     VV AA     AA
CC        AA     AA SSSSSSSS  SSSSSSSS AA     AA VV     VV AA     AA
CC        AAAAAAAAA  SSSSSSSS  SSSSSSSS AAAAAAAAA VV     VV AAAAAAAAA
CC        AAAAAAAAA        SS        SS AAAAAAAAA  VV   VV  AAAAAAAAA
CC     CC AA     AA SS     SS SS     SS AA     AA   VV VV   AA     AA
CCCCCCCCC AA     AA SSSSSSSSS SSSSSSSSS AA     AA    VVV    AA     AA
 CCCCCCC  AA     AA  SSSSSSS   SSSSSSS  AA     AA     V     AA     AA
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CASSAVA PRODUCTION,RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS

| COUNTRY | PRODUCTION 1000 MT 1966/68 | PRODUCTION 1000 MT 1976/78 | PRODUCTION 1000 MT 1983/85 | PERCENTAGE OF TOTAL % 1983/85 | PER CAPITA PRODUCTION KG 1983/85 |
|---|---|---|---|---|---|
| BRAZIL | 27061 | 25611 | 22129 | 78.651 | 167 |
| MEXICO | 0 | 58 | 43 | 0.153 | 1 |
| | 27061 | 25668 | 22172 | 78.804 | 106 |
| BOLIVIA | 180 | 270 | 279 | 0.992 | 45 |
| COLOMBIA | 859 | 1954 | 1653 | 5.874 | 59 |
| CUBA | 207 | 276 | 300 | 1.066 | 30 |
| DOMINICAN RP | 153 | 180 | 119 | 0.422 | 19 |
| ECUADOR | 278 | 247 | 224 | 0.796 | 25 |
| PARAGUAY | 1467 | 1710 | 2167 | 7.701 | 606 |
| PERU | 464 | 409 | 351 | 1.249 | 18 |
| VENEZUELA | 325 | 301 | 322 | 1.144 | 19 |
| TROPICAL SOUTH AMERICA | 3933 | 5347 | 5414 | 19.244 | 55 |
| COSTA RICA | 11 | 14 | 20 | 0.070 | 8 |
| EL SALVADOR | 11 | 14 | 25 | 0.088 | 5 |
| GUATEMALA | 6 | 8 | 9 | 0.033 | 1 |
| HONDURAS | 27 | 8 | 7 | 0.024 | 2 |
| NICARAGUA | 15 | 25 | 27 | 0.096 | 9 |
| PANAMA | 22 | 40 | 34 | 0.122 | 16 |
| CENTRAL AMERICA,PANAMA | 92 | 108 | 122 | 0.433 | 5 |
| BARBADOS | 1 | 1 | 1 | 0.003 | 4 |
| GUYANA | 0 | 0 | 0 | 0.000 | 0 |
| HAITI | 190 | 250 | 265 | 0.942 | 41 |
| JAMAICA | 12 | 26 | 19 | 0.066 | 8 |
| TRINIDAD TOB | 3 | 5 | 3 | 0.011 | 3 |
| CARIBBEAN | 206 | 282 | 288 | 1.023 | 26 |
| TROPICAL LATIN AMERICA | 31292 | 31405 | 27996 | 99.504 | 81 |
| ARGENTINA | 272 | 197 | 140 | 0.496 | 5 |
| TEMPERATE SOUTH AMERICA | 272 | 197 | 140 | 0.496 | 3 |
| LATIN AMERICA | 31564 | 31602 | 28135 | 100.000 | 72 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

