PN-AAW-478

48526

THE IMPACT OF THE ALCOHOL PROGRAM ON THE AGRICULTURAL SYSTEM OF BRAZIL

Alan Poole
Institute of Physics
University of São Paulo

A Report to the

Agency for International Development

under Cooperative Agreement No. AID/DSAN-Ca-0179

RESOURCES FOR THE FUTURE
1755 Massachusetts Avenue, N.W.
Washington, D.C. 20036

July 1983

ACKNOWLEDGMENT

The research for this report was funded under Cooperative Agreement No. AID/DSAN-CA-0179 established between Resources for the Future and the U.S. Agency for International Development, Office of Energy (Director, Alan B. Jacobs). Pamela L. Baldwin is the A.I.D. project officer for this Cooperative Agreement. William Ramsay of RFF is the principal investigator and project director, and Joy Dunkerley is the co-principal investigator.

This work in progress is issued with the dual purpose of informing the policy community of the state of knowledge and of eliciting comments on our efforts. The views expressed in this paper are those of the author alone and should not be interpreted as representing the views of either A.I.D. or Resources for the Future.

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Chapter 1

As in many developing countries, the agricultural sector in Brazil can be divided into two subsectors--one primarily oriented towards export, the other towards internal supply [1, 2, 3, 4, 5]. This distinction is important here because PROALCOOL is regarded by many agricultural economists as essentially an extension of the export subsector in terms of its impact on internal food supply. There are at least two major reasons for this equation. First, the crop which will completely dominate ethanol production for the next decade, at least, is sugarcane, a classical "export" crop. Second, while experience with the proposed dynamic growth of PROALCOOL is rather limited, there exists a much larger body of information and analysis on the impact of this export subsector.

There is not, of course, precise agreement on the dynamics of the two subsectors, but the differences among specialists who have studied the question are of detail [3]. Very briefly, the thesis is as follows. From the mid-1950s until the mid-to-late 1960s there was a generally satisfactory, if unspectacular, development of internal food supply. Beginning in the late 1960s, development of this subsector began to deteriorate. Production stagnated relative to demand. The existing low yields of the classic internal crops (rice, beans, cassava and corn), improved moderately in the case of corn, stagnated with rice, and, in the case of beans and cassava, started a serious decline. Meanwhile, the export crops--cocoa, coffee, soya, sugarcane, citrus--showed dynamism as a consequence of favorable international prices and supportive government policies. According to this thesis, this dynamism included not only a reasonable rate of improvement of yields (table 1-1) but an expansion of harvested area at the expense of internal food crops (table 1-2), particularly on the most fertile land. As a consequence of these trends, food prices rose relative

Table 1-1. Change in Yields of Major Crops in Brazil, 1966-1968 to 1976-1978

	Yield (kilograms per hectare)					Yield (kilograms per hectare)					Index	Annual growth rate
	1965	1966	1967	1968	Average 1966-68	1975	1976	1977	1978	Average 1976-78	1976-78/ 1966-68	1966-68/ 1976-78
Rice (paddy)	1,641	1,449	1,583	1,492	1,508	1,446	1,465	1,500	1,297	1,421	94	-0.59
Barley (cevada)	818	843	735	834	804	1,072	1,269	1,01	1,609	1,298	161	4.91
Beans	438	448	477	--	--	377	347	346	350	348	--	--
Black beans	700	646	700	661	669	550	453	503	475	471	70	-3.45
Corn for grain	1,381	1,397	1,385	1,337	1,373	1,504	1,596	1,632	1,219	1,482	108	0.77
Soybeans	1,212	1,213	1,169	907	1,096	1,698	1,749	1,769	1,225	1,581	144	3.73
Grain sorghum	--	--	--	--	--	2,326	2,279	2,449	2,179	2,302	--	--
Wheat	764	857	757	883	832	610	908	655	957	840	101	0.01
Sweet potatoes	10,227	10,906	12,029	11,648	11,528	10,428	9,984	9,810	8,979	9,591	83	-1.82
Irish potatoes	6,160	6,667	6,743	7,075	6,828	8,653	9,504	8,686	9,530	9,573	140	3.44
Onions	4,825	5,494	5,174	5,336	5,335	6,630	7,476	7,982	8,642	8,033	151	4.18
Cassava	14,282	13,884	14,243	14,616	14,248	12,793	12,153	11,918	11,848	11,973	84	-1.72
Banana[a]	1,463	1,424	1,576	1,596	1,532	1,159	1,225	1,216	1,267	1,236	81	-2.12
Cashew nuts[b]	52,826	46,245	52,856	--	--	42,355	50,486	46,694	59,641	53,274	--	--
Orange	76,054	71,157	75,143	78,459	74,920	78,289	86,636	84,948	86,097	85,894	115	138
Cocoa	333	374	412	345	377	624	569	605	640	605	160	4.84
Coffee	1,307	787	1,080	806	891	1,148	670	1,004	1,161	945	106	0.59
Sugarcane	44,486	46,339	45,857	45,413	45,870	46,477	49,283	52,898	54,002	52,061	113	1.27
Tomatoes	14,625	17,518	18,024	17,534	17,692	22,365	24,705	24,967	26,198	25,290	143	3.64
Peanuts	1,374	1,391	1,084	1,244	1,240	1,280	1,372	1,402	1,280	1,351	109	-.86
Bahian coconut	6,038	6,853	7,579	6,034	6,822	3,067	2,916	2,950	2,896	2,924	43	-8.12
Castor	901	949	985	982	972	887	812	881	905	866	89	-1.15
Cotton (tree)	496	479	455	512	482	179	152	170	186	169	35	-9.95
Cotton (herbaceous)	496	--	--	--	--	859	849	952	753	851	--	--
Sisal	968	869	959	953	927	961	592	761	748	700	76	-2.77
Tobacco	906	862	931	936	910	1,126	1,065	1,146	1,234	1,148	126	2.35

[a]Bunches per hectare.

[b]Fruits per hectare.

Source: Fundacao Instituto Brasiliera de Geografia e Estatistica, Anuario Estatistico do Brasil (Brasilia, 1968, 1975, 1978, 1980).

Table 1-2. Harvested Area of Major Crops in Brazil, 1966-1968 and 1973-1980
(in 1,000 hectares)

Portuguese	English	1966	1967	1968	1973	1974	1975	1976	1977	1978	1979	1980
Part A. Annual Crops												
Abacaxi	pineapple	28	31	27	34	29	28	26	26	27	25	25
Algagão	cotton	3,898	3,720	3,902	4,319	3,845	3,877	3,409	4,097	3,951	3,640	3,688
Amendoim	peanuts	644	694	606	506	374	345	371	229	254	287	311
Arroz	rice	4,005	4,291	4,459	4,795	4,664	5,306	6,656	5,992	5,624	5,441	6,206
Avela		32	28	29	37	34	45	36	40	96		77
Batata doce	sweet potato	175	185	182	159	148	153	138	117	98		
Batata Inglese	Irish potato	199	217	227	189	192	191	200	196	211	202	181
Cana de acucar	sugarcane	1,636	1,681	1,687	1,959	2,057	1,969	2,093	2,270	2,391	2,517	2,608
Cebola	onion	51	48	51	49	52	52	58	61	57	69	68
Fava		164	195	187	184	200	199	178	179	182		
Feijao	beans	3,325	3,651	3,663	3,815	4,289	4,146	4,059	4,551	4,617	4,211	4,638
Fumo	tobacco	265	261	276	235	241	254	280	311	328	319	310
Juta	jute	34	43	48	58	35	28	48	34	17	25	26
Mammona	castor	347	361	377	496	641	399	267	254	350	373	438
Mandioca	cassava	1,780	1,914	1,998	2,104	2,006	2,041	2,094	2,176	2,149	2,107	2,044
Melancia	melon	113	127	126	104	85	83	67	65	69		
Milho	corn	8,703	9,256	9,585	9,924	10,673	10,854	11,118	11,797	11,125	11,313	11,438
Soja	soybeans	491	612	722	3,615	5,143	5,824	6,413	7,070	7,782	8,330	8,767
Tomate	tomato	39	41	44	43	53	47	47	52	56	56	49
Trigo	wheat	717	831	970	1,839	2,471	1,932	3,540	3,153	2,811	3,831	3,084
SUBTOTAL	26,646	28,187	29,166	34,464	37,233	33,760	41,102	42,570	42,195			
Part B. Perennial Crops												
Banana	banana	250	255	268	310	310	314	312	352	328	345	373
Cacao	cocoa	456	473	433	416	515	451	407	413	444	461	469
Cafe	coffee	3,057	2,792	2,623	2,080	2,155	2,217	1,121	1,941	2,184	2,226	2,207
Caja	cashew	73	77	72	66	85	110	123	135	154		
Cocode bala	Bahian coconut	101	109	114	133	149	157	159	160	163	158	165
Laranja	orange	165	167	173	449	350	403	414	422	454	547	572
Manga	mango	44	43	45	38	42	42	41	41	41		
Sisal	sisal	331	332	345	248	264	327	281	296	270	287	296
Uva	grape	67	65	73	58	53	58	61	60	58	59	57
SUBTOTAL	4,544	4,313	4,146	3,798	3,923	4,079	2,919	3,820	4,096			

Source: Fundacao Instituto Brasiliera de Geografia e Estatistica, Anuario Estatistico do Brasil (Rio de Janeiro, 1968, 1975, 1975, 1978); Commisao Especial de Palnejamento, "Control e Avaliacao das Estatisticas Agropecuarias" (Brasilia, Levantamento Sistematica da Producao Agricola, December 1979, 1980).

to the general rate of inflation (table 1-3), particularly and perversely for cassava and beans, two important staples of the poorest strata of Brazilian society. PROALCOOL promises to intensify this dynamic over the next decade regardless of the small area involved relative to Brazil's theoretical ultimate agricultural potential--which everyone agrees is vastly greater than its current output.

The implications of this negative prognosis are far-reaching for policy analysis. The alcohol program needs large second-order, strategic, or developmental benefits to be justifiable in the face of its rather poor showing in terms of strict market economics.[1]

If the program has significant adverse impact on the price of food, especially staples, it becomes far harder to justify. This is an important problem anywhere, but it is made more important by the fact that a considerable fraction of the Brazilian population is malnourished, with shortages notably in calorie intake.

The hypothesis is thus important; however, how credible is it? The short answer is that while it is early to be certain, the situation is very tight and the prognosis is likely to be correct, but less because of the intrinsic characteristics of a sugarcane-ethanol program than because of the general economic and institutional framework into which it has been inserted. Even with regard to the characteristics of a sugarcane-ethanol program, the reasons most generally cited are probably not the most important ones. The implication of these caveats is that the negative impacts of PROALCOOL on internal food supply can be considerably less than they are likely to be with the continuation of the policies in the agricultural sector which have predominated until recently. Indeed, a main benefit of PROALCOOL could be the pressure and political highlight it throws on these policies and their inevitable consequences.

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1. The Institute of Technical Research of São Paulo (IPT) estimated the cost of ethanol to be about $60-65 per barrel of gasoline, equivalent at a discount rate of 10 percent and allowing for a 20 percent higher efficiency in Otto cycle engines than gasoline [6]. World market prices for gasoline in 1981 varied between $40 and $45 per barrel.

Table 1-3. Prices Received by Farmers in Relation to the General Price Index = 1966-1978
Average for Brazil (1965-1767 average = 100)

English name	Portuguese name	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Average 1966-68	Average 1976-78
Paddy	Arroz em casca	101.6	93.7	81.3	75.2	97.5	104.6	98.1	123.3	154.0	100.9	84.5	107.2	98.4	97.5
Potatoes	Batata-inglesa	52.3	36.5	69.3	54.3	44.8	58.3	106.4	81.7	65.9	91.5	77.3	80.8	62.9	83.2
Beans	Feijao	64.8	61.0	102.0	110.9	96.8	83.6	185.8	133.1	121.4	211.8	162.4	106.4	79.3	160.2
Cassava	Mandioca	128.9	124.5	132.3	144.3	190.3	189.8	188.7	194.8	232.1	419.6	542.5	461.7	117.8	474.6
Corn	Milho	107.8	88.7	102.6	100.9	104.7	122.2	140.2	141.7	149.1	144.1	113.3	142.3	98.8	133.2
Wheat	Trigo	94.5	89.9	90.6	87.8	78.7	74.1	76.1	90.6	104.1	94.1	87.0	89.0	94.8	90.0
Soybeans	Soja	--	--	--	100.0	113.0	114.0	202.0	171.0	145.0	137.0	146.0	133.0	--	139.0
Sugarcane	Cana-de-acucar	88.3	91.2	98.4	95.7	92.8	92.0	95.2	104.8	128.5	133.1	126.7	124.3	93.2	128.0
Orange	Laranja	100.7	120.1	136.5	138.7	153.1	160.8	158.7	151.9	122.3	141.7	167.4	164.1	106.9	157.7
Coffee	Cafe-em-coco	85.9	104.4	127.1	191.7	163.5	180.6	253.6	253.1	275.4	518.1	648.6	409.6	96.8	525.4
Cocoa	Cacao	90.6	136.4	175.0	117.0	87.9	105.5	197.9	234.8	164.9	259.8	507.4	366.5	109.0	378.0
Peanuts	Amendoim	85.9	96.2	100.0	93.5	106.1	97.2	155.5	144.2	149.8	126.0	165.3	164.5	94.0	152.0
Cattle for slaughter	Boi gardo pl corte	88.3	78.0	74.5	85.2	101.1	110.2	142.1	155.4	129.0	111.5	109.1	136.1	88.8	117.6
Pigs for slaughter	Suino pl corte	99.2	92.5	101.0	103.5	101.4	129.3	138.3	180.0	144.7	120.1	140.8	130.5	97.2	130.5
Poultry	Frango de corte	94.5	89.9	78.6	90.0	90.6	89.2	108.0	113.8	102.6	93.0	87.9	90.1	94.8	90.3
Milk	Leite	94.5	89.9	93.8	96.5	98.2	102.8	116.1	140.6	157.4	137.3	142.1	141.7	94.8	140.4
Eggs	Ovos	92.2	90.6	82.8	89.6	88.4	87.3	105.6	107.3	94.3	93.4	89.4	86.8	94.3	89.9
All crops		95.3	96.9	92.3	120.0	119.5	126.2	158.4	162.7	173.1	245.3	274.6	217.6	97.4	245.8
Animal products		92.2	84.9	83.9	91.3	97.8	107.1	129.5	147.7	132.1	115.5	116.7	128.2	92.4	120.1
Food cost in Rio de Janeiro			100.0	103.3	103.4	104.7	107.3	114.6	111.3	111.7	113.6	114.9		113.4	

Source: Centro de Estudos Agricolas, Precos Recibidos pelos Agricultores (Rio de Janeiro, Fundacao Getulio Vargas, various issues).

Allocation of Agricultural Land

The most common criticism of PROALCOOL is that sugarcane requires good agricultural land, and that expansion has dislocated and will dislocate important food crops. There are three levels to this argument-- national, state/regional, and municipal. It is at the municipal level that the argument carries the greatest weight, but it is also at this level that existing policy can, in principle, be most effective. The key point here is that most rural municipios[2] depend heavily on local supply for their staple food. The distribution system is simply not adapted to longer range transport of foodstuffs, and when this is required, the cost is high [7]. In this case, if cane expands enough to cut into the self-sufficiency of several contiguous rural municipios, the local impact on food prices can be quite serious.

A good example of this problem is a recent strike of cane workers in the northeast of the country, where cane production is particularly concentrated. One of the principal objectives of the strike was to obtain the release of some cane land for subsistence food crop production. Control of this type of dislocation problem is completely within the current project approval routine of the planning agency, CENAL. The problem is that the volume of project applications is too small to allow the application of careful screening criteria, given current production objectives. An insignificant fraction of applications is rejected by CENAL.[3] The pressure to expand rapidly also tends to lead to a greater emphasis on expansion in areas with existing infrastructure where local competition for land is stronger.

