# Soybean Production in Brazil: Main Determinants of Property Sizes

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## Abstract

Economies of scale are present in soybean production. In Brazil, the two largest producing regions have properties with different dimensions. In particular, the average size of properties in the South is much smaller than those in the country´s Mid-West region. This study analyzes the characteristics that favor small-scale soybean-producing properties in the country's Southern region. Its theoretical framework is based on the Neoclassical theory and in Transaction Cost Economics. Questionnaires were applied to producers from the State of Rio Grande do Sul. A regression analysis shows the relation between the selected factors and property size. Results show that a greater use of labor, particularly of family employees, and the greater diversity of crops contribute to explain the existence of small soybean properties in South Brazil.

**Keywords:** *economies of scale, soybean production, small property*

## 1 Introduction

Soybean cultivation began its expansion in Brazil in the 1970s. Before the 1980s it was concentrated in the Southern region: the states of Rio Grande do Sul, Paraná, and Santa Catarina. With the development of crops adapted to different soil and weather conditions, production expanded to the Mid-West: the states of Mato Grosso, Mato Grosso do Sul, Goiás, and the Federal District (BRASIL, 2009a). In 2008, the Mid-West and South were responsible for 83% of overall national soybean production, with shares of 48% and 35% respectively. From 1990 to 2008, the Mid-West production expanded by 340%, from 6.4 million tons to 28.5 million tons. The Southern region's production, in turn, increased by approximately 80% in the same period, growing from 11.5 million tons to 20.4 million tons (IBGE, 2009b).

Comparing the average size of properties in the largest producing regions, we observe that the average dimension, obtained by the division of the harvested area in hectares (ha) by the total quantity of properties, is different in both cases. According to data from the 2006 Agricultural Census (IBGE, 2009a), whereas the average size of properties in the Southern region is less than half the size observed throughout the country, the average property in the Mid-West region is some six times larger than the Brazilian average. This distinctive profile in both regions was one of the factors motivating the present research.

**Table 1.** Average size of soybean-producing properties in Brazil

| | Number of farms (a) | Harvested area (ha) (b) | Average size of farms (ha) (b/a) |
|---|---|---|---|
| Brazil | 215,977 | 15,646,939 | 72.45 |
| South | 194,913 | 6,806,245 | 34.92 |
| Mid-West | 13,085 | 6,556,231 | 501.05 |

Source: Created by the authors based on 2006 Agricultural Census (IBGE, 2009a).

Soybean cultivation is characterized by the existence of economies of scale, which associate an average cost decrease with increased production until an optimal production scale is attained, a situation corroborated in a study conducted by Conte (2006). Farms hope to

achieve a size that minimizes their production cost and brings higher returns. Thus, farms would all have similar sizes near the optimal condition.

In her study, Conte (2006) observed that the optimal size for both regions is different, which can be explained by the difference in input costs observed in each location. Nevertheless, farms in the southern region were observed to be, on average, much smaller than the optimal size.

In further examination of soybean-producing farms, we perceive that even in a specified area, farms with very different sizes are found. Within this context, this study aims at analyzing the characteristics that favor the existence of small-scale farms in soybean production. The following problem is examined: **What are the determining factors and their relative impact on the size of soybean-producing farms in Brazil's Southern region?**

In raising the determinants of small-scale soybean production, we intend to contribute to the current literature, as well as point out aspects of the topic that have not yet been explored. The focus on small farms, characterized basically by family agriculture, is also relevant, since it plays a significant role in the Brazilian economy.

According to the 2006 Agricultural Census, family agriculture accounts for 84.4% of all farms and involves over 12 million people directly occupied in production (IBGE, 2009a). That represents over 70% of total labor in an area that represents less than 25% of the total cultivated land, which demonstrates that in this case there is more use of labor per hectare.

