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The Competitive Position of the Brazilian Soybean Industry

Masahiko Gemma

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture, Forestry and Home Economics
St. Paul, Minnesota 55108

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** Graduate research assistant in the Department of Agricultural and Applied Economics, University of Minnesota.
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Contents

Abstract

This study examines the competitive position of the Brazilian soybean and its products as well as factors which have contributed to the expansion of the Brazilian soybean industry. Favorable economic conditions in supply and demand have influenced the development of this industry. Estimated acreage and yield response equations indicate a high price elasticity of the soybean supply for the observed period. Contributions of research, particularly breeding of high yield varieties, are also discussed.

1. Introduction

Since 1955 world production of soybean has been dominated by North America. Beginning the early 1970s, however, South America, especially Brazil, has become an active competitor. The Brazilian government has supported the expansion of soybean cultivation with special subsidies, trade policies, and intensive research. The effect of these supports are examined in this paper, particularly (1) in terms of factors that have contributed to the remarkable increase in Brazilian soybean production and (2) in relation to the competitive position of the United States and Brazil in world soybean production.

1.1) Background

Soybeans have been cultivated in Asia for some 5,000 years. Over the last 45 years they have been increasingly produced in the United States.[1] In 1940, for example, 84.5 percent of the world soybean supply was produced in Asia, and only 15.1 percent in North America. By 1970, however, North America accounted for 67.0 percent of the world soybean production; and in 1984[2] the United States was the world's largest soybean producer, with 51.4 percent of the total output (Figures 1 and 2). A remarkable expansion of soybean production has taken place in South America over the last 15 years. In Brazil, for example, production increased tenfold over the past decade.[3] As of 1984 Brazil is estimated to be the second largest world producer of soybeans with 18.1 percent of the total.[4]

2. Characteristics of the Brazilian Soybean Industry

In order to compare soybean production in Brazil and the United States certain basic differences must be distinguished. In this section, Brazilian soybean production, soybean products, and consumption are examined for differences from those of the United States.

2.1) Soybean Production

Soybeans are cultivated in a more tropical environment in Brazil than in the U.S. (Gulliver, 1981) and the rainfall pattern is generally less dependable (Murdock, 1986). Moreover, the Brazilian pests and pathogens have the potential for much more serious damage (Hymowitz, 1986). These disadvantages are offset, at least in part, by the advantage of double cropping. In a typical soybean growing area in Brazil, wheat is produced in winter and soybeans, the following summer. This cropping system facilitates the efficient use of fixed capital throughout the year.

The government subsidies for credits on machinery and fertilizer that are available to Brazilian wheat producers were also utilized to soybean producers during the last decade. These heavy subsidies have played very significant roles in encouraging the soybean-wheat rotation.

When soybeans were initially introduced, Brazilian farmers could lower the risk of experimenting with them by alternating the two crops every year. The result, however, has led to a comparative disadvantage for Southern Brazil, the major soybean producing area. It is less fertile than the U.S. Midwest. Indeed, only ten percent of the total area in which soybeans are grown is without serious soil limitations in Brazil (Gulliver, 1981).

The costs of soybean production in Brazil were significantly higher than those required in the United States in 1977. At that time the cost of producing one hectare of soybeans was approximately $331.41 in Brazil and only $188.20 in the United States. (Nogueira, 1979). Even considering the overvalued Brazilian currency and differences in yield, the production costs in the two countries were still substantially dissimilar in 1977. The latest input cost figures for Brazil and the United States, however, show that the 1977 diffrences in costs have disappeared (see Table 1). Also, as illustrated by Table 1, land and labor are less costly in Brazil. Regional differences within the two countries appear to be significant, nevertheless. The soybean base cost[5] per bushel in the midwestern U.S. is not as high as that for southern U.S. but is slightly lower than that for southern Brazil. It should be noted that Brazilian soybean producers face very high transportation costs because of their locations relative to markets and processing centers

(Murdock, 1986). The basis cost per bushel, which includes transportation costs and taxes, are almost five times higher in Brazil than in the United States.

Figures 3 and 4 provide rough comparisons of two economic indicators -- price and cost -- that clarify the comparative advantage over time of U.S. soybean production over Brazilian soybean production.[6] Both the prices received by and the costs to soybean producers for fertilizer (superphosphate 44-46 percent) were analyzed at the official exchange rate by Santana (1984). The analysis suggests that U.S. soybean producers received more money for their products and paid less money for their inputs than Brazilian producers. These differences are due in part to the various governmental policies on international trade and the production of soybeans and their products, and to the difference in resource endowments and infrastructure.

2.2) Soybeans, Soybean Oil, and Soybean Meal

The soybean and its products produced in Brazil contain different chemical characteristics than those produced in the United States. Although the free fatty acid content is higher in Brazilian soybean oil, which results in higher refining costs, the Brazilian soybean is reported to have higher oil and protein contents than the U.S. soybean (Thompson, 1979).

However, the Brazilian soybean needs more careful storage and more drying, due to the high humidity of the tropics, and Brazilian soybean oil requires the use of more bleaching clay because of the amount of red dust adhering to the beans.

European feed compounders frequently prefer Brazilian to U.S. soybean meal on the basis of lower cost per unit of protein content (Thompson, 1979).[7] Brazilian soybean meal reportedly contains more than 47 percent protein, whereas U.S. soybean meal contains 44 percent[8] and, at times, as little as 40 percent because hulls are sometimes mixed back into the meal. Thompson (1979) also reported that European feed compounders prefer the pelleted form of soybean meal produced in Brazil.

Because of favorable seasonal market price movements, Brazilian soybeans receive a higher price than U.S. soybeans. The international soybean price tends to increase from March to August, after which it typically decreases continuously until February. Brazilian soybeans are usually harvested between March and May; Brazilian soybean exporters can store the harvest until the price reaches its peak in August and sell out before the price starts to decline. U.S. exporters, on the other hand, harvest their soybeans in September and October and then must sell during the period of declining prices in the international market.

2.3) Domestic Consumption

The consumption of soybean oil and soybean meal has expanded in Brazil. The increase in soybean oil consumption stems from the shift in demand from lard to plant-origin edible oils, which has accompanied income growth, and from the substitutions of soybean oil for the previously favored edible oils derived from plants (Thompson, 1979). Figure 5 depicts the change in the domestic consumption of peanuts, cottonseed, and soybean oils between 1960 and 1982. The upward trend of soybean oil consumption and the constant consumption of peanut and cottonseed oils are mainly caused by relative price differences; the domestic price of soybean oil has been lower than the prices of the other two oils (Santana, 1984).

The demand for soybean meal also has grown as a result of the expanded Brazilian poultry industry; the industry consumes more than 75 percent of the soybean meal produced (Williams and Thompson (A), 1984). A trend of rapid growth in soybean meal and a decline in peanut and cottonseed meals consumption are shown in Figure 6 for 1950-1985. Soybean meal is preferred to other meals by poultry feeders because of its high lysine content, an essential amino acid for poultry (Gulliver, 1981). Soybean meal has been preferred also because it is toxin-free (Santana, 1984).

3. Brazilian Soybean Policies

Government policies on soybean production and international trade have played very important roles in establishing the competitive position of the Brazilian soybean industry. The production and trade policies are discussed in this section in turn.

3.1) Production Policies

Beginning in 1943 Brazil has employed a Minimum Price Policy (MPP) that covers more than 40 agricultural products (Santana, 1984). Three months before planting the government announces a minimum (guaranteed) price. Producers then have three options: they can sell their crops on the market, they can sell any quantity of the crop to the government at the minimum price, or they can obtain 4-6-month loans from the government and repay the loan plus interest and storage costs after they sell the crop. With the third option, borrowers can sell crops to the government at the minimum price if the market price stays lower, and the borrower is exempted from paying interest and storage costs.

Combined with the MPP, the government credit program has played a significant role in expanding and modernizing Brazilian soybean production. Between 1975 and 1982, more than 57 percent of the total credit for all crops was extended to soybean production (Santana, 1984). This credit program was started in 1937 by the Bank of Brazil. In the early 1970s (prior to 1978), soybean producers could borrow 60 percent of the projected value of the crop (minimum price times expected yield). The interest rate on credit was set well below the domestic inflation rate. Real interest rates in the last decade, therefore, have been negative.

Since 1979, however, the Brazilian government has been determined to reduce the volume of agricultural credit. Average production cost has been introduced as an alternative to projected value to calculate the quantity of production credit available to producers. With this new policy, soybean producers can borrow up to 80 percent of the average production cost. The policy represents a substantial decline in credit in real terms considering the country's high inflation rate of more than 90 percent (Williams and Thompson (A), 1984).