CASSAVA ANNUAL GROWTH RATES

| COUNTRY | PRODUCTION 1966/75 | PRODUCTION 1975/85 | AREA 1966/75 | AREA 1975/85 | YIELD 1966/75 | YIELD 1975/85 |
|---|---|---|---|---|---|---|
| BRASIL | -0.4 | -1.8*** | 1.1** | -1.1** | -1.5** | -0.7 |
| MEXICO | 5.8*** | -3.9 | 6.3*** | -4.1** | -0.5 | 0.2 |
| | -0.4 | -1.8 | 1.2** | -1.1** | -1.5** | -0.7 |
| BOLIVIA | 5.8*** | 0.1 | 4.6*** | 4.1 | 1.2*** | -4.0*** |
| COLOMBIA | 12.8*** | -1.6 | 8.3*** | -3.0*** | 4.6*** | 1.4 |
| CUBA | 1.9*** | 2.0** | 2.3*** | 2.7*** | -0.4 | -0.7*** |
| DOMINICAN RP | 3.3*** | -6.4** | 14.7*** | -9.0** | -11.4*** | 2.6** |
| ECUADOR | 3.7* | -3.2 | 5.0*** | -3.3* | -1.2 | 0.2 |
| PARAGUAY | -1.8 | 4.0*** | -1.6* | 4.2*** | -0.2 | -0.2 |
| PERU | -1.0 | -1.4 | -1.2** | -0.8 | 0.2 | -0.7 |
| VENEZUELA | -1.0 | 0.5 | 2.2 | 0.2 | -3.1** | 0.3 |
| TROPICAL SOUTH AMERICA | 3.9*** | 0.6*** | 4.5*** | -0.4 | -0.6 | 1.0** |
| COSTA RICA | -0.6 | 5.6*** | -4.2** | 10.6*** | 3.6*** | -5.0** |
| SALVADOR | 5.5*** | 7.0*** | 0.4 | 3.1** | 5.2** | 3.9*** |
| GUATEMALA | 2.8*** | 2.6*** | 3.6*** | -1.0 | -0.8*** | 3.6*** |
| HONDURAS | -11.0*** | -3.8*** | -3.4*** | -25.7*** | -7.6** | 21.9*** |
| NICARAGUA | 4.4*** | 1.8*** | 4.9*** | 1.9*** | -0.5* | -0.1 |
| PANAMA | 8.5*** | -2.0*** | 10.3*** | 0.9*** | -1.8** | -2.9*** |
| CENTRAL AMERICA,PANAMA | 2.2*** | 1.6*** | 2.3*** | 0.9** | -0.1 | 0.7 |
| BARBADOS | 3.0*** | 0.7*** | 4.1*** | 1.4*** | -1.1** | -0.7*** |
| HAITI | 2.5*** | 1.1*** | 0.9*** | 1.8*** | 1.6*** | -0.8** |
| JAMAICA | 4.9 | -2.6 | 5.2* | -3.0* | -0.3 | 0.4 |
| TRINIDAD ETC | 4.1*** | -6.0*** | -0.2 | -6.0*** | 4.3*** | -0.1 |
| CARIBBEAN | 2.7*** | 0.7*** | 1.0*** | 1.6*** | 1.7*** | -0.9** |
| TROPICAL LATIN AMERICA | 0.3 | -1.3 | 1.8*** | -0.9** | -1.5** | -0.4 |
| ARGENTINA | -0.5 | -5.5*** | -1.3 | -2.8** | 0.7 | -2.8* |
| TEMPERATE SOUTH AMERICA | -0.5 | -5.5 | -1.3 | -2.8** | 0.7 | -2.8* |
| LATIN AMERICA | 0.3 | -1.3 | 1.8*** | -0.9** | -1.5** | -0.4 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 * P<0.05

CASSAVA TRENDS IN YIELD LEVEL BY COUNTRY 1966/85

| COUNTRY | ANNUAL GROWTH RATE IN YIELD 1966/85 % | AVERAGE YIELD 1966/68 | AVERAGE YIELD 1976/78 | AVERAGE YIELD 1983/85 |
|---|---|---|---|---|
| | | ---KG/HA--- | | |
| BRASIL | -1.493*** | 14247.3 | 11973.3 | 11596.5 |
| MEXICO | -1.909** | 0.0 | 16309.8 | 17551.0 |
| | -1.491*** | 14247.3 | 11980.6 | 11604.1 |
| BOLIVIA | -0.974** | 11998.7 | 13661.9 | 9898.3 |
| COLOMBIA | 2.618*** | 5878.6 | 8792.0 | 9084.0 |
| CUBA | -0.175 | 7047.6 | 6934.6 | 6521.7 |
| DOMINICAN RP | -2.787** | 11100.5 | 5009.2 | 6024.2 |
| ECUADOR | -0.986** | 10228.5 | 8253.0 | 9229.9 |
| PARAGUAY | 0.184 | 14674.7 | 14950.2 | 14605.4 |
| PERU | -0.741*** | 11691.2 | 11319.4 | 10761.2 |
| VENEZUELA | -1.074** | 9978.6 | 7319.6 | 7990.0 |
| TROPICAL SOUTH AMERICA | 0.597*** | 9721.9 | 9909.9 | 10355.1 |
| COSTA RICA | -0.128 | 3871.5 | 5953.9 | 4081.0 |
| SALVADOR | 2.579*** | 7950.5 | 9929.8 | 13412.2 |
| GUATEMALA | 1.146*** | 3017.5 | 2750.6 | 3706.7 |
| HONDURAS | 3.031 | 6388.4 | 2799.0 | 17873.1 |
| NICARAGUA | -0.167*** | 4142.3 | 4057.9 | 4029.9 |
| PANAMA | -1.868*** | 10002.9 | 8742.2 | 7070.2 |
| CENTRAL AMERICA,PANAMA | -0.281 | 5650.4 | 5354.9 | 5768.3 |
| BARBADOS | -0.952*** | 28666.7 | 25140.1 | 24000.0 |
| HAITI | 0.253 | 3800.0 | 4390.6 | 4076.9 |
| JAMAICA | 0.580* | 8952.4 | 9152.2 | 9154.6 |
| TRINIDAD ETC | 2.165*** | 8967.2 | 12500.0 | 12371.8 |
| CARIBBEAN | 0.282 | 3983.3 | 4682.0 | 4273.4 |
| TROPICAL LATIN AMERICA | -1.210*** | 13191.8 | 11367.6 | 11087.7 |
| ARGENTINA | -1.834*** | 11506.9 | 9076.6 | 8729.2 |
| TEMPERATE SOUTH AMERICA | -1.834*** | 11506.9 | 9076.6 | 8729.2 |
| LATIN AMERICA | -1.211*** | 13175.2 | 11350.0 | 11072.8 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

