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Analysis of milk production at the Taquari Valley, Rio Grande do Sul, Brazil

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Additional keywords

Rotational grazing.
Breeding heifers.
Gross annual income.

SUMMARY

This study analyzed some factors responsible for the variability of production in the Taquari Valley in Rio Grande do Sul (RS), Brazil. The first objective was to evaluate the variability of rotational grazing with the practice of breeding heifers and their influences on gross annual income. The second objective was to analyze if the selection of breeding heifers and the type of investment influences the quantity of liters of milk per year. As a research method, the study then conducted an analysis of variance test with two factors to investigate the variability of the annual gross billing and the quantity of liters of milk per year. The study found that gross annual billing significantly increased when farmers practiced rotational grazing and selected breeding heifers. This increase was on an order of 35.86% for the farmers who practiced rotational grazing in relation to those who did not. For farmers who selected breeding heifers in relation to those who did not, the increase was on an order of 22.77%. The regression analysis showed that for each 1 liter of milk increase, the expected income increased by 1146 reais in the Taquari Valley, RS.

Análise da produção de leite do Vale do Taquari, Rio Grande do Sul, Brasil

Palavras chave adicionais

Pastejo rotacionado.
Matrizes de novilho.
Faturamento bruto anual.

RESUMO

Esta pesquisa analisa alguns efeitos responsáveis pela variabilidade da produção de leite do Vale do Taquari, Rio Grande do Sul (RS), Brasil. O primeiro objetivo foi avaliar a variabilidade do manejo de pastejo rotacionado com a prática da seleção de matrizes de novilha e suas influências sobre o faturamento bruto anual. O segundo objetivo foi analisar se a seleção de matrizes de novilha e o tipo de investimento têm influência sobre a quantidade de litros de leite/ano. Como método da pesquisa procedeu-se ao teste de análise de variância com dois fatores para investigar a variabilidade das variáveis faturamento bruto anual e quantidade de litros de leite/ano. Constatou-se que o faturamento bruto anual aumenta de forma significativa quando o produtor pratica o pastejo rotacionado e faz a seleção de matrizes de novilhas. Esse aumento é da ordem de 35,86% para os produtores que praticam o pastejo rotacionado em relação aos que não praticam. Para os produtores que fazem a seleção de matrizes de novilha em relação aos que não fazem o aumento é da ordem de 22,77%. A análise de regressão mostra que a cada aumento de 1 litro de leite, o faturamento esperado aumenta em 1,146 reais na região do Vale do Taquari, RS.

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INTRODUCTION

Milk production began in the Taquari Valley in Rio Grande do Sul State with the arrival of the second wave of German immigrants in the early twentieth century when the region was settled, which is now located in the municipalities of Bom Retiro do Sul, Estrela and Lajeado (Carvalho, 2006).

The German colonizers promoted an ethnic change in the region and reduced the production of corn, beans and wheat and gave priority to husbandry. Milk production was implemented and as a consequence cheese production (Barden *et al.*, 2001). According to Lang (1999), the transportation of milk began in the mid 1930s, while before the milk was sold raw, and farmers produced cream and later butter, selling these products in local shops. With improved roadways, milk transportation and after the first dairy companies were established that began to buy the farmers milk for industrialized products. The Taquari Valley became well known for the growth of the dairy sector. Around 1960 cooperatives began to appear and later private companies, making visible the region's importance in

the Rio Grande do Sul dairy market (Turatti, 2011). But the companies were dedicated to industrialization, often leaving the farmers without support. Despite recognition of the need for investments in the area, the focus turned to the client, which was good for developing the market, but neglected the quality of the raw material. According to Peres Netto *et al.* (2011) rotational grazing proved to be economically advantageous in relation to confinement, in the short and long term forecasts. But Egan *et al.* (2015) affirmed that the permanent grazing would be able to support dairy production. According to Santos and Lopes (2014) the use of breeding heifers in production systems, implied that administrators should dedicate greater attention in variable costs to pure females and in fixed costs to hybrid females. Meanwhile, feeding practices are among the most important characteristics in the distinction between farming systems (Gabbi *et al.,* 2013). For Peres *et al.* (2015) there is a relationschip between the feeding of heifers grazing and financial viability.