Certain policies on other commodities also have influenced soybean production in Brazil. The coffee Eradication Program in the 1960s, for example, had a direct impact on the expansion of soybean production. This program was introduced when the worldwide excess of coffee was a problem. The Brazilian government paid producers to remove old coffee trees and plant other crops. Soybeans replaced coffee trees to a great extent. The Brazilian wheat policy also encouraged the expansion of soybean production. The government maintained high support prices for wheat (relative to world market prices) for the purpose of becoming self-sufficient in wheat. The resulting expansion of the wheat area also led to expanding the area planted to soybeans.

3.2) Trade Policies

Restrictions have been imposed on exports of Brazilian soybeans, soybean oil and soybean meal. The objectives of the policy were to ensure adequate domestic supplies of oil and meal and to stimulate the use and expansion of the domestic crushing capacity (Williams and Thompson (A), 1984). Quotas, export tax, and subsidies also have been used to achieve these objectives from time to time.

The market shares of the Brazilian soybeans and their products on the international market are compared with those of the United States in Figures 7, 8, and 9. In the 1960s, Brazilian soybean oil was not exported and the market shares of Brazilian soybeans and soybean meal were very small. During the decade, U.S. soybeans as well as soybean oil and meal dominated the international markets.

In the 1970s, a change occurred. Although the United States continued to dominate the international soybean market it lost significant shares in the international soybean oil and soybean meal markets, particularly in the late 1970s. The Brazilian soybean share increased sharply in the middle of the decade but then declined and remained low. However, the performance of Brazilian soybean oil and meal in the international market strengthened. These products have expanded and maintained their competitive positions in the international markets since the middle of the 1970s.

The trade patterns of Brazilian soybeans and their products reflect government policies, complex trade restriction were maintained strongly until 1975 in order to insure enough soybeans for the expanding crushing industry and adequate soybean oil and meal to meet increasing domestic demands. Even after this period, the high level of value-added tax on soybean exports was still effective. It provided an incentive to use Brazil's soybean crushing capacity (Thompson, 1979). In addition, tax credits were allowed for the export of soybean oil. Soybean meal exports also benefited from a special export financing plan. These policies were biased to encourage the domestic crushing of soybeans and the exports of soybean oil and soybean meal. Strong evidence of this bias was quantitatively identified by Santana (1984).[9]

The Brazilian policies have influenced the performance of the U.S. soybean industry as well. The effect has been to raise the price of soybeans and lower the prices of soybean oil and meal in the international markets (Williams and Thompson (B), 1984)[10]. The U.S. soybean industry thus benefited. A sensitivity analysis undertaken by Mayers and Hacklander (1979)[11] indicated that a 30-million-bushel decline in Brazilian soybean exports would result in

25-million-bushel increase in U.S. soybean exports. In addition, Mayers and Hacklander estimated that this increase would be accompanied by a reduction of 285,000 tons in the production of U.S. soybean meal and an increase of $7.20 in its price.

The effects of the U.S. export embargo of 1973-1975 were studied by Paarlberg (1980). He concluded that even though the United States lost some shares in the European soybean and soybean product market, the decline in shares likely would have occurred without the export embargo.

4. Contributing Factors in Brazilian Soybean Production

The factors contributing to the tremendous increase in Brazilian soybean production are examined in this section. First, a supply function approach is used to identify the economic factors that are strongly related to the increase in acreage and yield,[12] and then, contribution of research to the increase is examined.

4.1) Acreage and Yield

Up until the late 1970s, the expansion of Brazilian soybean production was due primarily to an increase in the area harvested. In recent years, increases in yields themselves also have made a significant contribution to the expansion of the Brazilian soybean industry. Table 2 indicates the levels of production, areas harvested, and yields in the traditional and expansion cultivation areas between 1970 and 1983. The traditional area comprises the southern states of Parana, Rio Grande du Sul, Santa Catadina and Sao Paulo (see Figure 10). The expansion area is located north of the traditional area and includes Mato Grosso du Sul, the southern part of Mato Grosso, Goias, Maranhao, the Western part of Minas Gerais, and Behia.

In 1970, the soybean production in the traditional area was estimated at 1.5 million tons, 98.6 percent of the total Brazilian production. In 1983, the production in this area increased to 10.9 million tons, which was 75 percent of the country's total production. The soybean yields in this traditional area increased 1.5-fold from 1970 to 1975 and have stayed at this same level since then.

On the other hand, the expansion area, with only a 1.4 percent share of the total production in 1970 became a 2.2 million ton producing area by 1980, which represents more than a 25 percent share of total production. The production increased 175.7-fold between 1970 and 1983. Although the yields stayed the same in the early 1970s, they sharply increased in the late 1970s and in the early 1980s. Estimations of acreage and yield functions are examined to clarify the factor influencing the production decision and yields of Brazilian soybeans (Gemma, 1983).

A set of pooled time-series and cross-sectional data has been collected for the traditional soybean-producing states of Parana, Rio Grande du Sul, and Sao Paulo from 1971 to 1977. This area was chosen as the focus of investigation because of its homogeneity of natural environment and farm structure. The appropriateness of this method of pooling the data has been tested (Gemma, 1983, Appendix 2).

Acreage and yield response functions with adaptive expectations are specified in Table 3.[13] Minimum support prices are included as expected prices in these functions rather than the realized market prices during the previous year. The reasons are that (a) minimum prices have higher correlations with acreage and yield than previous year's prices and (b) it is reasonable to hypothesize that Brazilian producers take account of minimum prices before they design their production plans (Duran, 1979).[14] The summary statistics provided with each model consist of T-values, mean square error, degree of freedom for errors, coefficient of expectation (a)[15] and expected "normal" price (b)[16]. LNM1 represents the minimum supported price announced before planting. LAA1 signifies soybean acreage, and LAY1 the soybean yield during the previous period. LNC1 refers to the price of corn during the previous period. LNW1 represents a weather variable showing the precipitation from June to September. All the preceding variables are expressed in logarithmic terms. The two lagged dependent variables, LAA1 and LAY1, were derived separately as instrumental variables before being used in this estimation. D1 is the regional dummy variable for Parana. D2 is the regional dummy variable for Rio Grande du Sul.

The coefficients of the minimum support price of soybeans, which are the elasticities in logarithmic forms, are significant in regards to both acreage and yield response equations. These coefficients can be interpreted as short-run price elasticities of soybeans in the Nerlove sense (Nerlove, 1957).[17] The minimum support prices of soybeans also tend to be perceived as expected prices thereby affecting farmers' decisions. Consequently, they can also be considered as long-run elasticities. These values of the estimated elasticities are, in fact, quite high. The total (acreage plus yield) price elasticity of soybean supply was found to be 2.53.[18] The total long-run price elasticity in Nerlove terms (b) was found to be 4.17.[19]

Investigations of the total U.S. soybean supply elasticities have given an elasticity of 0.73 (Groenewegen, 1980).[20] The price elasticity of 2.53 implies that a one percent increase in soybean minimum price, <u>ceteris paribus</u>, would result in a 2.53 percent increase in the supply of soybeans. This finding seems extreme in light of the argument that agricultural supply responses are typically price inelastic due to lags in the biological production process (Tomek and Robinson, 1981). Hence, the results of the present study have strong implications for the price responsiveness of the Brazilian soybean supply during the observed period.

The coefficient of expectation (a) can be calculated as

0.57 for the acreage equation and 0.76 for the yield equation. These values are relatively high. They indicate that Brazilian farmers change their expectations significantly in the short run. Furthermore, they imply that the production of soybeans in Brazil may be influenced more by the latest change in the support price of soybeans than by farmers' expectations of the long-run 'normal' price. It seems evident, then, that Brazilian producers are very sensitive to economic variables.

Weather variation has a significant impact on year to year changes in the supply of soybeans. In both models, the precipitation between June and September shows a significant effect at the one percent significance level. Although this rainfall has positive effects on soybean acreage, it has negative effects on soybean yields. In Brazil, soybeans are planted in October and November. Gulliver (1981, P.160) illustrated the importance of rainfall during the four months prior to October for soybean production in Brazil: "If total accumulated rainfall from June through September rose, good soil moisture for planting was assumed. Inadequate moisture will retard germination." Therefore, it may be reasonable to assume that farmers will increase their planting areas if they have had sufficient rainfall prior to planting. It is likely that farmers consider it worth increasing the area to be planted to maximize profit. The negative coefficient on the rainfall in the yield equation can be partially explained by the relation between the rainfall and wheat-soybean rotation. Gulliver (1981) explained the problem of wheat-soybean rotation as follows:

> The wheat soybean rotation became popular from the middle of Parana to the southern tip of Rio Grande du Sul. Generally, in order to achieve larger yields, late maturing soybean should be planted. Planting should take place in the October/November period. If soybean planting is delayed, early maturing varieties, for which yields are lower, must be used. In order to accommodate an October/November planting, however, wheat must be harvested in the late spring months (of September and October) instead of November/December as would be the case in the absence of soybeans. Because wet weather frequently delays the wheat harvest, the wheat crop is seldom out of the ground by October. In fact, soybean planting proceeds without delay only during rare years of ideal harvest weather. (P.141)

A technical difficulty should be noted here, however. The measurement used in this yield equation estimation assumes a linear relation between rainfall and yields. A linear relationship would not indicate that too much rainfall is as undesirable as too little rainfall. Hence, the result may be biased to some extent.