**Table 2.** Family agriculture in Brazil

| | Total farms | | Total area (ha) | | People occupied in farms | |
|---|---|---|---|---|---|---|
| | Quantity | % | Quantity | % | Quantity | % |
| Family agriculture | 4,367,902 | 84.40% | 80,250,453 | 24.32% | 12,322,225 | 74.38% |
| Non-family agriculture | 807,587 | 15.60% | 249,690,940 | 75.68% | 4,245,319 | 25.62% |
| Total (Brazil) | 5,175,489 | 100.00% | 329,941,393 | 100.00% | 16,567,544 | 100.00% |

Source: Created by the authors based on 2006 Agricultural Census (IBGE, 2009a)

One important study of family agriculture is that of Nunes (2000), who verified that family agriculture, in comparison to commercial agriculture, provides a higher yield to producers. This type of productive arrangement is observed more in some crops than in others. According to the above-mentioned study, soybean and sugar cane crops would be the least favorable to be organized in a family arrangement. Nevertheless, in the Southern region there are small farms producing soybean.

We seek to investigate, based on Neoclassical theory and New Institutional Economics, the main characteristics that determine the size of soybean farms in the State of Rio Grande do Sul. More particularly we intend to:
- identify the variables determining the size of rural farms;
- analyze the characteristics of soybean production in the Southern region, starting with the state of Rio Grande do Sul; and
- verify the impact of the selected variables on the size of rural farms in this state.

After this introductory item, we move to a brief theoretical review. Next, we describe the methodology used and results found, make some final considerations and suggestions for future works.

## 2 Literature review

In this section, we first examine factors determining economies of scale and scope. Next, we present some aspects of Transaction Cost Economics, mainly those concerning the influence of transaction costs on cooperation in the supply chain and in the definition of firm size. Finally, we analyze soybean production in Brazil's biggest producing regions.

### *2.1 Economies of scale and scope*

By and large, in the presence of economies of scale and scope, "what is bigger is better" (BEZANCO et al, 2006, p. 93). Economies of scale occur when the average cost decreases (i.e. the cost per unit of production) as the production level increases. In this case, the marginal cost—cost of the last unit produced—must be lower than the general average cost. The moment the average cost starts to increase, diseconomies of scale occur and the marginal cost starts to exceed the general average cost.

Increased production leads to: decreased average cost when marginal cost is inferior to it; increased average cost when marginal cost is higher; and minimum average cost if the latter is equal to marginal cost (KREPS, 2004, p. 187). This intersection represents the efficient scale of production, which does not necessarily correspond to the point of profit maximization. Profit maximization depends on the average revenues and marginal revenues curves of the firm. Thus, profit maximization can occur with a quantity above, below or equal to the efficient scale—the one that minimizes average cost (KREPS, 2004, p. 196).

The average cost curve shows the relationship between average cost and production. Its U format is consistent with the fact that, for relatively low production levels, the firm can present economies of scale (marginal cost below average cost), and at higher levels, diseconomies of scale (marginal cost above average cost). This results from the diminution of fixed costs with the increase in the productive level. After a specific point, other costs raise the average cost, such as investments to increase production capacity (BEZANCO, 2006, p. 93; KREPS, 2004, p. 199).

In soybean production there are economies of scale, which do not present technical barriers to the entry of new competitors once the market is big enough for producers of an efficient size to participate in it.

Economies of scope are present if a firm saves when increasing the range of goods produced or services delivered. In this case, the total cost of production is assessed: when a firm can produce two products at a lower cost than if they were produced by independent firms, there are economies of scope. If this type of production has a lower cost, the joint production will characterize diseconomies of scope (BEZANCO, 2006, p. 94).

The level of economies of scope is measured by the percentage of economy in costs while jointly producing two or more products instead of producing them individually. By and large, economies of scope result from the presence of shared inputs. The transformation curve

demonstrates different combinations of two products that can be produced with a fixed quantity of inputs (FARINA, 2000, p. 47).
In combining product-specific economies of scale with economies of scope, one obtains multiproduct economies of scale. This phenomenon is favored by indivisible and flexible production technologies, which enable sharing inputs or factors (FARINA, 2000, p. 47). In multiproduct firms, the composition of costs, revenues, or both does not usually occur in an additive and independent manner, which hinders the division of these values along the production lines. The productive process suffers the impact of synergy effects, and the contrary is also possible. For instance, we have the sharing of administrative costs and research and development. Thus, allocating costs to one product depends on the quantity produced of the others (KREPS, 2004, p. 197).