In this sense, pasture management takes on an important role in animal productivity, given that it is only through correct knowledge, handling and allocation of the production factors soil-weather-plant and feed-animal, is it possible to obtain favorable productivity and profitability within any production system (Silva, 1995).

Decision making, according to Grigera *et al.* (2007) requires monitoring of pasture production and treating it at a management level. Solano *et al.* (2006) add that it is important to take a broad approach to the study of decision-making by farmers. The study shows the importance of these factors in the development of animal husbandry in Brazil considering that the Taquari Valley is the third largest milk-producing region in the state, according to data from the Brazilian Institute of Geography and Statistics (IBGE) reported in October 2013. Therefore, this study is justified by the importance of this region, and the vulnerable economic moment that the country is experiencing.

The purpose of this study is to analyze the variability of milk production in the Taquari Valley, RS. The variance analysis technique was used, a chi-squared test and analysis of correlation and regression to check the effects the variables of income and number of liters of milk per year.

According to the BDR (2011) the Taquari Valley is in the central region of Rio Grande do Sul, an average of 150km from Porto Alegre, and has a total of 4821.1km² (1.71% of the state) and has 327822 residents (3.07% of the state – Censo demográfico 2010). The region is traversed by the Taquari River and its affluents from the municipalities of Arvorezinha and Taquari. It extends westward to the municipalities of Progresso and Sério and eastward to Poço das Antas and Paverama. The municipalities that compose the Taquari Valley are: Anta Gorda, Arroio do Meio, Arvorezinha, Bom Retiro do Sul, Canudos do Vale, Capitão, Colinas, Coqueiro Baixo, Cruzeiro do Sul, Dois Lajeados, Doutor Ricardo, Encantado, Estrela, Fazenda Vilanova, Forquetinha, Ilópolis, Imigrante, Lajeado, Marques de Souza, Muçum, Nova Bréscia, Paverama, Poço das Antas, Pouso Novo, Progresso, Putinga, Relvado, Roca Sales, Santa Clara do Sul, Sério, Tabaí, Taquari, Teutonia, Travesseiro, Vespasiano Corrêa and Westfalia. The **figure 1** depicts the location of the Taquari Valley in Rio Grande do Sul - Brazil.

Table I. Number of dairy farms in the Taquari Valley (Número de propriedades de leite no Vale do Taquari).

Brazil, State and Municipality	Number of dairy farms (Emater/RS-Ascar 2013)				
	8888	100%			
Putinga – RS	790	8,89%	Encantado - RS	210	2,36%
Teutônia – RS	674	7,58%	Progresso - RS	206	2,32%
Anta Gorda – RS	600	6,75%	Coqueiro Baixo - RS	198	2,23%
Arroio do Meio - RS	550	6,19%	Colinas – RS	179	2,01%
Estrela – RS	495	5,57%	Relvado – RS	170	1,91%
Westfalia – RS	371	4,17%	Canudos do Vale - RS	145	1,63%
Sério – RS	351	3,95%	Arvorezinha - RS	130	1,46%
Marques de Souza - RS	350	3,94%	Dois Lajeados - RS	120	1,35%
Forquetinha – RS	336	3,78%	Capitão – RS	110	1,24%
Vespasiano Correa - RS	300	3,38%	Doutor Ricardo - RS	102	1,15%
Imigrante – RS	291	3,27%	Fazenda Vilanova - RS	90	1,01%
Nova Bréscia – RS	280	3,15%	Bom Retiro do Sul - RS	82	0,92%
Travesseiro – RS	270	3,04%	Poço das Antas - RS	65	0,73%
Santa Clara do Sul - RS	256	2,88%	Muçum – RS	62	0,70%
Cruzeiro do Sul - RS	250	2,81%	Ilópolis – RS	50	0,56%
Roca Sales – RS	245	2,76%	Lajeado – RS	50	0,56%
Pouso Novo – RS	230	2,59%	Tabaí – RS	32	0,36%
Paverama – RS	218	2,45%	Taquari – RS	30	0,34%

Source: Adapted from IBGE, 2013.