Previous corn prices have shown a negative and significant effect on Brazilian soybean yield at a 13 percent significance level. When the inclusion of fertilizer prices was attempted it was not shown to be significant, using these models. This conclusion implies that fertilizer price variation has not been great enough to affect acreage and yields.

4.2) Contribution of Research

Soybean cultivation in the traditional area is technologically advanced. Still it faces potentially serious difficulties in maintaining high yields in the near future because of severe erosion and insect control problems (Williams and Thompson (A), 1984). Rio Grande du Sul is characterized by its rolling land; the attempts to use no-till farming and shallow tillage there to avoid erosion have been effective. Research has shown definite yield increases from chisel plowing as well (Hartwig, 1986). In addition, soil compaction methods that increase water drainage have been developed so that soybeans are more dependent upon very frequent rain during the growing season (between November and March) (Hartwig, 1986).

The expansion area, considered technologically less advanced in comparison with the traditional area, also may have trouble maintaining yields in the future. This new area has more level land and less erosion than the traditional area (Hartwig, 1986). Nonetheless, an extreme infertility problem is emerging. As a result, an increase in the use of lime, phosphate and potash will be necessary. Truck transportation adds to costs in the north, except for the area below the Amazon region that has clear access to water transportation (Hartwig, 1986). Lowering transportation costs would effect future development of this expansion area strongly. The decline of credits on inputs in real terms may lead to less use of fertilizers and machinery. Due to the tropical environment, the continued use of chemicals is inevitable to protect against severe crop losses. Moreover, the expansion of soybean acreage is not expected (Williams and Thompson (B), 1984). Thus, the effectiveness of soybean research that is designed to raise yields and lower production costs is a key to maintaining expanding soybean production.

4.2.a) Agricultural Research System in Brazil[21]

The imperial government of Brazil created a few research institutes during the nineteenth century. Important stations are the ones established at Elisen Maciel in Rio Grande du Sul and the Bahino Agronomic Institute in Bahino. At the turn of the century, the federal government established other agricultural research institutes. In 1943, rural universities were established in conjunction with regional research institutes.

Later, due to difficulties with multi-internal decision making at the Ministry of Agriculture, the Department of Research and Agricultural Experimentation (DPEA) was organized to take care of all research-related affairs. Meanwhile, rural universities became independent of the Ministry of Agriculture. In 1969, the DPEA was reorganized and became the Office of Research and Experimentation (EPE).

However, in 1971 this Office changed its name to the National Department of Agricultural Research (DNPEA). Subsequently, after the creation of the Brazilian Corporation for Agricultural Research (EMBRAPA) in 1972, the DNPEA was abolished. In 1975 EMBRAPA established a National Soybean Research Center in Londrina, Parana. With the support of these agencies much soybean research has been completed, including the development of new soybean varieties, particularly by EMBRAPA and the National Soybean Research Center.

4.2.b) Contribution of Soybean Research

One of the major contributions to soybean research in Brazil has been the focus on high yield varieties. Table 4 gives the major soybean varieties with their average yields in chronological periods. One important characteristic required for the development of the Brazilian soybean varieties has been adaptability to shorter day conditions. Resistance to pests and pathogens, which are major obstacles in tropical soybean production, also has been important. During the middle 1960s some soybean varieties that originated in the southern U.S. and had these characteristics were introduced to Brazil. These southern U.S. varieties had many features that were adaptable to Brazil, such as shorter day conditions, good seed-holding qualities, and resistance to the major foliar diseases that are typical in warm and humid conditions (Hartwig, 1986). In this process, the National Soybean Commission,[22] which consisted of members from both the United States and Brazil, played a very important role in introducing the U.S. varieties and in developing new varieties adapted to Brazilian natural conditions (Hymowitz, Vernetti and Shands, 1968).

"Improved Pelican" was the first major variety to be planted in the Rio Grande du Sul, the initial site for Brazilian soybean production.[23] Despite the fact that this variety had not been used for seed production in the United States,[24] it became popular in Brazil because of its better adaptation to short-day conditions. Other U.S. varieties such as "Hill," "Hood," and "Lee" were introduced but were not productive under the short-day conditions.

"Bragg," which was originally released in the United States in 1963, was introduced to Brazil in 1966. "Davis," "Hardee," and "Bossier" became available later. In addition, many varieties such as "Delta," "Campos Gerais," "Vicosa," "UFV-1," and "Mineira," have been developed in Brazil from the U.S. varieties produced at the Southern Regional Soybean Program at Stoneville, Mississippi. Thus, the soybean varieties grown in Brazil are genetically related to the varieties found in the southern U.S.

Brazilian soybean research and development have now progressed to a third stage. The first was direct transfers of varieties from the United States; the second was the transfer of breeding materials from the United States; and the third, and more mature stage, is a program of germplasm enhancement using the genetic material developed in Brazil as well as genetic materials from all major soybean growing areas in the world.[25] In retrospect it appears that it was almost inevitable, once soybean varieties were developed that were suitable for southern United States, that Brazil also would acquire or develop varieties that were suited to the semitropical environment in which soybeans are now grown in Brazil. Even if an effort had been made to prevent the direct transfer of soybean varieties released in the southern U.S. to Brazil, it is doubtful that transfer of breeding methodology could have been restricted.

As a result of breeding efforts carried out in Brazil, average yields increased 64 percent between 1960/68 and 1980/83. Soybean resistance to plant diseases also has been improved substantially. The use of natural enemies (biological control) and biocides in insect control as well as the development of varieties with high resistance to diseases have been widely researched.

Inasmuch as the loss of soil is a serious problem, especially in Parana where annual loss of 50 to 100 tons per hectare is reported, soil conservation research has been undertaken. The development of the no-till technique is an example of one research effort. The development and introduction of new machines also have become important in Brazilian soybean production. Unfortunately, not all farmers are able to use the machines effectively. According to a report from the Organization of Cooperatives in Parana, a 50 percent loss in machinery efficiency has been attributed to the maladjustment of harvesting machines (Ayres, 1985).

The use of soybeans for human nutrition has become an important research topic in Brazil. One outgrowth of this research is the incorporation of soybean in pasta and bread production.

Ayres's study (1985) indicates that benefits from the investment in soybean research have been substantial; an estimated 1.3 to 1.8 billion Cruzeiro gain occurred as of 1983. He also estimated the average internal rate of return at 46 percent, and the marginal rate of return at between 40 and 49 percent. These rates demonstrate the importance of soybean research in Brazil. Research policy will become a key factor in the future development of Brazilian soybean production plans in addition to short run production and trade policies.

5. Summary

The studies reported in this paper demonstrated that Brazilian soybean producers have faced favorable economic conditions in demand and supply for their products. Consumers' preference for the Brazilian soybean and its products as well as the seasonal price advantages, due to the timing of the Brazilian harvest compared with other world soybean producers, have increased the demand for Brazilian soybeans and related products. Brazilian governmental policies, such as credits for soybean production combined with the soybean support price, encouragement of reductions in coffee production, and subsidies for wheat production, have all contributed to an increase in the country's soybean supply. In addition, the government's trade restrictions have encouraged the domestic crushing of soybeans and the export of domestic surpluses of soybean products. These restrictions have benefited the U.S. soybean industry as well.

Estimated acreage and yield response equations are given for the three soybean states from 1971 to 1977. The results, which indicate a very high price elasticity of the soybean supply in Brazil, imply that Brazilian farmers have been responding significantly to favorable soybean prices. The coefficient of expectation indicates that Brazilian soybean supply was influenced more by the latest change in the minimum price of soybeans than by farmers' expectation of long-run "normal" prices. In addition, this study demonstrates that the minimum price policy of the Brazilian government for soybeans has had a major influence on the expansion of Brazilian soybean production.

Brazilian soybean production has increased over time due to the expansion of the area harvested. Moreover, in recent years, the increase in yields has made a significant contribution to the growth in production. Thus, maintaining yields may well become a key factor in the future expansion of Brazilian soybean production. Because of Brazilian farmers' high responsiveness to changes in prices, lowering the costs of production can be expected to be critical in the future. Finally, based upon the documented profitable contributions of soybean research in Brazil and the emerging need to maintain high yields, it is apparent that research policy will continue to be an increasingly important and relevant area of focus for the future development of the Brazilian soybean industry.

