PRODUCTION RESPONSE TO TECHNOLOGICAL AND PRICE CHANGES:

A STUDY OF WHEAT AND CATTLE FARMING IN SOUTHERN BRAZIL

BY

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Abstract

This paper analyses the impact of the price changes on resource allocation on representative wheat and cattle farms in Southern Brazil with the help of a programming model that includes alternative production, sales and investment activities under various technologies. More specifically it evaluates the possible impact of changing the support prices of wheat now maintained under a program to stimulate wheat production in Brazil. Optimal and parametric results for short run and long run price changes show that under current support programs a wheat-soybean combination will continue to replace livestock production and that attempts to reduce support prices would lead to a transition away from wheat to soybean production or livestock production on improved pasture. Analysis of resource use shows that there is a seasonal unemployment and scarcity of labor and that cash use is not sensitive to changes in the short run. The internal rates of return to capital use also indicate that current interest rates charged to farmers are very low when compared to capital productivity, and are being heavily subsidized.

OUTLINE

1. Introduction
2. Area of Study and Data Sources
3. Model Summary
4. Empirical Results
 - 4.1 Wheat Production Response
 - 4.2 Beef Production Response
 - 4.3 Changes in Employment and Capital Use
5. Some Policy Considerations
6. Further Research

REFERENCES

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and Price Changes: A Study of
Wheat and Cattle Farming in Southern Brazil*

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1. Introduction

The purpose of this paper is to analyze the impact of various price policies on the production of wheat and competing farm outputs in Southern Brazil. This is done explicitly with the help of a programming model that includes alternative production technologies on wheat and cattle farms in Southern Brazil and is formulated to simulate the impact of varying prices and resource availabilities.

The importance of this study is twofold. First, Southern Brazil is one of those areas of the world that have experienced very high rates of growth in total agricultural productive capacity (that is agricultural capital formation) with resultant high rates of growth in total output and productivity. These high rates of growth have come about through rapid mechanization, large changes in the cropping pattern and increased use of non-farm inputs such as fertilizers, seeds and credit. Besides the primary impact of these mechanical, bio-chemical and financial ingredients of technological change and the green-revolution on output, productivity and regional resource use, these changes

*The present report is part of a larger study of wheat programs and production in Southern Brazil, and is one of a series of studies being undertaken to analyze the role of capital formation and technological change in developing agriculture by the Department of Agricultural Economics and Rural Sociology, Ohio State University under contract to U.S.A.I.D.

We would like to thank Professor Norman Rask who initiated the study and without whose help this paper would not have been possible and Professors John H. Sitterley and Dale Adams for many helpful suggestions. We would also like to thank Professor Richard L. Meyer for allowing us access to parts of his larger study examining Brazil's wheat programs, without which much of the background materials for this study would not have been available.

are of special interest because of their broader impacts upon regional employment, income growth and distribution, the demand for non-farm inputs and investments in agricultural infrastructure.¹ In this broader context it is part of the ongoing effort to understand the process of modern agricultural transformation and its role in stimulating national economic development in the L.D.C.'s.

Second, and the greater topical importance of the study lies in the need to analyze the impact of these new technologies in the context of the Brazilian program to increase self-sufficiency in wheat. The program initiated in 1962-63 centers around a government policy to purchase wheat at a fixed price assured to stimulate production and stabilize the domestic market for wheat.² The policy, designed to reduce Brazil's reliance on foreign supplies was institutionalized in 1967 by establishing the Bank of Brazil as official purchaser of wheat. The price subsidy program has also been tied to a credit policy that has subsidized the use of purchased inputs such as certified seeds, fertilizers and farm machinery. The combined impact of these programs has been to substantially increase both the area under cultivation and the production of wheat. As wheat production has become relatively profitable, farmers have shifted out of the traditional extensive livestock enterprises to the intensive cultivation of wheat.³

¹See Y. Hayami and V. W. Ruttan [11] and I. J. Singh [17] for a classification of technological change in developing agriculture and W. P. Falcon [10], H. Munthe-Kaas [14] and C. R. Wharton [21] on the ever widening secondary and tertiary socio-economic impacts of new agricultural technology once introduced.

²We are indebted for the information on Brazilian wheat programs in this section to a working paper by a colleague of ours working currently in Brazil. See R. L. Meyer [13].

³In the State of Rio Grande do Sul, 60-70% of the new wheat producers on large farms are renters attracted by the new profitability, who have rented land previously used primarily for livestock grazing.