According to IBGE (2013), there has been a growing increase in the Brazilian dairy herd, which demonstrates that the increase in annual milk production is tied to the increased herd and not to increased productivity. This shows the need to find analysis that lead to increased productivity in this dairy region and to reduce the deficit in the balance of trade and current excess capacity in the industry.

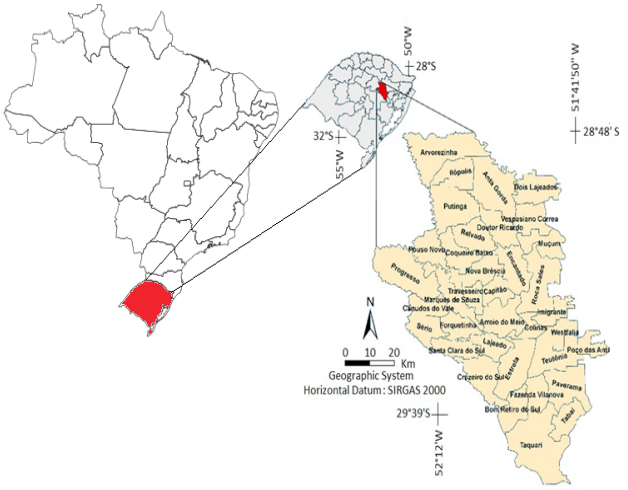

Figure 1. Area of study Taquari Valley, RS (Área de estudo Vale do Taquari, RS). Source: Adapted by the authors from FEE, (2013) and IBGE (2015).

According to IBGE (2013), there are 8,888 milk-producing farms in the Taquari valley region, distributed as indicated in **table I**.

According to Embrapa (2013), the Brazilian balance of trade in the dairy sector has changed considerably in recent years. In 2008 the country had a trade surplus with expectation of continued growth of exports. Due to the international economic crisis in 2008, the market suffered an enormous drop from which it has not recovered. Exports fell 1.7% from 2011 to 2012, at the same time that imports rose each year due to growth in domestic consumption of dairy products, which increased 3.9% from 2011 to 2012. Since 2009, Brazil has had a deficit in its balance of trade in the dairy sector.

An analysis of domestic consumption by dairy companies by state, found gains in participation in Brazilian production in the first quarters of 2013, compared to 2012, in Paraná, São Paulo, Rio de Janeiro and Santa Catarina States. Meanwhile, declines were found in Rio Grande do Sul, Minas Gerais, Pernambuco, Bahia, Ceará, and other states (IBGE, 2013). Rio Grande do Sul is one of the three states with the highest milk production in Brazil, but due to the lack of investments and modernization it should lose this position to Paraná in coming years, given that Paraná already has more dairy cattle than Rio Grande do Sul (Embrapa, 2011).

For Dorneles *et al.* (2009) the average productivity of Brazilian dairy herds has much to be desired, varying from 3.22 liters/cow/day in the north to 7.05 liters/milk/day in the south, with a national average of 5.61 liters/cow/day.

As can be seen in **figure 2**, according to Embrapa (2013) Brazil is among the countries with the lowest milk production per cow per year.

In perception to Montoya and Finamore (2005), Rio Grande do Sul had undergone deep changes in the dairy situation, due to national policies that sought deregulation of the market, stabilization of the economy and commercial opening. These changes have brought productivity gains to milk production, given that the relationship between the industry and the producer has increased considerably. In recent years there has been a distancing of industry from farmers, causing stagnation in productivity and opening space for a series of problems found today.