At higher levels of geographical aggregation, however, land dislocation appears to be of less clear importance, despite the considerable analytical prominence it has received, both in analyses of the export subsector and in the recent work on alcohol itself. The basic reason for

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2. The municipio is a unit of government roughly comparable to the U.S. county.

3. A fraction of projects (about 15 percent) have difficulties at the bank financing stage which follows CENAL approval, but this stage does not involve evaluation of impact on food supply.

the author's relative depreciation of this aspect of the problem is that land, even potentially good agricultural land, is generally the most abundant factor of production in Brazilian agriculture.[4] If we are looking for conflict over factors of production, first principles suggest that it is those factors which are generally scarce rather than those which are generally abundant which will be critical. These scarce factors are capital, technology, management, and information flow.

Returning to land, however, the first point to be made is that while it is customary to speak of export "crops" and internal food supply "crops," such a crop-based distinction inherently ignores the contribution which so-called "export" crops make to internal supply. Most Brazilian sugar production, for instance, is absorbed inside the country, and, as table 1-4 shows, it is an important source of calories. Similarly, soybeans play an important and growing role in internal food supply. Most of the soybean oil remains in Brazil for human consumption (note oils and margarine in table 1-4 for direct contribution), while soy meal is an important input for animal rations (table 1-5), especially for poultry where production has increased at a very high rate (figure 1-1) because it is now the cheapest meat in Brazil.

It may therefore be useful to speak of the agricultural land resource involved in producing for export as well as simply categorizing the crop. This has been attempted for 1966-1968 and 1976-1978 in tables 1-6 and 1-7. If we compare this with the fairly complete estimate of harvested area in table 1-2, an interesting point emerges. The reader may calculate that land devoted to export barely increased its fraction of the total harvested area (from 17.4 percent to 20.0 percent). If we take a more traditional view and look at the total harvested area of export crops, the picture changes little (from 34.7 percent to 37.2 percent). Unless we postulate a significant decline in the intrinsic productivity of land brought into production during this decade, the "land dislocation" thesis will not get us very far at the national level.

---

4. While labor is also abundant in many regions of Brazil, it can be a constraint in some (7, 8).

Table 1-4. Calorific Intake Per Day, By Type Of Food, In Brazil São Paulo and Northeast Region, 1975

	São Paulo		Northeast Region		Brazil	
	consumption per day (10^9 kcal)	percent of consumption	consumption per day (10^9 kcal)	percent of consumption	consumption per day (10^9 kcal)	Percent of consumption
Cereals	17.8	39.5	16.6	26.9	81.1	35.6
Rice	(11.4)		(7.8)		(43.4)	
Corn	(0.5)		(3.5)		(9.4)	
Wheat and products	(5.6)		(5.2)		(26.9)	
Roots	1.0	2.2	15.9	25.7	25.2	11.1
Cassava (incl. flour)	(0.4)		(15.0)		(21.6)	
Sugar and derivatives	6.3	14.0	6.8	11.0	29.8	13.1
Beans	4.0	8.9	10.4	16.8	25.7	11.3
Vegetables	0.6	1.3	0.3	0.5	2.1	0.9
Fruits	0.9	2.0	1.1	1.8	4.2	1.8
Meats and fish	3.8	8.4	5.7	9.2	19.9	8.7
Beef	(1.5)		(2.4)		(8.2)	
Fish	(0.3)		(0.7)		(1.9)	
Eggs, milk, cheese and oils	10.2	22.6	4.7	7.6	37.7	16.6
Oils and margarine	(5.3)		(1.7)		(14.7)	
Beverages	0.5	1.1	0.3	0.5	1.9	0.8
	45.1	100	61.8	100	227.6	100

Note: Estimates of calorie intake are for entire geographic region, not for individuals.

Source: Anuario Estatistico do Brasil, 1978.

Table 1-5. Detailed Derivation of Domestic Brazilian Consumption of Soybean Oil and Meal as Fraction of Total Production Equivalent in Soybean Grain (10^3 tons)

	1966	1967	1968	1972	1973	1974	1975	1976	1977	1978	1979[2]	1976-1978	1966-1968
Total production-soybeans	595	716	654		5012	7876	9893	11227	12513	9541	9949	11094	655
Equivalent production-soya oil[1]	107	129	118		902	1418	1781	2021	2252	1717	1791	1997	118
Equivalent production-soybean meal[1]	446	537	491		3759	5907	7420	8420	9385	7156	7462	8320	491
Export-unmilled soybeans	121	305	66	1037	1786	2730	3333	3639	2587	659	638	2295	164
Equivalent in soya oil[1]	22	55	12		321	491	600	655	466	119	115	413	30
Equivalent in soybean meal[1]	91	229	50		1340	2048	2500	2729	1940	494	479	1721	123
Soybeans not directly exported	474	411	588		3226	5146	6560	7588	9926	8882	9311	8799	491
Equivalent in soya oil[1]	85	74	106		581	926	1181	1366	1787	1599	1676	1584	88
Equivalent in soybean meal[1]	356	308	441		2420	2860	4920	5691	7445	6662	6983	6599	318
Export-soya oil	0	0	0	60	91	2	264	497	502	504	524	501	0
Export-soybean meal	171	123	225	1343	1562	2021	3134	4356	5329	5407	5171	5031	173
Nominal domestic consumption-soya oil	85	74	106		490	924	917	769	1285	1095	1152	1083	88
Nominal domestic consumption-soybean meal	185	185	216		858	1839	1786	1335	2116	1255	1812	1569	195
Domestic consumption as fraction of total production equivalent of = (a) soya oil (%)	79%	57%	90%		54%	65%	51%	43%	57%	63%	64%	54%	75%
(b) soybean meal (%)	41%	34%	44%		23%	31%	24%	16%	23%	18%	24%	19%	40%

Source: Fundacao Instituto Brasiliero de Geografia e Estatistica, Anuario Estatistico do Brasil (Rio de Janeiro, various issues, 1968-1980).

[1]One ton of soybeans as harveted ("soja em grao") is estimated to yield 0.75 tons of soybean meal (farelo) and 0.18 tons of oil.

[2]Preliminary estimate requiring confirmation.

Table 1-6. "Export Crops"--Derivation of Area Actually Required for Export Demand from Total Area in Each Crop, Average for 1966-1968

	Total area in crop (thousands of hectares)	Total production (thousands of tons)	Apparent domestic consumption (%)	Area assumed for export (thousands of hectares)
Soybeans	608	655	53%[a]	285
Sugarcane	1,668	4,134 (sugar)	72%[b]	465
Coffee	1,824	1,512	11%[c]	2,515
Cocoa	454	171	n.a.	455
Oranges	168	12,626	74%[d]	45
Cotton	3,840	1,852	72-76%[e]	920-1,075
Peanuts	648	800	70%[f]	195
Sisal and jute	378	356	55%[g]	170
Castor bean	362	351	n.a.	360
Tobacco	267	243	80%[h]	55
TOTAL	11,217			5,465-5,620

Note: n.a. = not available.

Source: Fundacao Instituto Brasiliero do Geografia e Estatistica, Anuario Estatistico do Brasil (Rio de Janeiro, various issues, 1968-1980).

[a]Table 1-8 shows the estimated export and domestic consumption of soya oil and meal equivalents. In 1966-1968, Brazil produced the equivalent of 118,000 tons of oil and 491,000 tons of meal, of which 88,000 tons of oil and 195,00 tons of meal were consumed domestically. Remainder of calculation as for 1976-1978.

[b]Sugar exports averaged 1,139,00 tons in 1966-1968.

[c]We assume same average per capita consumption of coffee as in 1976-1978, assuming a population of 113,2 million in 1976-1978 and 85.5 million in 1966-1968, or a domestic consumption of 272,000 tons.

[d]We calculate as for 1976-1978 using a population of 85.5 million.

[e]Cotton exports averaged 245,000 tons per year. Calculating as for 1976-1978, we obtain an input of cotton as harvested of 490,000 tons per year or 26 percent of the total (assume 24-28 percent).

[f]Direct peanut exports averaged 13,000 tons in 1966-1968. Peanut oil averaged 2,600 tons and meal averaged 135,200 tons. Calculating as for 1976-1978, we obtain 230,000 tons plus 13,000 tons exported directly.

[g]Exports of jute and sisal averaged 135,000 tons. Assuming 85 percent of harvested material recovered in processing, harvested inputs are 159,000 tons.

[h]Average exports were 43,500 tons. Calculating as for 1976-1978, we obtain 48,000 tons.

Table 1-7. A First Approximation of the Area Required to Provide Major Raw Materials for Brazilian Agricultural Based Exports, Average for 1976-1978

	Total area in crop (thousands of hectares)	Total production (thousands of tons)	Apparent domestic consumption (%)	Area assumed for export (thousands of hectares)
Soybeans	7,090	11,649	32%[a]	4,820
Sugarcane	2,251	7,544 (sugar)	75%[b]	565
Coffee	1,748	1,746	21%[c]	1,380
Cocoa	421	255	n.a.	420[d]
Oranges	431	36,932[e]	33%[e]	290
Cotton	3,819	1,578	80-90%[f]	380-764
Peanuts	285	385	35-40%[g]	170-185
Sisal and jute	315	227	5-15%[h]	270-300
Castor bean	290	253	n.a.	290[d]
Tobacco	306	354	65%[i]	105
TOTAL	16,956			8,690-9,119

Note: n.a. = not available.

[a]Table 1-5 shows the estimated export and domestic consumption of soya oil and meal equivalents. In 1976-1978, Brazil produced the equivalent of 1,997,000 tons of oil per year and 8,320,000 tons of meal, of which 1,083,00 tons of oil and 1,569,000 tons of meal were consumed domestically. The relative preponderance of domestic oil consumption (54 percent of total) versus domestic meal consumption (19 percent of total) and the price difference between these commodities suggests a calculation weighted by relative price to determine the percentage of domestic consumption. The price of oil was assumed to be 2.6 times that of meal per ton based on various market quotations.

[b]Sugar production averages 7,544,000 tons per year in 1976-1978. Exports averaged 1,861,000 over this period. The PROALCOOL program is assumed not to have significantly influenced the area of planted cane on average for this period.

[c]A rather approximate estimate. It is assumed that coffee consumption per capita in Brazil is 4.5 kg/year (Ann. Est., 1978, p. 236). With an estimated 1977 population of 113.2 million, consumption in that year is estimated at 509,000 tons. However, from Ann. Est. (1979, p. 442), we find that the average consumption of coffee (1976-1978) by Brazilian industry was 405,000 tons/year. In those years, soluble coffee exports averaged 40,000 tons. Roughly, then, domestic consumption was 360,000 tons.

[d]Where no basis for even a rough calculation existed, we assume that all the area is dedicated to exports.

[e]Estimates complicated by fresh fruit data including the harvested crop is in numbers of fruits, while juice (which now dominates exports) is in tons, with an unknown conversion factor. We resort to 1966-1968, when juice exports were small. Substracting exported fruits from total production, we obtain an apparent domestic consumption of 115 fruits *per capita* per year at this time, or perhaps 110, allowing for small juice export. Positive income elasticity for fruit has probably increased this figure since, but to be conservative we use it. With 1977 population, this comes to 12.5 billion fruits, or one-third of total output.

[f]Exports of cotton (in various forms) averaged 101,000 tons/year in 1976-1978 (*Ann. Est.*, 1979, p. 506). The problem is to relate this to cotton as harvested, which contains substantial amounts of material other than textile fiber. Indeed, some of this (cottonseed oil) is also exported. For lack of better evidence, we shall assume, very conservatively, that only 50 percent of the weight of cotton as harvested ends up as textile fiber. Thus 1.58 million tons of cotton as harvested yeilds 0.8 million tons of textile fiber as an average for 1976-1978. Exports thus accounted for 12.5 percent of production.

[g]Direct peanut exports averaged 24,000 tons (with and without shells). Peanut oil averaged 67,000 tons and meal averaged 63,000 tons. If we estimate conservatively that the yield of oil and meal is 60 percent of the weight of the peanut in the shell, then these figures imply an input of 216,000 tons of peanuts as harvetsed plus 24,000 tons exported directly. Total 240,000 tons as a rough approximation out of a total production of 385,000. No attempt was made to refine the calculation on a value basis.

[h]Average exports of jute and sisal products were 176,000 tons. No information is available on processing losses from harvested material. If we assume 85 percent recovery, 207,000 tons are exported.

[i]Average exports were 112,000 tons. If we assume 90 percent of harvested material (this is conservative, since 95 percent of exports of tobacco are in the form of leaf), we obtain an input of 125,000 tons.

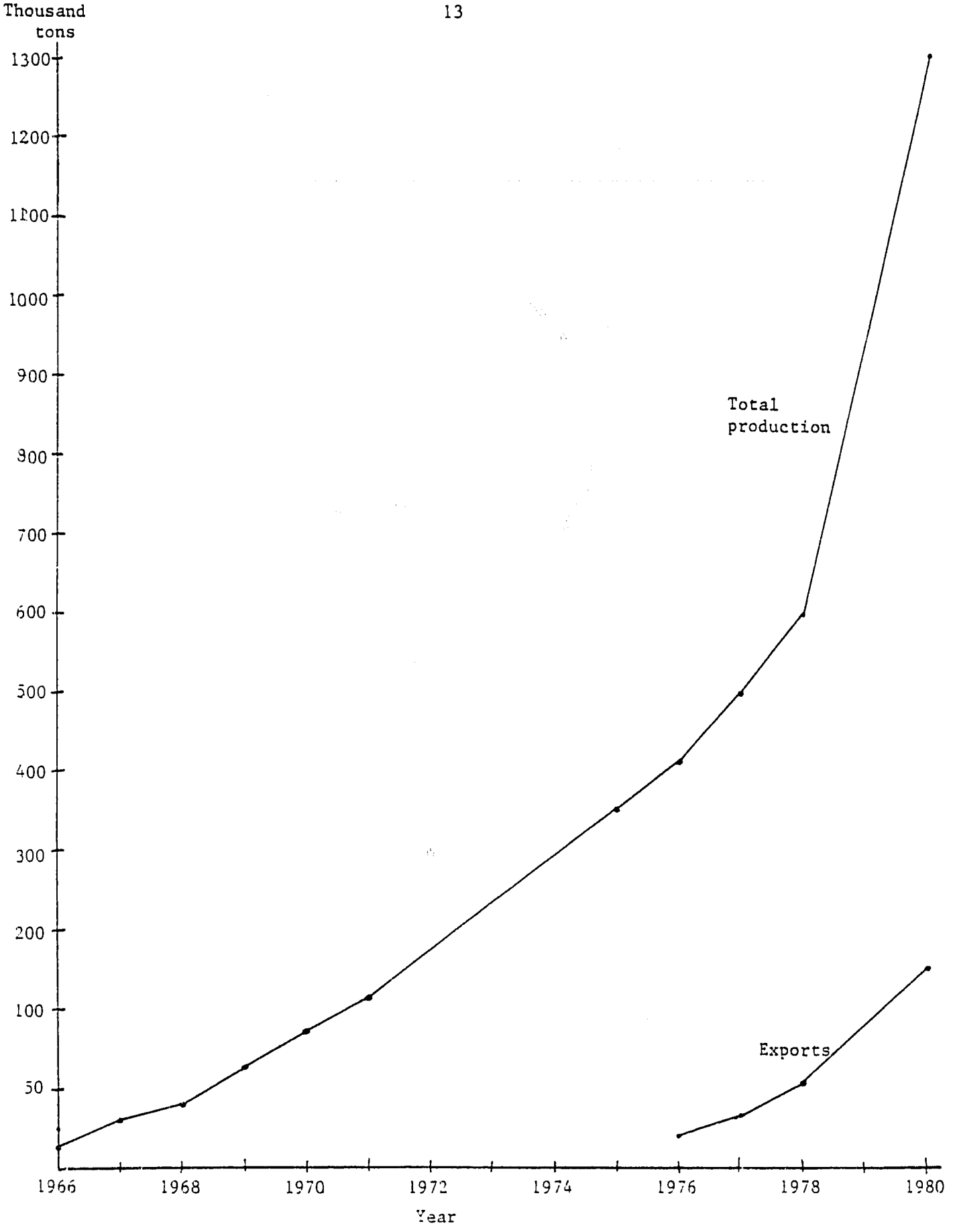

Figure 1-1. Poultry Production and Exports, Brazil

Source: Fundacao Instituto Brasilieiro do Geografia e Estatistica, Anuaro Estatistico do Brasil (Rio de Janeiro, various issues, 1968-1980).