The specific impact of these pricing and credit policies can be seen from Table 1 which gives the cultivated area, domestic production average per hectare yields, imports and domestic prices of wheat in Brazil from 1962-63 to 1970-71. The data show that the area under wheat cultivation has increased sevenfold in the eight years since the wheat program was initiated, domestic production has increased over sevenfold since 1964-65 while per hectare yields have varied from year to year. The total imports of wheat which have remained in the 2-2.5 million metric ton range from 1962-63 to 1968-69 have shown a substantial decline in the last two years, while the percentage of total domestic requirements provided by domestic production have increased from an average of about 10% in the 1962-67 period to an estimated 50% in 1970-71. The wheat price support program has stabilized the domestic price of wheat in real terms, by increasing the nominal price of wheat nearly eightfold to keep up with the inflationary trends in the economy.⁴

Currently the domestic price of wheat of Cr. \$490 per metric ton is about twice the world price.⁵

The broader impacts of these selective price and credit policies have included a rapid transformation of the agricultural sector in Southern Brazil

⁴Even though the domestic price of wheat has remained somewhat stable in real terms, the domestic price of wheat relative to the domestic price of beef products, the main competitor for land use in Southern Brazil, has increased nearly twofold since 1960. See [3] and [20].

⁵For 1970 the Bank of Brazil fixed the domestic price of wheat at U.S. \$100 per metric ton, while the price for imported wheat was U.S. \$58 per metric ton. See J. J. de C. Engler [9, pg. 8].

Table 1. Cultivated Area, Domestic Production, Average Yield per Hectare, Imports and Domestic Prices of Wheat in Brazil (1962/63 to 1970/71)

YEAR	AREA (In 1000 Hectares)	Domestic Production (In 1000 Metric Tons)	Ave. Yield per Hectare (In Kilo-grams)	Imports (In 1000 Metric Tons)	Domestic Production As a % of Total	Nominal Domestic Price (Cr \$/M. Ton)	Real Domestic Price** (Cr \$/M. Ton)
1962/63	258.22	303.40	1175	2175.0	12.24	40.79	266.6
1963/64	302.12	115.72	383	2609.0	4.25	64.54	254.9
1964/65	300.54	250.45	833	1876.0	11.78	119.71	237.0
1965/66	354.68	256.75	724	2379.0	9.74	195.36	271.7
1966/67	384.96	333.52	866	2434.0	12.04	260.18	255.1
1967/68	561.99	405.75	722	2611.0	13.45	307.44	242.1
1968/69	845.69	765.08	905	2362.0	24.47	366.92	246.3
1969/70	1299.52	1303.43	1003	1799.9*	42.0*	450.00	248.6
1970/71	1810.00*	1784.00	986*	1785.0*	50.0*	490.00	219.3

*Estimated

**Nominal domestic price deflated by the index of wholesale agricultural prices.

- SOURCES: 1) Area, Production and Prices from Anuario Estatístico Do Trigo, 1969/70, Page 1, Ministerio da Agricultura do Brasil. [3]
 2) Imports: Richard L. Meyer: "Brazil's Program for Increased Self-Sufficiency in Wheat" (mimeo). [13]
 3) Index of wholesale agricultural prices used as deflator from Conjuntura Economica, Vol. 24, No. 8, 1970, page 134.

through the adoption of mechanized wheat farming, and the increased use of non-farm inputs such as inorganic fertilizers, lime and improved seeds. The increasing purchase of non-farm inputs has been heavily subsidized through the extension of credit on favorable terms for machinery and other modern inputs. In response to the increased commercialization of agriculture in the region, agri-businesses and the public sector have responded by increasing investments in the marketing, financial and transportation infrastructure.⁶

The Brazilian program to stimulate wheat production is a successful example of the use of selective price and credit policies on a regional basis. This has been done mainly by changing the relative profitability as well as the resource availabilities to farmers in a selective manner. The sectoral impact of these policies has altered the pattern of regional production, employment and resource use, while intersectoral effects have included a flow of capital resources to agriculture in the region. In addition, this program has been carried out without substantial foreign assistance and provides an important case study of the efficiency of selective domestic policy instruments.⁷

In view of the increasing availability and adoption of new technologies, not only for wheat, but for other competing commodities, and in view of the goal on the part of the Brazilian government, to reduce the level of domestic wheat prices to world prices in the long run, the important policy focus of

⁶These and related research findings of agricultural transformation at the farm level in Southern Brazil have been reported by N. Rask [15].

⁷See N. Rask [15] and R. L. Meyer [13].

this study is an analysis of the impact of changes in relative domestic prices for outputs (particularly wheat and beef) and inputs (particularly the interest rates on working capital) on regional production, resource use and employment under varying technologies in Southern Brazil.

The next section describes the area and data sources, the third section gives a brief summary of the methodology, the fourth section discusses some model results and the final sections draw some tentative policy conclusions on the basis of these results, and suggest directions for further research.