*2.2 Transaction Cost Economics– TCE*

According to Transaction Cost Economics (TCE), production costs that are taken into consideration in traditional economic theory are not enough to explain all the costs involved in the functioning of the economy. This approach defends the existence of a price for the functioning of the market; performing transactions involves costs and establishing a firm would be a way to minimize them. Thus, in some cases, the hierarchical control enabled by the firm would allow lower costs than those obtained in market transactions.

Williamson (1985, chapters 1 and 2) defined transaction attributes, which vary among transactions, influence their costs and the organizational structure that minimizes them. According to the TCE, these main attributes are: asset specificity, frequency of transactions, and uncertainty about their results. Besides that, TCE also considers the difficulty to measure or assess the agents' performance and the interdependence between transactions.

The organizational structure and governance mechanisms influence transaction costs. According to the attributes of a transaction, costs vary according to the agents' organization. TCE identifies two polar organizational forms: market and vertical integration. Between them are hybrids or contractual forms, which can be nearer to one or the other pole according to the restrictions imposed on contractors. Within this context, agents choose the governance structure that corresponds to the lowest possible transaction costs (NUNES, 2000, p. 45).

One of the applications of the analysis of transaction costs refers to integration and coordination (LOADER, 2000, p. 417). According to Arndt (1979, cited by LOADER, 2000, p. 418), a number of markets restructure themselves as a result of a set of long-term binding and voluntary contracts. This form of relationship reduces uncertainty, decreases transaction costs, and offers access to economies of scale while overcome traditional market arrangements. The crucial point of these arrangements is to enable the firm to compete with alternative systems or networks. The author suggests that the higher the level of cooperative behavior in relationships between members of a system, the higher the profit obtained by the system or network as a whole.

Within this context are the cooperatives, which can be understood as hybrid organizational forms (CHADDAD, 2009, p. 2). Because of economies of scale and capital restrictions, an individual producer often cannot integrate vertically. Thus, a group of producers can organize an association to collectively bargain for better commercialization conditions with the processor.

The cooperative structure, as well as the activities it performs, is very variable. These can encompass only the sale of production, or also the purchase of inputs and part of the processing, as well as establish different degrees of participation, rights, and duties of associates. Such organization is extremely important for small producers, since the marketing of larger volumes, both for sale and purchase, provides a greater negotiation power to those responsible for the transaction.

*2.3 Soybean production in Brazil*

Analyzing the quantity of soybeans produced in Brazil from 1990 to 2008, we perceive a significant increase, from 19.9 million tons to over 59 million tons (IBGE, 2009b). During this period, the Southern and Mid-Western regions remained as the two major producers, together responsible for some 49 million tons produced in 2008.

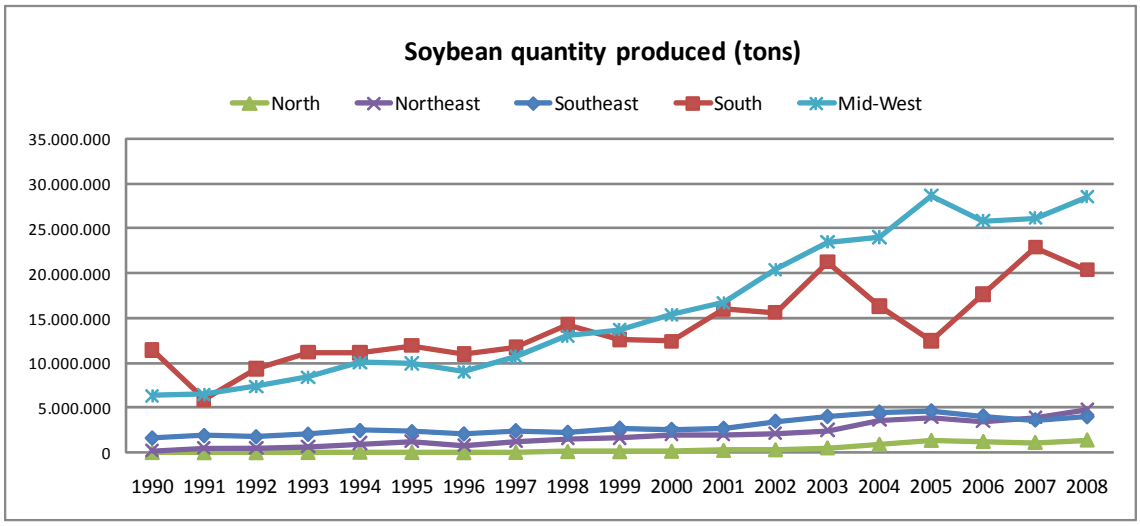


**Figure 1.** Soybean production (in metric tons) in Brazil from 1990 to 2008
Source: Created by the authors based on IBGE data (2009b)