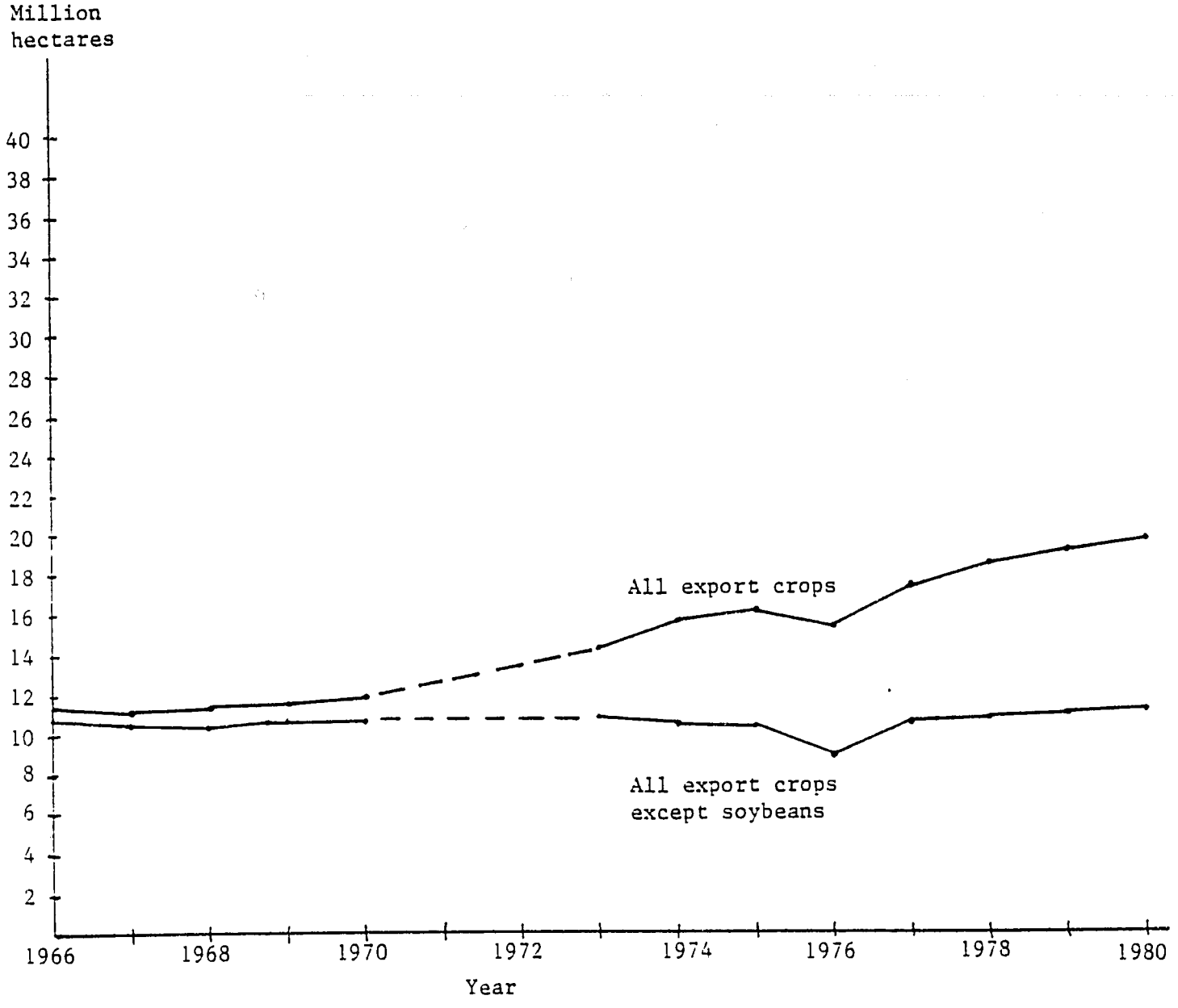

Figure 1-2. Harvested Area of Export Crops, 1966-1980

Source: Fundacao Instituto Brasileiro do Geografia e Estatistica, Anuario Estatistico do Brasil (Rio de Janeiro, various issues, 1968-1980).

But a regional instead of national view will reinforce this view even further. By far the most important agricultural area in Brazil is comprised of the four southern states--Rio Grande do Sul, Parana, Santa Catarina, and São Paulo. It is these states which also experienced the most important increases in the area of export crops in 1966-1968. Consider, for example, figure 1-2, which sums the total area harvested for "export crops." Note that all the net increase was for soybeans. Almost all the harvested area of soybeans was in these states. If any area of Brazil should have experienced dislocation of land, it was these states which constitute by far the most important agriculture area of Brazil. But what do we find happening among the classic four "internal supply" crops of Brazil--rice, beans, corn and cassava? Their rate of development as a whole was the same as in the country at large, despite the concentrated expansion of export crops in the region.

Table 1-8 shows that between 1966-68 and 1976-78 the proportion of regional rice production compared to national production decreased about 5 percent, corn and beans increased by 7-10 percent, and cassava decreased by more than 30 percent--which is to say that overall, on a caloric basis, the

Table 1-8. Production of Internal Food Supply Crops in Parana, Santa Catarina, Rio Grande do Sul, and São Paulo Relative to Brazil, 1966-1968 and 1975-1978

	Production in four states		Total production in Brazil		Four states as a percent of total in Brazil	
	1966-68 (10^3 t)	1975-78 (10^3 t)	1956-69 (10^3 t)	1976-78 (10^3 t)	1965-68 (%)	1976-79 (%)
Rice	2,764	3,997	6,415	8,682	43	41
Beans	1,030	994	2,372	2,108	43	47
Corn	7,521	10,942	12,336	16,859	61	65
Cassava	9,789	5,772	27,060	25,610	36	23
Total	14,112	17,142	29,854	34,966	49	49

Note: Since cassava roots have solids content of about 25 percent the tonnage of cassava shown has been divided by 3.5 to make it roughly equivalent to the grains when adding the total.

Source: Fundacao Instituto Brasilerio de Geografia e Estatistica, Anuario Estatistico do Brasil, (Rio de Janeiro, 1968, 1978).

proportion remained about constant. The sharp decline of cassava deserves some comment--especially since a casual perusal of the literature would suggest that this crop suffered by far the greatest shortfall by the end of the decade [5]. Estimates in 1975 suggest that approximately 50 percent of cassava production in Brazil was consumed as animal feed [9]. ENDEF data (also for 1975) also suggests that human consumption is higher in rural areas and in the northeast (table 1-9).

It would not be surprising if the decline in production of cassava were related to substitution by corn for animal food and by urban migration. However, this answer is in part contradicted by the intense escalation in price which cassava suffered in general (table 1-3). Furthermore, this price escalation was the highest in Brazil in two of these states. On the other hand, in two others (São Paulo and Santa Catarina) price escalation was well below the average for Brazil, and the price of cassava received by farmers was one-quarter to one-fifth that in Parana and Rio Grande do Sul in 1978. All this adds up to a complicated puzzle about which it is difficult to generalize--except that cassava evidently has a highly localized market. This suggests that cassava might best be considered as a special case of the rural municipio supply situation discussed earlier.

This perspective on land competition gives a very different impression from the more usual type of analysis which looks at proportions of cropland in different crops and ascribes a shift in proportion to dislocation, even in a context where the overall cropland base is growing [4, 10] and where the harvested area of a dislocated crop has increased (though at a slower rate than the total harvested area). It is recognized that this methodology tends to overestimate the impact of dislocation, especially in rapidly growing agricultural systems. The key criticism in such systems is that the methodology assumes overall growth would have occurred at the same rate without the dynamism of the dislocating crop [3]. The case just discussed of internal food crops in the four states where dislocation would be most intense suggests this may not be so. The methodology is probably most successful at the level of the small region, but all this tells us is that dislocation has occurred. It tells us almost nothing, by itself, of how important this dislocation is. To take an extreme example, coffee is declining in Parana but it is increasing rapidly in Minas Gerais. The

point here is not to argue that land dislocation is not or cannot be important, but rather that it has been overemphasized in most analyses to date.

Table 1-9. Consumption of Beans and Cassava by Region in Urban and Rural Areas in 1975

	Total consumption		Purchased with money	
	Feijão (kcal/day)	Cassava (incl. flour) (kcal/day)	Feijão (%)	Cassava (incl. flour) (%)
Region I-Rio de Janeiro	183.7	61.9	94	88
Metropolitan Rio de Janeiro	177.9	44.0	97	93
Urban non-metropolitan	181.8	66.9	93	90
Rural	229.2	190.6	72	77
Region II-São Paulo	186.5	18.5	88	71
Metropolitan São Paulo	169.6	13.6	96	90
Urban non-metropolitan	172.5	18.6	93	66
Rural	251.2	29.8	68	58
Region III-South	205.9	84.1	48	42
Metropolitan Curitiba	153.2	14.0	85	79
Metropolitan Porto Alegre	123.3	28.1	93	63
Urban non-metropolitan	149.4	52.9	84	74
Rural	254.5	115.9	31	32
Region IV-Minas Gerais	237.9	103.6	53	54
Metropolitan Belo Horizonte	146.1	20.3	95	86
Urban non-metropolitan	190.0	66.0	84	81
Rural	300.0	155.5	33	43
Region V-Northeast	280.5	466.8	46	59
Metropolitan Fortaleza	221.3	176.5	84	88
Metropolitan Recife	149.6	213.5	93	93
Metropolitan Salvador	149.7	272.8	97	96
Urban non-metropolitan	202.4	343.2	73	83
Rural	346.2	588.0	33	48
Region VII-North and Centra West	136.4	250.8	78	78
Metropolitan Belem				
Urban non-metropolitan in Rondonia, Amazona, Roraima, Para, Amapa				
Urban non-metropolitan in Mato Grosso and Goais				

Source: Fundacao Instituto Brasileiro de Geografia e Estatistica, Estudo Nacional de Despesa Familiar (Rio de Janeiro, 1978).

Crop Yields

In the author's view, an indicator for the poor performance of internal food supply crops (see table 1-10) which is far more important than land dislocation has been the problem of poor yields. An idea of the magnitude of the importance of yields can be obtained from a simple calculation. If we assume that yields for each of the major internal food crops had increased by 2 percent per year between 1966-1968 and 1976-1978, the difference between what would have been produced and what was actually produced works out, when translated back to area (using the actual yields of 1976-1978), to 7.4 million hectares. This is more than the entire net increase in harvested area for either soybeans or all export crops in that period. Given the low yields for these crops in Brazil relative to even modest estimates of potential, there is no basic reason why this kind of rate of yield increase could not have been achieved. Indeed, if we take an area-weighted estimate for "export" crops, the rate of yield increase actually achieved was higher (about 2.5 percent per year) between those years.

Pricing

The reasons for whatever land dislocations which took place and the stark difference in yield performance are, of course, related, and have to do with the prices received for given products (and their stability) and the cost, availability, and efficiency of use of inputs to produce these products. Relative prices received by farmers are clearly a potentially important reason, and this causative theory has received considerable emphasis and analysis. The author, however, will concentrate in this paper on issues on the input side. The reason for this choice is that received price seems to be most relevant as an explanatory factor in a well developed, relatively free market economy where producers have approximately equal access to essential inputs for major crops and use them with comparable efficiency. This is clearly not the case in Brazil, as can be judged from the extraordinary number of anomalies in the picture of relatively rising prices for a product leading to increased output or planted area. The reader is referred to table 1-3, which shows average national prices

received by farmers between 1966 and 1978. Beans and cassava experienced the sharpest increase in prices received over the decade, far greater than soybeans or sugarcane, but their production performance was abysmal. Corn was, according to most studies, heavily dislocated by cane and soya but its average price increased approximately as much as that for soya and cane (while beans, cassava, and peanuts, also displaced, increased much more in received price). The three export crops which increased most in price (coffee, cocoa, and peanuts) actually experienced declining planted areas. Finally, the one subsector of Brazilian agriculture which has expanded as fast or faster than soya (poultry), experienced a decline in prices received by farmers.

The most obvious explanation for these anomalies is that the evolution of return on investment has been quite different than that of prices. Ultimately this must be related in an important way to differences between crops in the development and diffusion of improved technology, with corresponding differences in the evolution of productivity of inputs. There have been great differences between crops in this respect, and it is probably fair to say that (in general) these differences are due more to government policy than to biological distinctions. Somewhat related to the problem of return on investment is the stability of return on investment--with crops for internal supply generally demonstrating greater instability. Experience in Brazil suggests that this relative instability has been prejudicial to their development.

Finally, while it is all very well to speak of return on investment, it is crucial not to forget that the producer must first of all have the capability to invest, which is to say that in agriculture he must have access to credit. Access to credit has been flagrantly different for typical producers of different crops, with crops for internal supply again suffering a disadvantage.

We shall enlarge on these observations, but first we make the following composite hypothesis about the past--which also has considerable relevance for the future. The key problem for internal food supply in the decade of the seventies was not the rapid development of export crops. Internal food supply could have grown at a much more satisfactory rate without greater government expenditures, with ultimately lower inflationary pressure and with little negative impact on exports. To blame the growth

of export crops for internal supply problems is to look for a scapegoat. To isolate government policies favorable to export crops for criticism is to gloss over the wider problem of Brazilian agricultural policy, though given those problems the export drive did exacerbate domestic food supply.

Brazilian Agricultural Policy

Agricultural Credit

Let us return to the three brief observations made above regarding productivity of inputs, stability of income and access to credit. Because of the sheer mass of resources involved, agricultural credit is a suitable place to begin. Data for agricultural credit were only available for 1969-1976. The author's inquiries suggest that 1976 is the most recent year for which any reasonable breakdown of statistics is available outside of the government.

Virtually all agricultural credit in Brazil is ultimately financed by the Brazilian government. Regular private commercial credit (which, for example, heavily predominates in the United States) barely exists. From 1969 through 1976, the amount exploded in real terms as shown in figure 1-3 (reaching 6 percent of GNP). Unfortunately, this large increase in credit has not led to a concomitant increase in either production (see table 1-10) or harvested area (see table 1-2). While this result is qualitatively to be expected from the law of diminishing returns, the quantitative shift is surprising, even allowing for the fact that cost inflation from 1970-1977 for prices paid by farmers was higher than the general price inflation [11]. There is considerable evidence, in fact, that an important part of the credit does not lead to a net increase in investment in agriculture.