2. Area of Study and Data Sources

The data for this study are from the state of Rio Grande do Sul in Southern Brazil which accounts for over 90% of the total domestic wheat production in Brazil. Three municipios, Carazinho, Nao-Me-Toque and Sao Borja were chosen for study.⁸ The first two municipios are in the plateau region called the Planalto Medio where there has been a recent transition from traditional to mechanized crop farming, while the third municipio lies in the lowland region of the state where there has been a transition from traditional range livestock farming on natural pasture to mechanized cropping and livestock farming on improved pasture.⁹ The transition from traditional to mechanized crop farming has been accompanied by a large increase in the

⁸ A municipio is a political subdivision roughly equivalent to a county in the United States.

⁹ See N. Rask [16]. Improved pasture as distinct from natural pasture involves fencing, the use of improved seeds and fertilizers and the consequent increase in the number of animals per hectare.

crop expenses per hectare, and in the amount of credit used for purchasing inputs along with an increase in the size of the operational unit.¹⁰ The transition of extensive livestock to mechanized crop farming has resulted in large increases in gross output, credit use and employment.¹¹ In both cases selective price and credit policies have been crucial factors in the regional transformation process.

For the purposes of this study detailed data with regard to input use, credit and cash flows, labour use and availability, yields and cropping patterns was obtained from a selected sample of 430 crop and livestock farms in the selected municipios.¹² Though the farms in Rio Grande do Sul range in size from 5 to 10,000 hectares in a few cases, the modal farm size ranged between 100 to 500 hectares, for mechanized wheat and livestock farms.¹³ The

¹⁰N. Rask [15, pp. 1-13] reports that crop expenses per hectare on small mechanized crop farms are two and a half to eight times greater than on non-mechanized farms, while the amount of credit used for purchased inputs is eight to twenty times greater.

¹¹Rask also reports a sixfold increase in gross output, a 50% increase in labour use and a level of credit use ten times greater on mechanized crop farms than on traditional livestock farms. Ibid., p. 7.

¹²This was only part of a larger sample of farm level data being collected in order to study the role of capital formation in agriculture. For detailed sampling procedures used and description of area see N. Rask [15].

¹³Farms with 50% or more of their gross income from the sale of wheat and having at least one tractor were designated as mechanized wheat farms and those with 60% or more of their gross income from livestock sales were designated as cattle farms and were chosen for the study. For details see J. J. de C. Engler [9].

sample data were used to develop a representative farm situation for a farm with 200 hectares of cropped area and 20 hectares of pasture land, and input-output coefficients and resource availabilities estimated from sample "averages" for the representative farm.¹⁴ For this representative farm data was constructed for two technologies: one representing the current average input use and yield structure and another representing a high input use and yield structure. The latter differs from the former in its increased use of modern inputs like certified seeds, fertilizers, insecticides and pesticides (modern inputs) and improved cultural practices including the better timing of operations to reflect a higher management input with consequent improved yields. These data were used to construct a programming model with a view to analyze the separable impact of price and credit policies under varying conditions. This model is briefly described below.

3. Model Summary

The linear programming model developed in this study included (1) a technology matrix representing the input-output structure of farm production (under two technologies), sales, investment and financial activities, (2) a constraint structure representing physical and financial resource limitations and (3) an objective function measuring the expected net returns from crop sales, the cost of purchased inputs and an investment charge based on

¹⁴This size is also used as a representative farm size in the region by the association of the cooperatives of wheat growers in Brazil (Federacao das Cooperativas Triticolas do Sul, Ltda.-FECOTRIGO) and was chosen for purposes of comparison. Also according to data from the Ministry of Agriculture (Comissao Central de Levantamento e Fiscalizacao das Safras Triticolas) the average cropping area of mechanized wheat was 162 hectares in 1969-70.

simple depreciation for investment and (4) exogenously given input and output prices.¹⁵

The model incorporates the production and sale of wheat, soybeans (following and independent of wheat), corn, rice, beef cattle (raised and fattened on both natural and improved pasture) and hogs.¹⁶ Intermediate activities allow for the use of corn and pasture for livestock production and the conversion of natural to improved pasture. Investments included the purchase of tractors and combines which augmented available machine capacities. The farm was allowed to purchase non-farm inputs including labor and corn for livestock and modern inputs such as fertilizers, improved seeds, lime, pesticides and herbicides. Three borrowing activities allowed the farm to borrow i) for general operating expenses at a 17% nominal rate of interest, ii) for equipment purchases at a 15% nominal rate of interest and iii) for modern variable inputs at a 7% nominal rate of interest.¹⁷ On farm

¹⁵The model follows the framework set out by R. H. Day [5], and used by T. Heidhues [12] and I. J. Singh [18] in explicitly treating investments and financial constraints in a regional farm sector model, even though it does not treat farm decisions dynamically in a recursive programming context. A detailed description of the model is available in J. J. de C. Engler [9].

¹⁶Two types of improved pasture were considered: summer (semi-perennial) and winter (annual) pasture.