Footnotes

[1] Soybeans were first introduced to the United States at Savannah, Georgia, from China in 1765 (Hymowitz and Harlan, 1983).

[2] Estimated from the latest issue of the FAO production yearbook.

[3] Soybeans were first grown in Brazil in 1882 at the Bahia School of Agriculture in S. Bentodas Lages, Bahia (Hymowitz, 1986).

[4] Latest issue of the FAO production yearbook.

[5] Excluding interest and transportation costs.

[6] The dollar paid for soybeans has been very sensitive to changes in exchange rates. The high value of $US in the early '80s has hurt the US farmer.

[7] Generally, this protein content is not a critical factor for producers because maximization of yield is concentrated upon (Hymowitz, 1986).

[8] This comparison (47% vs. 44%) has been questioned due to the similarity of production processes in both countries (Hymowitz, 1986).

[9] Santana (1984) estimated the effects if there were no interventions in foreign sales of soybeans. The income transfer between the sectors was also estimated.

[10] The net effects of Brazilian soybean policies on the world soybean market were examined by utilizing a simultaneous equations model of world soybean economy.

[11] An econometric model of the soybean industry was used to analyze the impacts of the key factors in the US domestic and international markets.

[12] Non-economic variables such as wheather variables will also be included in the econometric model.

[13] For details in methodology and sources of data, please refer to P.31-49 of Gemma's paper.

[14] Duran's work supports this hypothesis.

[15] This is considered as the permanent component of the change in price expectation. The following formula is used for its calculation. (a = 1 - [coefficient on LNM1])

[16] This is the long run price elasticity of supply in this framework.

[17] Refer to Marc Nerlove, Distributed lags and demand analysis for agricultural and other commodities, USDA, 1957.

[18] Since variables are in logarithmic terms, this can be obtained by simply summing the coefficients on LNM1 using both equations.

[19] This can be calculated by adding the expected " normal " prices (b) from both equations.

[20] It may be questionable, however, to compare two elasticities that were obtained from different areas and periods, and with different estimation methods.

[21] This section draws heavily on material from Ayres (1985).

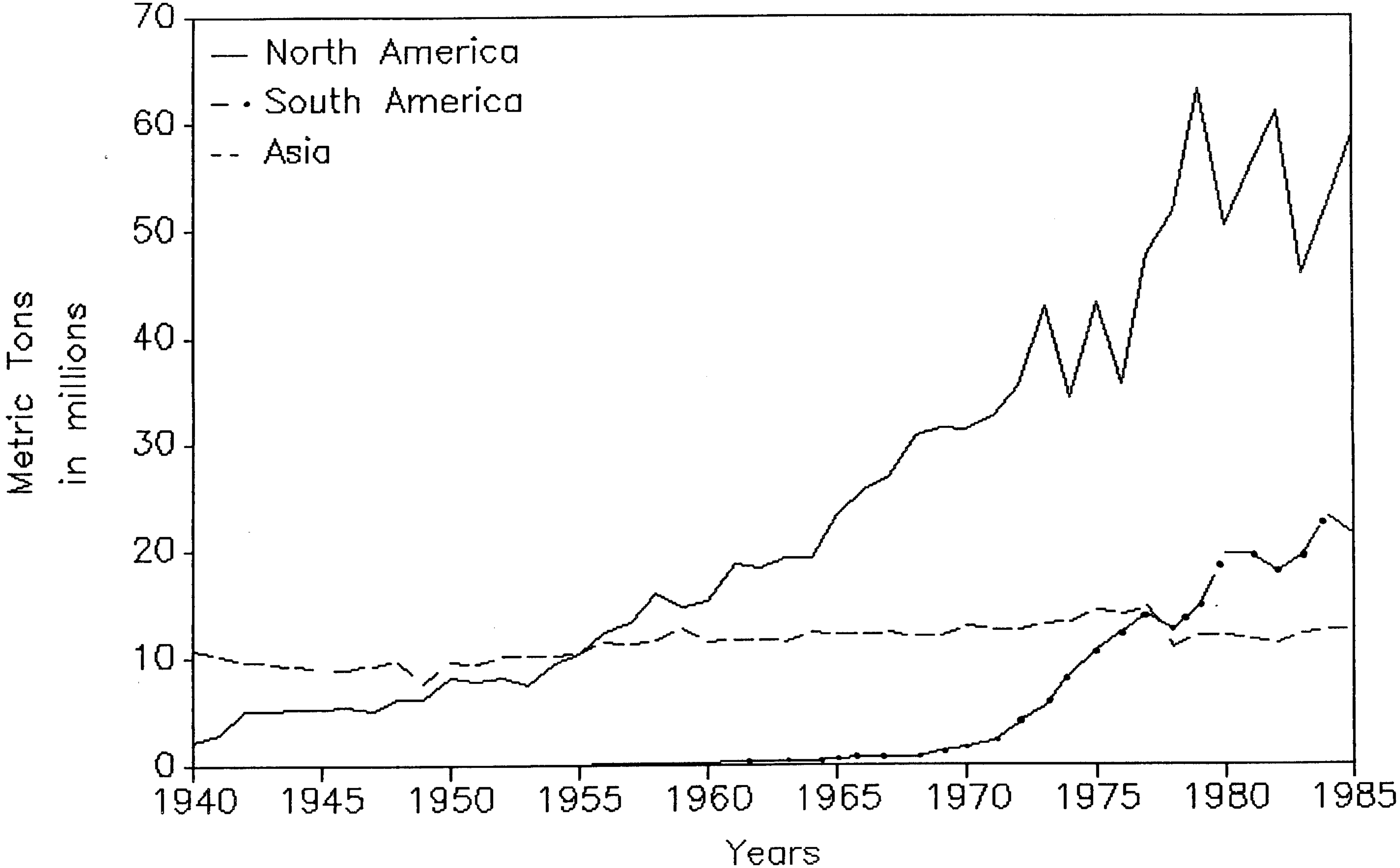
[22] About 25 agronomists were involved in this integrated soybean research program in the 1960s. USAID helped to establish this commission.

[23] The information regarding the varieties transfered to Brazil was obtained from Dr. Hartwig of the USDA's Soybean Production Research at Stoneville, Mississippi.

[24] This variety was basically used in Louisiana as a green manure to be turned under before planting sugar cane because of its heavy growth (Hartwig, 1986).

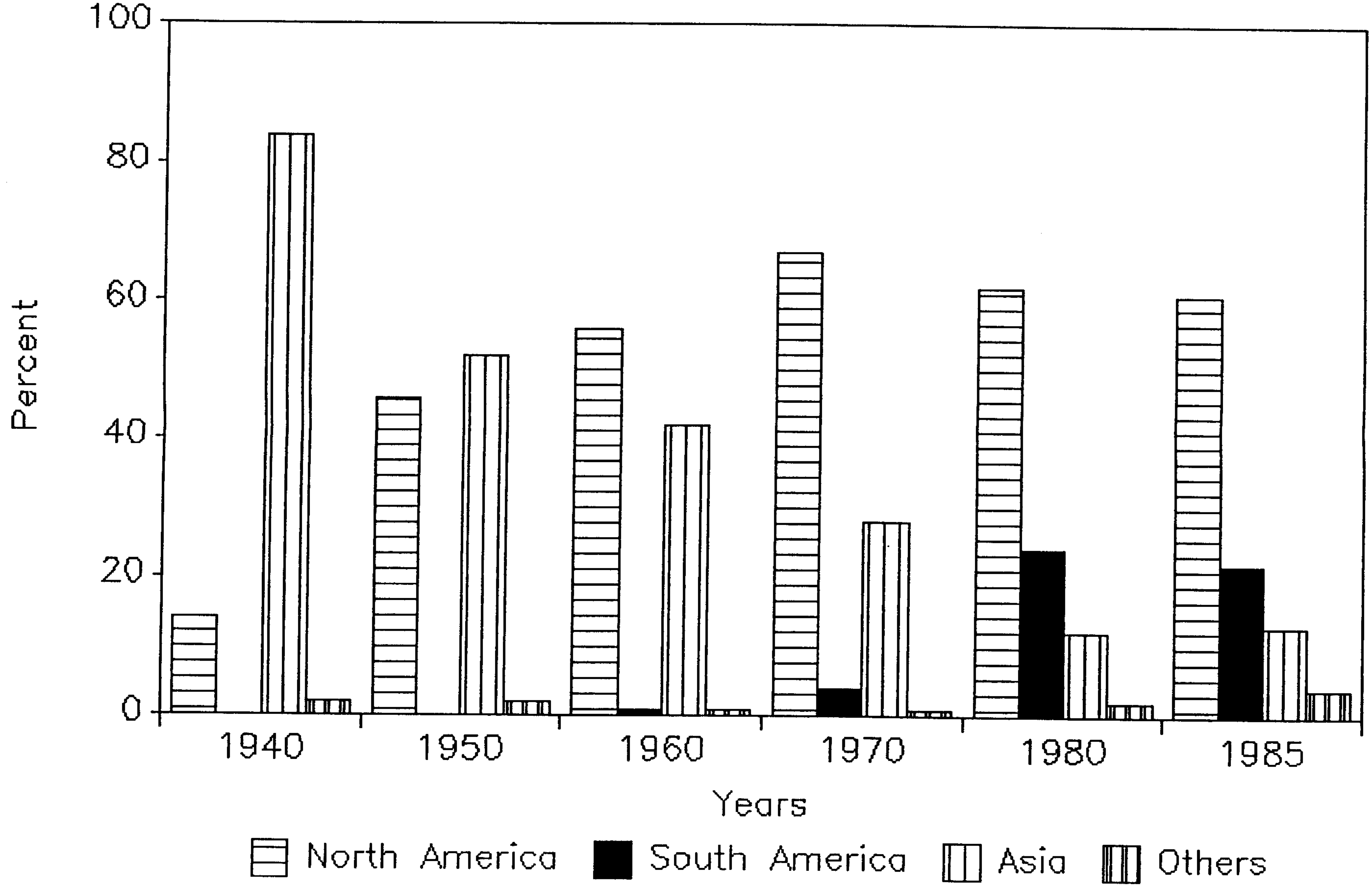
[25] For example, one variety from the Philippines has been combined with the US originated-varieties developed in Brazil to improve the capacity for short-day conditions (e.g., "Tropical") (Hartwig, 1986).

