Growth Potential of the Beef Sector in Latin America—Survey of Issues and Policies

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INTRODUCTION

This paper focuses on the economic forces in beef production and domestic and export beef markets in Latin America and relates them to the need for technological change. It has two parts. Part I discusses the structure of international beef trade and the leading role exports have played historically in this sector in South and Central America. It examines Latin American beef production and consumption trends between 1961–76 and projects the demand for beef relative to production projections in 1990. It also discusses some government policy constraints relevant to the future technological strategy for beef production.

Part II discusses new prospects for production growth to meet increased domestic and export demand, with emphasis on technological strategy for tropical Latin America. The topics discussed include reproductive performance as a constraint, improved pasture technology, how marginal lands expansion and increasing carrying capacity relate to the opportunity cost of land, and how the production structure relates to farm size. Finally, it analyzes some implications for future technology development.

PART I: WORLD BEEF TRADE

The most significant characteristics of the world beef market are:

1. Total world trade in beef and veal was virtually stagnant from 1973–76 (Table 1), yet most recent projections predict that consumption will increase in rich and less developed countries (LDCs), and that international trade will expand rapidly. In addition, compared to trade in other primary commodities (such as wheat), world beef trade represents a small proportion (about 5.5 percent) of world beef consumption.

2. Imports and exports are highly concentrated. Before 1973, four markets, the United States, Canada, the European Economic Community (EEC), and Japan purchased more than 80 percent of all beef and veal imports. Similarly, Oceania and South America accounted for the bulk of world exports. Since 1973, the EEC has reduced its imports and, in fact, has become a net exporter of beef and veal. In the same period, USSR imports have increased, and Near East imports have grown dramatically.

3. Although developing countries have a minimal share of the trade, beef and veal exports are important sources of foreign exchange earnings for many of these countries.

4. The beef market is segregated because of health and sanitary restrictions imposed by North America and Japan on most imports from South America, where hoof-and-mouth disease exists. Since there is no conclusive evidence that hoof-and-mouth disease is transferred through carcass beef, it is difficult to determine whether these restrictions represent a legitimate health measure or are merely a form of economic protection for domestic production.

5. Although it would be incorrect to represent the beef market solely as a series of independent bilateral trade flows, the differences countries have in their demand for imported manufacturing beef, of frozen and chilled beef, and of various processed beef products indicate that the beef market is heterogenous. The absence of an integrated and homogeneous international market inhibits classical commodity agreements (such as those for wheat, rubber, tea, and sugar).

6. The export price of beef is lower than it would be if trade were freer. Yet consumer prices of beef in importing countries are as much as 2.5 times c.i.f. import prices which severely restricts consumption in those countries.

7. World markets for beef are subject to large and erratic price changes caused primarily by cyclical changes in production in the developed nations. This often leads importing nations to impose crisis measures, which in turn exacerbate the price fluctuations. It is the system, rather than the level of protection now prevailing in developed countries, that increases world prices insta-

Table 1—Trade in beef and veal, 1973–76

	Net Trade			
	1973	1974	1975	1976
	(thousand metric tons)			
World production	40,293	42,235	44,121	45,715
Total world trade	2,584	2,293	2,421	2,639
Major net importers				
United States	580	468	536	570
Canada	37	33	47	55
EEC	576	15	–163	–3
Japan	125	54	45	92
USSR	–1	368	389	218
Near East	4	14	37	74
Major net exporters				
Developed countries				
Australia	583	493	418	551
New Zealand	203	183	191	228
Other developed exporters a/	852	1,007	1,221	1,158
Subtotal	1,638	1,683	1,830	1,937
Centrally planned economies				
Hungary, Poland, and Rumania	63	115	153	125
Yugoslavia	58	32	37	57
Subtotal	121	147	190	182
Developing countries				
Argentina	288	105	75	227
Uruguay	99	100	79	143
Brazil	97	–33	–18	–12
Nicaragua	26	16	22	26
Other LDC exporters	242	201	155	186
Subtotal	752	422	331	582

Table 1—Continued

	Net Trade			
	1973	1974	1975	1976
	(1975 constant $ US per kilogram)			
World prices				
USA imports [b/]	2.78	1.79	1.22	1.56
Argentina exports [c/]	2.17	2.09	.86	.90

Source: Food and Agriculture Organization of the United Nations, *Trade Yearbook* (SITC 011.1, 1978); International Monetary Fund, *International Financial Statistics*, (Washington, D.C.: IMF, January 1978).

Note: The volume of beef exports does not equal the volume of exports because intra-EEC exports have been included, and only major importers and exporters are reported.

a/ Includes trade within the nine nations of the EEC.

b/ Imported, frozen, boneless, 90 percent visible F.O.B. port of entry.

c/ F.O.B. frozen beef exports.

bility.[1] Paradoxically, major importing nations claim to be willing to support high-cost domestic production if they cannot be assured of "reasonable" stability in the price of imports.[2]

Unstable prices, uncertain market access, severe import restrictions in industrialized countries, and the resulting depression of international prices represent part of what Johnson termed the "disarray in world agriculture."[3] These disruptive tendencies inhibit long-term investments that would expand the supply of beef for export by low cost producers. Price instability has caused severe dislocations throughout the economies of the major exporting nations (e.g., New Zealand, Argentina, and Uruguay) including shifts in relative prices and income distribution, and, particularly, inflation. Moreover, import restrictions impose a large cost on consumers in industrial countries.

