DETERMINANTS OF SMALLHOLDER MILK PRODUCTION EXPANSION IN FOUR BRAZILIAN REGIONS

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Grupo de Pesquisa: 7 – Agricultura Familiar

Abstract – The objective of this paper was to analyze the determinants of smallholder milk production expansion in four Brazilian regions: Zona da Mata (MG), Rio de Janeiro, Tocantins, and Rondônia. A three years multi-period linear programming model was formulated to attain the objective purposed. The results show that smallholders can improve substantially their income with the adoption of low cost technologies, such as improvement in feeding and reproduction practices. The role of the public sector is important in this process of adoption of new technologies, especially providing accessible veterinary and extension services, and soft loans.

Keywords: milk production, smallholder, multi-period model, Brazil.

1. Introduction

In the 1990s the Brazilian dairy sector was forced to a strong adjustment in response to several policies implemented by the Government. These policies included an overall unilateral reduction of tariffs; implementation in 1994 of a stabilization plan (Real Plan) to control a

persistent inflationary process; creation of the MERCOSUR, a free trade area among Brazil, Argentina, Paraguay, and Uruguay; and deregulation of the dairy sector in 1991.

The Real Plan implementation and the openness of the economy have produced a more stable macroeconomic environment and have improved the income distribution. As a consequence, the demand for dairy products has increased substantially due to the high-income elasticity of these products. To face this increase of the demand, the Brazilian milk production has increased about 4.50% a year in the1990s, but it was not enough and the country had to import a large amount of dairy products.

The milk production rise in the last decade has occurred along with great changes in the dairy sector. The main changes related to the milk production include: a) regions far from big consuming urban centers, such as North and Center-West, have become important in milk production; b) the real price per liter of milk received by producers has decreased systematically; c) the environment more competitive has forced many milk producers to leave the activity; d) the largest producers, due to gains of scale, has increased their relative participation in the overall milk supply.

Several studies about the Brazilian dairy sector (see, for example, Gomes, 2000; and Yamaguchi et al., 2005) have highlighted several aspects of this sector's adjustment process in the 1990s. In the case of milk production, the most evident aspect of this adjustment process is the great vulnerability of the smallholder producers. Most of them have left the activity, and those who have remained in the activity have faced great difficulties to improve their competitiveness.

In this paper, we analyzed some farm strategies and policy options to identify the main determinants of smallholder milk production expansion in four Brazilian regions: Zona da Mata (MG), Rio de Janeiro, Tocantins, and Rondônia. Specifically, we analyzed the effects on gross margin of some farm strategies, such as optimal allocation of farm resources (land, herd, pasture, labor, etc.) and adoption of low cost technologies (improvement in feeding and reproduction practices). Among the policy options, we considered rural credit and accessible veterinary and extension services.

2. Analytical Model

We used as analytical instrument in this study a multi-period linear programming model. This kind of model is an extension of the traditional linear programming and can be used for planning over time. In a multi-period linear programming model, typical activities are repeated in a number of periods. A transfer activity is used as a linking mechanism between time periods. The constraints are progressively modified over time by sell, purchase, or accumulation of resources so that the optimal mix of activities within periods varies over time.

According to Oliveira (1984) and Dent et al. (1986), a multi-period linear programming model can be written in matrix form as following:

Optimizer $f = [C_1, C_2, ..., C_n][X_1, X_2, ..., X_n]' = CX'$

subject to $\begin{bmatrix} A_{11} & & & \\ A_{21} & A_{22} & & \\ ... & ... & ... & \\ A_{m1} & ... & ... & A_{mn} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ ... \\ X_n \end{bmatrix} \leq, =, \text{or} \geq \begin{bmatrix} B_1 \\ B_2 \\ ... \\ B_m \end{bmatrix}$, and $X \geq 0$,

where $i = 1, 2, \ldots, m$; $j = 1, 2, \ldots, n$; C is a row vector of returns (revenues or costs) composed of a series of sub vectors, $C_1, C_2, \ldots, C_n$, each one related to a corresponding period of time; X is a

column vector of activities that assume nonnegative values; *A* is a matrix of input-output technical coefficients composed of varies sub matrices, A_{11}, …, A_{mn}, each one related to a corresponding period of time; B is a column vector of resources composed of a series of sub vectors, B_1, B_2, …, B_m, each one related to a corresponding period of time and sub matrix A_{ij}.