The most important among the states in Brazil's Southern region is Paraná, whose share surpassed that of Rio Grande do Sul (RS) in the early 1990s and corresponded to 58% of the region's total in 2008. In the Mid-Western region, the state of Mato Grosso (MT) was the main producer during the entire period analyzed, accounting for 60% in 2008.
As previously mentioned, when we examine the average size of soybean farms we also observe a divergence between the overall value for Brazil and for the two biggest producing regions. Considering separately the farms that fit into family agriculture and those which do not meet this requirement, the difference is even more evident. The size of farms in the Mid-Western region is three times larger in the case of family agriculture, and five times larger when compared to other farms.

**Table 3.** Average size of soybean-producing farms in Brazil

| | Total (ha) | Family agriculture (ha) | Non-family agriculture (ha) |
|---|---|---|---|
| Brazil | 72.45 | 16.51 | 249.00 |
| Mid-West | 501.05 | 59.07 | 711.37 |
| South | 34.92 | 15.00 | 117.27 |

Source: Created by the authors based on 2006 Agricultural Census 2006 (IBGE, 2009a)

Analyzing each region, we observe a variation between different states. In the case of the Southern region, Rio Grande do Sul is the state with the largest quantity of farms and harvested area. In the Mid-west, the State of Mato Grosso has the largest harvested area, whereas Mato Grosso do Sul has the largest percentage of farms. If we compare the average size in Rio Grande do Sul and Mato Grosso, the difference is 30 times higher.

**Table 4.** Average size of soybean-producing farms in the Mid-western and Southern regions

| | Number of agricultural farms (a) | | Harvested area (ha) (b) | | Average size of farms(ha) (b/a) |
|---|---|---|---|---|---|
| | Quantity | % | Quantity | % | Quantity |
| **Mid-West** | **13,085** | **100%** | **6.556.231** | **100%** | **501.05** |
| MS | 5,005 | 38% | 1,184,788 | 18% | 236,72 |
| MT | 3,699 | 28% | 3,745,557 | 57% | 1,012.59 |
| GO | 4,152 | 32% | 1,584,381 | 24% | 381.59 |
| DF | 229 | 2% | 41,505 | 1% | 181.24 |
| **South** | **194,913** | **100%** | **6,806,245** | **100%** | **34.92** |
| PR | 79,967 | 41% | 3,151,156 | 46% | 39.41 |
| SC | 9,860 | 5% | 264,449 | 4% | 26.82 |
| RS | 105,086 | 54% | 3,390,640 | 50% | 32.27 |

Source: Created by the authors based on 2006 Agricultural Census 2006 (IBGE, 2009a)

Based on the above-described data and with the goal of identifying the factors influencing the size of farms, particularly those which produce on a small scale, the following analyses are based on the characteristics of the farms in Rio Grande do Sul. In addition to being the state with the lowest average size of farms among those with the most significant production in both regions, it is the location with the longest history of soybean cultivation among the mentioned areas.

### *2.4 Classification of small and large farms*

The classification of small farms is based on the definition set by the Federal Government, according to which a familiar producer is understood as one who exploits a rural property of up to four fiscal modules of the region where it is situated (BRASIL, 2009b). The fiscal module is established for each municipality and seeks to reflect the median of the municipality's rural modules (INCRA, 2009b). A rural module varies according to natural and socioeconomic factors; it represents the necessary quantity of land for a worker and his family (four people) to be able to support themselves. In locations where production conditions require little land, the module is smaller, whereas in regions requiring a wider area, the module is bigger. In this research, the farms that fit into the size criterion of family agriculture were considered as being small farms.