For Castro *et al.* (1998) the opening of the market and the establishment of Mercosul were responsible for

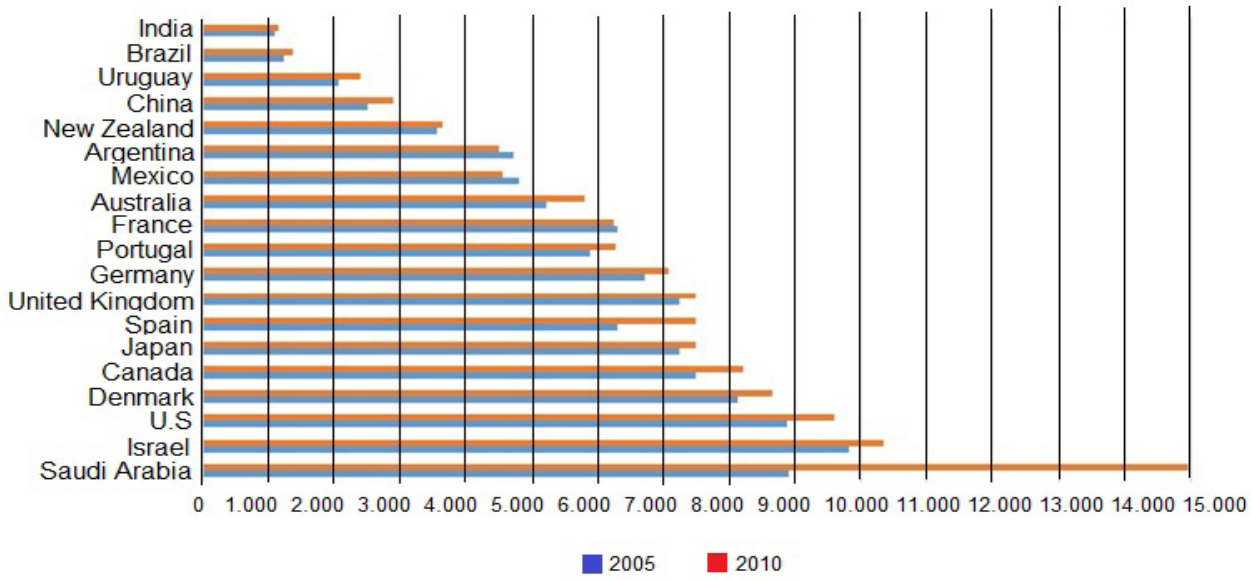

Figure 2. Production per cow/year in selected countries (Produção por vaca/ano em países selecionados). Source: Embrapa (2013).

intensifying competition,which has exposed the inefficiency of the dairy sector in Rio Grande do Sul. In this context, the productive quality of the dairy herd has become the main impediment in the productive chain.

In general farmers treat milk production as a complement to other activities, which has a direct reflection on productivity. Although it is higher in the region than the national average, it is still far below the averages in other countries with strong dairy sectors, even in Mercosul (Castro *et al.*, 1998).

According to Embrapa (2011) 1 kg of milk varies between 1028 and 1034 liters of milk depending on the variation in solids content.

Montoya and Finamore (2005) also affirmed that Rio Grande do Sul is an important exporter of liquid milk to other Brazilian states, raising the question of how a state that provides other states milk can have a shortage of raw material. They also found that the dairy production chain plays an important role in the state economy, and a crisis in this sector could harm the entire state economy.

MATERIAL AND METHODS

This study involved applied, explanatory and inferential research considering a sample of 263 interviews and 8888 dairy farmers in the Taquari Valley, RS. The questionnaire was administered by the Empresa de Assistência Técnica e Extensão Rural do Rio Grande do Sul [Rural Extension and Technical Assistance Company of Rio Grande do Sul] (Emater-RS) with the support of technicians who provide support to dairy farmers. The target population was small farmers who have at least one cow that produces milk in the municipalities in the Taquari Valley.

The size of the sample (n = 263) was calculated considering a 90% level of confidence and 5% sampling error, given by equation 1.

$$n = \frac{N \cdot p \cdot (1-p) \cdot Z^2}{p \cdot (1-p) \cdot Z^2 + (N-1) \cdot e^2}$$

With, N=8888; p= 0.5; Z = 1.645; e = 0.05

The variables selected in the study were *gross annual income; type of investments* (with a farmer's own capital; with financing, or with the farmer's own capital plus financing)*; rotational grazing* and *number of liters of milk/year*.