Much of this disarray is man-made, and this paper argues that government policies in the beef and dairy sector, particularly in importing countries, have an overriding influence on world price movements. The concentration of imports in a few industrial markets where small changes in production can cause relatively large shifts in imports[4] and the concentration of exports in countries where exports represent a major share of production and therefore short-run supply is relatively inelastic, create the necessary conditions for market instability. Moreover, major importing countries prevent trade from acting to stabilize prices by applying variable import quotas, levies, and duties (and less often variable export taxes and quotas).

Freer beef and dairy product trade would induce an expansion in world trade, primarily because it would cause domestic prices in industrial countries to fall closer to world prices. This would induce a rise in consumption resulting in an increase of their imports. If, simultaneously, feedgrain trade were liberalized, production of beef and veal in industrial countries would not contract significantly. On the other hand, in Europe, where dairy herds are the only source of veal, the major impetus to the uneconomic production of beef is the high subsidies to dairy products. Thus, if consumer price considerations override domestic farm policy objectives to make simultaneous reductions of the high rates of protection of beef and dairy products possible in the long run, trade liberalization could significantly reduce domestic beef production in industrial countries.

An estimate of the potential impact of a 50 percent reduction in trade barriers (including nontariff barriers) in the countries of the Organization for Economic Cooperation

[1] In an attempt to defend themselves against severe economic dislocations brought on by world price fluctuations (inflation and shifts in relative prices and income distribution), major exporters such as New Zealand have imposed measures, including export taxes and quotas, that have also contributed, at least marginally, to world price instability.

[2] For a useful discussion of the world beef market, see G.W. Reeves and A.H. Hayman, "Demand and Supply Forces in the World Beef Market," *Quarterly Review of Agricultural Economics* 28 (July 1975): 121–151; United Nations, Council for Trade and Development, Secretariat, "Elements of an International Arrangement on Beef and Veal" (TD/B/IPC/MEAT/2), January 19, 1978; and D.G. Johnson, *World Agriculture In Disarray* (London: Macmillan Press for the Trade Policy Research Centre, 1973).

[3] Johnson, *World Agriculture.*

[4] Beef and dairy imports make up only a small fraction of consumption in those countries.

and Development (OECD) on a sample of Latin American, Asian, and African countries is presented in Tables 2 and 3.[5] Table 2 shows the long-run effects of the estimated 5 percent rise in international beef prices resulting from trade liberalization.[6] Total export volume revenues would increase by US$ 360.5 million. This figure is substantial, representing an increase in the net *annual* flow of export earnings to LDCs over and above the "natural" growth in exports likely to occur even if trade is not liberalized. Also, the figures apply only to unprocessed beef production (Standard International Trade Classification 011.1) and thus, significantly underestimate the total gains from trade liberalization occurring through the entire beef market, including the gains for canned and processed beef exports from Argentina, Uruguay, and Paraguay. The last column in Table 2 shows the additional resources available to the LDCs after trade is liberalized, or what is called the transfer, is measured by the increase in export earnings induced by trade liberalization less the cost of producing the increased exports.[7] Beef importing LDCs, as observed in Table 3, cut their imports by approximately 31 percent in response to higher prices. This causes a welfare loss to consumers (measured by the decline in consumer surplus), and a foreign exchange "savings" of $48.3 million.[8]

Finally, a note of optimism for exporters. In addition to the dramatic increase in Near East imports noted previously, there is a growing market in LDCs for beef imports. The developing countries' share of total beef imports rose from 5 percent in 1970 to 9 percent in 1976.[9] As incomes grow in LDCs, the probability that markets in these countries will rapidly expand should be given more attention by Latin American exporters. Furthermore, a significant change is taking place in the composition of beef being traded, as the proportion of lower grade cuts and pre-cooked beef is increasing. Part of the change is due to an increase in demand for pre-cooked food in the United States, another to the importation by African and Middle Eastern nations of lower grades of beef than those traditionally imported by Europe. South American exporters are gaining access to the U.S. market because pre-cooked beef is not subject to

[5] These results were obtained from a current research project at IFPRI described in A. Valdes, *Trade Liberalization in Agricultural Commodities and the Potential Benefits to Developing Countries* (Washington, D.C.: International Food Policy Research Institute, February 1979). This project analyzes trade liberalization affecting several agricultural commodities.

[6] This 5 percent rise in world price is a result of increased demand by the trade-liberalizing developed countries.

[7] In LDCs, prevailing distortions in factor markets and in the exchange rate are likely to overstate the cost of additional production and hence to underestimate the gains in welfare.

[8] These figures are rough estimates. As in any analysis of this type, the authors had to make a number of simplifying assumptions. However, the given results are "typical" of the results obtained using various estimates of world and domestic elasticity parameters. Applying a reduction of trade barriers of only 25 percent, the net foreign exchange gain to LDCs is reduced by approximately 50 percent.

[9] Food and Agriculture Organization of the United Nations and the World Bank, *The Outlook for Meat Production and Trade in the Near East and East Africa*, 2 vols. (Washington, D.C.: FAO/IBRD, December 1977).

Table 2—Potential gains to beef exporting developing countries of trade liberalization in the OECD [a/]

Exporter	Actual	After Trade Liberalization		
	1972–74 Average Net Exports	Absolute Change in Exports	Increase in Export Revenues	Net Welfare Gain or Transfer
	(thousand metric tons)		(US $ million)	(US $ million)
Argentina	273	84	220.5	34.2
Colombia	21	11	26.2	2.9
Costa Rica	30	1	6.5	3.3
Guatemala	15	2	6.5	1.7
Mexico	31	16	38.6	4.2
Paraguay	9	4	9.0	1.2
Uruguay	107	10	33.3	12.2
Cameroon	2	1	2.5	0.3
Chad	30	1	6.3	3.3
Ethiopia	3	2	3.7	0.4
Mali	1	1	1.2	0.1
Sudan	5	3	6.2	0.7
Total	527	136	360.5	

a/ The percentage change in LDC exports equals the percentage change in world price (5 percent) times the individual country's export supply elasticity, e_s.