An important reason for this is that agricultural credit is available on very generous terms. From 1969 to 1973 the rate of interest (15 percent) was close to, but below the rate of inflation. From 1974, the rate of interest has been well below the rate of inflation. From table 1-11, it is estimated that approximately 30 percent of the $130 billion cruzeiros loaned in 1976 was a subsidy which is equivalent to 10 percent of domestic savings in that year. While this figure is higher than most, it could be conservative because inflation has increased since 1976, which must be taken into account for medium term loans. The temptation is certainly

Table 1-10. Production of Major Crops
(thousands of tons)

	1966	1967	1968	1976	1977	1978	Average 1959-1961	Average 1966-1968	Average 1976-1978
Rice	5,802	6,792	6,652	9,757	8,994	7,296	4,763	6,415	8,682
Beans	2,146	1,548	1,420	1,840	2,290	2,194	1,675	6,415	2,108
Corn	11,371	12,825	12,814	17,751	19,256	13,569	8,498	12,337	16,859
Soybeans	595	716	654	11,227	12,513	9,541		655	11,094
Wheat	615	629	856	3,216	2,066	2,691	623	706	2,657
Sweet potato	1,913	2,226	2,120	1,378	1,074	882	1,276	2,086	1,111
Irish potato	1,319	1,467	1,606	1,898	1,896	2,014	1,073	1,467	1,936
Onion	277	250	273	431	488	488	196	267	469
Cassava	24,710	27,268	29,203	25,443	25,929	25,459	17,415	27,060	25,610
Banana[a]	356	403	422	382	428	416	257	394	409
Cashew[b]	3,398	4,085	4,540	6,208	6,712	9,204	2,241	4,008	7,375
Orange[b]	11,767	12,523	13,587	35,841	35,823	39,132	8,387	12,626	36,932
Tomato	678	745	775	1,167	1,295	1,465	399	733	1,309
Cocoa	170	195	149	232	250	284	166	171	255
Coffee	2,406	3,015	2,115	752	1,951	2,535	4,491	2,512	1,746
Sugarcane	75,788	77,087	76,611	103,173	120,082	129,145	56,605	76,495	117,470
Peanuts	895	751	754	510	321	325	450	800	385
Castor bean	329	355	370	217	224	317	205	351	253
Cotton (tree)	1,865	1,692	1,999	357	439	462	1,612	1,852	1,577
Cotton (herbaceous)				905	1,463	1,108			
Tobacco	228	243	258	299	357	409		243	355

Source: Fundacao Instituto Brasiliero do Geografia e Estatistica, Anuario Estatistico do Brasil, (Rio de Janeiro, 1961, 1968, and 1978).

[a]Millions of bunches.

[b]Millions of fruits.

Table 1-11. Breakdown of Agricultural Credit in Brazil by Function and With Estimate of Subsidy[a], 1976

	Credit extended (10^9 cruzeiros 1976[c])	Estimated subsidy (10^9 cruzeiros 1978)
Crops - subtotal	92.95	26.83
Credit for planting and operations (custeio agricola)	46.99	4.23
Chemical and seed[b] inputs	20.14	4.23
Other	26.85	4.30
Investment	21.70	13.45
Machinery and equipment	11.00	
Other	10.70	
Commercialization	24.26	4.85
Animals - subtotal	37.27	12.72
Credit for operations	7.96	n.a.
Investment	20.51	12.72
Commercialization	8.80	n.a.
TOTAL	130.22	39.55

Note: n.a. means no attempt was made to calculate.

Source: Grupo de Informacao Agricola, Fundacao Getulio Vargas (Rio de Janeiro, interview).

[a]Estimate of subsidy based on the relation of interest rate to rate of inflation plus a 4 percent real interest rate. Nominal payback times used were 6 months for custeio, 9 months for commercialization, and 42 months for investment.

[b]Rice, brans, cassava, and corn: (10^9 cruzeiros 1976)
custeio 13.05
commercializaton 5.90

[c]One 1976 dollar equaled 10.76 cruzeiros.

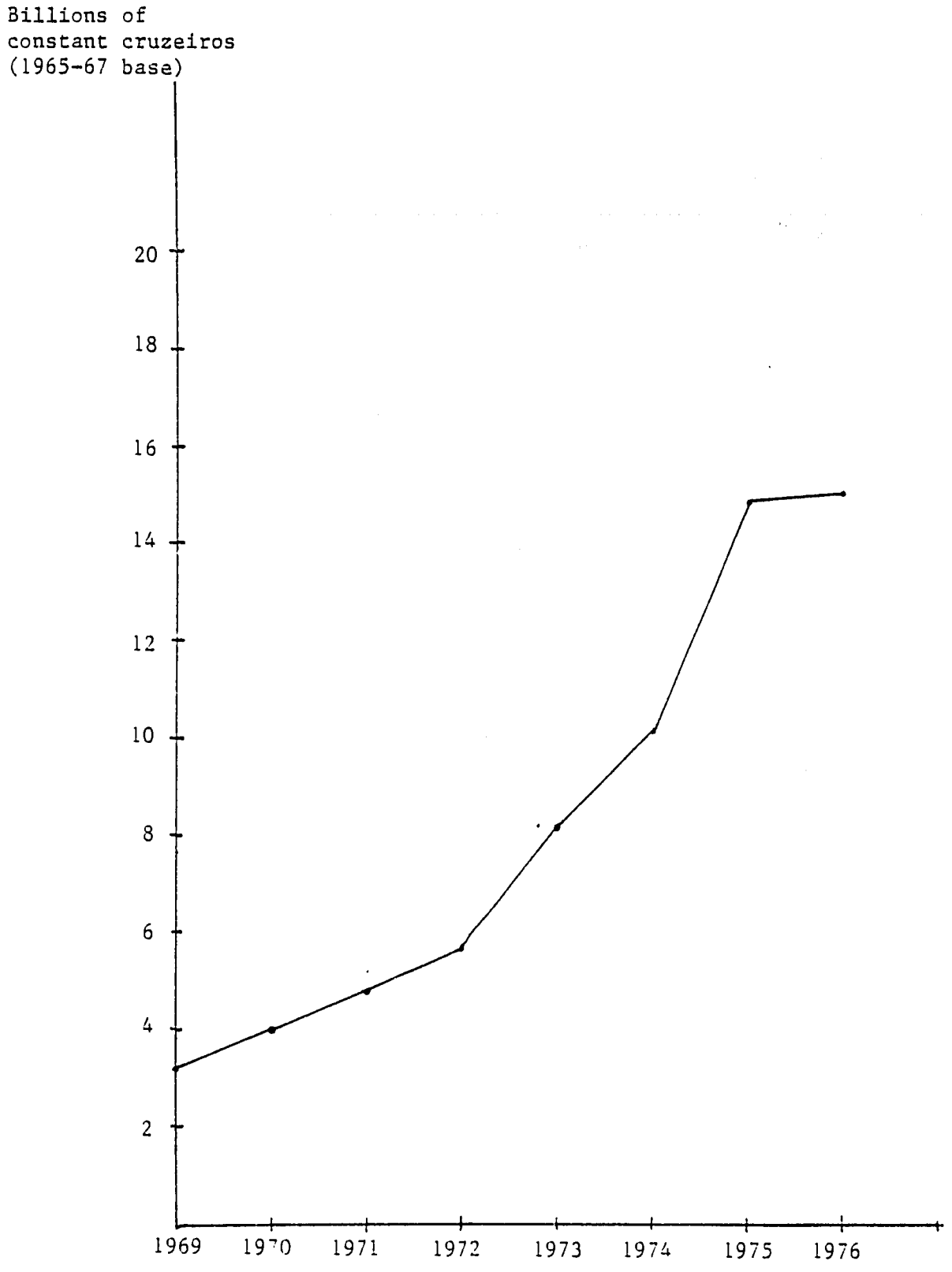

Figure 1-3. Growth of Rural Credit in Brazil

Source: Grupo de Informacao Agricola, Getulio Vargas, Interview (Rio de Janeiro).

Notes: [a]In 1974, a program of subsidies was added to other existing rural credit programs; this is included here though in the source it is not included in the total for rural credit.

[b]To give a rough idea of the magnitude in dollars, the 1976 figure is equivalent to $12.2 billion (1976 follars).

there to use rural credit as a cheap source of capital directly or indirectly for investments in other sectors. The steep rise in rural land values in the south and southeast appears to be related to this phenomenon. At any rate, it is estimated that at best in the mid-1970s, each cruzeiro of credit led to only 70 centavos increase in investment in agriculture. Furthermore, the distortions introduced by the subsidy have helped to ensure that an important part of these investments have been seriously sub-optimized. This appears to be particularly the case with farm machinery which, because of longer repayment periods, benefited especially from subsidized interest rates (on the order of 60 percent of the cost) and amounted to about Cr. $1 billion in credit (a little less than 10 percent of the total) in 1976. The steep rise in credit is directly related to the rapid increase in tractor production in the early seventies (table 1-12).

Table 1-12. Tractor Production in Brazil (excluding crawlers), 1972-1980

	Produced	Sold domestically	Exported
1972	35,549	n.a.	n.a.
1973	44,211	n.a.	n.a.
1974	52,741	n.a.	n.a.
1975	65,666	61,804	n.a.
1976	71,713	67,185	499
1977	59,331	51,613	4,615
1978	54,929	45,627	6,193
1979		55,684	7,455
1980		57,222	8,080

Note: n.a. = not available.

Source: "Agricultura," Visao, (São Paulo, 11 May 1981), pp. 35-98.

The allocation of this credit clearly favored export crops over crops for internal supply. There are several indications of this. If we take credit for annual operating costs and commercialization (about 75-80 percent of the total credit for crops), only 27 percent of the total went to corn, rice, beans, and cassava. (Another 8 percent went to wheat, which is, however, a special case of government-stimulated import substitution.) Beans and cassava combined received less than 2 percent of this credit. In

this light it is not hard to see why their production stagnated despite sharp increases in prices received. The remainder was accounted for by medium-sized producers.

Another way of looking at the issue is to see how allocations evolved in terms of farm size, since small farms are the principal producers of corn, beans, and cassava. In 1969, small producers received 34 percent of the value of credit, and large producers 21 percent. By 1976 the proportions had more than reversed, to 11 percent and 54 percent respectively.

A key and predictable problem with delivering credit to small producers through banking institutions was the need for collateral customarily required, and the higher cost of processing loans. Until 1981, there appears to have been little serious effort to address this problem. (The author has not had an opportunity to review the 1981 changes in policy.)

Thus, rural credit shows two aspects. This is the allocation of two-thirds of working capital (and probably also longer term investment capital) to export crops under subsidized terms. Second, these terms have generated some waste and apparently considerable diversion of credit to non-agricultural purposes.

The magnitude of the conservatively estimated 30 percent diversion of agricultural credit from agriculture deserves some comment. Assume that only half could have been avoided--that would be equivalent to a 25 percent increase in the working capital[5] for corn, rice and wheat, plus a ten-fold increase in cassava and beans, and a couple of hundred million dollars left over, in one year, for longer term investments. It can be safely said that if this sort of injection of capital had occurred as a pattern in the seventies, Brazil's internal food supply situation would have looked quite different, and would look quite different today. There is general agreement that this diversion of credit to investments in other sectors is

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5. Comprised of "custeio" or operating costs for production and marketing or "commercializacao," which in 1976 comprised 77 percent of total credit for all crops.

a result of the subsidies granted to agricultural credit, subsidies which amounted to 2 percent of GNP at a minimum.[6]

Would it have been possible for Brazil to have maintained a comparable export crop drive with credit available for producers at essentially commercial terms, or did export success depend on subsidies? The author has not been able to explore this issue in any depth, but it is at least suggestive that in 1969-1973, when subsidies were considerably lower, export growth was at least as rapid as since. This was when, for example, sugar and soybeans rocketed in terms of physical exports. Since then sugar has gone nowhere (table 1-13), while soybeans have begun to look like a semi-mature industry (figure 1-4). Their most vigorous growth occurred before the greatest growth in rural credit (figure 1-3) and in the rural credit subsidy. In the case of soybeans, it was occurring before the price peak of 1973/74 (figure 1-5). It is arguable that some subsidy was useful for some crops, but it is almost certainly less than was given by the mid-seventies. This competitiveness existed despite the indisputable fact that the agricultural sector has been carrying the weight of inputs from the domestic industrial sector above world market prices (see, for example, table 1-14 for fertilizer prices), and, as well, carrying the burden of a

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6. An interesting accompaniment to the discussion here of rural credit is the following recent quote (translated) from Mario Henrique Simonsen, former Minister of Planning.

> "There are agricultural producers who receive large subsidies. In general, though, it is those who receive no subsidy who really set the cost of the agricultural product. The others just get something more. This something more sometimes stimulates agricultural production, but often it only stimulates demand for urban real estate. Let's be frank, I had a lot of experience with this at the Treasury Department. The variations in agricultural credit are reflected much more in the price quotations for land and urban buildings than in agricultural production. I'm not saying that the credit funds themselves are detoured. There are a few cases of this, but usually the credit is applied in the agricultural sector itself. What happens, though, is that the agriculturalists own financial resources which cease to be used for agriculture. This is a reaction to the policy of indiscriminate subsidy."

Source: Roy Mesquita, ed., Jornal da Tarde, Em Discussao, o Brasil, São Paulo, 1981.

Table 1-13. Brazilian Sugar Exports

	Brazilian exports (10^3t				
	Crystallized sugar (gross)	Demerera sugar (gross)	Refined sugar	Molasses	Total excluding molasses
1968	--	1,026	--	142	1,026
1969	--	1,099	--	127	1,099
1970	--	1,125	--	288	1,125
1971	70	1,191	33	421	1,294
1972	480	2,054	2	587	2,536
1973	444	2,354	22	799	2,820
1974	487	1,767	102	1,004	2,356
1975	279	1,235	216	882	1,730
1976	206	601	361	844	1,168
1977	294	1,536	625	1,041	2,455

Source: Fundacao Instituto Brasileria da Geografia e Estatistica, Anuario Estatistica do Brasil (Rio de Janeiro, various issues, 1968-1980).

monetary exchange policy (according to some specialists) that has favored industry vis-a-vis export agriculture.

Research and Development

Research and development to improve productivity of inputs has been the second great area where crops for internal supply have suffered. It has been pointed out that government research budgets have consistently emphasized export crops. What has perhaps not been emphasized adequately is that this R&D has, by and large, paid off.[7] The real problem, at least until recently, has been the small amount of resources devoted to agricultural R&D as a whole. In 1976, the total budget of EMBRAPA (the federal agency for agricultura and forest research) was only $70 million, about 3 percent of the subsidy committed in that year for medium term private agricultural investment. This deprecation of domestic scientific and technical development is endemic in most sectors of Brazil, despite

7. Conversations with technical people suggest that it might have paid off even more in certain sectors (for example, sugar) if they had been subjected to more severe and sustained competitive pressure to increase productivity--another argument against the type of subsidy programs used.

