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# The Effect of Genetic and Infrastructure Investments in Dairy and Beef Producers' Profit in Chile

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**Poster paper prepared for presentation at the  
International Association of Agricultural Economists Conference,  
Gold Coast, Australia, August 12-18, 2006**

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**The Effect of Genetic and Infrastructure Investments in Dairy and Beef  
Producers' Profit in Chile.**

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JEL: O13,Q14,16

**Abstract**

The objective of this study was to evaluate the effect of infrastructure and genetic improvement investments, promoted by a government program (*Programa de Modernización Ganadera*), in milk and meat producers' profit in Region IX. Using a system of simultaneous equations, the effect of the investment on quality, in the price, in the yield and production cost of milk were estimated. In the case of milk, we reject the nonlinear hypothesis that the elasticities of investment in genetic improvement in gross income and variable costs are equal to zero. The estimation was done using information of 276 producers of the IX Region that participated in the program during the period 1998-99 (17,3 % of the regional population), with information for the years 1998 (baseline), 2001 and 2003. The results indicate that the investment in infrastructure had a positive and statistically significant impact in the quality of milk, which translates into a higher price received by producers. Meanwhile the investment in genetic improvement had a positive and significant effect in milk yield, but also in costs. Similar results were obtained for meat production, but the effect is weaker than in milk production, especially for infrastructure investments.

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# **The Effect of Genetic and Infrastructure Investments in Dairy and Beef**

## **Producers' Profit in Chile**

### **Introduction**

As a result of the signing of free trade agreements by the Chilean government farmers are receiving support through programs that try to improve their competitiveness. Part of this support is directed towards small farmers whose commercial viability is not clear in part due to a lack of human, physical and financial capital and also because of competition from international markets. Two of the main constraints for growth that are subject to short term policy intervention are access to credit and technical assistance. This study looks at the role that financial support, technical assistance as well as education has had on profits of cattle farmer from the IX region in Chile. These farmers are assisted by INDAP, an agency from the Ministry of Agriculture through the program for Investment development, PDI.<sup>3</sup>

Other studies have looked into the effects that several farm sector support programs have had on farmers but most look only into summary information and average changes. Lopez (1996)<sup>4</sup> found that although there was an increase in production and yields in farmers participating in the Technology Transfer Program (PTT),<sup>5</sup> this result is in part due to selection bias. Moreover he found that the increase in production was more than compensated by an increased cost and less out of farm income, having a questionable impact on overall welfare. Similar results were found by Caro et al (2005) when looking at the Incentives for the Recovery of

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<sup>3</sup> *Programa de Desarrollo de Inversiones*

<sup>4</sup> Se also Monardes et al., 1993; Banco Mundial, 1994; Berdegué, 2000)

<sup>5</sup> *Programa de Transferencia tecnológica*

Degraded Land Program (SIRSD).<sup>6</sup> This study did consider selection bias in its econometric modeling, and found evidence on yield increases but was not conclusive about the impact on profits.