Table 3—Potential losses to beef importing developing countries of trade liberalization in the OECD [a/]

Importer	Actual	After Trade Liberalization		
	1972–74 Average Net Imports	Absolute Change in Imports	Change in Value of Imports	Net Welfare Loss
	(thousand metric tons)		(US $ million)	(US $ million)
Brazil	10 [b/]	–5	–10.3	0.82
Chile	26	–6	–11.4	2.50
Venezuela	15	–8	–15.5	1.22
Algeria	2	–1	– 2.1	0.16
Egypt	4	–2	– 4.1	0.33
Libya	7	0	+ 0.2	0.75
Zaire	10	–1	– 1.0	1.04
Zambia	8	–1	– 2.1	0.80
Iraq	1	–1	– 1.0	0.08
Philippines	1	–1	– 1.0	0.08
Total	84	–26	–48.3	

a/ The percentage change in imports equals the world price change (5 percent) times the calculated import demand elasticity, η^m.

b/ 1974–77 average.

hoof-and-mouth restrictions. Tropical exporters should be able to compete with temperate nations for lower grade imports.

HISTORICAL AND PROJECTED CONSUMPTION AND PRODUCTION OF BEEF IN LATIN AMERICA

This section summarizes production and consumption trends from 1961 to 1976. It also projects domestic demand growth for 1990 (at constant prices and based on 1972–74 average consumption), and the production increases required to meet this demand.

Four countries–Brazil, Argentina, Mexico, and Colombia–have 77 percent of the total cattle stock of Latin America (Table 4). This stock is 2.7 times larger in tropical Latin America than in the temperate region. The difference in production between the tropical and temperate regions is narrower (61 and 39 percent, respectively) because average cattle productivity is higher in the temperate region by a ratio of 1.6 to 1 (Table 4). Cattle productivity varies according to country from 51 to 11 kilograms per year, which illustrates the heterogeneity of production conditions within Latin America and illuminates the risk of trying to generalize about a technological strategy for all Latin America.

In analyzing production trends, long-term growth rates (1961–76) have been emphasized in order to adjust for beef production cycles. Table 4 shows that countries in tropical Latin America, particularly in Central America, have consistently high rates of growth (over 4 percent).[10] In contrast, growth rates in the temperate region are low (1 percent or less). However, the more rapid production of the tropical region is largely offset by its higher rate of population growth. The temperate region produces an average of 76 kilograms per capita; the tropical region produces only 18 kilograms. For Latin America as a whole, production per capita for 1960–64 and 1970–74 remained constant at about 26 kilograms per capita.

It is the hypothesis of this paper that to a large extent, production performance differences between tropical and temperate Latin America are the result of differences in internal economic policies and access to export markets rather than of fundamental differences in resource endowment.[11]

Consumption

Per capita consumption of beef in Latin America is close to that of Western Europe and the USSR and considerably higher than that of Africa, the Middle East, and Asia (see the Appendix, Table 6). However, there are significant differences in consumption within Latin America. Between the periods 1960–64 and 1970–74, annual per capita consumption in the temperate region averaged 55.5 kilograms; compared to 13.5 kilograms in the tropical region.

[11] However, this statement should not preclude the possibility that the temperate climate production continuum found in the southern zone and in Mexico would generally support higher production levels than found in many tropical areas of Latin America. (We are grateful to Ned S. Raun for this clarification.)

[10] Central America, which is free from hoof-and-mouth disease, has the least restricted access to the U.S. markets. Therefore, exports have spurred production.

Table 4—Beef production in Latin America

Country and Region	Distribution of Stock and Production 1970–74		Cattle Productivity Per Head in Stock 1970–74	Growth Rate in Production 1961–76	Per Capita Production	
	Stock	Production		Compound Rate	1960–64	1970–74
	(percent of total)		(kg/year)	(percent)	(kg/year)	
Tropical Latin America	72.9	61.2	27		17	18
Brazil	35.2	30.1	28	3.8	21	23
Mexico	11.0	9.7	28	2.0	12	14
Colombia	8.9	6.4	23	1.8	23	21
Venezuela	3.6	3.2	29	4.2	19	21
Cuba	3.1	2.6	27		29	27
Paraguay	1.9	1.5	26	–0.8	66	50
Peru	1.7	1.2	23	2.5	9	7
Ecuador	1.1	0.8	25	3.2	9	10
Bolivia	0.9	0.7	24	4.0	16	11
Central America	4.3	3.9	28		14	16
Nicargua	1.0	0.9	28	4.9	21	32
Guatemala	0.9	1.0	29	4.8	11	11
Costa Rica	0.7	0.7	35	5.0	22	31
Honduras	0.7	0.6	27	7.0	10	15
Panama	0.5	0.6	34	4.9	26	29
El Salvador	0.5	0.2	11	2.9	9	4