CASSAVA TRENDS IN AREA LEVEL BY COUNTRY 1966/85

| COUNTRY | ANNUAL GROWTH RATE IN AREA 1966/85 % | AVERAGE AREA 1966/68 | AVERAGE AREA 1976/78 | AVERAGE AREA 1983/85 |
|---|---|---|---|---|
| | | -1000 HA- | | |
| BRASIL | 0.120 | 1897.5 | 2139.3 | 1914.2 |
| MEXICO | 0.115 | 0.0 | 3.5 | 2.4 |
| | 0.125 | 1897.5 | 2142.8 | 1916.6 |
| BOLIVIA | 2.648*** | 15.0 | 19.9 | 29.7 |
| COLOMBIA | 1.134 | 146.1 | 222.8 | 181.9 |
| CUBA | 2.976*** | 29.3 | 39.8 | 46.0 |
| DOMINICAN RP | -0.289 | 13.8 | 36.0 | 19.8 |
| ECUADOR | -2.082** | 27.1 | 29.3 | 24.4 |
| PARAGUAY | 2.665*** | 100.0 | 114.3 | 148.3 |
| PERU | -0.836*** | 39.6 | 36.1 | 32.7 |
| VENEZUELA | 1.077** | 33.7 | 41.3 | 40.3 |
| TROPICAL SOUTH AMERICA | 1.293*** | 404.7 | 539.6 | 523.1 |
| COSTA RICA | 4.489*** | 2.9 | 2.4 | 4.8 |
| EL SALVADOR | 2.385*** | 1.3 | 1.4 | 1.8 |
| GUATEMALA | 1.482*** | 1.9 | 2.8 | 2.5 |
| HONDURAS | -12.554*** | 4.2 | 3.0 | 0.4 |
| NICARAGUA | 3.632*** | 3.7 | 6.1 | 6.7 |
| PANAMA | 3.891*** | 2.2 | 4.6 | 4.9 |
| CENTRAL AMERICA,PANAMA | 1.710*** | 16.3 | 20.2 | 21.1 |
| BARBADOS | 2.505*** | 0.0 | 0.0 | 0.0 |
| HAITI | 1.715*** | 50.0 | 57.0 | 65.0 |
| JAMAICA | 2.307** | 1.4 | 2.9 | 2.0 |
| TRINIDAD ETC | -2.428*** | 0.4 | 0.4 | 0.3 |
| CARIBBEAN | 1.709*** | 51.8 | 60.3 | 67.3 |
| TROPICAL LATIN AMERICA | 0.396* | 2370.3 | 2762.9 | 2528.1 |
| ARGENTINA | -1.783*** | 23.6 | 21.6 | 16.0 |
| TEMPERATE SOUTH AMERICA | -1.783*** | 23.6 | 21.6 | 16.0 |
| LATIN AMERICA | 0.378* | 2393.9 | 2784.5 | 2544.1 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 * P<0.05

CASSAVA PRODUCTION,RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS

| COUNTRY | PRODUCTION 1000 MT 1966/68 | 1976/78 | 1983/85 | PERCENTAGE OF TOTAL % 1983/85 | PER CAPITA PRODUCTION KG 1983/85 |
|---|---|---|---|---|---|
| BRUNEI | 2 | 2 | 1 | 0.001 | 3 |
| BURMA | 12 | 22 | 63 | 0.129 | 2 |
| CHINA | 1535 | 2506 | 3939 | 8.023 | 4 |
| INDIA | 3976 | 6234 | 5599 | 11.403 | 8 |
| INDONESIA | 11112 | 12527 | 13645 | 27.791 | 84 |
| KAMPUCHEA DM | 27 | 108 | 95 | 0.193 | 13 |
| LAOS | 11 | 44 | 77 | 0.156 | 19 |
| MALAYSIA | 243 | 357 | 367 | 0.747 | 24 |
| PHILIPPINES | 499 | 1549 | 2039 | 4.153 | 38 |
| EAST TIMOR | 13 | 0 | 0 | 0.000 | 0 |
| SINGAPORE | 3 | 1 | 0 | 0.001 | 0 |
| SRI LANKA | 366 | 630 | 734 | 1.495 | 46 |
| THAILAND | 2188 | 12809 | 19673 | 40.068 | 390 |
| VIET NAM | 994 | 2661 | 2867 | 5.839 | 49 |
| ASIA | 20982 | 39449 | 49098 | 100.000 | 22 |

CASSAVA ANNUAL GROWTH RATES

| COUNTRY | PRODUCTION 1966/75 | PRODUCTION 1975/85 | AREA 1966/75 | AREA 1975/85 | YIELD 1966/75 | YIELD 1975/85 |
|---|---|---|---|---|---|---|
| BRUNEI | 2.2 | -13.1*** | 0.3 | -13.7*** | 1.9*** | 0.6 |
| BURMA | 8.0* | 17.0*** | 8.6** | 13.3*** | -0.6 | 3.7** |
| CHINA | 6.3*** | 6.2*** | 6.4*** | 2.5*** | -0.1 | 3.7*** |
| INDIA | 6.9*** | -1.7*** | 3.1*** | -2.8*** | 3.8*** | 1.1** |
| INDONESIA | 1.3 | 1.1** | -0.6 | -0.1 | 1.9** | 1.3*** |
| KAMPUCHEA DM | 4.2 | 1.2 | 8.7* | 3.0 | -4.5** | -1.7 |
| LAOS | 9.9*** | 11.3*** | 7.7*** | 12.1*** | 2.3*** | -0.9*** |
| MALAYSIA | 4.1*** | 0.6 | -1.7 | 0.6 | 5.8*** | -0.0 |
| PHILIPPINES | 2.4 | 7.8** | 2.5** | 6.3*** | -0.1 | 1.5 |
| EAST TIMOR | 1.7 | 0.0 | 7.0** | 0.0 | -5.2 | 0.0 |
| SINGAPORE | -11.4** | -11.8*** | -8.2 | -11.7*** | -3.2* | -0.1** |
| SRI LANKA. | 8.7*** | 0.4 | 11.8*** | -10.4*** | -3.0** | 10.8*** |
| THAILAND | 14.7*** | 9.0*** | 15.9*** | 7.7*** | -1.2 | 1.3 |
| VIET NAM | 1.8** | 5.4* | 1.6*** | 9.1*** | 0.2 | -3.8*** |
| ASIA | 5.1*** | 4.1*** | 2.7*** | 2.7*** | 2.4*** | 1.5*** |