The Variance Analysis (ANOVA) with two factors was used to identify the major sources of variability of the variables gross annual income and number of liters of milk per year. ANOVA compares the various groups or stratums of interest that allow investigating the existence of significant differences between these groups (Montgomery, 1991). In this study, the groups analyzed are the effects of the practices of rotational grazing versus selection of breeding heifers on the variability of gross annual income and on the variability of number of liters per year. The combination of the effect of these factors represents different modes of production that can reveal the natural variability of the process of productivity in the Taquari Valley.

The hypotheses considered in this study are:

H_0: Rotational grazing has no effect on gross annual income.

H_a: Rotational grazing has an effect on gross annual income.

H_0: The selection of breeding heifers has no effect on gross annual income.

H_a: The selection of the breeding heifers has an effect on gross annual income.

H_0: There is no interaction effect between rotational grazing and selection of breeding heifers on gross annual income.

H_a: There is an interaction affect between rotational grazing and selection of breeding heifers on gross annual income.

To verify the variability of the aspect productivity/economics on the aspect milk production yield, the hypotheses are given by:

H_0: The selection of breeding heifers has no effect on the number of liters of milk per year.

H_a: The selection of breeding heifers has an effect on the number of liters of milk per year.

H_0: The type of investment has no effect on the number of liters of milk per year.

H_a: The type of investment has an effect on the number of liters of milk per year.

H_0: There is no interaction effect between selection of breeding heifers and type of investment on the number of liters of milk per year.

H_a: There is an interaction effect between selection of breeding heifers and type of investment on the number of liters of milk per year.

The linear regression analysis and the respective parameters *a* and *b* were calculated by the least square method conducted to verify the existence of significant correlation between gross annual income and the number of liters of milk per year. Also χ^2 test was applied to determine the dependency between variables rotational grazing and selection of breeding heifers.

The data were tabulated and processed with Sphinx software and in Microsoft Excel for statistical analysis.

RESULTS AND DISCUSSION

The **table II** presents the variance analysis with two factors, rotational grazing and selection of breeding heifers for the response variable gross annual income.

With the F test, under the hypothesis: H_0: rotational grazing does not have an effect on gross annual income versus H_a: rotational grazing has an effect on gross annual income, H_0 is rejected to 1% of significance, or the main effect of rotational grazing is very significant for gross annual income, ($F_{calculated}$ = 10.83, 1-p = 99.87%).

Table II. Results of the ANOVA for the gross annual income variable (Resultados da ANOVA para a variável faturamento bruto anual).

Source of variation	Sum of squares	Degrees of liberty	Square means	F	p-value
Rotational grazing	48886216296.55	1	48886216296.55	10.83	0.0013*
Selection of breeding heifers	12511431143.00	1	12511431143.00	2.89	0.0864**
Interaction	5219529556.20	1	5219529556.20	1.21	p>0.1
Error	1121651620686.03	259	4330701238.17		
Total	1188268797681.78	262			

*Significant to 1% ; **p<0.01.

Table III. Means of the levels of the rotational grazing and selection of breeding heifers factors for the gross annual income (in reais) response variable (Média nos níveis dos fatores pastejo rotacionado e seleção de matrizes de novilha para a variável resposta Faturamento bruto anual (en reais).

Rotational grazing (factor A)	Selection of breeding heifers (factor B)		
	Yes	No	Total
Yes	82545.25	72349.94	80881.80
No	56106.96	38579.86	51064.92
Total	76029.65	58712.02	72605.63

There is evidence to affirm that when rotational grazing is conducted, there is a moderate increase in gross annual income.

For hypotheses: H_0: The selection of breeding heifers has no effect on gross annual income versus H_a: The selection of breeding heifers has an effect on gross annual income, rejecting H_0 to 10% of significance, or that is, the main effect of the variable selection of breeding heifers is not significant for income, ($F_{calculated}$= 2.89, 1-p = 91.36%). In this case, there is an moderate increase in income on a low scale when there is selection of breeding heifers.