Table 4—Continued

Country and Region	Distribution of Stock and Production 1970–74		Cattle Productivity Per Head in Stock 1970–74	Growth Rate in Production 1961–76	Per Capita Production	
	Stock	Production		Compound Rate	1960–64	1970–74
	(percent of total)		(kg/year)	(percent)	(kg/year)	
Caribbean	1.2	1.0	28		5	6
Dominican Rep.	0.6	0.7	38	3.9	8	12
Guyana	0.1	0.0	15	1.8	5	5
Other Caribbean [a/]	0.5	0.3	18		4	3
Temperate Latin America	27.1	38.8	44	0.6	83	76
Argentina	22.0	32.2	47	0.4	102	100
Uruguay	3.9	4.6	37	1.0	133	117
Chile	1.2	1.9	51	1.2	19	15
Latin America	100.0	100.0	32	2.0	27	26

Sources: The production growth rates are from International Food Policy Research Institute, "Projections on Beef and Milk for Latin America," May 1978. (Mimeographed.) Other figures are from L. Rivas and G. Nores, "Evolucion de la Ganaderia Bovina en America Latina, 1960–74," Centro Internacional de Agricultura Tropical, Cali, Colombia, February 1978. (Mimeographed.)

Between the periods 1960–64 and 1970–74, consumption per capita declined in the temperate region, but on the average remained constant in tropical America (see the Appendix, Table 7).[12] This decline was induced in part by rising prices. Several countries imposed direct measures, such as meatless days, to restrict consumption in an effort to increase exports (or reduce imports).[13] Guatemala and Honduras cut consumption by raising domestic prices, which enabled them to take advantage of high export prices during 1970–74. As a result, they were able to expand their beef exports at the impressively high annual rates of 17 and 14 percent per year, respectively, while raising the share of these exports in total production.[14]

With lower export prices since 1973–74 (particularly for South America, which has lost much of its European market), the incentive to substitute exports for domestic consumption has been weakened, so per capita consumption may be rising now.

Demand Projections

Beef consumption in tropical Latin America has increased significantly since 1973 and should continue to do so. Although population growth accounts for most of this increase so far, an increase in per capita consumption reflects the high income elasticity of demand. If incomes do not grow, however, the continent as a whole will remain a large net exporter in 1990, as the last column in Table 5 indicates.

Table 5 shows projections to 1990 of the deficit or surplus of beef for each country, calculated by subtracting its projected consumption from its projected production (both at constant prices). The results show that Central America and the temperate regions will continue to be net exporters, while Mexico and tropical South America will become net importers by 1990. Tropical South America must increase beef production by 5 percent annually if it wants to meet projected consumption. Historically from 1961 to 1976, production measured by slaughter increased at an annual rate of approximately 3 percent.

Figure 1 relates the historical rate of production growth of each country to the rate of production growth necessary to satisfy the increase in its domestic consumption by 1990 at constant prices. Potential exporters, which fall below the 45-degree self-sufficiency line on the graph, are those countries whose production will exceed projected consumption in 1990 if their production continues to grow at its 1961–76 rate. For example, Argentina and Uruguay could meet the growth in domestic demand even if production fell.[15] Countries which are above the self-sufficiency line may be importers by 1990.[16] Tropical South America, in contrast to Argentina and Uruguay, will require an extraordinary increase in production to meet domestic consumption in 1990.

[12] Venezuela and Ecuador are the only countries where per capita consumption has increased.

[13] Argentina, Chile, Colombia, Peru, and Uruguay.

[14] Beef exports expanded from 10 to 17 percent in 1960–64, and from 37 to 50 percent in 1970–74.

[15] However, in Argentina and Uruguay the rest of the economy would expect positive growth since beef is an important sector of the economy and a major source of foreign exchange revenues.

[16] It should be noted that there is nothing inherently good about being a net exporter or bad about being a net importer.

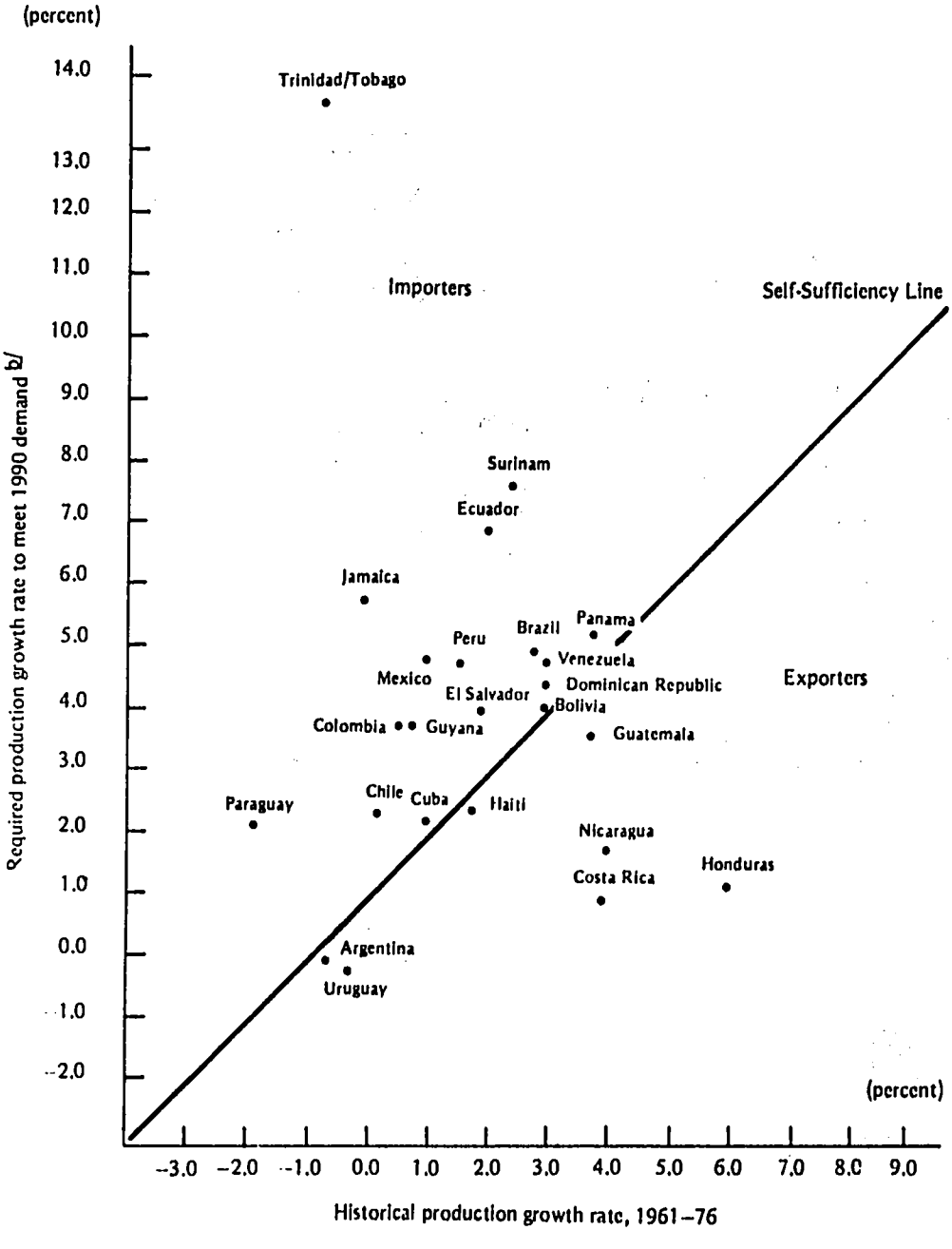
Table 5—Net deficit or surplus beef production in Latin America, 1973 and 1990 [a/]