CASSAVA TRENDS IN YIELD LEVEL BY COUNTRY 1966/85

| COUNTRY | ANNUAL GROWTH RATE IN YIELD 1966/85 % | AVERAGE YIELD 1966/68 | AVERAGE YIELD 1976/78 | AVERAGE YIELD 1983/85 |
|---|---|---|---|---|
| | | KG/HA | | |
| BRUNEI | 1.025*** | 7135.8 | 8222.2 | 8725.3 |
| BURMA | 0.852 | 10285.0 | 9142.3 | 12265.9 |
| CHINA | 1.560*** | 12358.1 | 12093.9 | 16055.6 |
| INDIA | 1.666*** | 13111.3 | 16444.8 | 18066.6 |
| INDONESIA | 2.079*** | 7342.1 | 9164.3 | 10040.3 |
| KAMPUCHEA DM | -3.920*** | 13188.2 | 7488.9 | 7658.1 |
| LAOS | 0.609** | 13194.4 | 15482.2 | 14386.6 |
| MALAYSIA | 0.721 | 9204.9 | 10193.6 | 10949.7 |
| PHILIPPINES | 3.848*** | 5847.9 | 9130.1 | 8637.4 |
| EAST TIMOR | -5.219 | 2622.9 | 0.0 | 0.0 |
| SINGAPORE | -0.143 | 12413.2 | 11047.6 | 11000.0 |
| SRI LANKA | 5.062*** | 5687.5 | 6213.1 | 13195.8 |
| THAILAND | 0.450 | 14948.5 | 14511.0 | 16644.3 |
| VIET NAM | -1.061** | 7261.6 | 7950.2 | 5789.0 |
| ASIA | 2.156*** | 8702.8 | 11253.2 | 12433.8 |

CASSAVA PRODUCTION, RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS

| COUNTRY | PRODUCTION -1000 MT- 1966/68 | 1976/78 | 1983/85 | PERCENTAGE OF TOTAL % 1983/85 | PER CAPITA PRODUCTION KG 1983/85 |
|---|---|---|---|---|---|
| ANGOLA | 1523 | 1733 | 1950 | 3.588 | 228 |
| BURUNDI | 907 | 465 | 492 | 0.905 | 107 |
| CAMEROON | 740 | 747 | 640 | 1.177 | 67 |
| CENT AFR REP | 626 | 897 | 893 | 1.644 | 355 |
| CHAD | 125 | 169 | 263 | 0.484 | 54 |
| CONGO | 468 | 565 | 603 | 1.110 | 356 |
| BENIN | 475 | 656 | 690 | 1.269 | 175 |
| EQ GUINEA | 41 | 50 | 54 | 0.100 | 141 |
| GABON | 165 | 232 | 252 | 0.463 | 222 |
| GHANA | 1525 | 1842 | 2728 | 5.020 | 207 |
| GUINEA | 443 | 622 | 497 | 0.914 | 84 |
| IVORY COAST | 522 | 1008 | 1313 | 2.416 | 139 |
| KENYA | 480 | 612 | 421 | 0.774 | 21 |
| LIBERIA | 257 | 285 | 320 | 0.589 | 151 |
| MADAGASCAR | 1068 | 1465 | 2060 | 3.791 | 212 |
| MALAWI | 140 | 273 | 299 | 0.550 | 44 |
| MALI | 32 | 50 | 73 | 0.134 | 9 |
| MOZAMBIQUE | 2225 | 2800 | 3160 | 5.814 | 233 |
| NIGER | 172 | 194 | 180 | 0.331 | 30 |
| NIGERIA | 8588 | 10633 | 11583 | 21.312 | 126 |
| RWANDA | 220 | 411 | 449 | 0.825 | 76 |
| SENEGAL | 238 | 75 | 15 | 0.028 | 2 |
| SIERRA LEONE | 76 | 88 | 105 | 0.193 | 30 |
| SOMALIA | 21 | 30 | 36 | 0.066 | 8 |
| SUDAN | 167 | 99 | 126 | 0.232 | 6 |
| TANZANIA | 3467 | 5145 | 5500 | 10.119 | 253 |
| TOGO | 492 | 386 | 417 | 0.767 | 145 |
| UGANDA | 994 | 2620 | 3900 | 7.175 | 260 |
| ZAIRE | 9667 | 11942 | 15046 | 27.682 | 517 |
| ZAMBIA | 148 | 172 | 210 | 0.386 | 33 |
| ZIMBABWE | 44 | 51 | 77 | 0.142 | 9 |
| AFRICA | 36056 | 46320 | 54352 | 100.000 | 128 |

