INTERNATIONAL FARM MANAGEMENT CONGRESS 2003
FARMING AT THE EDGE

DIVERSIFICATION AS A FORM OF RISK MANAGEMENT IN AGRICULTURE

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ABSTRACT

The objective of this study is to show the importance of diversification in the risk management process. The study areas are: Mato Grosso, with large properties, and Rio Grande do Sul with small. The developed activities are annual cultures and cattle for slaughter. The hypotheses of the work are: a) rural producers diversify their activities using modern techniques. b) Diversification has been efficient in the producers' risks reduction. c) Producers tend be as effective as possible, though they differ in the rates of risk aversion. The MOTAD and E-V models were used.

Key-words: MOTAD model, E-V model, rate of risk aversion, risk management

Introduction:

When managing their properties agricultural producers face problems to achieve maximum profit within acceptable limits of risk. This fact was aggravated from the moment the agricultural business stopped being protected by government policies and started to work under a different view of the reality of market risks, going beyond the traditional production risk. Thus, farm income became even more exposed to the variation of prices and productivity. Therefore, producers started to search for alternatives to adapt himself to this new reality. Amongst them, diversification of activities outstands as a form of managing the ups and downs in the income flow of the property. What has been observed is a process of farm diversification based on modern technology. It corresponds to the beginning of the logical development observed in

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traditional agriculture and cattle raising, now in a dynamic context of higher technology. The paper's approach used mathematical modeling with data from panels representing producers from Mato Grosso and Rio Grande do Sul states.

Methodology:

Optimization models in risk conditions

Linear programming models assume that variables are deterministic and that the choice criterion considers only the expected revenues (Peres, 1976). Major limitations of these models are in the process of segmentation of the production function as a form of producing results closer to the farmer's observed behavior.

According to Silva (2000), the Markowitz's (1952) model was developed for the financial market and for this reason handles deviations randomly. In an agricultural model, the use of this model must be carried out observing the special characteristics of the activity, once the turnover of agricultural activities can somehow present trends due to farming characteristics. Thus, productivity gains, changes in the production system, etc. can distort an analysis, since these elements introduce trends in the series.

In a typical activity analyses model the combination of activities that maximize profits is verified under the implicit assumption that farmers are indifferent to risk. The objective of the producer, in this case, is to optimize the firm's revenue, independent of production and prices variations. A modified model is considered for the study of the property under uncertainty conditions. The new model is proposed with the purpose of determining the efficient frontier between expected income and income variance, which is a way to show the trade off between profit and risk faced by the farmer. For the construction of this model, we used Hazell's (1971) proposition - *Minimization of Total Absolute Deviation* (MOTAD), derived from the mean-variance model developed by Markowitz (1952). The model assumes that decision makers will choose the alternative that presents minimum variance for a given expected income or, stated in an alternative way, will choose the maximum expected income for a given level of variance.

Formally, the model proposes to minimize:

$$\frac{S_r}{2} = \sum_{i=1}^{n} Y_{i'} \quad (4)$$

subject to:

$$\sum_{j=1}^{n} x_j D_{rij} + Y_i \geq 0 \quad (5)$$

$$\mathbf{f'x} = R_0 \quad (6)$$

$$\mathbf{Ax} \leq \mathbf{b} \quad (7)$$

$$\mathbf{x} \geq \mathbf{0}_e \quad \mathbf{Y_i} \geq 0 \quad (8)$$

Where:

S – the sum of the absolute deviations in relation to the linear regression of the gross revenues;

Y – the total gross margin;

X – is the activities vector;

D – matrix of deviations from the average value for each time serie value;

A – is the matrix of technical coefficients for the production processes;

f - is the vector of mean contribution for each **x**;

b – is the vector of restrictions for each production factor.

In this model, deviations were calculated as differences between observed values and those calculated by linear regressions functions, where the dependent variable is the observed gross revenue and the explanatory variable was time. The absolute deviation of the gross revenue in relation to the simple linear regression of gross revenues along time was calculated through (9):

$$D_r = P_{ij} v_{ij} - (\alpha + \beta T_{ij}) \quad (9)$$

where P_{ij} it is the price received of culture j in year i. The value of v_{ij} is the yield for culture j in year i, therefore, $P_{ij}\, v_{ij}$ equals to the gross revenue of culture j in year i; a is the angular coefficient and b is the coefficient of the independent variable.

The quadratic model is based on the matrix of variance and covariance of the gross revenue deviations in relation to the linear regression of each culture, as described in (9). The objective function has the following form:

$$\min : \Omega = X \sigma^2 X$$

where X is the vector of possible activities and s^2, the matrix of variance and covariance. The restrictions are the same as those of the linear model.