Country Group/Country	1973	1990		
		High Income Growth	Low Income Growth	No Income Growth
		(thousand metric tons)		
Mexico	93	–395	–310	– 83
Central America and Caribbean	83	62	149	297
Costa Rica	19	59	64	77
Cuba	1	– 30	– 2	11
Dominican Republic	8	– 13	– 5	14
El Salvador	3	– 12	– 9	– 1
Guatemala	10	20	32	63
Guyana	0	– 2	– 1	0
Haiti	2	0	5	7
Honduras	20	36	39	45
Jamaica	– 4	– 19	– 16	– 8
Nicaragua	26	42	49	66
Panama	0	– 10	0	27
Trinidad and Tobago	– 2	– 9	– 7	– 4
Tropical South America	220	–1,286	–683	850
Bolivia	14	31	43	75
Brazil	165	–911	–462	661
Colombia	47	–110	– 56	102
Ecuador	0	– 82	– 56	2
Paraguay	9	– 62	– 60	– 52
Peru	– 7	– 83	– 66	– 21
Surinam	0	– 2	– 1	0
Venezuela	– 8	– 67	– 25	83
Temperate South America	304	214	256	371
Argentina	269	108	136	219
Chile	– 53	– 50	– 40	– 10
Uruguay	88	156	160	162
Total Latin America	700	–1,405	–588	1,435

Source: International Food Policy Research Institute, "Projections on Beef and Milk for Latin America," Washington, D.C., May 1978. (Mimeographed.)

a/ Domestic slaughter and net exports of live animals are covered. Negative numbers indicate deficits.

Figure 1--Projected potential direction of trade in beef of Latin American countries by 1990 a/



a/ At constant prices.

b/ Median income variant.

This is unlikely to occur without rapid technological change.

It is important to emphasize that Figure 1 is based on projections of production and consumption which assume constant prices. However, if trade liberalization occurs as discussed earlier, world prices would rise, stimulating production and reducing consumption in all countries where domestic prices reflect world prices. Therefore, trade liberalization could increase the surpluses and reduce the deficits projected in Table 5, and may cause many of the potential importers in Figure 1 to become exporters.

SOME DOMESTIC POLICY CONSIDERATIONS

Direct government intervention measures have profoundly influenced the domestic markets for beef and milk in Latin America. In the future, they will continue to significantly influence the socioeconomic environment surrounding the livestock sector, and affect the role technology can play in its development.

Most countries, particularly in South America, have held domestic prices of beef and milk below world prices with export taxes and quotas, direct price controls, and overvalued exchange rates. In effect, this amounts to negative protection of domestic beef production.[17] Governments are under strong pressure to follow such "cheap food" policies. Since beef makes up the largest single share of family food expenditures, policy makers tend to treat beef as a "wage good" like rice, beans, and maize. In most of Latin America, even low income families spend no less than 10 percent of their total income on beef. Therefore, beef should be analyzed as a staple food. The high nutritional value of beef and the high income elasticities of demand of low income groups imply that high beef prices adversely affect the cost of living and could worsen income distribution and nutrition.[18]

Policy makers must choose between a freer trade policy that puts pressure on the cost of living and domestic consumption, but increases production and foreign exchange earnings, and a "cheap food" policy that benefits consumers of all incomes, but reduces private investment and export surpluses. In the past, particularly in temperate South America and in Brazil, rather than export production increases they were used domestically, which caused a transfer of welfare from producers to domestic consumers.[19]

As discussed earlier, export capacity is likely to be severely limited by significant annual increases in the domestic demand for beef. To reduce this growing demand, domestic price policies may try to encourage the substitution of chicken, fish, and pork for beef, although this has been tried without much success.[20]

[17] For example, L. Reca, "Rasgos Caracteristicos de la Ganaderia Vacuna en Argentina," draft, 1978.