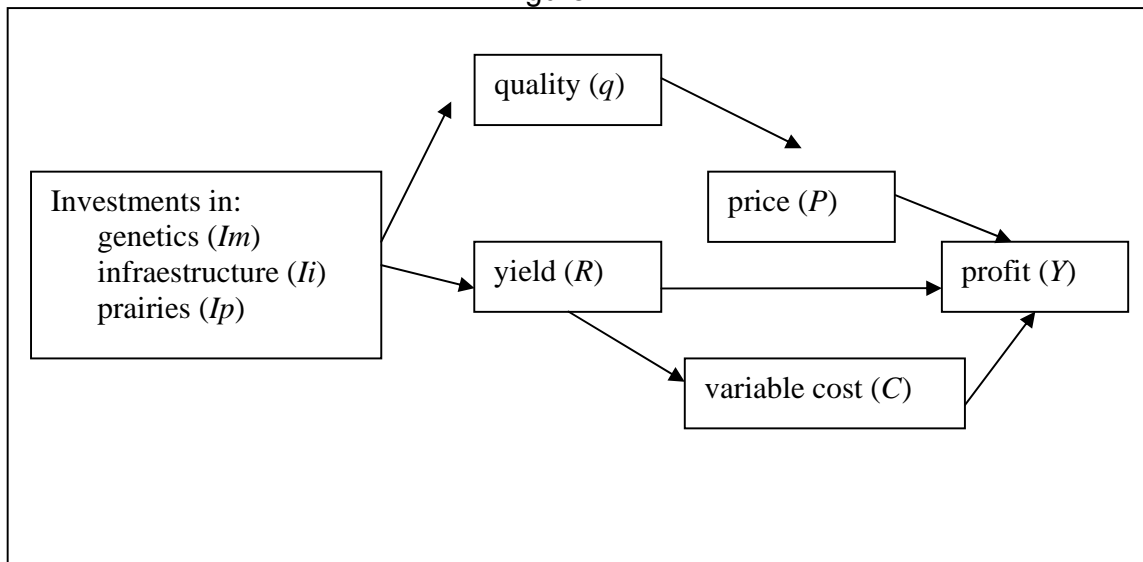
### Model and Data

Based on stylized facts of the situation of small farmer in Chile we propose a simple model where profit ( $Y$ ) depends on yields ( $R$ ), price ( $P$ ), costs ( $C$ ) and in the case of milk also quality ( $q$ ).

$$Y = P(q) \cdot R - C \quad (1)$$

We suggest that the impact that investments in livestock genetic quality, infrastructure and prairie quality affect profit directly through a change in yields and costs,<sup>7</sup> and indirectly through a change in quality and thus price, as shown in Figure 1.

Figure 1



<sup>6</sup> Sistema de Incentivos para la Recuperación de Suelos Degradados.

<sup>7</sup> We do not consider fixed cost, it may have an impact on medium to long term decision.

From these relationships we derive a system of equation that can explain the impact of investment on each component and therefore on profit.

$$\begin{aligned} \text{Price:} & & P &= P(q, Z) \\ \text{Yield:} & & R &= R(I_p, I_i, I_m, P, Z) & (2) \\ \text{Variable Cost:} & & C &= C(R, Z) \\ \text{Quality:} & & q &= q(I_p, I_i, I_m, Z) \end{aligned}$$

Where  $Z$  represents a set of other factors affecting each variable. This last equation and quality in general will only be considered for milk cattle. In this system then, price, yield, variable cost and quality are endogenous variables.

The data used correspond to the commercial segment of small farmers assisted by INDAP in the IX Region. From a total of approximately 1.900 farmers, 532 participated in the program during the 1998 season, and a sample of 276 were randomly selected for this study. From this number 171 were milk producer and 105 were beef cattle producers. Milk producers delivered to four different plants.

Information was available from INDAP for the year 1998 and 2001. Additional data was collected for the year 2003, thus generating a panel for three years.

### **Model Specification**

The panel was used to construct dependant variables of system (2) that reflected their change for the periods 1998-2001 and 1998-2003. Also initial values for

investment and final values for other values were use in each equation. Thus for milk system (2) yields:

#### Change in Milk Quality

$$\Delta \ln q_i = \alpha_0 + \alpha_1 \ln Ii_{i,t-k} + \alpha_2 \ln Im_{i,t-k} + \alpha_3 \ln Iap_i + \alpha_4 \ln Ei + \alpha_5 \ln U_i + \alpha_6 \ln S_i + \alpha_7 AT_i + \sum_{j=8}^{10} \alpha_j PP_j + \varepsilon_i$$

#### Change in Milk Price

$$\Delta \ln P_i^L = \beta_0 + \beta_1 \Delta \ln V_i + \beta_2 \Delta \ln q_i + \sum_{j=3}^5 \beta_j PP_j + \sum_{j=6}^9 \beta_j Z_j + \eta_i$$