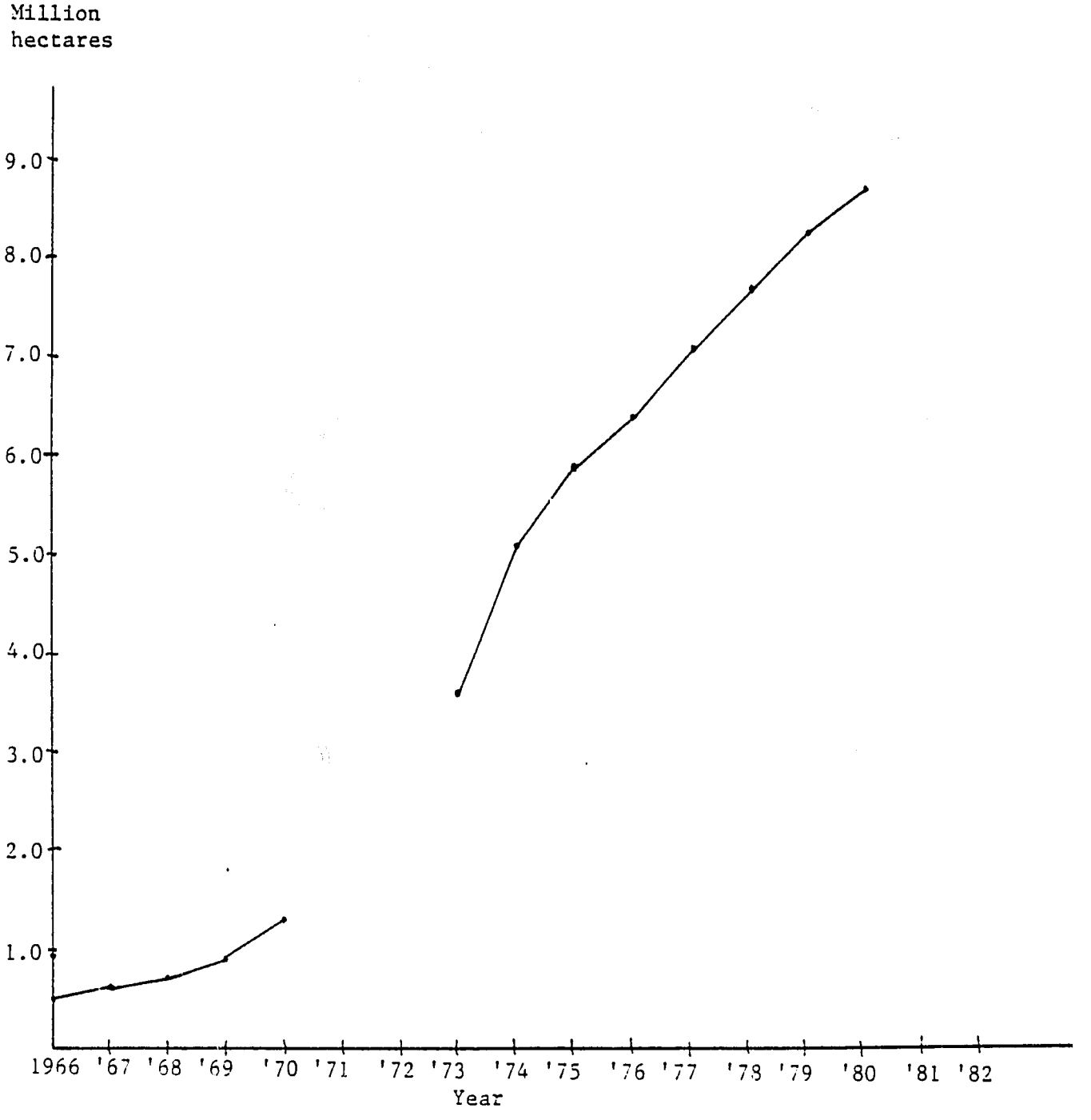

Figure 1-4. Harvested Area of Soybeans

Source: Fundacao Instituto Brasileiro do Geografia e Estatistica, Anuario Estatistico de Brasil (Rio de Janeiro, various issues, 1968-1980).

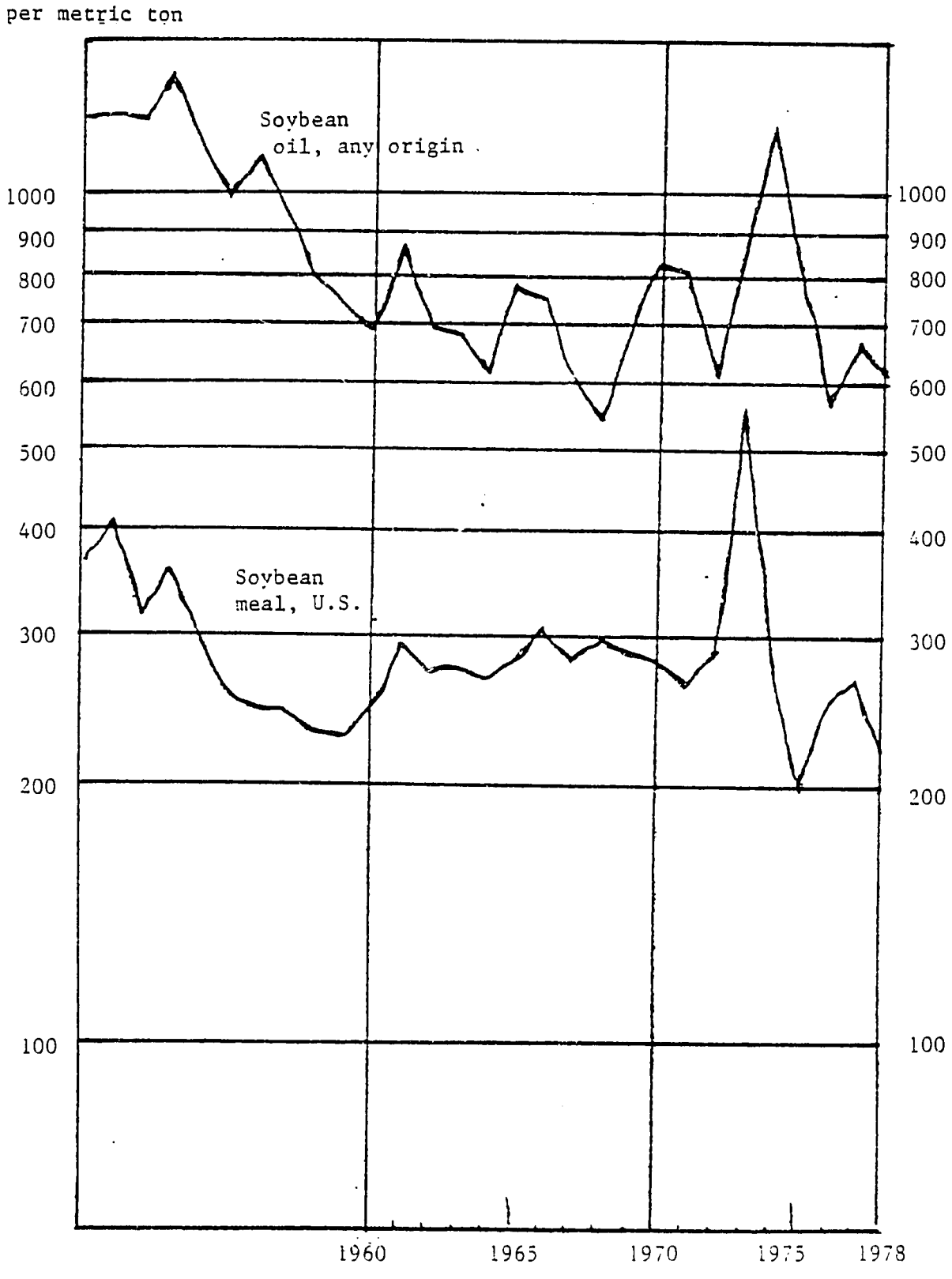

Figure 1-5. Yearly Average Prices in International Market for Soybean oil and Soybean Meal (constant 1978 dollars)

Source: World Bank, Commodities and Export Projections Divisions, Commodity Trade and Price Trends (Washington, D.C., The World Bank, August 1979).

Table 1-14. Comparison of Fertilizer Prices in the United States and Brazil, January 1978

Nutrient as % of weight of fertilizer	Fertilizer	Price in Brazil		Price in United States	
		CR$/ton of fertilizer	US$/ton of nutrient	US$/ton of fertilizer	US$/ton of nutrient
63.2% K	Potassium chloride	2,289	$227	$176	$143.50
20.6% N	Ammonium sulfate	2,262	688	561	141.80
46% N	Urea	3,979	542	407	249.50
20% P_2O_5	Superphosphate	1,750	549	550	109.70
46% P_2O_5	Triple superphosphate	4,496	613	363	281.90

Note: January 1978 exchange rate: 15.95 Cr$/US$.

Source: Economic Research Service, U.S. Department of Agriculture, Fertilizer Situation-1978 (Washington, D.C., U.S. Government Printing Office); Tennessee Valley Authority, Review and Analysis of the Fertilizer Situation in Latin America (Chattanooga, Tenn., TVA).

loud complaints from the technical community. In agriculture, which is inherently site specific in its problems, this relative neglect can have profound implications. Consider the following example. In 1977, Brazil imported two-thirds of its phosphate fertilizer (in terms of nutrients). More than half of Brazil's total phosphate consumption was applied on four crops--coffee, soybeans, wheat, and sugarcane. Note that all four have benefitted from relatively strong research programs (wheat, although not an export crop, has been the object of a concerted government effort of import substitution). In table 1-15 it is estimated that the rate of phosphate nutrient removal in these crops was about 195,000 tons, that is, one-quarter the rate at which phosphate was being applied. Nor can it be argued that these crops are near yield saturation. Even soybean yields were 20 percent below the U.S. average, and they showed by far the best relative performance. More generally, it is worth noting the contrast between the steep growth in industrial fertilizer consumption, a six- to seven-fold increase in the decade 1966-1968/1976-1978, (table 1-16) and the overall modest rate of yield increase (perhaps 1 percent per year if we weigh all crops).

Fertilizer, as a key physical component in augmenting productivity, also helps to highlight the problem faced by food crops in Brazil. In terms of access to essential resources discussed above in financial terms, corn and rice received less than 14 percent of fertilizer nutrients. Adding beans and cassava would probably not increase this to over 15 percent. This is an even lower proportion than the analysis of rural credit would suggest. At the same time, with crop varieties, cultural priorities, and soil analyses that were available to most farmers, it is unclear that an increase in application rates would have helped much.

Table 1-15. Removal of Crop Nutrients Nitrogen, Phosphorus, and Potassium in Brazil, 1966-1968 and 1976-1978, by Some Major Crops Compared to Rate of Application of Nitrogen, Phosphorus, and Potassium in Fertilizers Used for Them

	Removal of macronutrients (thousand of tons) Average 1966-1968[a]			Average 1976-1978[b]			Application per crop in 1977[c] (thousands of tons)			Rate of application in 1977 (kilograms per hectare)		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Cotton	127	41	113	108	35	96						
Rice	238	127	333	321	171	450	41	118	60	6.8	19.7	10.0
Coffee	23	5.0	34	16	3.5	24	168	34	119	86.6	17.5	61.3
Sugarcane	101	18	102	156	28	157	127	130	143	55.9	57.3	63.0
Corn	407	78	277	558	107	379	46	115	54	3.9	9.7	4.6
Soybeans	46	6.5	18	777	110	304	39	425	136	5.5	60.1	19.2
Wheat	54	14	21	205	53	80	41	196	63	13.0	62.2	20.0
TOTAL							462	1,018	575			
Brazil 1977							688	1,534	927			

Source: Antonio Aguirre, "Os Fertilizantes Quimicos no Brasil," Fundacao J.P. (Belo Horizonte, 2-25 maio, 1978), vol. 8, no. 5, pp. 2-16; Instituto de Planejamento Economico e Social, Tecnologia Moderna para a Agricultura, Vol. II-Fertilizantes Quimicos (Brasilia, 1975).

[a]From Tecnologia Moderna para a Agricultura.

[b]Obtained by multiplying production index of 1976-1978 relative to 1966-1968.

[c]From Aguirre, "Os Fertilizantes Quimicos no Brasil."

Table 1-16. Apparent Consumption of Fertilizers, 1966-1978 (thousands of tons of nutrients)

	Nitrogen	Phosphorous (P_2O_5)	Potassium (K_2O)
1966	71	117	93
1967	106	205	137
1968	144	273	184
1969	165	266	196
1970	276	416	307
1971	278	536	351
1972	412	875	460
1973	346	805	529
1974	389	914	521
1975	406[a,b]	1,014[a,b]	558[a,b]
1976	482[a]	1,285[a]	698[a]
	498[a]	1,308[b]	722[b]
1977	685[a]	1,534[a]	927[a]
	688[b]	1,570[b]	927[b]
1978	708[b]	1,523[b]	991
1979 (preliminary)	749	—	1,047

Source: Figures through 1974 are based on Antonio Aguirra, "Os Fertilizantes quimicos no Brasil," Fundacao J.P., vol. 8, no. 5, 2-24 maio, 1978, pp. 2-16.

[a]Source: Fundacao Instituto Brasileiro de Geografia e Estatistica, Anuario Estatistico do Brasil (Rio de Janeiro, 1978).

[b]Source: Sindicato da Industria de Abudos e Correctivas do Estado de São Paulo. All time series agree to 1974. This last source is regarded as the most accurate for 1976 and 1977.

Chapter 2

NEAR TERM SUPPLY-DEMAND BALANCES

Until recently, the size of the Brazilian alcohol program has in fact been quite small relative to the agricultural system as a whole. Anyone seeking to get a historical perspective on possible impact beyond the local level must look at the analogy of export crops. This situation will, however, change as the program approaches its goals for 1985. During this period the rate of expansion of land resources for alcohol production will approximate the net rate of expansion for export (tables 1-6, 1-7), which occurred from 1966-1968 through 1976-1978, giving allowance for a larger total agricultural system. The latter figure represented an increase of about 3.5 million hectares in ten years (much smaller, as the author has pointed out, than people suppose), while alcohol will take about 2 million additional hectares from 1980 through 1985.

The comparison should give pause for thought. If Brazil's export campaign in the seventies raised as much concern, then what can be the impact of a new, comparable program superimposed on a continuing export drive? It is not claimed that this perspective contains the whole truth, but it is at least an antidote to soothing journalistic pronouncements such as "in 1985 PROALCOOL will occupy less than 5 percent of existing harvested land," or, worse, "0.3 percent of Brazil's area."

As the author has gone to some trouble to emphasize, land is not the key issue. It is, however, an important currency in analysis. Let us therefore begin looking at the magnitudes of PROALCOOL and the agricultural system in terms of production, yield, and area in order to begin to get some sense of their possible interaction.

A big hurdle that anyone making this kind of inquiry soon faces is the apparent nonexistence of serious work looking at how food supply and demand may evolve in Brazil over the next few years. Perhaps an elaborate model is buried somewhere in the bowels of the Ministry of Agriculture, but agricultural economists with whom the author has discussed the matter know

of none. If true, it is a staggering observation that the second largest agricultural food exporter in the world, with a malnourished population, and full of talented economists and planners, has not made a systematic effort to chart out some of the trade-offs it may confront as it launches a bold experiment in the massive use of biological resources. At any rate, the author's search turned up nothing of this sort. What it did turn up were two different essentially back-of-the-envelope calculations by professional agricultural economists who would presumably have used something better if it were available.

The first set of calculations, performed by Fernando B. Homem de Melo, is explicitly normative [1]. The purpose was to see if there was serious conflict in the objectives of government policy for food supply, agricultural exports, and energy (alcohol). The results were disturbing, to say the least.

First, looking at export crops, Homem de Melo suggested as a low projection a continuation of the 1968-1977 trend in area harvested for an aggregate of seven crops,[8] which he found to be 7.3 percent per annum. This would mean that, between 1978 and 1985, 12.2 million hectares would have to be allocated to this function.[9] He suggests, however, that for agricultural exports to increase at a pace consistent with the government's overall objective to export U. S. $40 billion by 1985, an increase of 16.7 million hectares would not be unrealistic. (It is not made clear if important export crops like coffee, cocoa, and sisal, which were excluded in the growth rate calculation, are included in these figures.)

The next important sector is internal food supply. Homem de Melo includes six crops in his analysis--the classical "big four," corn, rice, beans, and cassava--together with potatoes and onions. He cites another government goal "to fill the pot," which means, essentially, to improve the supply/demand balance so that producer prices are not a leading edge in

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8. Soybeans, peanuts, oranges, cotton, sugarcane, tobacco and castor beans.

9. The author has not been able to reproduce this calculation. Using 1978 areas of the given crops he arrives at an increment of 9.9 million hectares to be added by 1985.

inflation. In order to do this he postulates growth in production as follows:

rice	5	percent	per	year
beans	4	"	"	"
cassava ..	5	"	"	"
corn	6	"	"	"
potatoes .	5	"	"	"
onions ...	5	"	"	"

The base year is 1978. Though this is not made entirely specific, Homem de Melo makes the period of analysis for increased area 1978-1985, so without any other notification the author has taken 1978. Yield assumptions are of course important, and the trend from 1967 to 1976 was used. This resulted in growths of area as follows:

rice	5	percent	per	year
beans	7.5	"	"	"
cassava ..	7.5	"	"	"
corn	4.5	"	"	"
potatoes .	1.5	"	"	"
onions ...	1.5	"	"	"

Based on these assumptions, Homem de Melo found an increment of 12.66 million hectares. Thus it was projected that between 1978 and 1985, harvested area for export and internal food crops must increase by 24.9-29.4 million hectares.