Figure 1 World Soybean Production
1940 – 1985



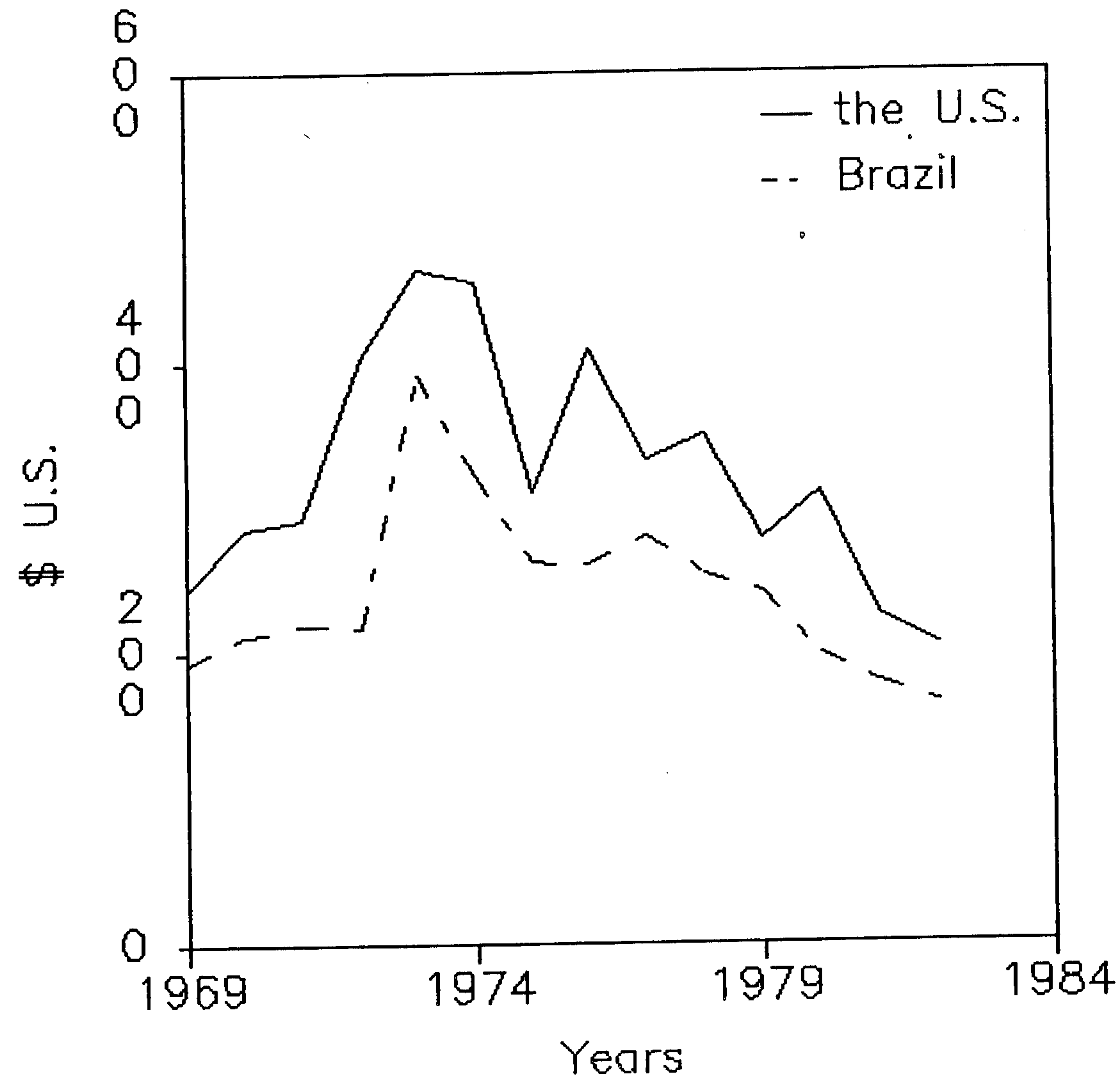
Sources: FAO Production Yearbook for
1940 – 1984 and Crop Production (USDA)
for 1985

Figure 2 Percentage Distribution of World Soybean Production (total=100%)



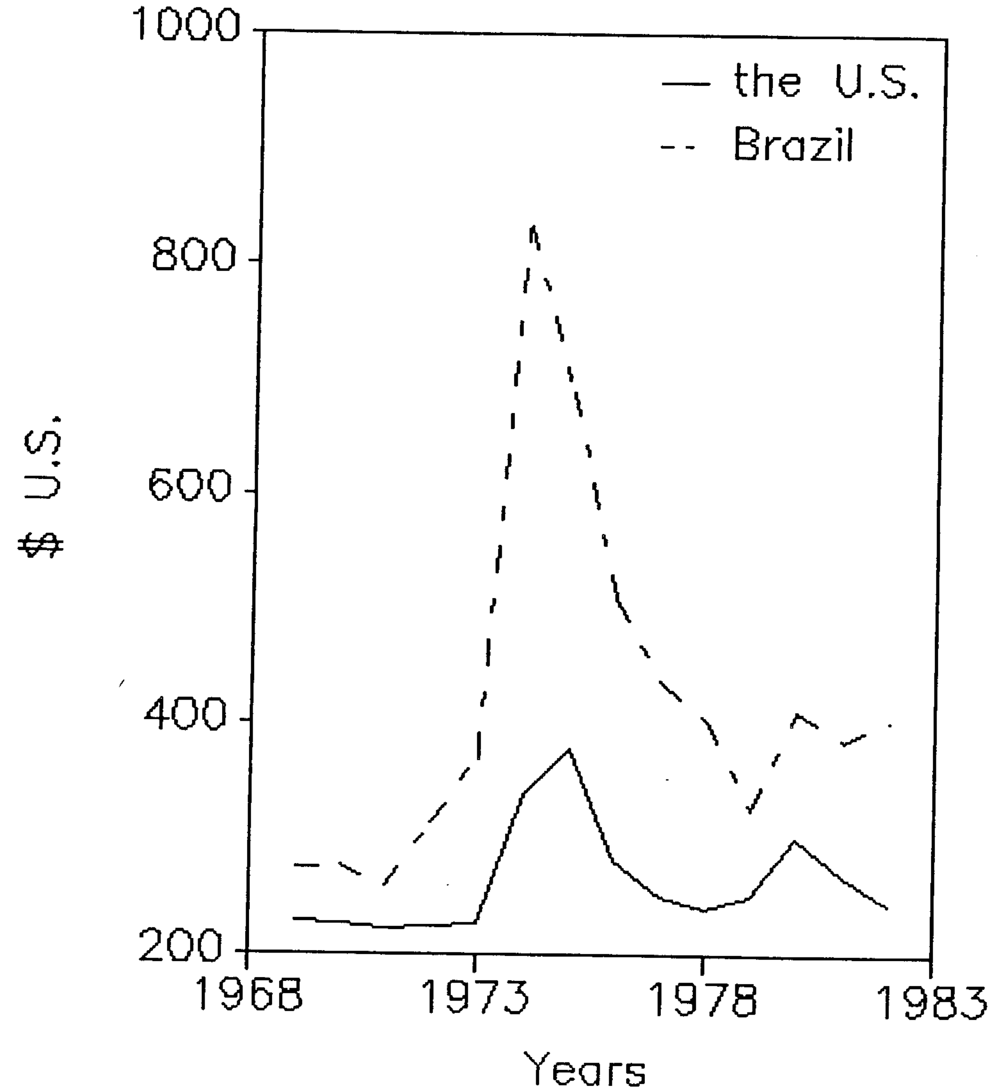
Sources: FAO Production Yearbook, Agricultural Statistics (USDA), and World Crop Production(USDA)