¹⁷These nominal rates of interest are based on data from the Central Bank of Brazil: Manual de Credito Rural [4]. The most important feature of the interest structure is the high subsidy at negative real rates of interest being provided to borrowers since prices have increased nearly ninefold in Brazil between 1963 and 1970. In 1969 the rate of interest in Brazil was approximately 25 percent. In an excellent review of agricultural credit policies in Latin America Dale W. Adams states: "... the high rates of inflation in Argentina, Brazil, Chile, Columbia, Peru and Uruguay have resulted in negative real rates of interest having been charged on a large part of institutional agricultural credit in the 1960's. In Brazil a subsidy of \$100 to \$200 million per year has moved through institutional lending agencies to agricultural credit borrowers via these negative interest rates." [1, p. 168]. The resulting factor price distortions and their impact on technological change is therefore one of the most important issues in agricultural development research today. Also see N. Rask [16].

resources included land of various qualities and family labour.

The specific constraints defining the limitations on the choice of outputs included land (cultivable, irrigated, convertible pasture and natural pasture), labor (family and hired), cash available (estimated from the average balance on hand at the end of the year plus off-farm cash incomes) and credit limitations on credit endogenously estimated at 60% of gross sales for general operating expenses and equal to the value of the purchase for modern variable inputs and investment goods.¹⁸ The exogenous variables include input and output prices and interest rates.

The model is estimated for current (1970-71) input and output prices and credit policies to determine resource use and cropping patterns. These results are discussed below.

4. Empirical Results

The central focus of the study is an analysis of the impact of changes in the domestic support price of wheat from the current (1970-71) level to the level of world prices, upon production and resource use for various levels of productivity.

The estimated enterprise combination and net returns per hectare for the representative farm are shown in Table 2 for two levels of productivity. At current input and output prices, all available cultivable land is planted to wheat followed by soybeans in a double cropping pattern. A comparison of these results with the current situation in the wheat regions of Rio Grande do Sul confirms this, since there has been a dramatic shift from traditional

¹⁸ These credit constraints define the current credit policies being followed by institutional lending agencies in Brazil. See [4].

TABLE 2

OPTIMUM ENTERPRISE COMBINATION AND NET RETURNS
FOR THE REPRESENTATIVE FARM UNDER TWO
LEVELS OF PRODUCTIVITY

Wheat Region, Rio Grande do Sul, Brazil, 1970/71

Situation*	Net Returns Per Hectare	L A N D U S E			LIVESTOCK
		Wheat (P ₁)	Soybeans Follow- ing Wheat (P ₂)	Natural Pasture (P ₆)	Beef Using Natural Pasture (P ₉)
	Cr \$/Ha	H E C T A R E S			COW UNITS
CURRENT LEVEL OF PRODUCTIVITY					
Ia	226.69	150	150	50	20
Ib	359.43	150	150	50	20
IIa	217.09	150	150	50	20
IIb	349.89	150	150	50	20
HIGH LEVEL OF PRODUCTIVITY					
Ia	247.12	150	150	50	25
Ib	379.86	150	150	50	25
IIa	237.38	150	150	50	25
IIb	370.13	150	150	50	25

- *Situations : Ia. No charge for family labor and fixed cost is charged on the investment on mechanized equipment.
 Ib. No charge for family labor and fixed cost is not charged on the investment on mechanized equipment.
 IIa. Family labor is charged and fixed cost is charged on the investment on mechanized equipment.
 IIb. Family labor is charged and fixed cost is not charged on the investment on mechanized equipment.

Note: The annual fixed cost for owning mechanized equipment includes depreciation and interest, and is equal to 20 percent of the purchase price of the equipment.

SOURCE: Model results.

beef cattle production to wheat. The wheat-soybean combination was found to be the most profitable land use under varying assumptions, for both high and current levels of productivity, and with or without a charge for the use of family labor.¹⁹

The net returns per hectare vary from Cr \$ 217 to Cr \$ 359 at current levels of productivity and from Cr \$ 237 to Cr \$ 380 at high levels of productivity depending upon whether family labor and fixed costs of investment purchases are included or not.

Given current conditions, what is the expected impact of changes in the support price of wheat? This question is analyzed with respect to both short-run and long-run changes in support prices, since farms already engaged in wheat production have the necessary equipment and can be expected to respond differently in the short run than those farms that are not engaged currently in wheat production and would have to invest in equipment in order to make the transition. To account for these differences the price response analysis considered explicitly the long-term prospects for present and potential wheat producers (by including the capital costs of machine purchases and replacements) and the short run prospects for present wheat producers (by including only variable costs for machine operations) under current and high productivity conditions.

4.1 Wheat Production Response

The production response to changes in the support price of wheat at various productivity levels are given in Table 3, which gives both the short

¹⁹Since model results showed considerable stability with regard to whether a charge for family labor was included or not, the charge was excluded for further analysis.