## 3 Methodology

As a first step to this descriptive research (GIL, 1999), based on the literature review, we raised the main factors affecting the size of rural farms. The criteria used follow the orientation of the main evidence about the differences between family and commercial agriculture described in the study conducted by Nunes (2000). We also examined the differences pointed out in the comparison between the production characteristics in the two largest producing regions (South and Mid-West). Lastly, we took into consideration the results obtained by Conte (2006) in the study about the optimal size of soybean production.

After the literature review, data were amassed referring to soybean production in the country's southern region, through interviews conducted with thirty rural producers in the State of Rio Grande do Sul. The sample was selected by convenience due to the difficulty in accessing complete records of all of the state's soybean producers, as well as farms, and corresponding data.

The information collected was examined to characterize soybean production in the region. A multiple regression analysis was also conducted (GUJARATI, 2006) to verify the most influencing factors to the determination of soybean farms size.

Initially, we characterized the farms studied. To that end, they were jointly and individually assessed. The division between small and large farms considered the classification criteria set forth by the government, as previously described. Thus, for the region studied, we classified as small farms (or family agriculture) properties up to 80 hectares, a size calculated based on the rounding up of the average size found, considering the fiscal module of the municipalities in which the studied farms are located.

**Table 5.** Fiscal module of selected municipalities of Rio Grande do Sul (RS)

| RS Municipality | Fiscal module (ha) | Small farm (maximum size - ha) |
|---|---|---|
| Cachoeira do Sul | 20 | 80 |
| Candelária | 20 | 80 |
| Cruzeiro do Sul | 18 | 72 |
| Minas do Leão | 20 | 80 |
| Pantano Grande | 20 | 80 |
| Rio Pardo | 20 | 80 |
| Santa Cruz do Sul | 20 | 80 |
| Vale Verde | 14 | 56 |
| Average | 19 | 76 |

Source: Created by the authors based on data from the Institute for Agrarian Reform and Colonization - Incra (2009a).

For the regression analysis, we visualized this preliminary function, specified in Figure 4:
Size (of the soybean farm) = ¦ (diversity of crops, cooperative association, number of employees, land ownership, and farm income derived from soybean production)

| Explanatory variable | Source | Measurement scale | Expected sign |
|---|---|---|---|
| Leasing | More expenditures with leasing in family agriculture (NUNES, 2000) | Percentage of total farm that is leased | Negative |
| Association to cooperatives | Decreased transaction costs and economies of scale (LOADER, 2000) | *Dummy* (1 – cooperated producer; 0 – non-cooperated producer) | Negative |
| Crop diversity | Economies of scope (KREPS, 2004) | Quantity of crops produced | Negative |
| Number of employees | More intense use of labor in family agriculture (NUNES, 2000) | Total number of employees (family or not) per hectare | Negative |
| Farm income derived from soybean production | Economies of scope (KREPS, 2004) | Income percentage referring to soybean production | Positive |

**Figure 4.** Explanatory variables for the size of soybean farms
Source: Created by the authors

Based on collected data, we used Eviews to estimate a regression, using the ordinary least square method. The results are described in the next section.

## 4 Results analysis

This section initially describes some characteristics of the farms analyzed. Next, it presents the results of the regression analysis.

### *4.1 Characteristics of the farms and comparison between small and large farms*

With regard to the average size of farms, we verify that soybean farms are smaller than farms as a whole, which indicates the existence of other crops being cultivated. The average sizes of the farms and of the soybean cultivated area, comparing small and large farms, differ by more than a factor of ten, as can be seen in Table 6.

**Table 6 .** Average size of farms studied

| | Quantity of farms | Total average size (ha) | Average size of soybean production (ha) |
|---|---|---|---|
| Total | 30 | 339.20 | 262.17 |
| Small farm | 13 | 44.54 | 32.69 |
| Large farm | 17 | 564.53 | 437.65 |

Source: Created by the authors based on research data

Employee average per hectare also shows differences: whereas in small farms the figure is 0.04, in large farms it is 0.009, composed of 0.004 employees with family ties and 0.005 which do not belong to the family. Concerning production in smaller areas, family employees represent a larger share: 0.03 against 0.01 on non-family. This result is in line with the evidence pointed out in the study conducted by Nunes (2000, p. 3) that family agriculture has a more intense use of labor that commercial agriculture.