In this model, there is *n* period of time and *m* groups of constraint relationships. Each constraint relationship of each group involves one of the three signs ≤, =, ≥. Note that each period of time is essentially a complete static linear programming model with the activities and constraints operating in the normal way. The solution to the multi-period programming model can be obtained thought the use of linear programming algorithms, such as the Simplex method.

In a milk farm planning, the producer's prime objective can be to obtain as high a periodic gross margin as possible. Typical activities include, for example, growing grass, feeding cattle, breeding own replacements, borrowing rural credit, selling cattle, purchasing cattle, milking cows, selling fresh milk, and renting pasture. Usual constraints on the free selection of activity levels can be, among others, land, labor, tractor-hours per period of time, and cooling equipment capacity. Transfer activities are used to provide the link between the periods in a multi-period model.

3. Data and Procedures

The data used in the formulation of the multi-period linear programming model of this study were obtained from milk farms of four Brazilian regions: Zona da Mata (MG), Rio de Janeiro (RJ), Rondônia (RO), and Tocantins (TO). Zona da Mata and Rio de Janeiro are traditional milk production regions, while the others two are regions of agricultural frontier far from the big urban centers of consuming.

The Zona da Mata's milk producers considered in this study are beneficiaries of a Program agreed by Nestlé and Universidade Federal de Viçosa for dairy development in the micro region of Viçosa. Currently, there are 35 milk producers participating of this program; 10 of these producers are newcomers. They receive technical assistance from professionals and students of the Universidade Federal de Viçosa and their farms productivity, in general, is higher than milk farms of other Brazilian regions. The data of the other regions comprise 292 milk farms from Tocantins, 194 from Rio de Janeiro, and 114 from Rondônia and were collected in recent years by SEBRAE to make diagnosis of the dairy sector of these regions.

The farms considered in this study are oriented to milk production as the main source of cash income and most of the producers use zebu-dairy crossbred cattle. The milk farms of Zona da Mata are more specialized than those of the others regions considered in this study. Most of the milk producers, especially from Rio de Janeiro, Tocantins, and Rondônia, use zebu bull to provide beef-producing characteristics to male calves due to better prices in the market for beef. In most of the cases, female calves are retained for herd replacement and growth.

Besides herd characteristics, the main differences among farms of the four regions considered in this study include technology and land size. Farms from Zona da Mata are smaller in size, but they have better feed, reproduction practices, infrastructure, and machinery used for milk production when compared with the farms from the other regions, where milk production is deficient in feeding, reproduction practices, infrastructure and machinery. In most of the farms, the family, with limited hired labor, carries out milk production.

To study these farms, we formulated a basic three years multi-period linear programming model. This model was adapted to each region according to its particular characteristics, such as herd structure (average number of cows, average number of heifers, etc.), average annual milk production per cow, technology (managing feed supply, supplementary feeding), and average size area (in hectare) of the farm used for milk production. These different versions of the model permitted identify the effects of improvement in feeding and reproduction practices as well as optimal allocation of farm resources on the gross margin, the performance measure used in this study. The complete model comprises 110 activities and 100 constraints.

To calculate most of the technical coefficients of the multi-period programming model we used only information of those farms with number of cows between 20 and 30. Thus, we eliminated micro small farms and the largest ones. Basically, the criterion used to select only farms with this number of cows was their potential to become highly productive milk farms as occurred with many farms of Zona da Mata assisted by the program mentioned before. The information of these farms was also important to validate the model. Additional information used to calculate technical coefficients was obtained from specialized publications.

4. Results e Discussion

Four versions of the three years multi-period linear programming model, one for each region, were solved using the GAMS software. Each version of the model represents a typical milk farm (20-30 cows) of each region. Besides the cows, the model comprises also bull, calves, and heifers. The gross margin obtained by the representative farm of each region in a period of three years was: Zona da Mata, R$ 67,679.97; Tocantins, R$ 1,173.25; Rio de Janeiro and Rondônia, R$ 0.00 each.

Zona da Mata is the most profitable region in milk production and this reflects the sample characteristics used in this study. As mentioned before, the producers of this region are beneficiaries of a program for dairy development and their farms are highly productive. While milk yields per cow is 14 liters in Zona da Mata, the average of others regions is 3-4 liters per cow. Great part of this difference in productivity is due to accessible veterinary and extension services in Zona da Mata.

Even though the gross margin calculated for the regions Rio de Janeiro and Rondônia is equal to zero, it is important to note that the model include payment to family for milking and management services. Thus, a gross margin of zero does not indicate the business is infeasible. Most of the payment for services goes to smallholder families instead of to temporary hired labor.