Table 3. Wheat Production Response to Changes in the Support Price of Wheat at Various Levels of Productivity: Wheat Region, Rio Grande Do Sul, Brazil, 1970/71

Wheat Support Price (Cr. \$ per 100 kg)	% Decrease in Price	Net Returns Per Hectare (Cr. \$/Ha)	% Decrease in Production	Elasticity of Production w.r.t Price**
Current Productivity Levels - Short Run				
49.0*	-	359.48	-	-
30.0	-39.0	222.91	-8.66	0.22
29.0	-41.0	217.13	-26.00	0.63
28.0	-43.0	215.27	-92.66	2.16
27.0	-45.0	215.25	-100.00	2.22
Current Productivity Levels - Long Run				
49.0*	-	226.69	-	-
41.0	-16.0	169.49	-40.66	2.54
28.0	-43.0	117.22	-53.32	1.24
25.0	-49.0	108.37	-100.00	2.04
High Productivity Levels - Short Run				
49.0*	-	379.86	-	-
31.0	-37.0	221.24	-26.0	0.70
30.0	-39.0	216.45	-67.3	1.73
29.0	-41.0	215.92	-100.0	2.44
High Productivity Levels - Long Run				
49.0*	-	247.12	-	-
40.0	-18.0	169.51	-40.7	2.26
37.0	-24.0	155.90	-100.0	4.16

* 1970/71 support price for wheat.

** Measured from 1970/71 support price and output levels.

SOURCE: Model results.

run response of present producers and the long run response of both present and potential wheat producers. Since a decrease of 49% in the current domestic support price of wheat is required to bring it in line with the international price, the analysis was confined to price decreases.

The model shows that for farmers currently producing wheat, in the short run and at current levels of productivity wheat support prices can be decreased about 39% before any reduction in the wheat acreage occurs. Any further reductions cause a rapid shift in land use from a wheat-soybean combination to soybeans independent of and in competition with wheat. Since the net returns over variable costs for soybeans are greater than for livestock, even with improved pasture, beef production does not increase. Similar short run results are evident for high productivity levels for all enterprises, except that the margin of decrease before wheat production changes is smaller due to the increased relative profitability of soybeans. The crucial policy implications of course are that a reduction of wheat support prices to the level of world prices would reduce the returns from wheat below variable costs, so that wheat will not be grown, and current producers of wheat will have a strong incentive to shift their land use to soybeans. This is so in the short run for those current producers who have the required equipment for wheat production at both the current and high levels of productivity.

In the long run, and for farmers operating at current levels of productivity the price decrease before there is a substantial drop in wheat production is limited to 16%. At this point soybeans begin to replace wheat, while beef, even under improved pasture, remains non-competitive. At

high levels of productivity, even though the margin of price decrease possible before reduction in wheat production does not change, the full double cropping of wheat and soybeans does not provide enough returns to cover the cost of the additional equipment required by this intensive land use. Instead a decrease in the order of 24% will make wheat and soybean in any combination less profitable than beef production using improved pasture. At this price all cultivable land is used for improved pasture and if support prices were to drop to this level, the long run transition will be from extensive cattle grazing to beef production on improved pasture rather than to mixed cropping of wheat and soybeans.

It is evident that the recent increases in wheat production in Brazil are the direct outcome of the wheat price supports program and are highly dependent upon it. The continuation of the program can be expected to bring more beef producers, producing on extensive grazing land, into wheat production in combination with soybeans. This intensive land use pattern would require mechanization and would continue to be the most profitable enterprise combination available to farmers in Southern Brazil. Attempts to reduce the domestic support price of wheat would lead to a transition into soybean production at current levels of productivity and into intensive beef production on improved pasture at high levels of productivity in the long run.

As expected the net returns per hectare continue to decline as support prices are reduced, the extent of the decline varying upon conditions. A 30% price reduction results in a 38% reduction in the net returns per hectare in the short run, while a 16% price reduction results in a 25% reduction in the net returns per hectare in the long run at current productivity levels. At higher productivity levels a 37% price reduction reduces net re-

turns per hectare by 42% in the short run and a 18% price reduction reduces them by 32% in the long run. Therefore, depending upon productivity, wheat prices can be reduced between 35-40% in the short run and 15-20% in the long run without affecting the production of wheat. However, such changes can only be brought about by substantially reducing the profit margins and farm incomes of both current and potential wheat producers.

4.2 Beef Production Response

The analysis also shows that in general, unless the productivity of beef production is raised, by conversion from extensive to improved pasture, beef production is not likely to displace the current pattern of land used devoted to wheat and soybeans. A related question considered therefore was the possibility of increasing the relative price of beef. The results of this analysis are shown in Table 4 for both the short run response of current producers and the long run response of current and prospective producers, at different levels of productivity. For those already in wheat production an increase of 220% in the price of beef is required before beef production is increased, though if beef productivity was increased a change of only 56% in beef prices would increase beef production. The elasticity of production with respect to beef prices at high levels of productivity is fairly high for both the short and long run. Therefore, if beef production is to be made competitive, either beef productivity will have to be raised and production converted to improved pasture or the price increases would have to be very large, requiring a beef subsidy program that would be far more costly than the current wheat subsidy program.