Figure 3 Prices Received by Soybean Producers in the U.S. and Brazil



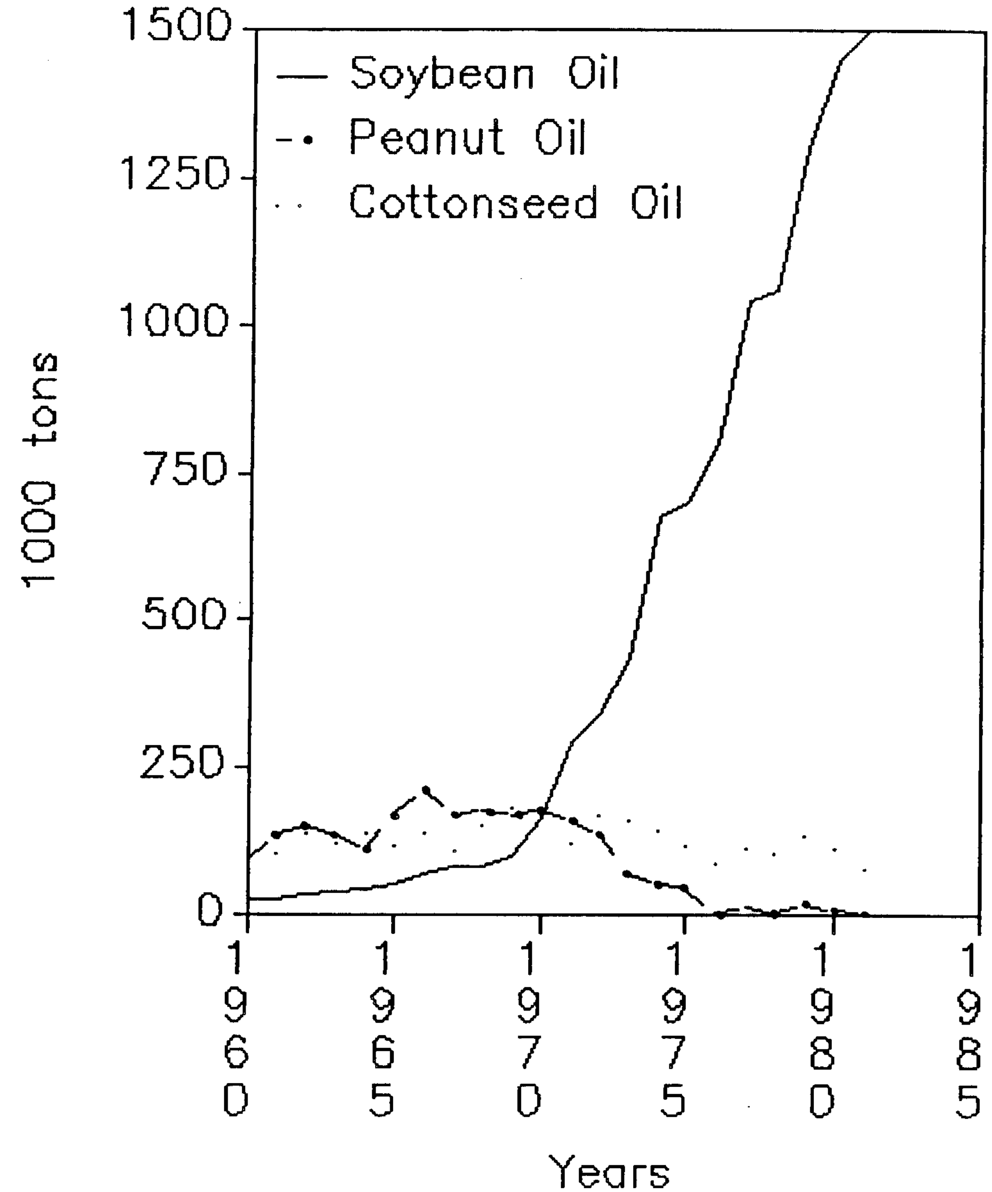
Source: Santana (1984)

Figure 4 Real Prices Paid by Soybean Producers (Superphosphate 44-46 Percent)



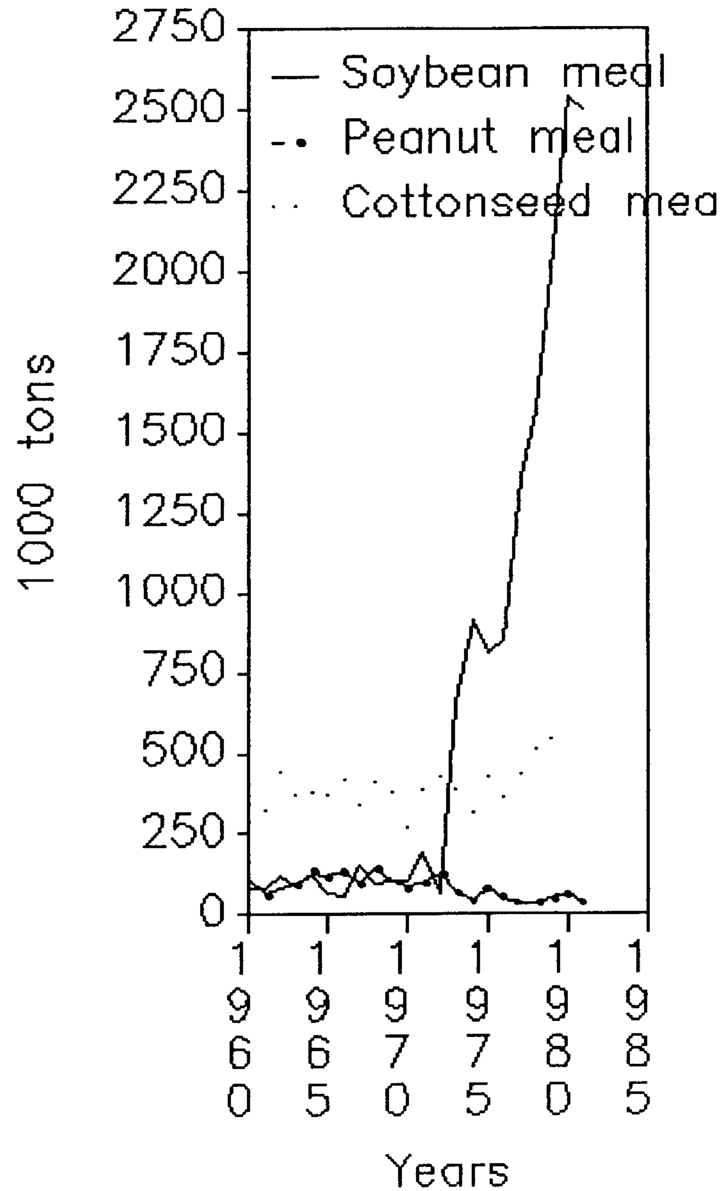
Source: Santana (1984)