The MOTAD is widely used for modeling and requires little computational resources. The E-V model, in turn, has some advantages in the precision of the results, since it does not go through a linearization process.

Results and discussion:

Two kind of producers were observed in the two distinct regions of the country. Also, two mathematical models were constructed: a linear and a quadratic one. The regions chosen for analysis were Tangará da Serra, in Mato Grosso State, and Carazinho, in Rio Grande do Sul State. Mato Grosso's typical property has 3.000 hectares whereas the size of Rio Grande do Sul typical property has 200 hectares.

The farmers of Brazilian Midwest have entrepreneur abilities and accepted to migrate from their original region in search of cheaper land to crop larger areas. In this process, large "cerrado" (Brazilian Savana) areas are being cultivated even though deficiencies in transportation, energy and communication systems are present in the region. Most of these entrepreneurs are descendents of Europeans, mainly Italian and Germans immigrants. The cities are new and the infrastructure is at an initial phase of development. Differently from the description above, the Rio Grande do Sul's farmers have more financial stability and live in an area with better infrastructure (road, electricity, telephone, etc) but, on the other hand, have few possibilities of expanding their farm area. Most of then have a university education. The one thing both producers - from Rio Grande do Sul and Mato Grosso - have in common is their European background.

The results of the linear model were significantly modified, coming closer to the observed situation of the typical farms. The risk model results incorporate more activities, showing that the minimization of risks involves a diversification process. In the risk models the soybean crop and the cropping of corn as second crop are among the economic activities indicated by the model at all defined net revenue levels.

The maximum income point (R$ 380 thousand) is given by the solution of the linear model with no risk considered. At this point, the following activities are included: corn planted after soybean (2.24% of the total area), cotton (12.88%), soybean (2.24%) and cattle (84.87%).

Efficient Frontiers

The frontiers of economic efficiency is defined as a set of points within the return and risk area where the company achieves the best return corresponding to a given level of risk. The construction of the efficient border can be made using the MOTAD or the quadratic model. The format of the curve depends on the restrictions of inputs and resources of the farm.

It is expected that properties with the characteristics considered in the model combine activities in a form consistent with the mix indicated in the efficient frontiers. The Mato Grosso farm efficient frontier curve show the typical crops of a large farm of the region. The same can be said about the graph of Rio Grande do Sul although the curve represents a smaller property of about 200 hectares. The efficient frontier graphs of the quadratic models for the farms of Rio Grande do Sul and Mato Grosso are presented in Figures 1 and 2.

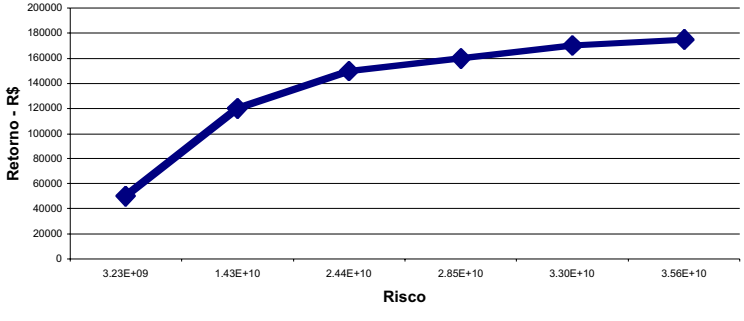
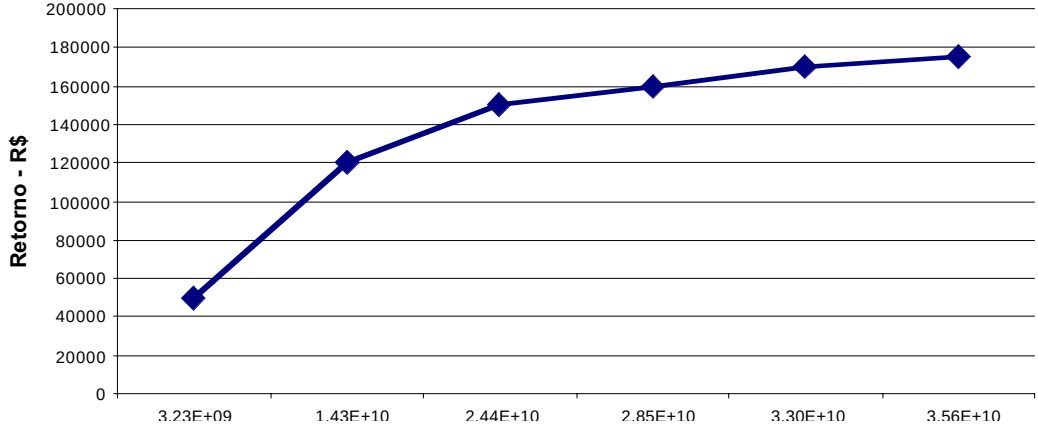
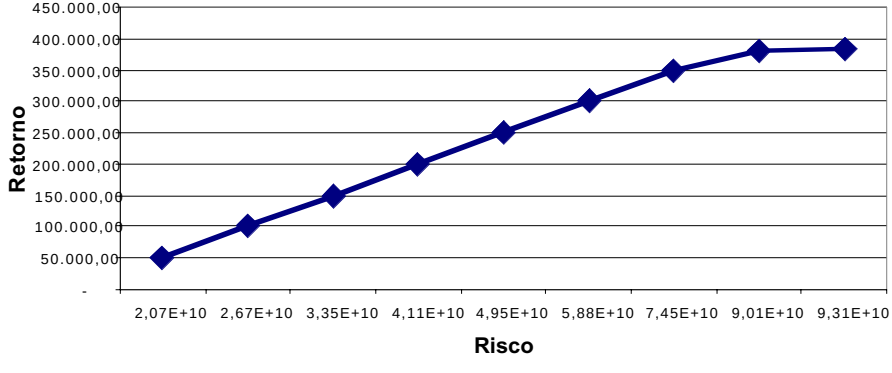