As expected, increased beef prices increase the returns per hectare, but in the short run a 230% increase in prices increases these returns by only

Table 4. Beef Production Response to Changes in the Price of Beef at Various Levels of Productivity. Wheat Region, Rio Grande Do Sul, Brazil, 1970/71

Beef Prices (Cr. \$ per 100 kg. of live weight of steer)	% Increase in Price	Net Returns Per Hectare (Cr\$/Ha)	% Increase in Production	Elasticity of Production w.r.t. Price**
Current Productivity Levels - Short Run				
120.0*	-	359.43	-	-
384.0	220.0	394.21	70.0	0.32
386.4	222.0	345.15	195.0	0.88
391.2	226.0	347.79	260.0	1.15
396.0	230.0	401.86	565.0	2.46
Current Productivity Levels - Long Run				
120.0*	-	226.69	-	-
302.0	152.0	252.73	565.0	3.72
High Productivity Levels - Short Run				
120.0*	-	247.12	-	-
187.0	56.0	391.15	88.0	1.57
194.4	62.0	396.39	352.0	5.67
196.0	64.0	401.37	612.0	9.56
199.0	66.0	407.37	780.0	11.82
High Productivity Levels - Long Run				
120.0*	-	247.12	-	-
156.0	30.0	253.67	780.0	26.0

* 1970/71 beef prices.

** Measured from 1970/71 price and output levels.

SOURCE: Model results.

12% at current productivity levels and a 66% increase in prices increases returns by 65% at high productivity levels. In the long run a 152% increase in price increases returns by 11% at current levels of productivity and a 30% increase in price results in a mere 2% increase in returns at high levels of productivity.

4.3 Changes in Employment and Capital Use

An additional line of inquiry focuses on the impact of changes in wheat support prices on the use of labor, and capital resources.

An analysis of labor use (Table 5) shows that for farms with the wheat-soybean combination in the current pattern of land use, 52-57% of the total annual family labor was employed for crop enterprise, the rest being either unemployed or having to seek other employment. There is, however, a marked seasonal pattern to labor use with scarcity during the months of May and June when wheat is planted and November and December when wheat is harvested and land prepared for soybean planting. During these months labor has to be hired to supplement family labor. In other months, however, (July through October, January, and February) family labor is gainfully employed for only about 5% of the time. Thus seasonal unemployment and scarcity of labor characterize the current pattern of production.

When wheat support prices are reduced and soybeans become profitable there is a structural shift in labor use. To begin with total labor use declines, but labor requirements in September-October increase substantially and additional labor is hired during the soybean planting period, but employment declines sharply in the months of May, June, November and December.²⁰

²⁰ Similar seasonal patterns and marked structural shifts in the demand for labour during a period of transition to mechanization have also been reported for the Indian Punjab. See I. J. Singh [19].

Table 5. Changes in Family Labor Use in Response to Changes in Wheat Prices for Various Levels of Productivity. (By Seasons) Wheat Region, Rio Grande do Sul, Brazil, 1970/71

Wheat Price (Cr. \$ per 100 kg.)	Percentage Family Labor Used (By Season)							TOTAL
	I	II	III	IV	V	VI		
	May-June	July-Aug	Sept-Oct	Nov-Dec	Jan-Feb	Mar-Apr		
Current Productivity Levels - Short Run								
49.0	109.9	4.1	4.1	136.4	4.1	57.0	52.6	
30.0	100.0	4.1	14.9	124.0	4.1	57.0	50.7	
29.0	80.9	4.1	35.6	100.0	4.1	57.0	46.9	
28.0	5.4	4.1	117.4	5.8	4.1	57.0	32.3	
27.0	4.1	4.0	118.8	4.1	4.1	57.0	32.0	
E over price range*	2.14	0	-61.8	2.16	0	0	0.87	
Current Productivity Levels - Long Run								
49.0	109.9	4.1	4.1	136.4	4.1	57.0	52.6	
41.0	64.1	4.1	53.7	79.1	4.1	57.0	43.7	
28.0	50.0	4.1	69.1	61.4	4.1	57.0	40.9	
25.0	4.1	4.1	69.1	38.5	4.1	57.0	29.5	
E over price range*	1.96	0	-32.1	1.46	0	0	0.89	
High Productivity Levels - Short Run								
49.0	128.6	5.3	5.3	137.4	5.3	58.1	56.6	
31.0	93.6	5.3	42.6	100.0	5.3	58.1	50.8	
30.0	40.1	5.3	100.0	42.6	5.3	58.1	41.9	
29.0	5.3	5.3	137.4	5.3	5.3	58.1	36.1	
E over price range*	2.3	0	-61.4	2.4	0	0	0.9	
High Productivity Levels - Long Run								
49.0	128.6	5.3	5.3	137.4	5.3	58.1	56.6	
40.0	95.0	25.0	82.3	100.0	25.0	77.9	67.5	
37.0	64.8	50.0	64.8	64.8	64.8	100.0	76.5	
E over price range *	2.1	-75.2	-47.2	2.2	-47.2	-3.0	-1.46	

*Elasticity of employment with respect to the price of wheat measured from 1970-71 support price and employment levels.