[18] P. Pinstrup-Andersen, N.R. de Londono, and E. Hoover, "The Impact of Increasing Food Supply on Human Nutrition: Implications for Commodity Priorities in Agricultural Research and Policy," *American Journal of Agricultural Economics* 58 (May 1976): 131–142.

[19] R. Lattimore and G.E. Schuh, "Un Modelo de Politica para la Industria Brasilena de Carne Vacuno," *Cuadernos de Economia* 39 (August 1976): 51–75.

[20] L. Jarvis believes that a major reason for this is that the cyclical behavior of cattle prices increases cycles in the demand for these other commodities, driving many operators out of business whenever beef prices are low and beef abundant (personal correspondence).

There is ample empirical evidence to show that investment decisions of South American ranchers are very sensitive to prices. Because of the inherently cyclical nature of beef production, in the short-run (two to three years) decreases in supply resulting from increases in beef prices remain consistent with relatively high long-run increases in supply.[21] However, supply adjustment is delayed by low productivity, particularly in tropical America. It may take five years or longer for supply to complete its response to an increase in prices.[22] In trying to reduce the effects of world price fluctuations on domestic prices, food price stabilization policies have often inadvertently prevented long-run supply expansion from taking place.

Finally, no economic policy for the beef sector can be designed without explicitly recognizing that on most beef cattle farms in tropical American regions (and certainly in Chile in the temperate region) a high percentage of breeding cows are milked.[23] To a large extent then, beef and milk are joint products and the profitability of one affects the production of the other.

Whether or not Latin America will accelerate production will depend on the availability of profitable new technology capable of inducing significant supply shifts and on how each country chooses to resolve the economic policy dilemma of "cheap food" policy versus expanding exports. The importance of the price structure to technological development is often underestimated. This issue of technological change is examined in the second part of this paper.

[21] A. Valdes, "Algunos Aspectos Economicos de la Industria Ganadera en America Latina," in *El Potencial para la Produccion de Ganado de Carne en America Tropical* (Cali, Colombia: Centro Internacional de Agricultura Tropical [CIAT], November 1975).

[22] See, for Brazil, Lattimore and Schuh, "Un Modelo de Politica"; and for Argentina, Yver, "El Comportamiento de la Inversion y la Oferta de la Industria Ganadera en Argentina," *Cuadernos de Economia* 28 (March 1972): 5–63.

[23] In Nicaragua, 70 to 80 percent of lactating cows are milked. [Latino Consult S.A., "Mercado de Ganado y Carne Bovina en Nicaragua," report for the Banco Central de Nicaragua, Managua, 1975. (Mimeographed.)]. In Colombia, more than 50 percent of the milk consumed is obtained from beef cattle herds [L. Rivas, "Aspectos de la Ganaderia Vacuna en las Llanuras del Caribe en Colombia," Centro Internacional de Agricultura Tropical, Cali, Colombia, February 1978. (Mimeographed.)]. The ratio in Brazil is about 35 percent [R. Lattimore, "An Econometric Study of the Brazilian Beef Sector." (Ph.D. dissertation, Purdue University, 1974)].

PART II: TECHNOLOGICAL STRATEGIES

The following discussion of technological strategies analyzes only those factors that merit particular consideration in the case of tropical Latin America. The temperate region is excluded because the great heterogeneity of production conditions as noted previously precludes generalizing for Latin America as a whole and because 70 percent of the total cattle stock is contained in the tropical region of Latin America, which is widely assumed to have a greater potential for growth than the temperate regions.

THE NEED FOR TECHNOLOGICAL CHANGE

Productivity in the livestock sector of tropical Latin America increased between 1960–64 and 1970–74. Estimates for that period indicate that the region's extraction rate increased at an average rate of 1.5 percent per year. There are also indications that a similar increase occurred in reproductive efficiency, defined as births minus deaths over total stock.[24] In spite of this increase in productivity, the rate of growth of production (3 percent per year) has not matched the rate of growth of domestic demand (5.6 percent per year). As a result, the real price of beef has increased in most tropical countries.[25] If this gap between the growth rates of production and demand persists in the future, prices will rise. However, as in the past, policy constraints such as those discussed in Part I may prevent prices from rising enough to cause production to increase enough to meet domestic demand. Supply shifts induced by technological change are the only means of accomplishing this task.

EMPHASIS ON REPRODUCTION

If production is to increase at higher rates, research must focus on improving reproductive performance. Average weaning rates in tropical Latin America are currently so low that little animal selection based on reproductive performance can be practiced. Calving rates must increase and calf mortality must fall if higher growth rates are to be achieved and progressive animal selection allowed for. How this can be done depends on the principal constraints in each region.

HORIZONTAL EXPANSION VERSUS FACTOR DEEPENING

In those South American countries with large land endowments, there is question about whether beef production will increase by expanding livestock production into

[24] Gustavo Nores, "Observed Versus Required Rate of Growth of Production in Tropical Latin America," Centro Internacional de Agricultura Tropical, Cali Colombia, 1978. (Mimeographed.)

[25] Changes in world prices have also affected domestic prices, with variations from country to country (L. Rivas and G. Nores, "Evolucion de la Ganaderia Bovina en America Latina, 1960–74," Centro Internacional de Agricultura Tropical, Cali, Colombia, February 1978). (Mimeographed.)

marginal lands or by increasing the carrying capacity in present livestock areas. This will depend on the interaction between the economic policies of each country, particularly those regarding livestock vis-a-vis crops, and regional incentives through credit and tax policies and investment in infrastructure; the technological alternatives available to producers; and the actual farm structure, in terms of factor endowment and factor access by farm size.