In analyzing crop diversity, we observe that smaller farms show greater diversification than larger ones. The only exception was wheat, which is usually cultivated in larger areas. Tobacco, for its part, is characteristic of small farms and we identified this production exclusively with smaller producers: on average, it is the second-highest income-generating crop. These results are consistent with what is expected and can be one of the factors that enable the maintenance of family agriculture. In the totality of the cases, at least some 70% of the farm income comes from soybean. Within the larger ones, the crop with the second-highest contribution to income is rice.

**Table 7.** Crop diversity in soybean farms

| | | Rice | Wheat | Corn | Tobacco | Soybean |
|---|---|---|---|---|---|---|
| Total | Quantity | 8 | 7 | 10 | 4 | 30 |
| | % | 27% | 23% | 33% | 13% | 100% |
| | Share infarm's income | 34% | 13% | 16% | 44% | 77% |
| Small farm | Quantity | 4 | 0 | 6 | 4 | 13 |
| | % | 31% | 0% | 46% | 31% | 100% |
| | Share infarm's income | 43% | 0% | 13% | 44% | 68% |
| Large farm | Quantity | 4 | 7 | 4 | 0 | 17 |
| | % | 24% | 41% | 24% | 0% | 100% |
| | Share infarm's income | 25% | 13% | 21% | 0% | 85% |

Source: Created by the authors based on research data

The average quantity of equipment per hectare, which includes owned or leased tractors, harvesters, planters, and grain trucks, is 0.12 for smaller ones and 0.02 for larger ones. This fact indicates a higher cost for smaller farms as they fail to use economies of scale that could reduce their average cost per hectare. In this sense, there would be incentive to increase the size of the farms.

Concerning the planting mode, we verified that one half of the small farms use traditional planting in some 60% of the planted area. Among large producers, however, less than 30% use this method and the cultivated area thus corresponds to some 20% of the total area. Within this group, we observed direct planting[1] in all of the farms, which corresponds on average to over 90% of the farm. For the smaller ones, percentages for both cultivated area and direct planting are near 80%. The data described demonstrate a technological difference between production in smaller and larger scale, which again benefits large producers because direct planting allows for a better use of resources, and, therefore, lower costs.

With regard to production sale, 65% of large farms sell 25% of their production to cooperatives, whereas 38% of smaller ones sell 50% of their harvest to these organizations. Over one-half of large farms deliver on average 44% of their production to industry, while almost one-third of small farms deliver over 70% of their crop to industry. With resales, the percentages of relationship and sale are similar for both groups. To some extent, these

1. Direct planting integrates techniques that seek to improve environmental conditions relative to water, soil, and weather to explore in the best possible manner the genetic potential of crops production . It enables minimizing costs per unit produced based on the maximization of the productivity of the inputs and labor (EMBRAPA, 2009).

figures are contrary to what is expected. The relationship with cooperatives would be an opportunity for small producers to obtain cost reductions and better prices in the market. However, large farms have more contact with these buyers. On the other hand, among small producers that sell to cooperatives, the portion of production traded in this manner is greater than among large producers, a fact that may point to the exploitation of economies of scale and scope. The sale to the industry would represent a disadvantage for small producers because they would have less bargaining power. Although this type of sale is used by a smaller percentage of farms, those who use it deliver a large part of their production to this buyer. In other words, cooperation among smaller farms and the search for other buyers could lead to gains for these producers.

*4.2 Regression analysis*

In the regression analysis, we first conducted a simple regression with each of the variables chosen and previously described (diversity of crops, cooperative association, number of employees, land ownership and farm income derived from soybean production). Thus, based on the coefficients test (t test) and on the regression adjustment ($r^2$), we verified that, at the 10% significance level, among the variables chosen only that referring to crop diversity was not significant and presented low explanatory power. For this reason, this variable was excluded from ensuing tests.

With the goal of obtaining a more complete and meaningful explanation, we considered the variables as a whole, using the Stepwise method. At a 10% significance level, the combination that enabled higher explanatory power, with significant coefficients, was the one that considered the quantity of employees and cooperative association, as seen in the following result[1].