SOURCE: Model results.

In the long run transition at high productivity levels from wheat to livestock, the situation is different. Total employment increases with 76.5% of the family labor employed, and though employment declines in the periods of wheat planting and harvesting, livestock production offers greater year round employment opportunities. Even then only about two thirds of the family labor force is gainfully employed on the farm in most of the months.

An analysis of the impact of wheat price changes on working capital and credit use (Table 6) shows that at current input and output prices, land use patterns and current productivity levels the average working capital use per hectare is Cr \$ 243 of which Cr \$ 167 is borrowed for purchase of modern inputs and Cr \$ 26 for other operating expenses. The figures at high productivity levels are Cr \$ 330, Cr \$ 48 for the same items respectively.

When wheat support prices are reduced, total working capital use declines also but in the short run the elasticities of cash use with respect to price declines are less than unity. (Table 7.) Only in the long run as transition occurs from wheat to soybean production at current productivity levels and to livestock production at high productivity levels do these elasticities exceed unity. Therefore, both total cash use and borrowing for modern inputs are not too sensitive to changes in the price of wheat in the short run, though borrowing for operating expenses, due to a decline in the use of mechanized equipment, is more sensitive.

Given the concern with regard to subsidized institutional credit at negative real interest rates, additional parametric analysis on the cost of credit available for the purchase of modern inputs revealed that at current input and output support prices the internal rate of return to credit use (in nominal terms) is such that borrowing for modern inputs and operating

Table 6. Changes in Working Capital and Credit Use Per Hectare in Response to Changes in Wheat Prices for Various Levels of Production. Wheat Region, Rio Grande do Sul, Brazil, 1970/71.

Wheat Price (In Cr. \$ per 100 kg.)	Credit for Modern Inputs.	Credit for Operating Expenses	Total Working Capital
	(In Cr. \$ per Hectare)		
Current Productivity Levels - Short Run			
49.0*	166.70	26.24	242.95
30.0	160.25	23.05	233.30
29.0	147.78	17.58	215.36
28.0	98.74	0.0	148.74
27.0	97.68	0.0	147.68
Current Productivity Levels - Long Run			
49.0*	166.70	26.24	242.95
41.0	136.95	13.56	200.56
28.0	127.69	10.12	187.80
25.0	65.12	0.0	115.92
High Productivity Levels - Short Run			
49.0*	231.82	48.23	330.04
31.0	212.36	37.72	300.08
30.0	182.51	25.22	257.73
29.0	163.05	18.40	231.45
High Productivity Levels - Long Run			
49.0*	231.82	48.23	330.04
40.0	208.09	41.03	299.12
37.0	76.25	0.0	126.25

* 1970/71 support price for wheat.

SOURCE: Model results.

expenses showed no decline even when the nominal rate of interest was raised to 40 percent. This lends some evidence to the contention that credit is severely underpriced in Brazil and that nominal interest rates can be raised from the current 7 to 17 percent range to substantially higher levels, without affecting the level of borrowing. This would bring the nominal rates of interest in closer conformity to the real rates of return to capital use in an inflationary situation.²¹

5. Some Policy Considerations

In arriving at policy considerations stemming from this analysis it should be emphasized that the nature of the conclusions are tentative at best. Keeping this in mind the important policy conclusions based on this study can be summarized as follows:

1) At current support prices and productivity levels an intensive double cropping pattern with wheat followed by soybeans is the most profitable enterprise. At these prices the transition from extensive livestock production to mechanized cropping, already observed in the region, will continue. Although the domestic support price for wheat can be reduced between 35-40% in the short run and between 15-20% in the long run without affecting regional wheat production, such changes would substantially reduce the net returns per hectare and the farm incomes of wheat producers. Furthermore, a reduction of domestic support prices to the world price level for wheat would make it unprofitable to produce wheat in both the short and long run, given current levels and even expected higher levels of productivity. Before Brazilian wheat production can compete in international markets, wheat yields would have to be

²¹Precisely the recommendation of Dale W. Adams [1, p. 169] for agricultural credit in Latin America.