One important point to be considered is the opportunity cost of land (i.e., its alternative uses) in each region. According to FAO, during the period 1961–65 to 1974, cultivated land expanded at an average rate of 1.54 percent per year.[26] Such area expansion most likely came about at the expense of pasture area, which, in turn, shifted over to marginal or unsettled land. One may expect the expansion of cultivated land into pasture areas to continue, if not to increase, particularly in the more fertile areas.

While it is probably easier to increase beef production in fertile areas, net gains to society will be higher if it is achieved by using resources of low opportunity cost. In other words, from the social point of view it does not make sense to increase beef production by competing with crops for land. However, it does make sense in marginal lands, or if it complements crop production in rotational systems or by using crop residues or by-products which have low opportunity costs.

Past research efforts have done little to increase beef production in fertile areas. We need to learn from these examples how to choose the appropriate areas in which to work.

PRODUCTION STRUCTURE AND FARM SIZE

Although the relationship between production structures and farm size varies considerably between and within countries, it can be summarized as follows:

1. *Small Farms*—Approximately one-third of the total cattle stock in tropical Latin America is on small farms (less than 50 head) ranging from subsistence to commercially oriented small farms for which crops are also important. Owning livestock is one of the few ways the rural poor, who do not have easy access to the banking system, can save and invest. Beef and milk production complement crop production, since they use resources with low opportunity costs such as family labor, crop residues, and the forage available on public roadsides.[27] Although animal productivity is in general quite low, overall socioeconomic efficiency is probably high. Since production constraints, resource endowment, and access to production factors are different in each region, productivity on this type of farm would be increased more easily by regionally oriented whole-farm systems research than by straightforward livestock research.

2. *Medium-size Farms*—Another third of the total stock of tropical Latin America is believed to be on commercial medium-size ranches (50 to 300 head) in which beef and milk production are major activities. In general, animal productivity, although still low, is higher in this category than in the others because of economies of scale and easier management of medium-size herds. In many of these farms, beef cows are also used for milk production. Therefore, research should explicitly consider dairy ranching

[26] Rivas and Nores, "Evolucion de la Ganaderia."

[27] G.E. Schuh, "Government Policy and the Perspective of Animal Protein: An International Perspective," in *New Protein Foods*, eds. A.M. Altschul and H.L. Wilcke (New York: Academic Press, forthcoming).

systems and the biological and economic trade-offs between beef and milk production. To continue not to pay more attention to dairy ranching is to ignore reality and to seriously jeopardize the possibility of long-run growth in many areas.

3. *Large Farms*—Finally, the last third of the total stock of tropical Latin America is believed to be on large ranches (more than 300 head), which usually specialize in beef production.

If beef production in tropical Latin America is to grow at the same pace as demand, technology developed should not ignore any one of these three production structures. Thus, technology should either be scale neutral or develop economically viable technologies for each of these different farm sizes and production systems. Otherwise, besides valid equity considerations, production growth could be seriously jeopardized.

OPPORTUNITY COST OF RESOURCES

As Schuh notes: "The economic rationale for producing beef and milk is not that bovines are efficient converters of concentrate feeds (since they are not), but that they are efficient users of low cost feeds which normally have little or no opportunity costs elsewhere in the economy."[28] Except for some Caribbean countries and El Salvador, the most abundant resource in tropical Latin America is land, including grassland. At the same time, capital has a high opportunity cost. The question is how to use these resources most efficiently. The case of improved pastures may serve to illustrate this point.

Both native and improved pastures have strong seasonal patterns for the volume and quality of dry matter production (i.e., its digestibility, protein content, etc.). Therefore, it is not a matter of substituting one for the other, but rather of supplementing native pastures with improved ones. Improved pastures, whose digestibility is low during the slack season, may be attractive for fattening purposes in areas where the opportunity cost of land is high. Substituting capital for land may be possible where land values are high. Also, the possibility of obtaining high compensatory gains may allow for a rapid turnover of the capital invested in the animals.

However, in areas where land has a low opportunity cost, there is little advantage in replacing native pastures with improved pastures that are also poor in quality during the slack season. In cow-calf operations, there are no compensatory gains in reproduction. Lack of conceptions, as well as abortions and higher mortality during the slack season of the pasture cannot be compensated for during its productive season. Hence, in those areas where the quality and availability of forage during the slack season are major restraints on calving rates, pasture research should emphasize ways to supplement native pastures with improved ones during that season.

In his analysis of the diffusion of improved pastures in Uruguay, Jarvis comments:

> Although it has been hoped that the new technology would be applied to substantially all of Uruguayan pasture area, I find that the final ceiling will be about 12 percent and that the diffusion process is now rapidly ending.[29]

[28] Ibid.

[29] L. Jarvis, "Predicting the Ultimate Diffusion of New Technologies Under Varying Profitability: Artificial Pastures in the Uruguayan Livestock Sector," University of California, Berkeley, 1977, (abstract).

He concludes that:

> diffusion is sensitive to the profitability of new pastures, as influenced by the variation in the price of beef and fertilizer, but this sensitivity is not as large as previously thought. Other factors affecting the profitability of the use of artificial pastures are considered to explain why diffusion is reaching a ceiling so much below what was originally expected.