CASSAVA ANNUAL GROWTH RATES

| COUNTRY | PRODUCTION 1966/75 | PRODUCTION 1975/85 | AREA 1966/75 | AREA 1975/85 | YIELD 1966/75 | YIELD 1975/85 |
|---|---|---|---|---|---|---|
| ANGOLA | 1.3*** | 1.6*** | 0.7*** | 1.0*** | 0.6** | 0.6** |
| BURUNDI | -11.7*** | 1.2 | -10.8*** | 1.2*** | -1.0* | -0.1 |
| CAMEROON | 1.0 | -2.6** | 15.1*** | -3.3*** | -14.1*** | 0.7 |
| CENT AFR REP | 5.1*** | 0.4 | 2.5*** | 0.2 | 2.5*** | 0.2 |
| CHAD | 2.3*** | 6.0*** | 1.3*** | 4.3*** | 1.0** | 1.7*** |
| CONGO | 1.5*** | 1.2** | 0.8*** | -0.1 | 0.7 | 1.3 |
| BENIN | 2.7** | 1.2 | 1.4 | 2.2* | 1.3 | -1.0 |
| EQ GUINEA | 1.8*** | 1.2*** | 4.7*** | 2.3*** | -2.9*** | -1.1*** |
| GABON | 7.5*** | 0.4 | 1.0*** | -0.1 | 6.5** | 0.5 |
| GHANA | 1.6** | 3.8 | 4.2*** | 2.0 | -2.5*** | 1.9*** |
| GUINEA | 4.2*** | -2.8*** | 4.1*** | -2.7** | 0.0 | -0.1 |
| IVORY COAST | 4.7*** | 3.9*** | -1.1 | 3.9*** | 5.9*** | -0.1 |
| KENYA | 1.9*** | -5.7 | 1.6*** | -2.4 | 0.3*** | -3.3 |
| LIBERIA | -0.3 | 2.1*** | -0.1 | 1.8*** | -0.2 | 0.4** |
| MADAGASCAR | 2.2*** | 5.0*** | 1.7*** | 5.6*** | 0.4 | -0.6 |
| MALAWI | 8.6* | 1.4*** | 9.1** | 1.4*** | -0.5 | 0.0 |
| MALI | 1.4 | 5.9*** | 0.0 | 4.9*** | 1.4 | 1.0*** |
| MOZAMBIQUE | 1.7*** | 2.1*** | 2.4*** | -0.3 | -0.7 | 2.4*** |
| NIGER | -0.5 | -0.5 | 2.8 | -0.4 | -3.3** | -0.0 |
| NIGERIA | 2.2*** | 1.3* | 1.3** | 1.5*** | 0.9 | -0.2 |
| RWANDA | 7.4*** | 0.3 | 4.1*** | 2.8*** | 3.4*** | -2.5 |
| SENEGAL | -9.4*** | -20.6*** | -8.1*** | -19.0*** | -1.2 | -1.6 |
| SIERRA LEONE | 1.3 | 2.6*** | 0.4 | 7.4*** | 0.9 | -4.8*** |
| SOMALIA | 3.7*** | 2.5*** | 2.6*** | 2.7*** | 1.1*** | -0.2 |
| SUDAN | -4.6** | 1.9* | -5.3*** | 1.4* | 0.6 | 0.4 |
| TANZANIA | 3.6** | 0.4 | 2.6** | -2.7** | 1.0 | 3.2** |
| TOGO | -1.6 | 0.2 | -4.5** | -4.8* | 2.9*** | 4.9 |
| UGANDA | 13.8*** | 4.8 | 11.6*** | -4.3* | 2.2 | 9.1*** |
| ZAIRE | 2.4*** | 3.0*** | 2.3*** | 2.7*** | 0.1 | 0.3 |
| ZAMBIA | 1.6*** | 2.7*** | 1.5*** | 1.8*** | 0.1 | 0.9*** |
| ZIMBABWE | 1.2*** | 5.3*** | 1.5*** | 2.1*** | -0.3 | 3.2*** |
| AFRICA | 2.6*** | 2.1*** | 3.0*** | 0.8** | -0.3 | 1.3*** |

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BBBBBBBB   EEEEEEEEE     AAA     N       NN   SSSSSSS
BBBBBBBBB  EEEEEEEEE    AAAAA    NN      NN  SSSSSSSSS
BB     BB  EE          AA   AA   NNN     NN  SS     SS
BB     BB  EE         AA     AA  NNNN    NN  SS
BBBBBBBB   EEEEEE     AA     AA  NN NN   NN  SSSSSSSS
BBBBBBBB   EEEEEE     AAAAAAAAA  NN  NN  NN   SSSSSSSS
BB     BB  EE         AAAAAAAAA  NN   NNNN          SS
BB     BB  EE         AA     AA  NN    NNN   SS     SS
BBBBBBBBB  EEEEEEEEE  AA     AA  NN     NN  SSSSSSSSS
BBBBBBBB"  EEEEEEEEE  AA     AA  NN      N   SSSSSSS
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BEANS, DRY — PRODUCTION, RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS

| COUNTRY | PRODUCTION 1000 MT 1966/68 | 1976/78 | 1983/85 | PERCENTAGE OF TOTAL % 1983/85 | PER CAPITA PRODUCTION KG 1983/85 |
|---|---|---|---|---|---|
| BRAZIL | 2372 | 2108 | 2251 | 50.536 | 17 |
| MEXICO | 950 | 820 | 1212 | 27.216 | 16 |
| | 3322 | 2928 | 3463 | 77.751 | 17 |
| BOLIVIA | 3 | 3 | 9 | 0.200 | 1 |
| COLOMBIA | 38 | 72 | 82 | 1.831 | 3 |
| CUBA | 22 | 25 | 27 | 0.606 | 3 |
| DOMINICAN RP | 24 | 38 | 66 | 1.485 | 11 |
| ECUADOR | 37 | 26 | 28 | 0.634 | 3 |
| PARAGUAY | 20 | 63 | 60 | 1.347 | 17 |
| PERU | 64 | 57 | 46 | 1.027 | 2 |
| VENEZUELA | 40 | 32 | 30 | 0.678 | 2 |
| TROPICAL SOUTH AMERICA | 248 | 315 | 348 | 7.807 | 4 |
| COSTA RICA | 16 | 15 | 23 | 0.511 | 9 |
| EL SALVADOR | 21 | 39 | 46 | 1.039 | 9 |
| GUATEMALA | 56 | 73 | 110 | 2.472 | 14 |
| HONDURAS | 50 | 34 | 44 | 0.978 | 10 |
| NICARAGUA | 54 | 50 | 53 | 1.183 | 17 |
| PANAMA | 7 | 4 | 3 | 0.073 | 2 |
| CENTRAL AMERICA,PANAMA | 205 | 215 | 279 | 6.256 | 11 |
| HAITI | 40 | 44 | 51 | 1.152 | 8 |
| JAMAICA | 0 | 0 | 0 | 0.004 | 0 |
| CARIBBEAN | 40 | 44 | 52 | 1.157 | 5 |
| TROPICAL LATIN AMERICA | 3815 | 3502 | 4141 | 92.971 | 12 |
| ARGENTINA | 27 | 153 | 217 | 4.875 | 7 |
| CHILE | 75 | 98 | 93 | 2.089 | 8 |
| URUGUAY | 2 | 3 | 3 | 0.064 | 1 |
| TEMPERATE SOUTH AMERICA | 103 | 254 | 313 | 7.029 | 7 |
| LATIN AMERICA | 3918 | 3756 | 4455 | 100.000 | 11 |

COLUMNS MAY NOT ADD EXACTLY DUE TO ROUNDING

BEANS, DRY ANNUAL GROWTH RATES

| COUNTRY | PRODUCTION 1966/75 | 1975/85 | AREA 1966/75 | 1975/85 | YIELD 1966/75 | 1975/85 |
|---|---|---|---|---|---|---|
| BRASIL | 0.0 | 1.4 | 2.2*** | 2.4** | -2.2** | -1.1 |
| MEXICO | 0.6 | 4.6* | -2.0* | 3.8* | 2.7*** | 0.8 |
| | 0.2 | 2.4 | 0.8* | 2.8** | -0.6 | -0.4 |
| BOLIVIA | -6.0 | 16.1*** | -17.5** | 10.9*** | 11.5*** | 5.2*** |
| COLOMBIA | 9.4*** | 0.4 | 5.7*** | -0.1 | 3.6*** | 0.6 |
| CUBA | 0.9*** | 1.1*** | 0.0 | 0.0 | 0.9*** | 1.1*** |
| DOMINICAN RP | 5.7** | 7.4*** | 1.4 | 4.9*** | 4.3*** | 2.5*** |
| ECUADOR | -4.3*** | 1.2 | -3.7*** | -2.4 | -0.6 | 3.7*** |
| PARAGUAY | 10.9*** | 0.9 | 8.0*** | 1.5* | 2.8*** | -0.6* |
| PERU | -1.3 | -2.6 | -1.1 | -3.1* | -0.2 | 0.5 |
| VENEZUELA | -2.9* | -1.3 | -2.4* | -2.4* | -0.5 | 1.1 |
| TROPICAL SOUTH AMERICA | 2.5** | 1.3** | 0.5 | -0.2 | 2.0*** | 1.4*** |
| COSTA RICA | -1.9 | 4.8* | -2.2 | 4.5* | 0.3 | 0.3 |
| SALVADOR | 7.6*** | 1.8* | 6.9*** | 0.5 | 0.7 | 1.3 |
| GUATEMALA | 4.8*** | 4.7** | 5.1 | 3.2 | -0.3 | 1.5 |
| HONDURAS | -5.9*** | 3.4* | -1.0 | -1.2 | -4.9*** | 4.5*** |
| NICARAGUA | -3.6** | 1.6 | -1.8 | 3.8** | -1.7* | -2.2 |
| PANAMA | -9.4*** | -3.0* | -6.8*** | -8.1*** | -2.6** | 5.1** |
| CENTRAL AMERICA,PANAMA | 0.2 | 3.3 | 1.4 | 1.8 | -1.2 | 1.4* |
| HAITI | 1.1 | 2.0*** | -0.3 | 0.1 | 1.4* | 1.9** |
| JAMAICA | 19.4*** | 1.0 | 19.6*** | -3.8*** | -0.2 | 4.8*** |
| CARIBBEAN | 1.1* | 2.0* | -0.2 | 0.1 | 1.4* | 1.9** |
| TROPICAL LATIN AMERICA | 0.4 | 2.4 | 0.8* | 2.5** | -0.5 | -0.1 |
| ARGENTINA | 18.0*** | 6.0** | 16.8*** | 3.9** | 1.2 | 2.0 |
| CHILE | 0.7 | 2.5 | 2.5 | 0.9 | -1.8* | 1.6 |
| URUGUAY | 0.4 | 2.2*** | 1.0 | 1.1*** | -0.5 | 1.0*** |
| TEMPERATE SOUTH AMERICA | 7.9*** | 4.7*** | 8.9*** | 2.9* | -1.1 | 1.8 |
| LATIN AMERICA | 0.6 | 2.5 | 1.0** | 2.5*** | -0.4 | -0.0 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 * P<0.05