Under the hypothesis of interaction, H_0: there is no interaction effect between rotational grazing and selection of breeding heifers on gross annual income versus H_a: there is an effect of the interaction between rotational grazing and selection of breeding heifers on gross annual income, accepting H_0. Since the interaction between these variables did not prove to be significant for the response of income, the main effects were evaluated. **Table III** presents the results of the means of the factors, rotational grazing and selection of breeding heifers for the variable response gross annual income.

The values in **table III** are the averages of the Income variable for each pair of citations. The evaluation of the main effects is described in **figure 3**.

The **table III** values represent the average annual gross sales in the levels of grazing factors rotated and selection of heifer arrays.

We can note that the lines, yes and no, of the variable selection of breeding heifers are approximately parallel, which indicates an absence of interaction between these factors on income. That is, the behavior of a farmer who does or does not rotate grazing is approximately the same as one who does or does not select the breeding heifers on gross annual income. In this way, the effect of the practice of rotational grazing alone has a strong positive effect on gross annual income, on the order of 36.86%, that is, the gross annual income of farmers who practice rotational grazingis 36.86%, higher than of those who do not practice rotational grazing. The effect of conducting the selection of breeding heifers has a bit lower effect on gross annual billing, on the order of 22.77%, or that is, gross annual income of the producers who practice the selection of breeding heifers increased 22.77% in relation to those who do not practice selection.

Chi-Squared Test (χ^2) for independence:

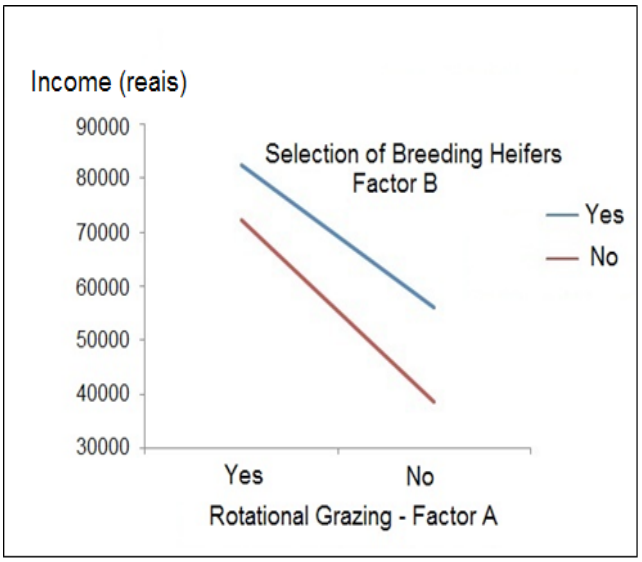

Figure 3. Graphic representation without interaction between the factors (Representação gráfica sem interação entre os fatores).

Although the variables pasture rotation and selection of breeding heifers do not present dependence between them in relation to annual gross income, they have an association of dependence between them proven by text χ^2. H_0: The variables rotational grazing and selection of breeding heifers are independent versus H_a: The variables rotational grazing and selection of breeding heifers are dependent, rejecting H_0 to a level of significance of 5%, or that is, it was found that the variables rotational grazing and selection of breeding heifers are dependent, χ^2= 5,15, gl = 1, 1-p = 97,68%).

Table IV. Results of the ANOVA for the quantity of liters of milk/year variable (Resultados da ANOVA para a variável quantidade de litros de leite/ano).

Source of Variation	Sum of squares	Degrees of liberty	Squared means	F	p-value
Selection breeding heifers	24457057298.38	1	24457057298.38	11.34	0.001**
Type of investment	69547507833.80	2	34773753916.90	16.12	0.0001***
Interaction	21977457156.32	2	10988728578.16	5.09	0.0069**
Error	554382110222.35	257	2157128833.55		
Total	67036413251.85	262			

**p<0.01; ***p<0.001.

Table V. Means of the factors of selection of breeding heifers and investments for the liters of milk per year variable (Médias dos fatores da seleção de matrizes de novilha e Investimentos para a variável litros leite/ano).