Table 7. Percentage Changes in the Use of Working Capital and Credit in Response to Changes in Wheat Prices for Various Levels of Productivity. Wheat Region, Rio Grande do Sul, Brazil 1970/71

Wheat Prices		Percentage Change In			Elasticity of Cash Use w.r.t Wheat Price. **
Price (Cr. \$/100 kg)	% Change in Price	Credit for Modern Inputs	Credit for Operating Expenses	Total Working Capital	
Current Productivity Levels - Short Run					
49.0*	-	-	-	-	-
30.0	-39.0	-3.87	-12.15	-3.97	0.10
29.0	-41.0	-11.35	-33.02	-11.28	0.28
28.0	-43.0	-40.76	-100.0	-38.78	0.90
27.0	-45.0	-41.40	-	-39.21	0.87
Current Productivity Levels - Long Run					
49.0*	-	-	-	-	-
41.0	-16.0	-17.84	-48.33	-17.46	1.09
28.0	-43.0	-23.41	-61.44	-22.69	0.53
25.0	-49.0	-60.47	-100.0	-52.59	1.07
High Productivity Levels - Short Run					
49.0*	-	-	-	-	-
31.0	-37.0	-8.39	-21.77	-9.08	0.25
30.0	-39.0	-21.27	-47.71	-21.90	0.56
29.0	-41.0	-29.66	-61.84	-29.87	0.73
High Productivity Levels - Long Run					
49.0*	-	-	-	-	-
40.0	-18.0	-10.24	-14.9	-9.37	0.52
37.0	-24.0	-67.11	-100.0	-61.74	2.57

* 1970/71 support price for wheat.

** Measured from 1970/71 support price and output levels.

SOURCE: Model results.

raised substantially above the current levels. Serious considerations should be given to policies designed to increase per hectare wheat yields in Brazil which currently are less than half the yields being realized elsewhere in the LDC's.²²

2) Unless livestock productivity is increased by the conversion from a system of extensive natural range pastures to a system of intensive improved pastures, beef production cannot compete successfully with mechanized crop farming even if support prices for wheat were to be reduced. Increasing the relative domestic price of beef without increasing livestock productivity by conversion to improved pasture would require price increases in the range of 250-300% before beef production could compete successfully. Such price increases would require a domestic beef price support program several times as costly as the current wheat program.

3) The recently observed regional transition from extensive livestock farming to mechanized crop farming has resulted in a high degree of seasonality in the demand for labour, a seasonality that was far less pronounced under livestock production which is characterized by greater year round employment. Further changes in this direction bringing about structural changes in the regional demand for labour, can be expected to create a problem of seasonal unemployment. Policy measures designed to provide off-season employment and to reduce the problems of rural underemployment should be seriously considered before the vast regional transformation under way creates large labour surpluses and unplanned rural-urban migrations.²³

²²For example the average wheat yields in the Indian Punjab stood at 2170 kilograms per hectare in 1968-69 and have increased since. See [8, p. 84].

²³A similar process of technological change in the 1940's and 1950's in the rural South of the United States led to the vast influx of displaced Negro sharecroppers to the cities of the North with the resultant socio-economic dislocations of the 1960's. The process and its impact on population movements is described by R. H. Day [6].

4) The insensitivity of the demand for working capital and credit to short run changes in the nominal interest rates suggests that credit is a substantially underpriced resource. A more detailed analysis would be required to consider to what extent interest rates can be increased without substantially changing existing patterns of production in order to bring them closer to the real rates of return to credit use in the region. There is no doubt that serious policy and research considerations should be given to this and related issues of factor-price distortions and their consequences for regional agricultural development.

6. Further Research

The importance of examining in greater detail the impact of factor-price distortions on the process of regional agricultural development in Southern Brazil, as an item on any agenda for future research has already been mentioned. In addition further analysis is needed of the possibilities of reducing wheat support prices and the substitution of livestock production on improved pasture. The export possibilities for Brazilian beef to earn foreign exchange to import Brazilian wheat requirements at the lower international price should be investigated. The feasibility of increasing domestic wheat yields and the policies, institutional framework and costs of such a program need urgent research attention.

Since the current analysis is in a representative farm framework and since the farm size issue is of some importance in Southern Brazil, the methodology needs to be extended to incorporate various farm sizes to observe the differential impact of price changes. In view of the importance of rapid technological change and its regional impact on production, invest-

ment, employment and migration, the methodology should incorporate the dynamics of farm decisions and should be extended to the regional level to provide detailed information of regional agricultural transformation for policy purposes.²⁴

²⁴The ability of dynamic models that explicitly incorporate technological change to provide detailed information on the regional history of farm production, resource use and organization for policy purposes was emphasized by R. H. Day and E. H. Heiden [7]. One such model examining agricultural transformation in the LDC's has been completed for the Indian Punjab by one of the authors [18]. Another comprehensive dynamic model of agricultural development that incorporates farm size is being developed for Southern Brazil by Choong Y. Ahn and one of the authors at Ohio State University. See [2].

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