Anyone with any knowledge of the historical trends, current scale, and realities facing Brazilian agriculture today will know that these figures represent an impasse, just with these two subsectors. By comparison, the relatively small 3 million hectares of increment for PROALCOOL merely makes an already hopeless conflict of objectives a little more assuredly desperate. Homem de Melo finds the trend in growth rate of total harvested area to be 3.7 percent per year, which extrapolates to 15.24 million hectares between 1978 and 1985. He estimates that with heavy emphasis on opening up

new land it could increase to 5 percent per year, adding 18.28 million hectares by 1985.

The second estimate of future goals is more limited and, within its confines, apparently more tranquil. This estimate is restricted to food crop demand, and was elaborated by Ines Lyra and Tito Ryff of the Agricultural Information Group (GIA) of the Fundacao Getulio Vargas [3]. As can be seen from table 2-1, the production targets intended to prevent a

Table 2-1. Alternative Projections for the Year 1975 for Production and Harvested Area of Four Major Domestic Food Crops

	Production (millions of tons)	Area (millions of hectares)	Change in area relative to 1978 (millions of hectares)	Yield assumed (kg/ha)
Projection 1[a]:				
Rice	10.27	7.91	2.29	1,298
Corn	20.40	15.13	4.01	1,348
Beans	2.88	7.66	3.04	376
Cassava	35.82	3.57	1.42	10,034
TOTAL	--	34,27	10.76	--
Projection 2[b]:				
Rice	11.68	7.61	1.99	1,535
Corn	23.13	13.54	2.42	1,706
Beans	2.46	5.34	0.72	461
Cassava	28.30	2.32	0.17	12,198
TOTAL	--	28.81	5.30	--

Note: -- = not applicable.

Source: Fernando Bento Homem de Melo, A Agricultura nos Anos 80: Perspectivas e Conflitos entre Objetivos de Politica, trabalho para Discussao no. 35 (São Paulo, Instituto de Pesquisas Economicas, Universidade de São Paulo, March 1980); Ines Tereza Lyra and Tito Bruno Bandeira Ryff, "Agricultura de Abastecimento Interno: Problemas e Perspectivas" (Brasilia, Revista de Economia Rural, July/September 1980), pp. 581-600.

[a]Calculation by Homem de Melo.

[b]Calculation by Lyra and Ryff.

further deterioration in the food price situation[10] are rather different from those of Homem de Melo. The production targets are about 10 percent higher for rice and corn and 20-25 percent lower for beans and cassava.[11] Since corn and rice are today about 2 1/2 times as important (in terms of harvested area) as beans and cassava, one might expect these production differences to balance out in terms of harvested area. This is not, however, the case. Using Homem de Melo's parameters, his estimate of the increment in harvested area for food crops is double that of the GIA (table 2-1). The difference, of course, is in the yield estimates. Figure 2-1 compares the yield estimates of the two projections with actual performance. Those of the GIA are slightly optimistic but within the range of recent experience. Those of Homem de Melo are well below the average for the past five years. This is because, in the case of rice and corn, the base year chosen (1978) had the worst performance in recent years. In the case of cassava and beans, it was assumed that a historical trend in declining yields would continue. Of course, these trends could continue, particularly if the government's talk about food priorities remains just that--convenient political rhetoric. The downward trends appear, however, to be far from ineluctable. To take an example, consider beans in São Paulo. In 1975 through 1980 beans were the fastest growing crop in the state, comfortably exceeding sugarcane, while in 1979 and 1980 yields surged, not only reversing previous trends but jumping well above average levels of ten to fifteen years ago.[12] The author does not know why this remarkable (and little commented on) development occurred, or why in 1981

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10. The parameters used are essentially those of a study done in 1974 projecting demand for 1975 and 1980 and which indicated, compared to actual results in 1980 [5], none too good a situation. This study, now out of date, is the closest thing which the author has seen to a serious five year estimate of demand for food in Brazil. The author respects it as such, but entertains some doubts. First among these is the very high demand for cassava which the study projected.

11. The author excludes potatoes and onions from Homem de Melo and potatoes and bananas from the GIA work because they have an essentially trivial impact on land requirement figures.

12. In 1966/67 average yields in São Paulo were 598 kg/ha. They had steadily fallen to 531 kg/ha in 1976-1978. In 1979-1980 the average was 634 kg/ha.

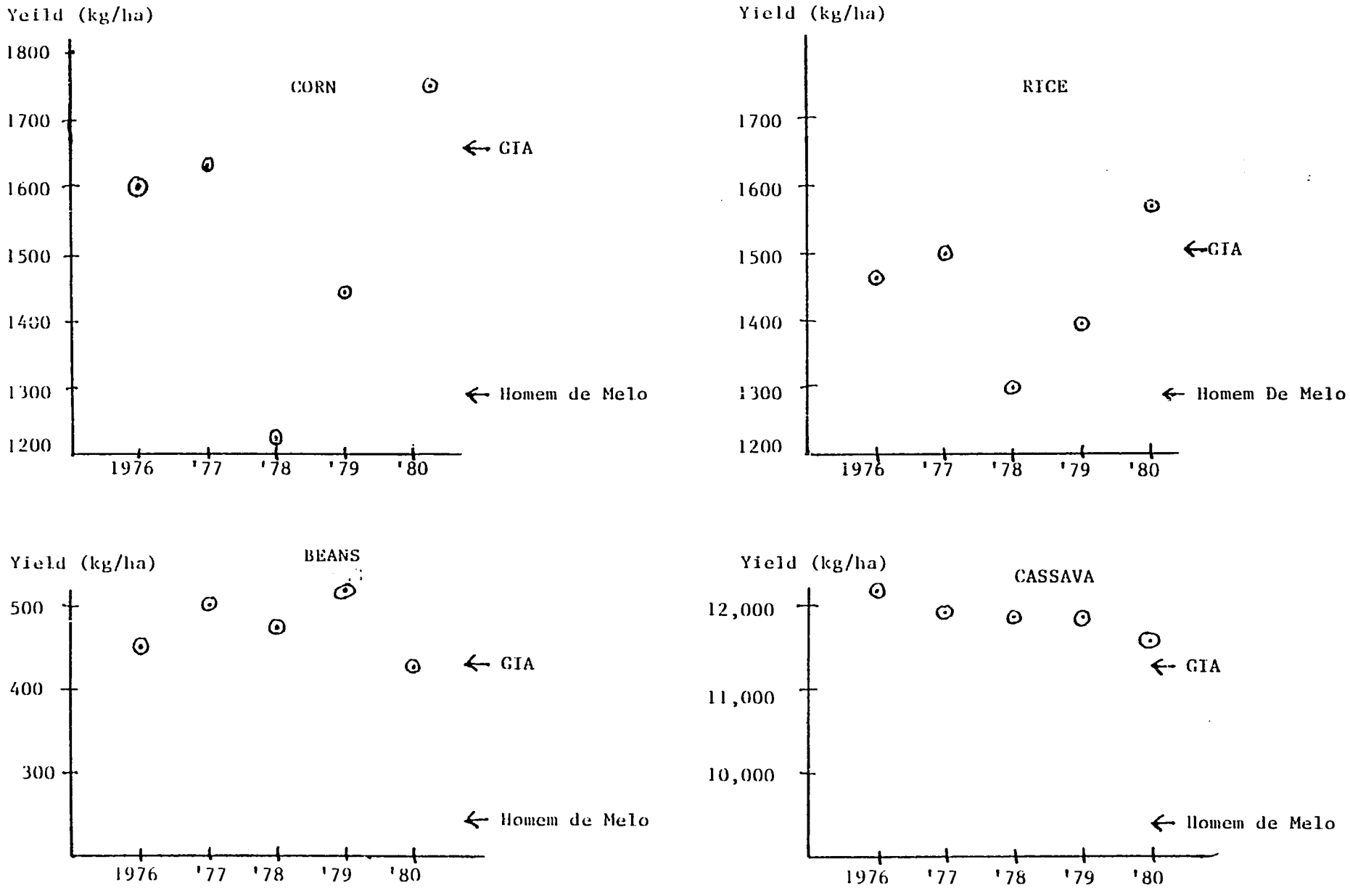

Figure 2-1. Comparison of Yields in Brazil, 1976-1980 with Yeilds Assumed in Projections in Table 2-6.

Source: Homem de Melo, Fernando B. "A Agricultura nos Anos 80: Perspectivas e Conflitos entre Objetivos de Politica,"Trabalho para Discussao no. 35 (Sao Paulo, Instituto de Pesquisas Economicas, Universidade de Sao Paulo (March, 1980); and Lyra, Ines Tereza and Tito Bruno Bandeira Ruff, "Agricultura de Abastecimiento Interno: Problemas e Perspectivas" (Brasilia, Revista de Economica Rural July/September 1980), pp. 581-600.

the picture appears to have deteriorated again, but it clearly was not just "good weather." What makes the case of São Paulo especially interesting is that it is in precisely that state where the issue of crop dislocation is most intense today, and given the "sick-man" tradition of beans, one would have expected that crop to have been particularly hard hit. This case, isolated but real (425,000 hectares), certainly suggests that means are at hand (sterilized seeds on the technical side, improved incentives on the economic side) to reverse the downward slide in yields in a fairly short time, at least in the more developed southeastern states. One advantage of appalling low yields is that it doesn't take much in R&D to make them better.

In general, the author finds the GIA's definition of major food crop production, area, and yields the more plausible. Corn production estimates, though higher in the GIA estimate, are probably not high enough. Before discussing corn, however, let us turn back to a more critical look at the land requirement estimates for export crops.

The author's reading of past trends for these crops suggests a growth rate for a trend projection that is substantially less than that proposed by Homem de Melo. Figures 1-2, 1-4, 2-2 and 2-3 summarize the historical experience for the export crops cited by him, as well as coffee, cocoa and sisal. Between 1966-1968 and 1977-1979[13] the growth rate in harvested area was 4.4 percent per year. Extrapolating this trend, and using the same year (1978) as a base, yields a net increment of 6.6 million hectares by 1985. This is about one-half of Homem de Melo's low estimate. Up through 1980, growth has been slightly below this projected trend, even though sugarcane for PROALCOOL in more significant amounts than before was included. Preliminary indications for the 1981 harvest (officially, 1980/81) suggest a further decline in area below trend

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13. Although most comparisons are between 1966-1968 and 1976-1978, 1976 saw a sharp drop in harvested acreage for export crops, about half of which was due to a frost in Parana which killed a large part of the coffee crop there.

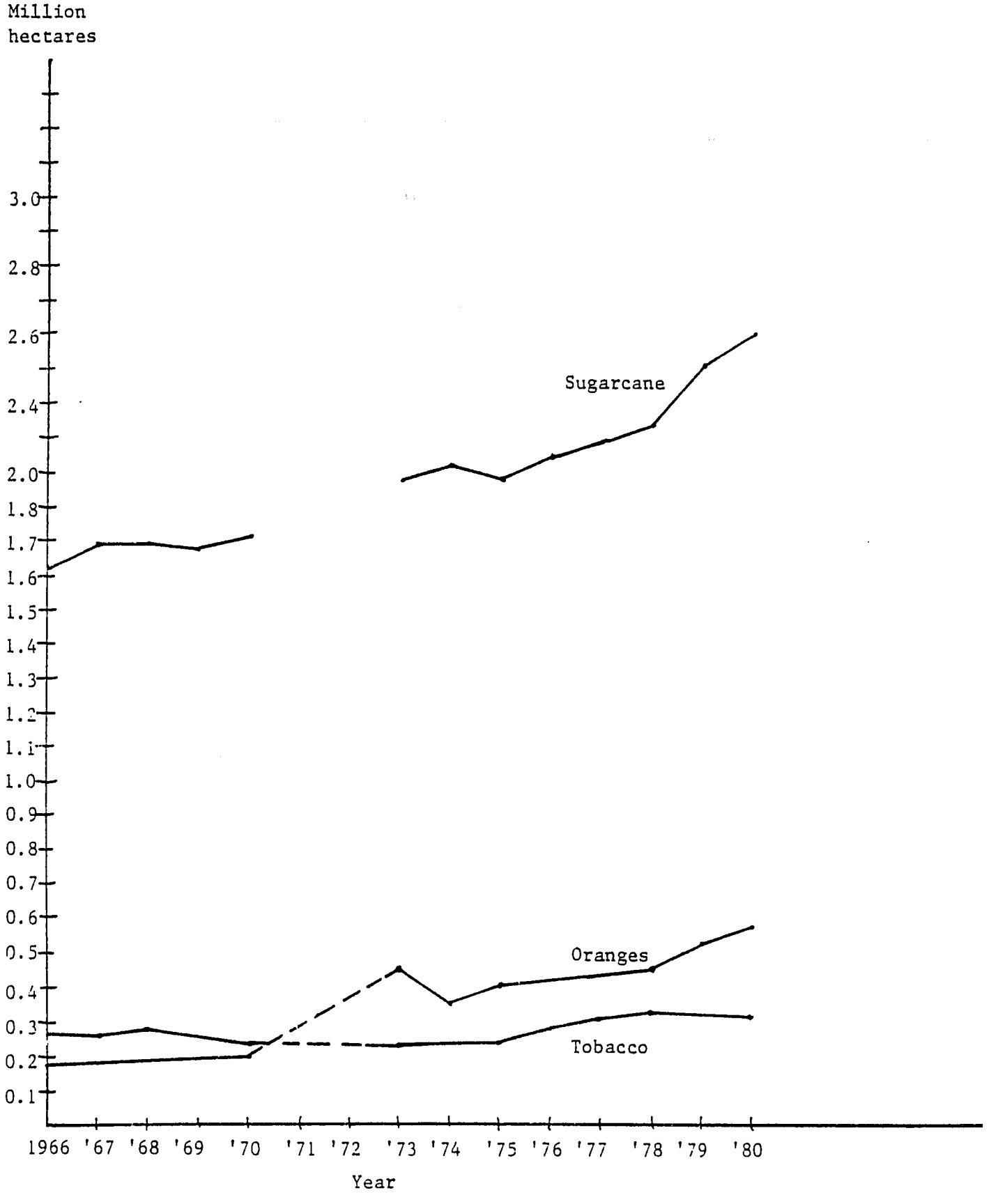

Figure 2-2. Harvested Area of Tobacco, Oranges, and Sugarcane

Source: Fundacao Instituto Brasileiro do Geografia e Estatistica, Anuario Estatistico do Brasil (Rio de Janeiro, various issues, 1968-1980).