Figure 1- Efficient frontier in Rio Grande do Sul - E-V model.



The curve of the E-V model for Rio Grande Do Sul presents a sharper inclination for the lower income level. It means that small income increases are associated to high risk increases.

Figure 2- Efficient frontier in Mato Grosso - E-V model.



The curve for Mato Grosso presents a distinct behavior. In the lower ranges of expected net return the risk-return relation grows slowly than in higher levels. This can be attributed to the largest number of potential economic activities of the region. In low yield layers, producers exchange lower income amounts for higher returns.

In the curve of the results for Rio Grande do Sul, a sharper inclination in the first ranges of expected income is noticed. These differences between the form of the curves of these two states can be related the structural characteristics of the farms, clime, commerce or, yet, cultural factors.

The inclination of the straight line at the point that corresponds to a production "mix" that is similar to the observed for the typical farm show the correspondent aversion to risk of these farms. Producer's risk aversion rates for each region are discussed bellow.

Rates of risk aversion

The efficient frontier represents, as already defined, the different combinations of activities in which producers get the maximum revenue with the production factors they have, within the risk-return context. Therefore, any point along this curve is considered maximum efficiency. With data from the panels, it is possible to identify where the utility curve touches the frontier and, at that point, the typical property must be situated. The inclination of the efficient frontier in this point shows the producer's risk aversion rate.

Point B corresponds to the mix of activities where the utility curve of the producer touches the efficient border. In Figures 3 and 4 one can see the locus of tangency of the utility curves for the Mato Grosso and Rio Grande do Sul typical farms.

Figure 3- Efficient frontier - Mato Grosso - Modelo E-V.

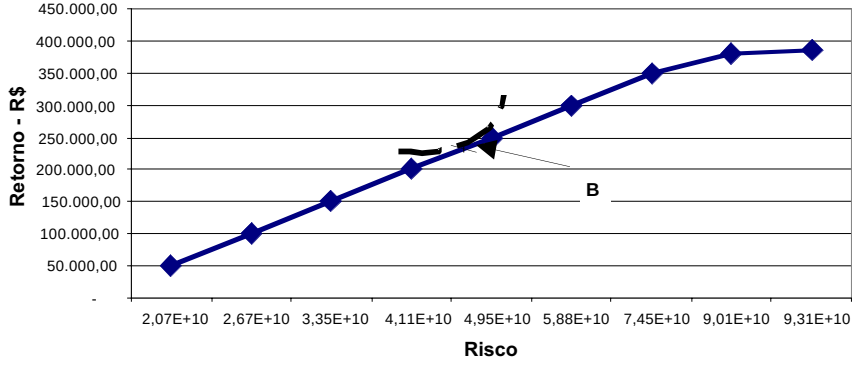


Figure 3- Efficient frontier - Mato Grosso - Modelo E-V.

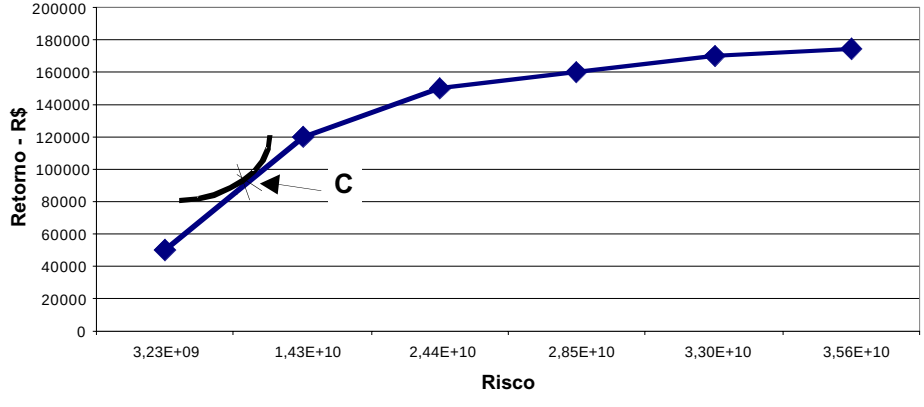


Figure 4- Efficient frontier - Rio Grande Do Sul - Modelo E-V.