Figure 5 Brazilian Domestic Oil Market



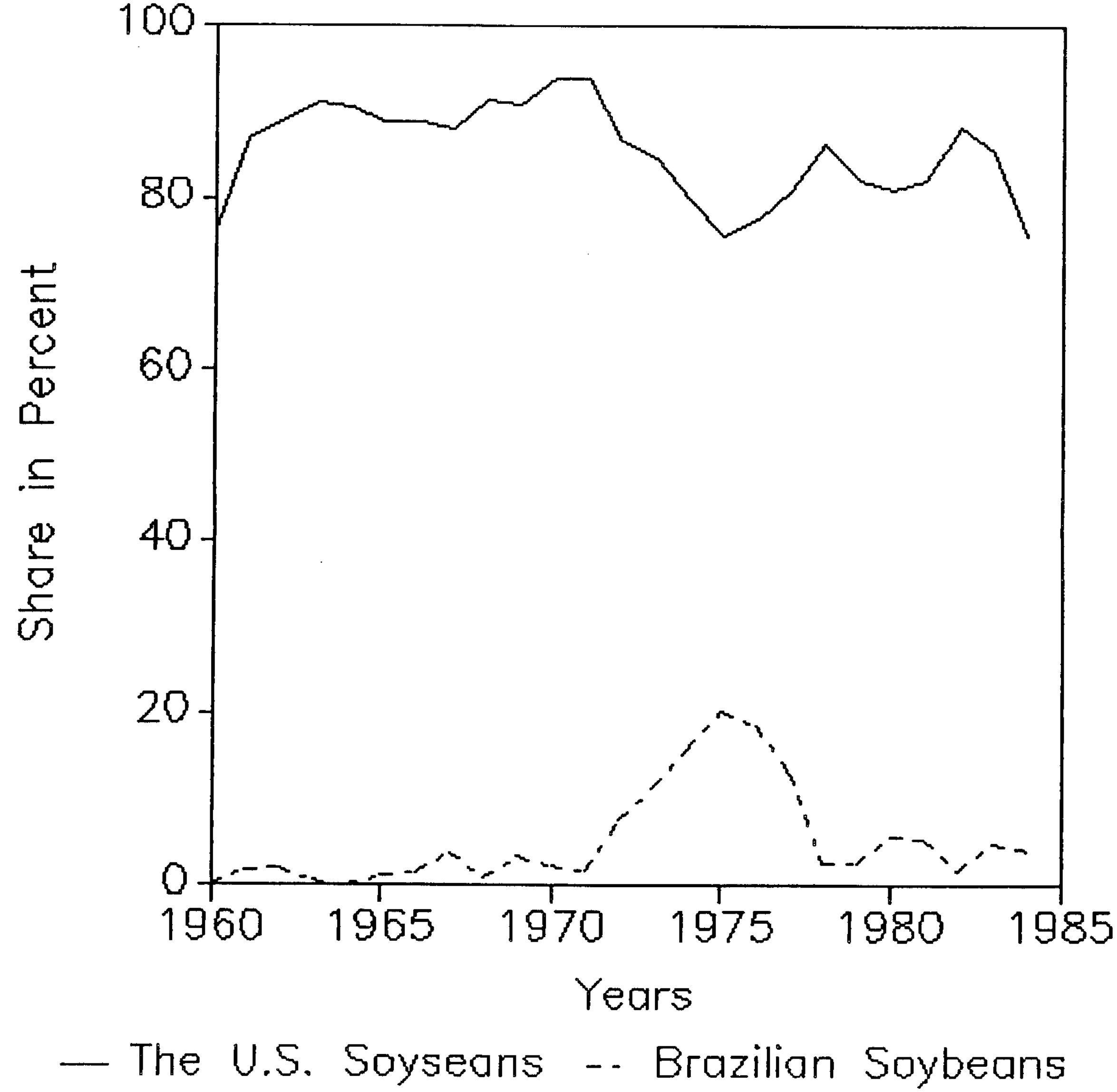
Source: Williams and Thompson (1984,A) and Santana (1984)

Figure 6 Brazilian Domestic Meal Market



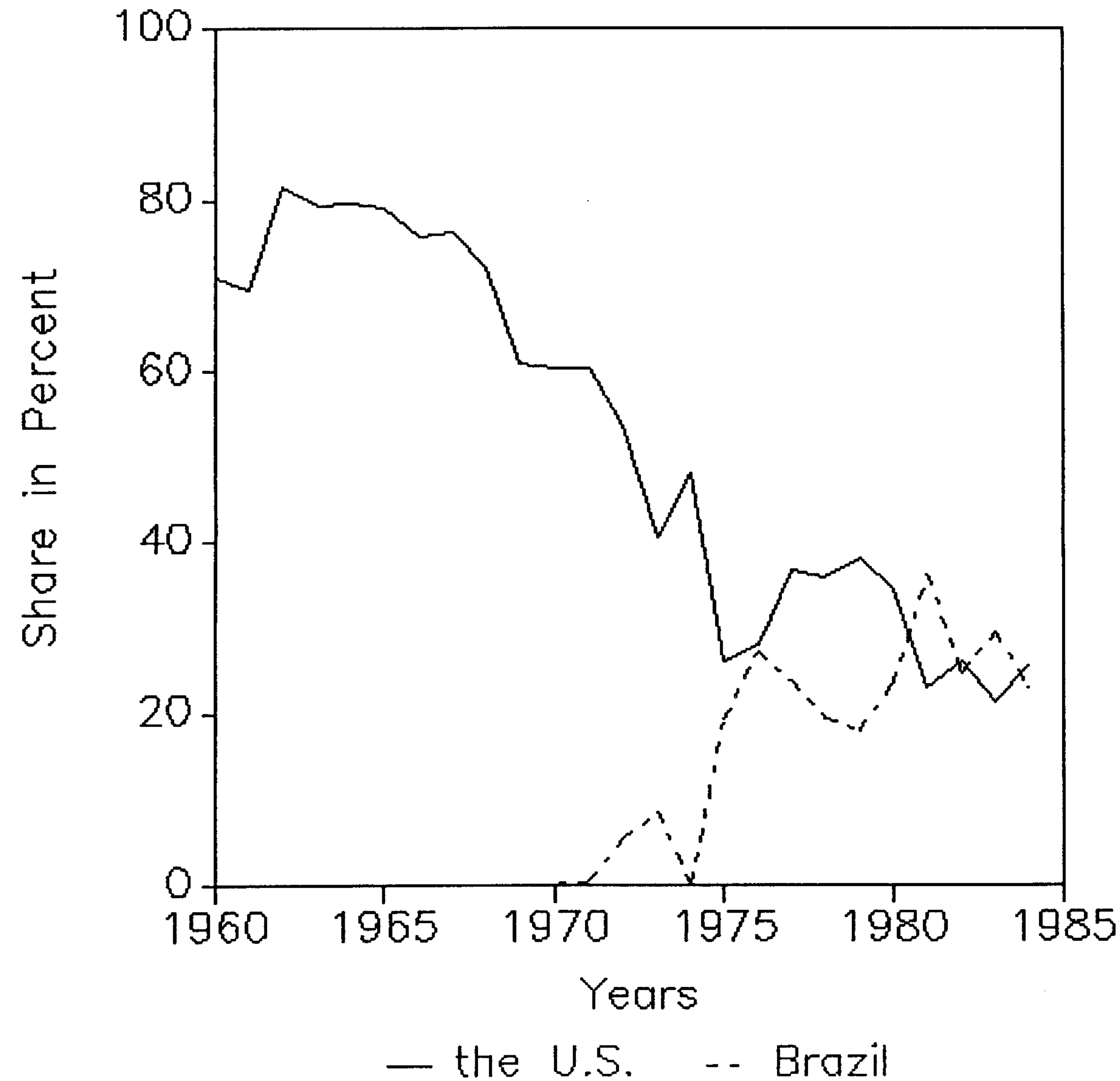
Source: Williams and Thompson (1984,A) and Santana (1984)

Figure 7 Worldwide Shares of Soybean Exports



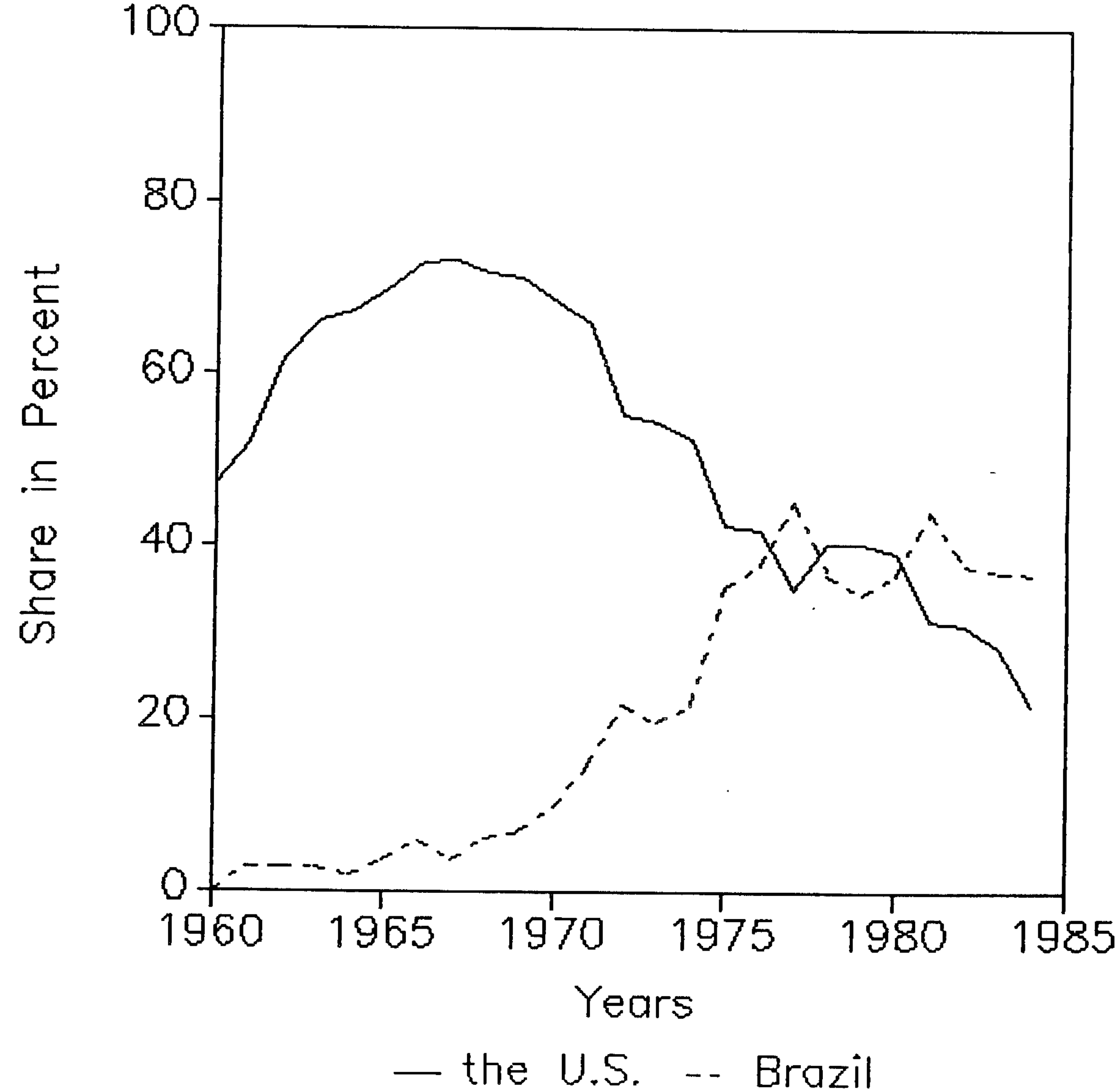
Sources: Williams and Thompson (1984,A) and latest FAO Production Yearbook.