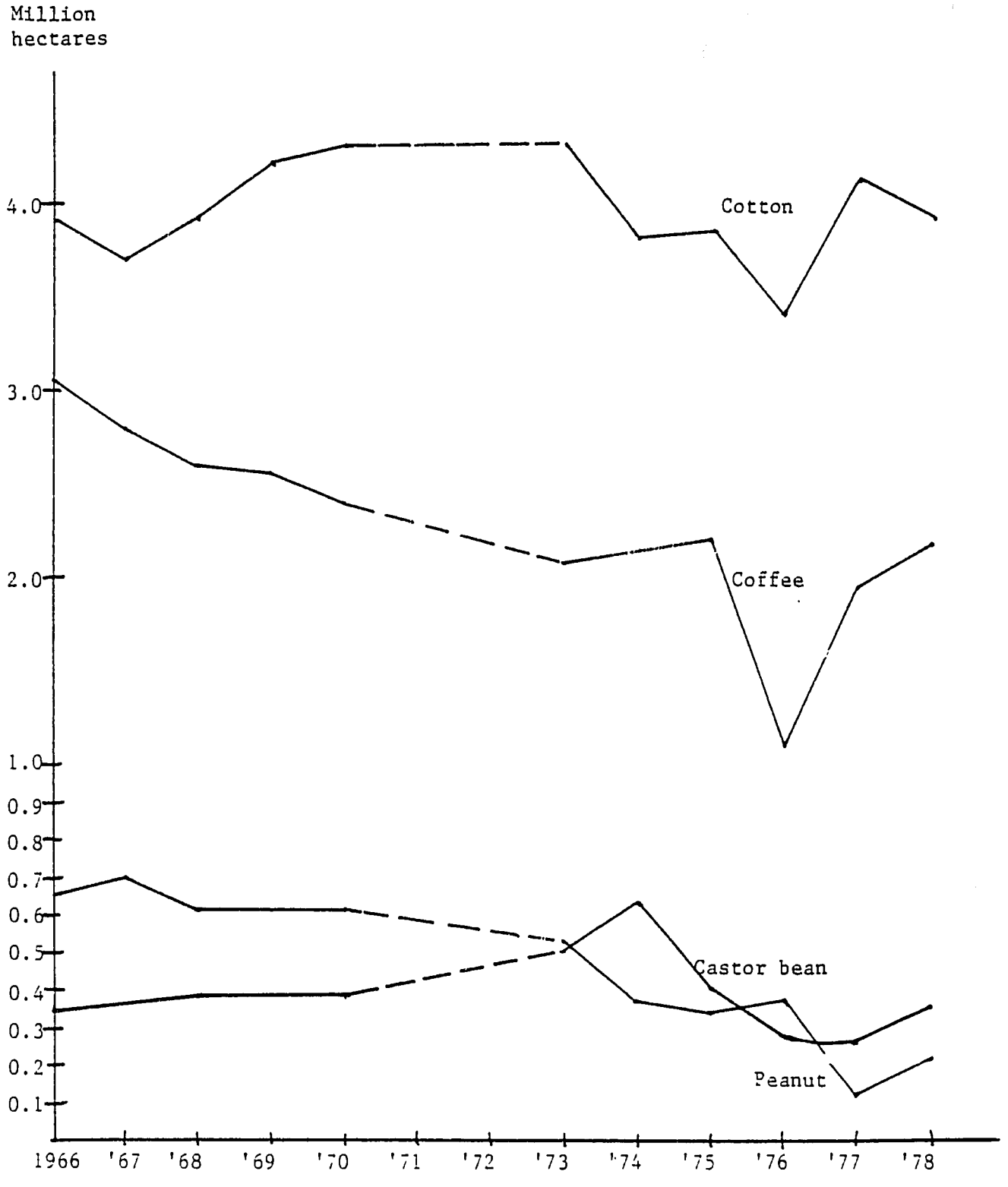

Figure 2-3. Harvested Area of Cotton, Coffee, Castor Bean, and Peanuts

Source: Fundacao Instituto Brasileiro do Geografia e Estatistica, Anuario Estatistico do Brasil (Rio de Janeiro, various issues, 1968-1980).

for at least two key crops (soybeans and cotton)[14] [12]. If 16 million more hectares for export crops are really essential to meet overall goals for 1985--which the author doubts--the government will either have to give far stronger incentives than it has recently or reduce the goals.

If we add together the lower estimates (GIA) for food production area and the trend expansion in area of export crops, we obtain a total necessary expansion of about 12 million hectares. Remembering Homem de Melo's estimate of possible rate of expansion of 15.5-18.0 million hectares by 1985, it would seem that the situation is basically stable from the point of view of land resources. We have 2.5-3.0 million more for alcohol and 0.5-1.0 million for "other" crops expansion.[15]

This promising picture may be made considerably more stringent with two observations. First, it is quite likely that harvested area will have trouble expanding at this rate. Second, the estimate for corn demand may be too low by a significant amount. Figure 2-4 and table 2-2 show the growth in harvested area for the sum of most important Brazilian crops. Between 1966-1968 and 1976-1978 the harvested area increased by 3.5 percent per year. If we extend this to the most recent three-year period (1978-1980) the growth rate falls to 3.25 percent. Using simple trend extrapolation, we obtain an estimate of about 11.5 million hectares of new land.[16]

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14. Preliminary estimates for soybeans indicated that the harvested area would be more or less the same as in 1979/80, though momentum is developing for dynamic development in the Mato Grosso/Goias region. The harvested area for cotton should be up 4 percent over 1979/80. Cotton and soybeans account for 65 percent of the harvested area of "export crops," while soybeans have been responsible for all the net growth from 1966-1968 through 1978-1980.

15. "Other" crops are those outside the categories of export crops and the four major internal supply crops. They include wheat, grapes, bananas, pineapple, oats, sweet potatoes, Irish potatoes, onions, fava, jute, melon, tomatoes, coco-da-baia, and mango. In 1978 they accounted for 4.2 million hectares.

16. This trend extrapolation of harvested area is considerably lower than Homem de Melo's, lower than can be explained by a lower growth rate (3.25-3.5 percent compared to 3.7 percent, due presumably to the practice in this paper of taking 3-year averages rather than single years). This discrepancy is particularly inexplicable because this author has used a larger number of crops (and thus, presumably, a larger area) as a base for the projection.

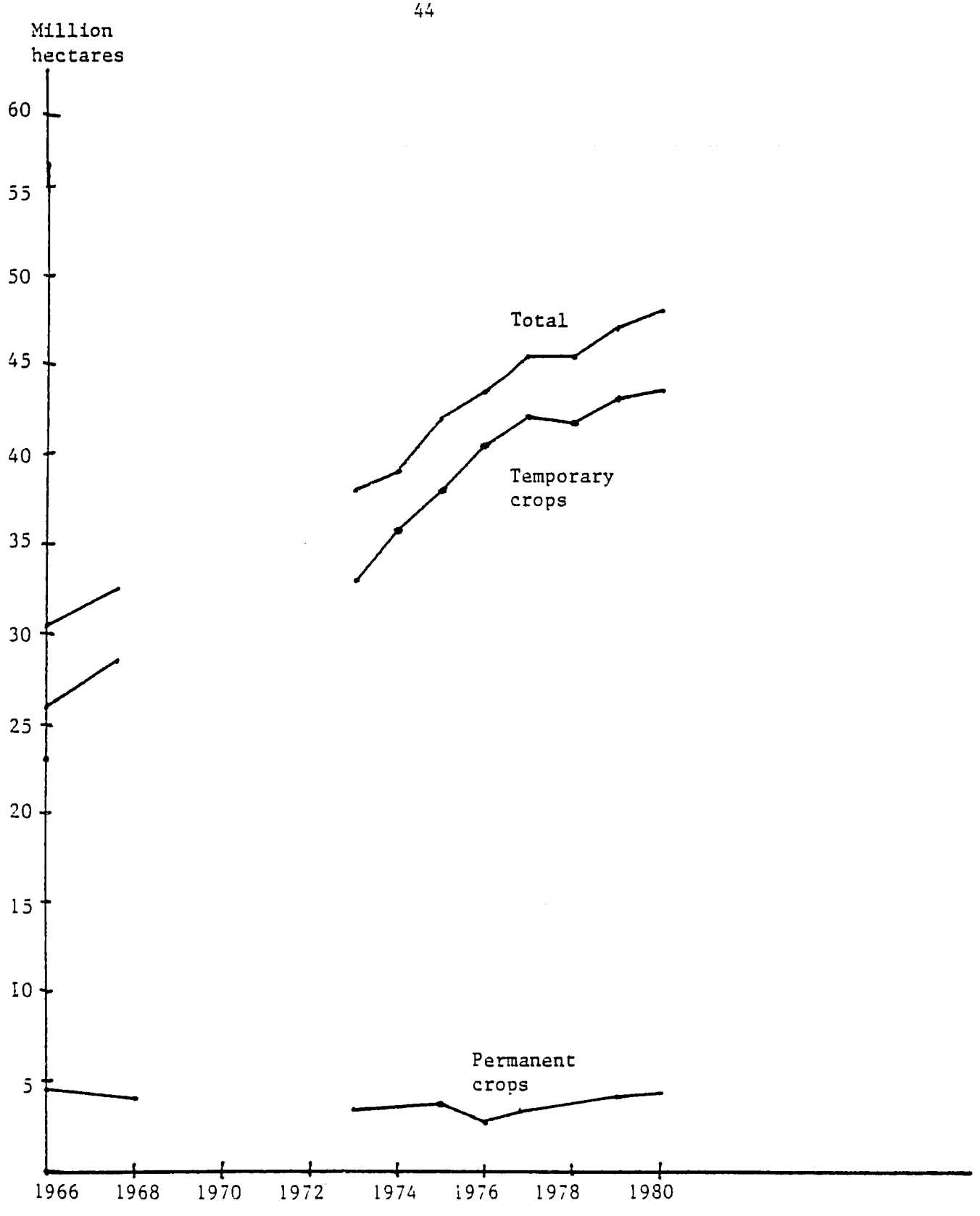

Figure 2-4. HArvested Area, Brazil, 1966 - 1980

Source: Fundacao Instituto Brasileiro do Geogradia e Estatistica, Anuario Estatistico do Brasil (Rio de Janeiro, various issues, 1968-1980).

Table 2-2. Harvested Area of Major Crops in Brazil, 1966-1968 to 1976-1978

	Average harvested area (thousands of hectares) 1966-1968	1976-1978	Index 1976-1978/ 1966-1968	Growth rate: 1966-1968 to 1978-1978
Rice	4,252	6,090	143	3.66
Barley	--	77	--	--
Beans	182	180	99	-0.11
Black beans	3,546	4,409	124	2.20
Corn for grain	9,181	11,347	124	2.14
Soybeans	608	7,089	1,166	27.84
Grain sorghum	--	135	--	--
Wheat	840	3,168	377	14.20
Sweet potato	181	118	65	-4.19
Irish potato	214	202	94	-0.58
Onion	50	58	116	1.50
Cassava	1,897	2,139	113	1.21
Banana	258	331	128	2.52
Cashew	74	137	185	6.35
Orange	168	430	256	9.85
Cocoa	454	421	93	-0.75
Coffee	2,824	1,749	62	-4.68
Sugar cane	1,668	2,251	135	3.04
Tomato	41	52	127	2.41
Peanuts	648	285	44	-7.89
Bahian cocoanut	108	161	149	4.07
Castor	362	290	80	-2.19
Cotton (tree)	3,840	2,462	99	-0.05
Cotton (herbaceous)	--	1,357	--	--
Sisal	336	282	84	-1.74
Tobacco	267	306	115	1.37

Source: Fundacao Instituto Brasileiro de Geografia e Estatistica, Anuario Estatistica do Brasil (Rio de Janeiro, various issues, 1968-1980).

This makes things tight even without considering PROALCOOL. But there is no assurance that even this trend will hold up. Statistically there appears to have been a falling off in the growth of area over time, from over 4 percent per year in the 1950s to about 3.5 percent from the mid-sixties to the mid-seventies.[17] There is more to this concern than simply examining statistics. An important focus of growth in area was the rapid expansion in the more fertile frontier areas of Parana and Mato Grosso (table 2-3 gives some sense of this). There appears to be a

17. Anuario Estatistico do Brasil.

Table 2-3. Harvested Area of Major Crops in São Paulo, Paraná, Minas Gerais, Goías, and Mato Grosso, 1967, 1975, and 1980

	Sao Paulo			Parana			Minas Gerais			Goias			Mato Grosso		
	1967	1975	1980	1967	1975	1980	1967	1975	1980	1967	1975	1980	1967	1975	1980
Peanuts	576	185	211	74	96	54	6	6	7	1	2	1	15	36	27
Rice	719	524	300	403	493	391	776	814	592	768	947	1,184	221	773	1,397
Banana	41	34	36	8	5	3	32	40	30	7	17	27	3	7	11
Coffee	831	691	805	1,180	943	636	340	310	462	30	8		17	21	
Sugarcane	496	621	1,010	41	46	58	239	255	186	39	15	21	15	8	20
Beans	257	231	459	651	768	815	501	567	656	133	223	159	60	53	147
Oranges	72	272	427	6	6	4	21	21	26	3	2	3	1	2	1
Cassava	98	39	23	111	100	45	120	138	129	75	35	21	27	57	38
Corn	1,302	1,106	1,002	1,338	1,923	2,157	1,540	1,623	1,740	413	540	803	422	246	192
Soybeans	28	391	560	83	1,632	2,411		77	163		56	246	2	194	877
Wheat	5	123	164	89	800	1,440							1	42	122
Cotton	447	368	270	271	207	336	166	108	103	30	38	31	33	90	49
TOTAL	4,872	4,585	5,267	4,255	7,079	8,510	3,741	3,959	4,094	1,499	1,983	2,496	517	1,529	2,881

Source: Fundacao Instituto Brasiliero de Geografia e Estatistica, Anuario Estatistico do Brasil (Brasilia, 1967, 1975, 1980).

consensus that these more fertile areas are beginning to be saturated. There are very large areas of the cerrado (dry savannah) with good long term agricultural potential, but development of this potential will require considerable investment. An example of this is Goias, which despite being a frontier area saw a comparatively slow rate of expansion (table 2-3). This is due in part to a greater predominance of cerrado soils in that state, precisely the kinds of soils that will have to be confronted increasingly.

A problem which accentuates that posed by the nature of the soils which must increasingly be used on a stable basis is the problem of transport. Over the next decade this must be done essentially by truck. Only one very precarious railway line serves the southern (and already most developed) frontier region. The problem is not a new one in Brazilian agriculture. The last critical manifestation of it was in the severe problems associated with bringing soybeans to the export market in the early 1970s [13], especially from western Parana. At that time it was reckoned that unit transport costs to port were five times as high as for U.S. soybean producers. Much of the subsidies which Brazilian soybean producers received was eaten up by costs of a transport system caught by surprise and made irrational by the rapid flow of events. A similar pattern of events seems likely to occur with the cerrado frontier. The federal transport planning agency (GEIPOT) was not, as of October 1980, even considering a new railway into the cerrado region. As a consequence, millions of tons of new production (of agricultural and forest products) will supposedly be moved by truck. It will not be cheap. At 5-6 cents per ton-kilometer, the additional distances to the main centers of consumption are likely to cost something like 10 percent of the current cost of delivered grain.

Responses to this are possible. Raise yields on current land, shift important intermediate consumers westward (for example, poultry), and bring

pasture in the developed regions under cultivation. But these raise imponderables for a set of programs on a tight schedule.[18] The second major factor is the market for corn which is growing much faster than earlier projections postulated. It was recently estimated that domestic demand for corn would reach 24 million tons in 1981 and 26 million tons in 1982 [14]. Compare this with the 1985 estimate of 20-23 million tons in the projections discussed earlier (table 2-2). Standing behind the domestic demand is a potentially large foreign demand if Brazil can reverse its recent habit of being a net importer. Time does not permit an adequate treatment in this work of the complex question of corn supply and demand. However, it is so significant that the author feels it should be a primary point of comparison for the economics of fuel alcohol. Comparisons of alcohol with sugar miss the basic point that the foreign market for sugar does not offer much scope for expansion (nor has Brazil expanded exports much over the past five years). The foreign market for corn, however, could be very large.

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18. For example, from one perspective it appears that capacity for expansion into pasture in more developed regions could be substantial. For example, in São Paulo, the state with the most intensive agricultural system, it is estimated that planted pasture alone covers as large an area as the total harvested area of crops (6.5 million hectares). There is in addition 3.5 million hectares of natural pasture. It is estimated that only half the feed produced on this land is actually consumed by cattle, which are stocked at a rate of about one per hectare. This suggests that adoption of silage techniques alone could substantially increase animal product output in the state as a whole, even if harvested area of crops increased by 20-25 percent. On the other hand, this process of substituting crops on pasture has gone on in the past and is included in the trends. In São Paulo there is another problem. Between 1972 and 1979 land in crops and in pasture both fell. A substantial area, comparable to the PROALCOOL target of 2.5-3.0 million hectares, seems to have been removed from active farms. (Source: Eduardo Castanho Filho and Denyse Chabaribery, Perfil Energetico da Agricultura Paulista, Instituto de Economia Agricola, São Paulo, 1981.)