BEANS, DRY — TRENDS IN YIELD LEVEL BY COUNTRY 1966/85

| COUNTRY | ANNUAL GROWTH RATE IN YIELD 1966/85 % | AVERAGE YIELD 1966/68 | AVERAGE YIELD 1976/78 | AVERAGE YIELD 1983/85 |
|---|---|---|---|---|
| | | KG/HA | | |
| BRASIL | -2.492*** | 668.2 | 477.2 | 453.8 |
| MEXICO | 1.406*** | 479.6 | 545.0 | 588.2 |
| | -1.255*** | 600.3 | 494.0 | 495.8 |
| BOLIVIA | 6.460*** | 376.6 | 829.3 | 1214.7 |
| COLOMBIA | 1.101*** | 560.7 | 663.5 | 736.7 |
| CUBA | 1.168*** | 638.1 | 709.5 | 771.4 |
| DOMINICAN RP | 1.656*** | 686.9 | 816.5 | 1008.3 |
| ECUADOR | 1.668*** | 444.6 | 463.8 | 591.8 |
| PARAGUAY | 1.110*** | 633.3 | 799.0 | 750.0 |
| PERU | 0.158 | 848.6 | 831.5 | 839.0 |
| VENEZUELA | 1.734*** | 418.7 | 469.9 | 481.7 |
| TROPICAL SOUTH AMERICA | 1.611*** | 575.4 | 678.7 | 751.6 |
| COSTA RICA | 1.771*** | 394.2 | 550.8 | 532.0 |
| SALVADOR | 0.706 | 669.6 | 742.6 | 806.1 |
| GUATEMALA | 2.019** | 650.3 | 718.6 | 661.3 |
| HONDURAS | -0.879 | 702.1 | 437.8 | 609.0 |
| NICARAGUA | -2.028*** | 837.5 | 768.1 | 629.5 |
| PANAMA | 0.849 | 332.4 | 245.5 | 366.9 |
| CENTRAL AMERICA,PANAMA | 0.483 | 648.5 | 628.8 | 646.6 |
| HAITI | 1.647*** | 424.9 | 448.1 | 550.1 |
| JAMAICA | 1.288*** | 681.2 | 611.0 | 893.1 |
| CARIBBEAN | 1.650*** | 425.1 | 448.6 | 550.9 |
| TROPICAL LATIN AMERICA | -0.921*** | 598.5 | 512.8 | 519.7 |
| ARGENTINA | 1.511* | 866.4 | 1014.9 | 1094.4 |
| CHILE | -0.198 | 1197.9 | 1006.7 | 1100.7 |
| URUGUAY | 0.553* | 552.7 | 571.4 | 614.2 |
| TEMPERATE SOUTH AMERICA | 0.413 | 1054.4 | 1005.4 | 1088.8 |
| LATIN AMERICA | -0.728*** | 605.4 | 530.4 | 539.6 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005 ** P<0.01 *P<0.05

BEANS, DRY    TRENDS IN AREA LEVEL BY COUNTRY 1966/85

| COUNTRY | ANNUAL GROWTH RATE IN AREA 1966/85 % | AVERAGE AREA 1966/68 | AVERAGE AREA 1976/78 | AVERAGE AREA 1983/85 |
|---|---|---|---|---|
| | | -----1000 HA----- | | |
| BRASIL | 2.277*** | 3546.2 | 4409.2 | 4900.5 |
| MEXICO | -0.151 | 1986.9 | 1508.9 | 2062.3 |
| | 1.544*** | 5533.0 | 5918.1 | 6962.7 |
| BOLIVIA | 1.401 | 8.7 | 3.4 | 7.0 |
| COLOMBIA | 3.516*** | 67.7 | 109.2 | 110.7 |
| CUBA | -0.000 | 35.0 | 35.0 | 35.0 |
| DOMINICAN RP | 4.281*** | 35.4 | 46.7 | 65.6 |
| ECUADOR | -3.598*** | 82.5 | 55.3 | 47.5 |
| PARAGUAY | 5.940*** | 31.5 | 78.1 | 80.0 |
| PERU | -2.309*** | 75.1 | 68.3 | 54.1 |
| VENEZUELA | -2.898*** | 95.1 | 68.0 | 62.3 |
| TROPICAL SOUTH AMERICA | 0.521*** | 430.9 | 464.1 | 462.2 |
| COSTA RICA | 0.114 | 40.9 | 26.9 | 42.7 |
| EL SALVADOR | 3.363*** | 31.1 | 52.4 | 57.4 |
| GUATEMALA | 1.255 | 86.6 | 104.5 | 166.5 |
| HONDURAS | -0.198 | 72.0 | 77.6 | 71.4 |
| NICARAGUA | 1.260** | 65.0 | 65.2 | 83.7 |
| PANAMA | -4.677*** | 20.7 | 15.7 | 9.0 |
| CENTRAL AMERICA,PANAMA | 0.905* | 316.4 | 342.3 | 430.7 |
| HAITI | -0.070 | 93.3 | 98.3 | 93.3 |
| JAMAICA | 4.925*** | 0.1 | 0.3 | 0.2 |
| CARIBBEAN | -0.063 | 93.4 | 98.6 | 93.6 |
| TROPICAL LATIN AMERICA | 1.432*** | 6373.7 | 6823.1 | 7949.2 |
| ARGENTINA | 11.635*** | 31.8 | 151.3 | 198.3 |
| CHILE | 3.506*** | 62.2 | 96.9 | 84.7 |
| URUGUAY | 1.451*** | 3.7 | 4.4 | 4.7 |
| TEMPERATE SOUTH AMERICA | 7.632*** | 97.7 | 252.6 | 287.6 |
| LATIN AMERICA | 1.595*** | 6471.4 | 7075.7 | 8236.8 |