Figure 8 Worldwide Shares of Soybean Oil Exports



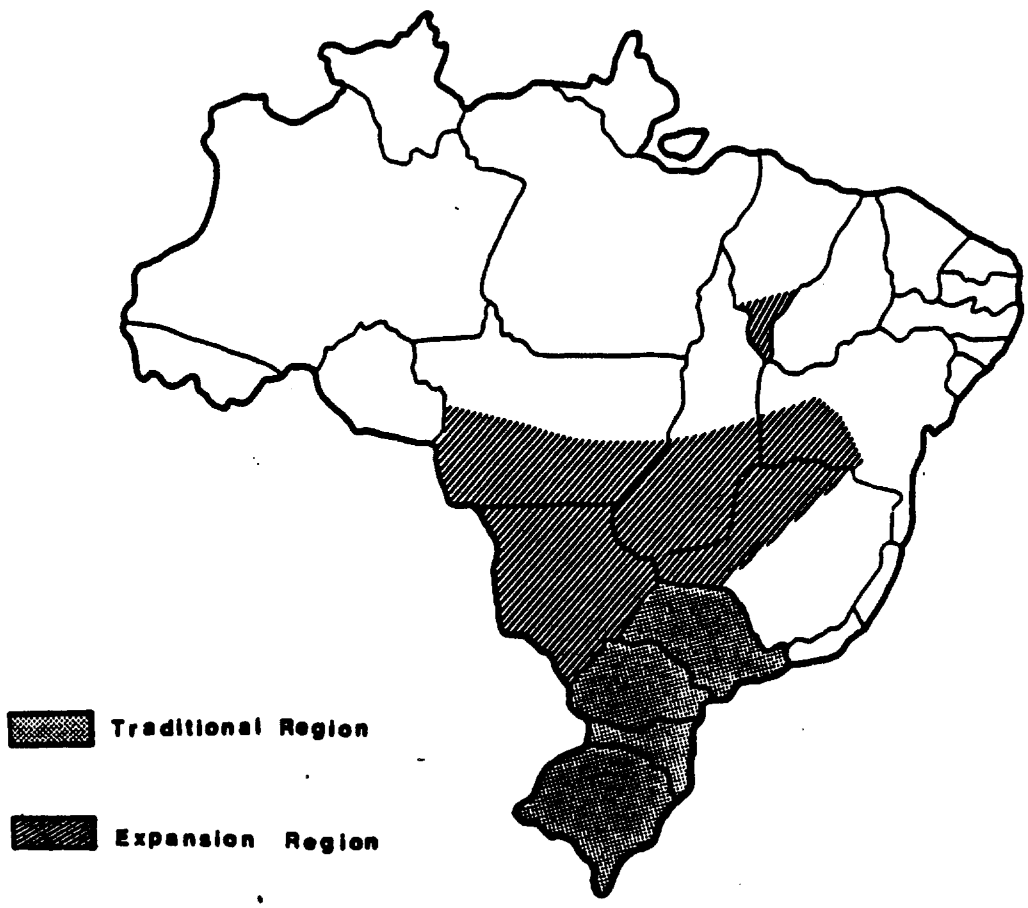
Source: Williams and Thompson (1984,A) and latest FAO Production Yearbook.

Figure 9 Worldwide Shares of Soybean Meal Exports



Source: Williams and Thompson (1984,A) and latest FAO Production Yearbook

Figure 10 Map of Brazil



Source: Ayres (1985)

Table 1 Comparative Average Soybean Production Costs/Acre (1985) in Brazil and the United States in $US

Input	Brazil South	Brazil W.Central	U.S.A. Midwest	U.S.A. South
Land	25	15	90	30
Preharvest Costs				
Equipment	20	20	22	25
Fuel	8	8	5	6
Labor	5	4	12	12
Materials				
Seed & Treatment	9	9	10	10
Fertilizer	20	20	18	25
Lime	20	12	5	10
Herbicides	10	10	20	20
Insecticides	10	5	5	15
Harvesting	20	20	22	22
Sub Total (per acre)	147	123	209	175
Sub Total (per ha)	291	304	516	432
Yield (bu/acre)	23	30	35	24
Base Cost (per bu)	6.39	4.10	5.97	7.29
Basis (per bu)*	1.10	1.50	0.25	0.30

* In this context, the basis is the price difference between the CBOT (Chicago Board of Trade) price and the price received by farmars. This includes transportation costs, taxes, etc.

Source: American Soybean Association (1986)

Table 2 Soybean Production, Area and Yield for Traditional and Expansion Regions in Brazil, 1970 to 1983 (Index 1970=1)

		Production		Area		Yield	
	Year	# Index	Share	# Index	Share	# Index	Level (kg/ha)
Traditional Area	1970	1.0	98.6%	1.0	98.8%	1.00	1141
	1975	6.4	95.6%	4.2	94.4%	1.51	1720
	1980	8.7	85.6%	5.8	85.3%	1.52	1735
	1983	7.4	75.1%	4.8	76.9%	1.54	1752
Expansion Area	1970	1.0	1.4%	1.0	1.2%	1.00	1350
	1975	21.0	4.4%	21.4	5.6%	0.99	1330
	1980	106.0	14.4%	84.2	14.7%	1.26	1699
	1983	175.7	24.9%	123.1	23.1%	1.42	1927

Source: Ayres(1985)

Table 3 The Acreage and Yield Response Equations for Brazilian Soybeans, 1971 to 1977

	Acreage Models	Yield Models
Intercept	-4.11*** (-3.29)	-1.69* (-1.88)
LNM1	1.91*** (5.42)	0.62*** (3.05)
LAA1	0.43*** (4.47)	
LAY1		0.24* (1.72)
LNC1		-0.25* (-1.65)
LNW1	0.60*** (5.75)	-0.11*** (-3.55)
D1	0.60*** (3.89)	
D2	0.88*** (3.24)	
M.S.E.	1.34	1.18
D.F. for errors	16	16
a	0.57	0.76
b	3.35	0.82

* 15% significance level
** 5% significance level
*** 1% significance level

Source: Gemma (1983)

Table 4 Average Yield of Soybean Varieties Planted in Brazil

Period	Average yield (kg/ha)	Varieties
before 1960	NA	Amarela Comum, Abura, Pelicano and Mogiana
1960/68	1060	Improved Pelican, Lee, Hill, Hood, Majos, Bienville and Hampton
1968/74	1394	Bragg, Davis, Hardee, Santa Rosa, Delta, Campos Gerais, IAC-2, Vicosa and Mineira
1975/80	1541	IAS-4, IAS-5, Planalto, Prata, Perola, BR-1, Parana, Bossier, Sant Ana, Sao Luiz, IAC-4 and UFV-1
1980/83	1740	BR-2, BR-3, BR-4, Ivai, Vala Rica, Uniao, Cobb, Lancer, Co-136, IAC-5, IAC-6, IAC-7, UFV-2, UFV-3, Cristalina and Dokko

Source: Ayres (1985)

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