Chapter 3

CONCLUDING REMARKS

The issue is not so much whether the alcohol program will make output from the rest of the agricultural sector more expensive. The issue is how much. With all the complexities that the problem of competition has, this simple point should not be lost sight of. Will the opportunity cost be large or small? It will be larger if:

a. output currently and in the near term is essentially supply rather than demand limited;

b. the elasticity of supply is low;

c. the elasticity of demand with respect to price is low and the domestic market is not open to imports for deficit items;

d. the productivity of the system cannot be significantly improved;

e. there is competition for the key limiting inputs, that is, the alcohol program is closely linked to the agricultural sector as a whole.

In general, it appears that agricultural production, especially of crops for internal food supply, is supply rather than demand limited. One can get into involved discussions about what "supply limited" means, but it is clear that the Brazilian situation with regard to rice, wheat, corn and beans is very different than the situation of, say, U.S. agriculture in these products. The United States has a significant capability in place to increase production of these crops in the short-term, and must in fact restrain it. Brazil does not, and is a regular or intermittent importer of all these commodities. The tendencies of various projections analyzed earlier suggest that this supply side limit may persist. The situation may not be as bad as some observers have stated, but it does look tight.

Capability to expand supply at higher producer prices with current technology base and institutions (roughly elasticity of supply with price) presents a very complicated picture which the author has not been able to address adequately. As has already been pointed out, an analysis of the history of price received compared with output is unlikely to give very useful results because the price received may not be the price signaled to the farmer at the time of planting in the form of the official minimum price, because the risk of variations in income at the farm level changes from crop to crop, and because access to developed technology institutions and credit also varies from crop to crop and over time. An analysis which could be very helpful in this light would look at the relation of profitability and output, an enormous task. If we take a panoramic view, however, it can be said that export crops in general show a rather high elasticity of supply while internal food supply crops do not, and it is these latter which raise the greatest concern. Another broad point is that while prices have increased, the rate of expansion of cropland has steadily decreased.

This would seem to be of fundamental importance in the near term because it suggests a decreasing elasticity of supply of the input upon which Brazilian crop agriculture has relied most heavily--land. Why is this occurring? There is a large reserve of land in the form of pasture (almost four times the harvested crop area) which is very extensively used. The key to the slowdown in the rate of growth of cropland (despite higher producer prices) is likely to be found at the interface with cattle-raising. Taking account of distortions such as rural credit,[19] what is the relative profitability of crops and cattle raising in the frontier zones as well as elsewhere? In addition to this economic question, there is a sociological/institutional issue. Ranching, the dominant form of cattle raising in Brazil, is very distinct in this case from crop farming.

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19. Note for example in table 1-10 that credit for investment in animal husbandry was almost as large as for crops, and the investment category of rural credit is the most heavily subsidized. The subsidy in credit for animal production was at least half that for all crops. It is likely that rural credit represents a greater relative distortion of the market in cattle raising than for the crops against which it competes.

Ranchers may be reluctant to shift their land to crops, even if theoretically they could make a higher return on investment.

There are thus considerable grounds for concern regarding the capability of the Brazilian agricultural system to adequately meet domestic food requirements if export and energy goals are to be met. Looking at trends, a principle ground for optimism on this score is that the dynamism of cropland in the export sector appears to have spent itself, thus possibly freeing up several million hectares from the projection made in the preceding section. This carries with it, though, the implication that the broad goals for agricultural export earnings in the mid 1980s will not be met. Somewhat the same thing appears to be happening in the alcohol program, as 1985's production goals are deferred to 1987. The relative failure of other goals has taken some of the pressure off of internal food supply, such that with short-term measures such as modifying agricultural credit priorities and pricing policies the government can improve the internal food balance.

This easing of pressure in the near term places renewed emphasis on the impact which more fundamental changes in agricultural policy could have on the rate at which the agricultural system can expand output. Over the past decade, physical output has been increasing at about 4-4.5 percent per year and at least three-quarters of this has been based on expansion of area. Policies which maintain the rate of expansion of area and bring the average rate of yield increase to 2-2.5 percent per year could result in an output expansion of 5.5-6.0 percent. Something like this rate of expansion will be necessary if internal food objectives, export potential, and modestly reduced fuel alcohol objectives are to be met. The work performed in this study suggests that the capability of the Brazilian agricultural system to expand more rapidly and with greater efficiency does exist. In this context a fuel alcohol program will still carry opportunity costs, but they may be less severe and politically visible.

There is a tendency to view the alcohol program as an integral part of the agricultural system, and much of the work in this paper shares it implicitly. There is a clear case for this treatment. Fuel alcohol production uses standard agricultural crops as raw material. There is a factor which, however, makes it distinct. Financial resources for investment in crops for fuel alcohol come from a different sector of the

economy. Capital is a key constraint (more so than land), and sugarcane for alcohol does not compete directly for the same administrative pool of capital as do, for example, cotton and rice. One could argue that any expansion of area devoted to fuel alcohol is simply superimposed on top of whatever expansion the rest of the agricultural system would achieve anyway.

Such a complete or nearly complete delinking does not appear to be justifiable, however. A principal reason is that while the pool of capital to be invested may be distinct, the pool of skilled people who invest it and implement it is much less distinct. While there are some new actors, the producer will generally be an existing agricultural, predominantly crop, producer. Furthermore, he is likely to be a relatively well capitalized and skilled farmer. The pool of such farmers is limited, and they are likely to choose between a fuel alcohol crop and another crop either on existing cropland or new cropland.[20]

Some, as yet undetermined, delinking is valid until such time as all decisions on investment capital in Brazil compete evenly with one another. We may therefore think of some fraction of the raw material output as coming on top of the agricultural sector's output for food and export. This fraction can probably be increased by judicious planning of distillery location and suppliers (which is likely to be helped in turn by an alcohol program with a more modest rate of expansion).

This makes the model of export and crop-food crop sectors considerably less relevant as an analytical tool to analyze the impact of a fuel alcohol program. This model is likely to become less relevant in general over the coming decade anyway, especially if corn (treated today as an internal food supply crop) evolves into a major export crop. The role of export crops and wheat in the diet and food expenditures of even the lowest 25 percent of the population will then be equal to or more than that of crops classified as internal supply.

The extent of unlinking may be critical. This point may be illustrated by the following crude calculation of the opportunity cost of

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20. Experience in São Paulo suggests that 30-40 percent is an existing cropland.

one million hectares planted to sugarcane for alcohol. It is assumed that if displacement occurs 50 percent is corn, 30 percent is rice, and 20 percent is cotton. These are all crops which were directly displaced by sugarcane in São Paulo [4]. It is assumed that one million hectares of cane produces enough alcohol to substitute for 15 million barrels of gasoline.[21] If for every 10 hectares for alcohol, 3 hectares of cropland are foregone, then for every $680 million dollars of gasoline substituted, $210 million dollars would be foregone. At a tighter linkage (6 hectares of cropland lost for every 10 to alcohol) this would double to $420 million. This calculation is purely illustrative. If, for example, alcohol were compared with a potentially open-ended export crop like corn, as has been suggested earlier, these figures would fall to $55 million and $110 million.

Realistic quantitative estimates are still not possible. It is hoped, however, that this paper has contributed to a clearer appreciation of the diverse factors which can determine the impact of the alcohol program on the agricultural sector. Concern about the magnitude of this impact has emerged from Brazil's experience with a dynamic export sector in the 1970s. Work here suggests that there was nothing inevitable about the adverse impact of export crops on domestic food production. Indeed, the problem was not the rate at which these crops expanded (which was lower than is often supposed) as the inherent weaknesses of the Brazilian agricultural system. Fuel alcohol production is likely to be less tightly linked to the agricultural system than export crops. Even so, the moral of the story remains that the impact will depend as much on the efficiency of general agricultural policy and alcohol program planning as on the size of proposed alcohol programs.

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21. Approximate longer term world market values of $125/ton for corn, $450/ton for rice and $2125/ton for cotton were assumed at 3600 liters/hectare and 20 percent greater efficiency of use. Gasoline valued at $45 per barrel.

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Table A-1. Net Availabiilty of Major Crops for Human Consumption, 1975 (thousands of tons)

	Production	Net trade	Animal use	Seeds	Losses	Net availability for human consumption
Rice	7,538	88		401	1,508	5,717
Banana	5,311	(148)			2,124	3,038
Irish potato	1,669	(15)		289	334	1,061
Beans	2,271	(52)		166	681	1,372
Oranges	6,333	(435)			950	4,948
Cassava	25,812	(59)	12,906		2,581	10,266
Corn	16,354	(1,158)	10,630	219	4,088	259
Soybeans	9,892	(4,802)		349	989	3,751
Wheat	1,788	2,947		29	89	4,616

Source: Centro de Estudos Agricolas, Projecoes da Demanda e da Oferta de Productos Agricolas para 1975 e 1980, Fundacao Getulio Vargas (Rio de Janeiro, 19740.

Table A-2. Family Expenditure (Monetary and Non-monetary) by Type of Food and Income Class as a Fraction of Total Food Expenditures for Home Consumption (1975) in Four Regions

Food type	Family, income class (monetary and non-monetary) in cruzeiros per month fraction of home food expenditures								
	average	<4500	4500-6799	6800-8999	9000-11,299	11,300-13,599	13,600-15,799	15,800-22,599	22,600-31,599
A) Region - Maranhao, Piavi, Ceara, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, Sergipe and Bahia									
Grains and sugar	.226	.203	.222	.234	.241	.246	.245	.241	.222
Tubers	.084	.138	.119	.106	.085	.079	.075	.055	.047
Beans	.107	.175	.153	.130	.112	.109	.093	.073	.056
Meat, fish, milk and eggs	.406	.330	.354	.373	.398	.406	.417	.436	.462
Oils and fats	.035	.019	.024	.028	.033	.033	.038	.043	.049
Percent families in income class	--	27	22	14	10	6	5	7	4
B) Region - São Paulo									
Grains and sugar	.247	.336	.305	.277	.252	.224			
Tubers	.024	.030	.027	.024	.024	.024			
Beans	.059	.108	.085	.067	.057	.049			
Meat, fish, milk and eggs	.397	.241	.317	.373	.403	.424			
Oils and fats	.080	.114	.100	.086	.080	.073			
Percent families in income class	--	12	21	19	10	13			
C) Region - Rio de Janeiro									
Grains and sugar	.228	.322	.318	.286	.259	.237			
Tubers	.031	.051	.044	.037	.032	.030			
Beans	.056	.113	.097	.077	.065	.058			
Meat, fish, milk and eggs	.420	.225	.278	.351	.393	.416			
Oils and fats	.073	.105	.095	.087	.078	.075			
Percent families in income class	--	3	11	22	19	17			
D) Region - Minas Gerais and Espirito Santo									
Grains and sugar	.293	.336	.344	.341	.325	.293	.269		
Tubers	.036	.054	.043	.033	.034	.038	.031		
Beans	.065	.121	.095	.080	.072	.062	.050		
Meat, fish, milk and eggs	.322	.173	.231	.255	.287	.333	.36		
Oils and fats	.108	.132	.122	.121	.116	.112	.107		
Percent families in income class	--	14	26	11	15	13	9		

Source: Fundacao Instituto Brasileiro de Geografia e Estatistica, Estudo Nacional de Despesa Familiar (Rio de Janeiro, 1978).

Table A-3. Harvested Area of "Export Crops" in Brazil, 1979-80

	1979	1980
Cotton	3,640	3,688
Peanuts	287	311
Cacao	461	469
Coffee	2,226	2,207
Sugarcane	2,517	2,608
Tobacco	319	310
Oranges	547	572
Castor	373	438
Sisal	287	296
Soybeans	8,330	8,767
TOTAL	18,987	19,666

Source: Commissao Especial de Planejamiento, "Control e Avaliacao das Estatisticas Agropecuarias" (Brasilia, Levantamento Sistematico da Producao Agricola, December 1979, 1980).

Table A-4. Cassava (Mandioca) Production in Major Producing States, 1966-1968, 1975-1977, and 1979-1980 (thousands of tons)

	1966-1968	1975	1976	1977	1979	1980
Para	755	835	1,004	1,084	1,446	1,239
Maranhão	1,703	1,843	2,113	2,616	3,065	3,280
Ceara	1,466	1,451	1,465	1,740	1,232	1,085
Pernambuco	1,441	1,575	1,891	2,036	1,881	1,508
Bahia	3,412	5,109	4,470	4,350	4,704	4,880
Minas Gerais	2,017	2,246	2,122	1,951	1,843	1,943
São Paulo	1,981	720	610	710	553	470
Parana	1,874	1,953	1,292	1,122	801	888
Santa Catarina	2,608	1,429	1,304	1,240	1,121	1,631
Rio Grande do Sul	3,326	3,166	2,901	2,756	2,490	1,719
Frontier states						
Mato Grosso	536	856	916	907	318	261
Mato Grosso do Sul					522	334
Goias	1,305	487	645	374	265	297
Others	4,637	4,448	4,710	5,043	4,694	4,510
BRAZIL	27,060	26,118	25,443	25,929	24,935	24,045

Source: Anuario Estatistico do Brasil, 1968, 1977, 1980.

Table A-5. Rice (Arroz) (Paddy) Production in Major Producing States, 1966-1968, 1975-1977, and 1979-1980 (thousands of tons)

	1966-1968	1975	1976	1977	1979	1980
Maranhão	632	907	953	1,138	1,070	1,281
Minas Gerais	968	773	962	636	659	832
São Paulo	890	510	840	360	308	420
Parana	430	851	1,089	905	286	638
Santa Catarina	199	293	318	333	260	429
Rio Grande do Sul	1,245	1,804	1,976	2,105	1,675	2,293
Frontier States						
Mato Grosso	337	1,003	1,627	2,096	975	1,174
Mato Grosso do Sul					457	504
Goias	1,126	868	1,319	620	1,155	1,460
Others	588	773	673	801	744	716
BRAZIL	6,415	7,782	9,757	8,994	7,589	9,747

Source: Anuario Estatistico do Brazil, 1968, 1977, 1980.

Table A-6. Corn (Milho) Production in Major Producing States, 1966-1968, 1975-1977, and 1979-1980 (thousands of tons)

	1966-1968	1975	1976	1977	1979	1980
Minas Gerais	2,088	2,323	2,340	2,735	2,608	3,011
São Paulo	2,276	2,100	2,724	2,520	2,277	2,336
Parana	2,254	3,813	4,823	4,631	4,169	5,467
Santa Catarina	796	2,127	2,453	2,674	1,708	3,014
Rio Grande do Sul	2,194	2,367	2,443	2,680	1,853	3,162
Frontier States						
Mato Grosso	152	381	353	385	109	142
Mato Grosso do Sul					146	188
Goias	635	1,229	1,274	1,553	1,781	1,750
Others	1,942	1,994	1,341	2,078	1,657	1,303
BRAZIL	12,337	16,334	17,751	19,256	16,308	20,373

Source: Anuario Estatistico do Brasil, 1968, 1977, 1980.

Table A-7. Black Bean (Feijao) Production in Major Producing States, 1966-1968, 1975-1977, and 1979-1980 (thousands of tons)

	1966-1968	1975	1976	1977	1979	1980
Ceara	176	175	83	144	105	51
Pernambuco	133	127	73	149	133	61.5
Bahia	179	194	73	11	180	265
Minas Gerais	273	284	266	284	211	329
Sao Paulo	149	108	140	202	261	283
Parana	547	608	588	577	503	462
Santa Catarina	109	169	99	134	192	120
Rio Grande do Sul	224	156	140	110	137	80
Frontier States						
Mato Grosso	53	45	57	89	30.0	34.9
Mato Grosso do Sul					25.1	23.6
Goias	126	113	107	86	72.2	36.2
Others	403	303	214	399	338	222
BRAZIL	2,372	2,282	1,840	2,290	2,187	1,969

Source: Anuario Estatistico de Brasil, 1968, 1977, 1980.