Point C corresponds to a net income of R$ 90 thousand for a producer from Rio Grande do Sul and point B corresponds to R$ 220 thousand for a producer from Mato Grosso. The inclination of the efficient frontier at these points shows the risk aversion rate for both producers. The sharper the inclination, the highest the producer's risk aversion rate.

In point B of Figure 3, where the utility curve of the producers of Mato Grosso touches the efficient border, the inclination of the straight line that touches the locus indicates producer's risk aversion rate. In the case, the risk aversion rate is 5.42×10^{-6}.

The utility curve of the Rio Grande do Sul producer touches the efficient border in point C of Figure 4, indicating that its risk aversion rate is 6.32×10^{-6}.

The risk aversion rate is higher for the producers from Rio Grande do Sul than for the producer from Mato Grosso. This was expected once the southern production structure is more stable than that of Mato Grosso. Unlike Mato Grosso, Rio Grande do Sul does not have new areas to be cultivated. Moreover, producers from Rio Grande do Sul has, proportionally to the total necessary volume of resources, more capital and access to official agricultural credit.

CONCLUSIONS

Some sectors of the Brazilian agriculture have reached, over the last few years, a considerably high standard of competitiveness. Such evolution occurred in a period where the governments started to have a more passive position and, producers, in turn, tried themselves to modify the production structures, adapting to the forces of the market and to the demands for internal and external competitiveness.

The models, both the linear and the quadratic one, show that these Brazilian producers, regardless the size of their farms, are not indifferent to the risk. The results of the net revenue maximization model - initial phase of the process of models adjustment, where the producer is considered indifferent to the risk of the activities - are far from the composition of activities observed in the studied properties.

The maximization of the net revenue for the properties prescribes investments in most profitable activities; but, frequently, the most profitable activities are associated to the high revenue oscillations and, therefore, high risks. This explains why the composition of the mix of activities that maximizes net revenue is far from the set observed in the field.

The producers are aware of such relation and choose the activities according to the level of income they generate without losing sight of the associated risks. Producers from Mato Grosso know about the high mean return that the cotton culture offers. However, they also know that, in cropping cotton, there are important risk factors. Soybean cropping yields less gross revenue variation and, therefore, presents fewer risks. Knowing that producers may decide to crop larger areas of this culture. The results of the models for the Mato Grosso farm show that this possibility is compatible with the optimization of the net income. The soybean area prescribed in the models is similar to the observed in the field.

In Rio Grande do Sul, producers also adopt diversification with the same objectives. The model that maximizes the farm income suggest leaving all cropping area for corn in the summer and for wheat in the winter. However, this is not effectively observed in the field. Producers from Rio Grande do Sul chooses more products in the composition of his *portfolio*. Clearly, this producer is not indifferent the to risk either preferring to divide the land between soybean and corn in the summer and between cattle and wheat in the winter. Moreover, it is important to notice that, differently from Mato Grosso, in the Rio Grande do Sul model cattle productivity was incorporated in the mix of activities. Results show that producers from Rio Grande do Sul have a higher risk aversion rate than producers from Mato Grosso. That is consistent with what was empirically verified.

The last point to be discussed about the results of the models is that, in general, producers do not make use of agricultural credit. This shows that the 10%-a-year rate that was considered in the modeling are above the accepted level for the activity. Producers make use of external resources when the risk levels are higher; at lower and more realistic levels, producers tend to make use of their own money.

In Rio Grande do Sul producers are worried about the fact that external money represents a higher degree of risk. In Mato Grosso money from official sources is not sufficient and involves a lot of bureaucracy. They prefer to use credit operations connected to anticipation of sales of their products thus eliminating the risks of price fluctuations.

Are producers from Mato Grosso being more efficient than those of Rio Grande do Sul? The mix of activities observed in the Rio Grande do Sul typical farm is at a point inferior to the efficient frontier. Producers from Mato Grosso, in turn, are situated on the efficient frontier. According to the model they are more efficient than the Mato Grosso farmers. However, caution must be taken when drawing this kind of conclusion, since the results are extremely dependent on the specific data used in the research and the assumptions involved in the process of optimization employed.

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