**Table 8.** Result of multiple regression using the Stepwise method

| | |
|---|---|
| Dependent variable : Area | Method: Stepwise backwards |
| Sample: 30 observations | Stopping-criterion: p-value – 0,1 |

| Variable | Coefficient | T-Statistic | Probability |
|---|---|---|---|
| Constant ($\beta_0$) | 325.6499 | 3.188784 | 0.0036 |
| Employee average (EMPREG) | -7.268.477 | -4.491373 | 0.0001 |
| Association to cooperatives (COOP) | 170.1681 | 1.745862 | 0.0922 |

| | | | |
|---|---|---|---|
| Adjusted R-square | 0.448861 | Durbin-Watson Stat. | 1.973580 |
| F-statistic | 12.80913 | Probability (F-stat.) | 0.000122 |

| Selection Summary |
|---|
| Income and leasing variables removed |

Source: Created by the authors based on results from Eviews software

Estimated regression: Area = $\beta_0 + \beta_1$(EMPREG + $\beta_2$(COOP)
Result: AREA = 325.6498755 - 7268.476523*EMPREG + 170.1681457*COOP
Both variables chosen were submitted to a new regression using the ordinary least square method, and adjusting the covariance of coefficients according to Newey-West. In this case,

1. The result of the regression can be seen in the annexes.

both coefficients were at the 5% significance level. The other results remained the same as those of the previous equation.

**Table 9.** Result of multiple regression using the ordinary least square method

| Dependent variable: Area | Method: ordinary least square |
|---|---|
| Sample: 30 observations | |
| Standard error and covariance according to Newey-West HAC (lag truncation: 3) | |

| Variable | Coefficient | t-statistic | Probability |
|---|---|---|---|
| Constant ($\beta_0$) | 325.6499 | 4.951586 | 0.0000 |
| EMPREG | -7,268.477 | -5.594263 | 0.0000 |
| COOP | 170.1681 | 2.812027 | 0.0091 |

Source: Created by the authors based on results from Eviews software

In order to enhance the study's reliability, we also verified whether the assumptions of the regression were satisfied. In this case, at a 5% significance level, we found no evidence of heteroscedasticity or residual autocorrelation. The requirement of error normality was not satisfied. To enable the regression analysis we resorted to the central limit theorem and the thirty producers researched were considered a large sample.

**Thus, we can say that, for the studied sample, 45% of the variation in farm size is explained by the variation in quantity of employees, with or without family ties, and by the association (or not) with cooperatives.**

The expected size of soybean farms, regardless of quantity of employees and cooperative association, corresponds to 325.65 hectares, a value well above the average observed for small farms, but near enough to the sample average and the average of large farms. This coefficient will hardly correspond with accuracy to the farms's dimension, but serves as an indication that both factors considered in the regression are not sufficient to determine the farms' size.

The average quantity of employees per hectare presented the expected direction: a higher average indicates smaller farms. This result corroborates the above-described analyses. Once again, the coefficient value (-7,268.48) may not be exactly verified in practice, but is an approximation. The essential lies in understanding the meaning of the result, which is in accordance with what is expected.

In a contrary sense, the association with cooperatives showed a positive sign, which contradicts expectations and indicates that cooperative association signals a trend for larger farms. This result reinforces the evidence that a higher percentage of large producers market their crop with cooperatives than do smaller ones, as mentioned in the previous item. However, it is not in line with the theoretical prediction: the association with cooperatives would be one of the characteristics favoring small farms while allowing a reduction in transaction and production costs. Once again, the coefficient (170.17) should not be considered exact, but an approximate value, and mainly with a focus on the above-described meaning.

## 5 Final considerations

This work was aimed at gaining a better understanding of soybean production in Brazil, based on the identification of factors that contribute to maintaining small farms. To that end, the neoclassical theory was combined with the New Institutional Economics as a theoretical framework.
Based on results obtained in previous studies (NUNES, 2000; CONTE, 2006; ZANON et. al. 2009), we selected the variables to be researched. We conducted interviews with thirty producers from the State of Rio Grande do Sul, which has the second smaller average size of farms (calculated by dividing the soybean cultivated area by the total quantity of farms). These data allowed a characterization of soybean cultivation in Brazil's southern region and an identification of the main factors influencing the size of the farms.