Selection breeding heifers	Investments			
	Farmer's own capital	Financing	Farmer's own capital and financing	TOTAL
Yes	35225.83	52348.39	127201.67	55235.22
No	28390.91	32684.30	22892.50	31022.87
TOTAL	33392.07	48764.29	105241.84	50447.99

The result of the test indicates that there is evidence to affirm that the groups that practice the selection of breeding heifers are dependent on those groups that practice rotational grazing. **Table IV** presents the results of the ANOVA with two factors, selection of breeding heifers and type of investment for the variable response quantity of liters of milk/year.

With the F test, under hypotheses: H_0: the selection of breeding heifers does not have an effect on the quantity of liters of milk per year versus H_a: the selection of breeding heifers has an effect on the quantity of liters of milk per year, rejecting H_0 to 1% of significance, or that is the main effect of the selection of breeding heifers is very significant for the quantity of liters of milk/year ($F_{calculated}$ = 11.34, 1-p = 99.90%). There is evidence to affirm that when there is a selection of breeding heifers, there is a moderate increase in the quantity of liters of milk/year.

For hypotheses: H_0: the type of investment does not have an effect on the quantity of liters of milk/year versus H_a: The type of investment has an effect on the quantity of liters of milk/year, rejecting H_0 to 1% of significance, or that is, the main effect of the variable type of investment is very significant for the quantity of liters of milk per year, ($F_{calculated}$= 16.12, 1-p = 99.99%). Thus, there is evidence to affirm that there is a moderate increase in the quantity of liters of milk/year with the type of investment utilized.

Under the hypothesis of interaction, H_0: there is no effect of the interaction between selection of breeding heifers and type of investment on the quantity of liters of milk per year versus H_a: There is an effect of the interaction between selection of breeding heifers and type of investment on the quantity of liters of milk per year, deciding to reject H_0 to 1% of significance. Thus, it is concluded that the effect of the interaction is very significant, that is, the effect of the selection of breeding heifers depends on the type of investment used and the opposite too. When the interaction is significant we should examine the behavior of a factor at each level of the other factor, as shown by **table V** and **figure 4**.

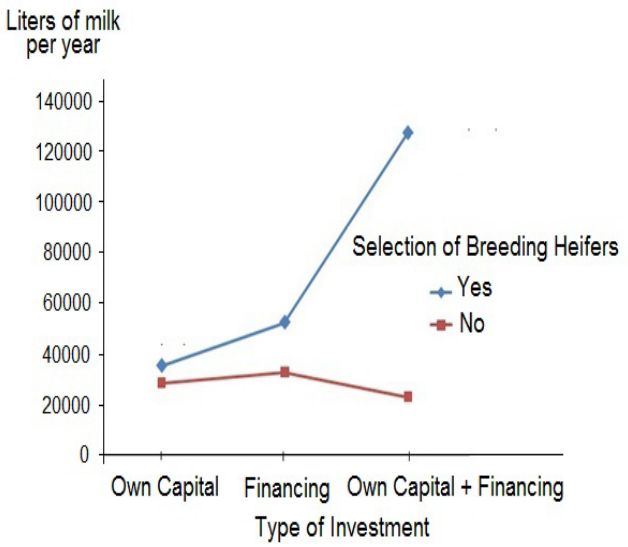

Figure 4. Graphic representation of the effects of selection interaction of breeding heifers versus type of investment (Representação gráfica dos efeitos da interação seleção de matrizes de novilha versus tipo de investimento).

Table V presents the results of the averages of the quantity of liters of milk per year within the groups of farmers who select breeding heifers related to the groups of the types of investments.

The amounts in the table are the means of the variable quantity of liters per year for each pairof citations.