Table 1 shows the expenses with temporary hired labor. As we can see, the expenses per annum with hired labor are very low in most of the regions. Temporary hired labor was more important in Zona da Mata than in the other regions. These results for hired labor corroborate the fact that the payment for services in a milk farm goes primarily to smallholder family.

Table 1. Optimal use of temporary hired labor (expenses measured in R$)

Labor\Region	RO	TO	RJ	MG
Labor – year 1	86.44	334.19	155.44	951.15
Labor – year 2	121.51	165.77	89.48	414.20
Labor – year 3	66.68	33.84	89.30	411.87

Source: Research data.

Other important result of the model is the optimal use of land for milk production. Table 2 shows the optimal use of land for each year and for each region. As we can see, land is not restrictive for milk production in the regions studied, except in Zona da Mata. In this region, all the land available for milk production is used in all the three years of the model. Note also that farm size in Zona da Mata is, in general, smaller than the other regions considered in this study.

Table 2. Optimal area with pasture for milk production (in hectare)

Land\Region	RO	TO	RJ	MG
Average land available (ha)	44.00	58.00	39.00	28.40
Land – year 1	16.04	48.70	15.63	27.48
Land – year 2	12.55	30.91	6.58	28.40
Land – year 3	5.12	5.60	6.58	28.31

Source: Research data.

Another aspect that can be observed from tables 1 and 2 is the reduction of hired labor and land used for milk production over the years. Only in Zona da Mata this reduction was not so drastic. In fact, the model suggested the reduction of the herd size as the best option for most of the regions analyzed. Again, Zona da Mata was the region less affected when we consider optimal use of these two resources. The family income was improved with the sale of part of the herd, but, at the same time, family future income will be smaller with the reduction of the herd size.

When the model permitted the milk producer to rent pasture up to 5 hectares, all the regions rented the area permitted, except Zona da Mata. This result is coherent with those presented in table 2. Land is not restrictive in Rio de Janeiro, Tocantins, and Rondônia and the rent of pasture can be an important source of income to smallholder families of these regions. In the case of Zona da Mata, only when the opportunity cost of land is lower than the market price for rent, it is interesting the rent of pasture.

In the multi-period model, we simulated also the use of rural credit. The analysis of the sample data showed that only a small number of milk producers use rural credit in their activities. Most of this credit used for smallholder milk producers comes from the National Program for Familiar Agriculture (PRONAF) whose interest rate charged is lower than that charged by the market. With these favorable conditions, the model suggested the use of rural credit by the producers of all regions.

The analysis of the results as a whole permits identifying what is limiting the smallholder milk production expansion in each region. In Zona da Mata, land is the main limiting resource. In the other regions, the access to low cost technologies, such as improvement in feeding and reproduction practices, is limiting seriously the expansion of milk production. Rural credit is a limiting resource for all regions. Improvement of infrastructure in the rural areas can also benefit all the regions.

The Government policy has an important role to overcome most of the limiting factors of smallholder milk production expansion. The milk production expansion requires generally a high quality of support services and most of smallholder producers cannot afford to pay for these services. Thus, the Government can provide some basic requirements for milk production, especially in those poorest regions, such as accessible veterinary and extension services, improvement of infrastructure, marketing facilities, soft loans and other necessary incentives.

5. Concluding Remarks

In this study we analyzed the determinants of smallholder milk production expansion in four Brazilian regions: Zona da Mata (MG), Rio de Janeiro, Tocantins, and Rondônia. We used a multi-period linear programming model to simulate the effects of farm strategies and policy options on gross margins of representative milk farms from these regions. In the simulations, among others strategies, we considered improvement in feeding and reproduction practices, and use of rural credit.

The results obtained show that different factors limit the smallholder milk production expansion in these regions. In Zona da Mata, for example, land is the main limiting resource. In the other regions, the access to low cost technologies, such as improvement in feeding and reproduction practices, is limiting seriously the milk production expansion. Rural credit is a limiting resource for all regions. Improvement of infrastructure in the rural areas can also benefit all the regions.

It is proposed some Government policies to overcome most of the factors that limit smallholder milk production expansion in the regions studied. In general, milk production requires a high quality of support services and most of smallholder producers cannot afford to pay for these services. Thus, the Government can provide some basic facilities, such as accessible veterinary and extension services, infrastructure, marketing, soft loans and other necessary incentives.

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