In accordance with the expected results, in line with the work conducted by Nunes (2000), employee average per hectare was higher among small producers. The number of family workers surpassed that of non-family employees, a situation that characterizes family agriculture. In addition to that, crops diversity also had a stronger impact on the income of this group, a factor that favors the existence of small-sized farms. In the opposite direction, a less intensive use of equipment per hectare (tractors, planters, harvesters, and grain trucks) and a more intensive use of direct planting contribute to the emergence of large farms.

One of the important factors that behaved differently from what was theoretically expected is the association with cooperatives. Small producers were expected to present a higher percentage of adhesion to cooperatives, so as to have gains of scale and reduced transaction costs, but large farms showed stronger adhesion to cooperatives, as well as a higher percentage of crop marketing with these entities. However, smaller farms that sell soybean to cooperatives do so, on average, for a larger percentage of their production than larger producers. A possible cause for this concentration in sales is that small producers, due to their inferior quantity, direct their sales to a single channel, whereas large ones have more options and market their crop through different channels.

The significant variables in the multiple regression analysis were: number of employees and cooperative association. In the first case, as above-mentioned, the result was in line with what was expected: small farms tend to use more labor. The association with cooperatives, for its part, signaled an increase in the size of the farms, countering expectations. Together, the variation of these two characteristics accounts for 45% of the variation in the size of farms.

This research provided a better understanding of the configuration of soybean farms in Brazil's southern region. Because it is a non-probabilistic sample, the results found cannot be extrapolated to the entire state or other Brazilian regions. The information about production costs, credit and trade, as well as producer's appropriated income, has not been analyzed. Future studies can enhance the scope this work's application. Another possibility is to compare results from different regions and states. Besides that, the variables that have not been explored here can be included in the research.

## 6 References


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ANNEXES

**Annex 1.** Result of Multiple regression analysis using Stepwise method

Dependent Variable: AREA
Method: Stepwise Regression
Date: 01/06/10 Time: 14:14
Sample: 1 30
Included observations: 30
Number of always included regressors: 1
Number of search regressors: 4
Selection method: Stepwise backwards
Stopping criterion: p-value forwards/backwards = 0.1/0.1

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| C | 325.6499 | 102.1235 | 3.188784 | 0.0036 |
| EMPREG | -7268.477 | 1618.319 | -4.491373 | 0.0001 |
| COOP | 170.1681 | 97.46944 | 1.745862 | 0.0922 |

| | | | |
|---|---|---|---|
| R-squared | 0.486870 | Mean dependent var | 262.1667 |
| Adjusted R-squared | 0.448861 | S.D. dependent var | 285.3286 |
| S.E. of regression | 211.8245 | Akaike info criterion | 13.64403 |
| Sum squared resid | 1211479. | Schwarz criterion | 13.78415 |
| Log likelihood | -201.6605 | Hannan-Quinn criter. | 13.68886 |
| F-statistic | 12.80913 | Durbin-Watson stat | 1.973580 |
| Prob(F-statistic) | 0.000122 | | |

Selection Summary

Removed RENDA
Removed ARREND

*Note: p-values and subsequent tests do not account for stepwise selection.

Source: Eviews, based on research data.

**Annex 2.** Results of multiple regression analysis using Ordinary Least Square Method

Dependent Variable: AREA
Method: Least Squares
Date: 01/06/10 Time: 14:23
Sample: 1 30
Included observations: 30
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 325.6499 | 65.76678 | 4.951586 | 0.0000 |
| EMPREG | -7268.477 | 1299.273 | -5.594263 | 0.0000 |
| COOP | 170.1681 | 60.51441 | 2.812027 | 0.0091 |

| | | | |
|---|---|---|---|
| R-squared | 0.486870 | Mean dependent var | 262.1667 |
| Adjusted R-squared | 0.448861 | S.D. dependent var | 285.3286 |
| S.E. of regression | 211.8245 | Akaike info criterion | 13.64403 |
| Sum squared resid | 1211479. | Schwarz criterion | 13.78415 |
| Log likelihood | -201.6605 | Hannan-Quinn criter. | 13.68886 |
| F-statistic | 12.80913 | Durbin-Watson stat | 1.973580 |
| Prob(F-statistic) | 0.000122 | | |

Source: Eviews, based on research data