In **figure 4**, the fact that the interaction is significant is indicated by the absence of parallelism between the lines corresponding to the groups of the variables selection of breeding heifers versus type of financing. This absence of parallelism occurs only between the groups of farmers that select breeding heifers and use their own capital plus financing and the groups of

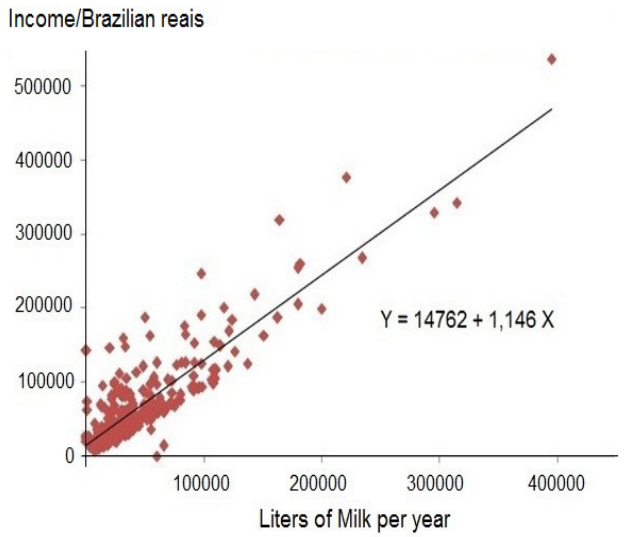

Figure 5. Linear regression between gross annual income and production of liters of milk/year (Regressão linear entre faturamento bruto anual e produção litros de leite/ano).

farmers who do not select breeding heifers and use their own capital plus financing. In this case, these two groups differ significantly, that is, the quantity of liters of milk per year is much higher when there is a selection of breeding heifers and farmers use their own capital plus financing compared with the other groups of farmers who do not select heifers.

The **figure 5** exhibits the 263 points of coordinates Income and Liters per year. The dependence is very high. The line of estimated regression for income (Y) is given by Y= 14762 + 1.146 X.

Based on the graphic representation of data in **figure 5,** it is possible to visualize a positive linear relationship between income and quantity of liters of milk per year. The Pearson coefficient of correlation for this data resulted in r = 0.87, as well as its respective significance test in Z calculated = 21.45, which compared to the tabled Z value, 5% = 1.96, provides evidence of a linear relationship between these two variables, or that is, there is considerable evidence that to the degree that there is an increase of liters of milk per year, the gross annual income also increases in the same proportion. Given that the angular coefficient of line b = 1.146, this means that for each increase of 1 liter of milk, the income (expected) increases by 1.146 reais. The coefficient of determination, 0.757 indicates that the variation in the gross annual billing explains 75.7% of the quantity of liters of milk/year.

CONCLUSION

This study showed some effects responsible for variability in the economic and productive aspects of milk production in the Taquari Valley in RS. Using ANOVA, it was possible to identify the causes of the variations in gross annual income and production in the quantity of liters of milk per year. It was found that the gross annual income increased significantly when farmers practiced rotational grazing and selected breeding heifers. This increase was on the order of 35.86% for farmers who practice rotational grazing in relation to those who do not. For farmers who select breeding heifers in relation to those who do not the increase is on the order of 22.77%. The significance of the effect of selecting breeding heifers on the level of producers who have their own capital plus financing to make investments is manifest with a high increase in the production of the quantity of milk per year, as shown in **figure 4**.

The text χ^2 for Independence concludes that the producers who use rotational grazing are dependent on those who practice the selection of breeding heifers.

The effects of factors observed in this study are due to the economic conditions and on the organization of production among the families who have dairy farms in the Taquari Valley. Nevertheless, it was observed that through planning and execution of basic techniques, such as management of rotational grazing, and by improving productivity by selecting breeding heifers, better economic results are obtained ascan be seen in income, implying the strengthening of milk production. One aspect to be considered in this study is that there are other factors that were not addressed here that can also influence the results. As a suggestion, to give continuity to this study in future work, studies of factors can be addressed related to farm management such as: training, professionalism and administrative and managerial competence, which involve knowledge of market flows and of sales and a strong commitment to quality.

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