Among those factors, one

> which most severely constrains development. . . is the technological-managerial problem of dealing with the improved pastures on a large proportion of a ranch. . . . Most producers find the artificial pastures to be highly profitable when planted on a small proportion of their ranches, this small proportion providing an improved nutrient base during the crucial winter months. . . (improved pastures) have been used to supplement the traditional pastures, however, not to replace them. . . (they) have not been profitable for most ranches when planted to a large proportion.[30]

Since improved pastures are a sizeable and risky investment, it is reasonable for producers to use them seasonally to supplement forage from native pastures, during certain physiological states of the animal (i.e., grazing by lactating cows, flushing before mating, etc.), or to recover sick or weak animals in order to avoid capital losses. Improved pastures are thus best used only when there is a high capacity for response. Further increases in the proportion of area planted with improved pastures would mean grazing them with animals that respond less easily and thus, may be unprofitable. Moreover, unless forage conservation is economically feasible, forage from the improved pasture will probably be wasted during the productive season. While burning native pastures is a very common practice in tropical Latin America, it is risky to use it in improved pastures to control their growth. Undergrazing, like overgrazing, is also risky in terms of pasture persistence, particularly if it is composed of a mixture of legumes and grass. As Jarvis notes: "considerable learning-by-doing is required before improved pastures can be well managed. . . . And the greater the proportion of improved pastures on a ranch, the greater is the management sophistication and dedication required."[31]

SOME IMPLICATIONS FOR TECHNOLOGY DEVELOPMENT

If production in tropical Latin America is to increase faster than it has historically, the production structure should be explicitly considered, and more fruitful interaction between economic and technological policies should be sought. To the extent that economic policies, particularly price policies, are constrained by "cheap food" policies, balance of payments situations, international prices, and access to market, additional burdens are placed on the development of new technology. In South America, the price structure has been a major factor impeding the introduction of intensive technologies in the beef sector. If it is to be adopted, technology must not only be profitable and

[30] Ibid., pp. 44–46. Many new technologies though apparently simple, require much attention and relatively sophisticated judgments on the part of the rancher. In regions where many ranches have absent owners, it is difficult for the new technologies to be profitable. In part, however, the price structure plays a role because the prevailing price ratios imply that the absolute profitability of new technologies is relatively low and provides little incentive for skilled management to make the social and economic sacrifices required to live on the ranch.

[31] Ibid.

of low risk, but must also be feasible within the limits set by the producers' factor endowment and access. The more a technological package increases output and the less it is capital intensive, the more likely it is to be adopted by producers.

It is usually claimed that it is not possible to increase output with little additional capital. Yet to bypass this conflict is precisely the technological challenge faced by the livestock industry. It can be done, as in the past, by supplementing low-opportunity cost native pastures with improved ones and by selecting the plant species which are most productive and resilient during the slack season. It can also be done by screening different species for pasture adaptation with minimum soil-fertility corrections, by biological nitrogen fixation through legume-grass mixtures, and by reducing establishment costs through minimum tillage systems and lower seed costs.

In conclusion, to summarize other important factors already mentioned:

1. Emphasis must be placed on improving the reproductive performance of herds in order to increase production growth rates and allow for progressive animal selection.

2. New technologies must explicitly recognize the role of milk production in beef cattle production if they are to be adopted, particularly on small and medium-size farms.

3. Technological strategies for small farms should be approached through regionally oriented whole-farm-systems research rather than through isolated livestock research.

4. Net gains to society will be higher if increased production is achieved by using resources with low opportunity cost such as marginal land or land with little competition from crops, and by properly complementing native pastures with improved pastures during slack seasons. In areas where the opportunity cost of land is high, research efforts on grazing beef production systems will have a lower social pay-off unless crop residues are abundant.

APPENDIX: SUPPLEMENTARY TABLES

Table 6—Per capita beef consumption by region, 1970 and 1975

	1970	1975
	(kg/year)	
World	10.7	11.2
Developed countries		
North America	52.5	56.4
Western Europe	21.2	23.3
Oceania	62.6	63.8
Others [a/]	6.7	7.7
Centrally planned economies	20.3	22.7
USSR	15.6	17.5
Asian centrally planned	2.5	2.8
Developing countries		
Asia		
South	0.7	0.8
East and Southeast	2.4	2.6
Africa		
Northwest, Central, and West	3.6	3.9
East	9.0	9.6
Latin America	21.2	21.2
Near East		
In Africa	7.2	7.6
In Asia	4.3	4.8

Source: FAO, *Agricultural Commodity Projections, 1970–80* (Rome: FAO, 1971).

a/ Israel, Japan, and South Africa.

Table 7—Per capita beef consumption in Latin America [a/]

Country and Region	1960–64	1970–74
	(kg/year)	
Tropical Latin America	14	13
Brazil	18	18
Mexico	9	7
Colombia	21	17
Venezuela	17	20
Paraguay	38	21
Peru	8	7
Ecuador	8	9
Bolivia	13	11
Central America	10	8
Nicaragua	16	14
Guatemala	8	7
Costa Rica	17	10
Honduras	7	7
El Salvador	8	5
Caribbean	6	6
Dominican Republic	7	6
Guyana	5	5
Other Caribbean	6	6
Temperate Latin America	60	51
Argentina	79	68
Uruguay	75	61
Chile	19	18
Latin America	21	18

Sources and definitions in L. Rivas and G. Nores, "Evolucion de la Ganaderia Bovina en America Latina, 1960–74, Centre Internacional de Agricultura Tropical, Cali, Colombia, February 1978. (Mimeographed.)

a/ Apparent consumption = Output + (Imports-Exports). Trade includes beef and veal and canned meat in equivalent carcass weight.

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