LEVEL OF SIGNIFICANCE IS REPRESENTED AS FOLLOWS
*** P<0.005    ** P<0.01    * P<0.05

BEANS, DRY — PRODUCTION, RELATIVE IMPORTANCE IN THE REGION AND PER CAPITA PRODUCTION LEVELS

| COUNTRY | PRODUCTION 1000 MT 1966/68 | PRODUCTION 1000 MT 1976/78 | PRODUCTION 1000 MT 1983/85 | PERCENTAGE OF TOTAL % 1983/85 | PER CAPITA PRODUCTION KG 1983/85 |
|---|---|---|---|---|---|
| ANGOLA | 64 | 58 | 40 | 2.737 | 5 |
| BURUNDI | 133 | 324 | 270 | 18.497 | 59 |
| CAMEROON | 51 | 85 | 107 | 7.344 | 11 |
| ETHIOPIA | 45 | 24 | 35 | 2.374 | 1 |
| LESOTHO | 2 | 13 | 5 | 0.342 | 3 |
| MADAGASCAR | 50 | 55 | 44 | 2.978 | 4 |
| MALAWI | 44 | 61 | 70 | 4.767 | 10 |
| RWANDA | 126 | 168 | 254 | 17.412 | 43 |
| SOMALIA | 2 | 11 | 21 | 1.409 | 5 |
| SOUTH AFRICA | 63 | 86 | 45 | 3.071 | 1 |
| SUDAN | 7 | 7 | 4 | 0.262 | 0 |
| SWAZILAND | 0 | 1 | 1 | 0.049 | 1 |
| TANZANIA | 123 | 206 | 281 | 19.252 | 13 |
| UGANDA | 155 | 294 | 239 | 16.382 | 16 |
| ZIMBABWE | 23 | 25 | 46 | 3.125 | 5 |
| AFRICA | 890 | 1417 | 1462 | 100.000 | 7 |

BEANS, DRY ANNUAL GROWTH RATES

| COUNTRY | PRODUCTION 1966/75 | PRODUCTION 1975/85 | AREA 1966/75 | AREA 1975/85 | YIELD 1966/75 | YIELD 1975/85 |
|---|---|---|---|---|---|---|
| ANGOLA | 1.5** | -6.0*** | 0.1*** | -0.9*** | 1.5** | -5.0*** |
| BURUNDI | 11.4*** | -2.2*** | 4.9*** | -0.9*** | 6.5*** | -1.3*** |
| CAMEROON | 4.1** | 3.7*** | 3.7*** | 2.5*** | 0.4 | 1.1*** |
| ETHIOPIA | -0.3 | 0.6 | -1.3 | 2.7 | 1.0 | -2.1 |
| LESOTHO | 21.2*** | -12.5** | 14.5*** | -5.6 | 6.7*** | -6.9 |
| MADAGASCAR | 2.6*** | -4.2*** | 2.1*** | -4.1*** | 0.5 | -0.1 |
| MALAWI | 3.3*** | 2.0*** | 3.5*** | 1.9*** | -0.2 | 0.2** |
| RWANDA | 0.5 | 5.4*** | 1.9** | 2.9*** | -1.5 | 2.6** |
| SOMALIA | 13.9*** | 6.5 | 13.7*** | 6.2 | 0.2 | 0.3** |
| SOUTH AFRICA | 2.2 | -5.5 | -1.6*** | -6.0** | 3.8 | 0.5 |
| SUDAN | -4.1 | -5.2 | -6.6* | -4.8* | 2.5 | -0.5 |
| SWAZILAND | 9.3** | -4.3 | -1.3 | -1.5 | 10.6*** | -2.8 |
| TANZANIA | 2.1 | 6.6*** | 2.2** | 4.7** | -0.1 | 1.9** |
| UGANDA | 7.0** | -2.5 | 9.3*** | -2.9 | -2.2 | 0.4 |
| ZIMBABWE | 1.5*** | 7.4** | 0.8** | 4.5** | 0.7** | 2.8** |
| AFRICA | 4.8*** | 0.7 | 3.7*** | 0.8** | 1.0 | -0.1 |