#### Change in Milk Yields

$$\Delta \ln R_i^L = \gamma_0 + \gamma_1 \ln Ii_{i,t-k} + \gamma_2 \ln Im_{i,t-k} + \gamma_3 \ln Iap_i + \gamma_4 \Delta \ln P_i + \gamma_5 \ln E_i + \gamma_6 \ln U_i + \gamma_7 \ln S_i + \gamma_8 AT_i + \sum_{j=9}^{15} \gamma_j Z_j + \mu_i$$

#### Change in Milk costs

$$\Delta \ln C_i^L = \theta_0 + \theta_1 \Delta \ln R_i + \theta_2 \ln E_i + \theta_3 \ln U_i + \theta_4 \ln S_i + \theta_5 AT_i + \sum_{j=6}^{11} \theta_j Z_j + \nu_i$$

In the case of beef cattle the system of equation in (2) is reduced to two equations one for yield and the other for cost, since there are no quality consideration and the price is not responsive to individual conditions. These equations are:

$$\Delta \ln R_i^C = \lambda_0 + \lambda_1 \ln Ii_{i,t-k} + \lambda_2 \ln Im_{i,t-k} + \lambda_3 \ln Iap_i + \lambda_4 \ln E_i + \lambda_5 \ln U_i + \lambda_6 \ln S_i + \lambda_7 AT_i + \sum_{j=9}^{15} \lambda_j Z_j + \sigma_i$$

for yield, and

$$\Delta \ln C_i^C = \delta_0 + \delta_1 \Delta \ln R_i^C + \delta_2 \ln E_i + \delta_3 \ln U_i + \delta_4 \ln S_i + \delta_5 AT_i + \sum_{j=6}^{11} \delta_j Z_j + \omega_i$$

for cost.

Where:

$\Delta \ln q$  = represents the change in the log of the milk quality measure in CFU (colony forming units)

$li$  = infrastructure investment in 1998 (1998 chilean pesos)

$lm$  = genetic improvement investments in 1998 (1998 chilean pesos)

$lap$  = cumulative prairie investment (1998 chilean pesos)

$E$  = age of farmer (years)

$U$  = schooling (years)

$S$  = proportion of farming area devoted to cattle

$AT$  = received technical assistance (1=yes, 0=no)

$PP_j$  = plants where milk is delivered, dummy variables.

$\Delta P$  = change in milk price (1998 chilean pesos per liter)

$\Delta \ln V$  = change in the log of milk sales (liters)

$Z_i$  = dummy for *Comunas*

$\Delta \ln R^L$  = change in the log of milk yield (liters per hectare)

$\Delta \ln C^L$  = change in the log of variable cost in milk production (1998 chilean pesos per hectare)

$\Delta \ln R^C$  = change in the log of beef yield (kilos/hectare)

$\Delta \ln C^C$  = change in the log of variable costs in beef production (1998 chilean pesos per hectare)



## Estimation and Results

The systems of equations were estimated using three stage least squares and for changes in the periods 1998 to 2001 and 1998 to 2003.

The estimated equations for milk are presented on the following four tables.

**Table 1**

| ln(CFU change)                      | Changes for period 1998-2001 |           |              | Changes for period 1998-2003 |           |              |
|-------------------------------------|------------------------------|-----------|--------------|------------------------------|-----------|--------------|
|                                     | Coef.                        | Std. Err. | Significance | Coef.                        | Std. Err. | Significance |
| Investmet in infraestructure        | -0.0209764                   | 0.0024977 | ***          | -0.0193992                   | 0.0024529 | ***          |
| Investment in genetics              | -0.0018425                   | 0.0022786 |              | 0.000378                     | 0.0021396 |              |
| Investment in prairies              | 0.0221518                    | 0.0463714 |              | 0.024291                     | 0.0384333 |              |
| Age                                 | -0.0596353                   | 0.1310785 |              | -0.1773625                   | 0.1327225 |              |
| Schooling                           | -0.149554                    | 0.0726809 | **           | -0.1582734                   | 0.0696656 | **           |
| cattle area proportion <sup>+</sup> | 0.0749626                    | 0.1542983 |              | 0.0820662                    | 0.1416901 |              |
| Technical assitance                 | -0.1978582                   | 0.0629063 | ***          | -0.1664323                   | 0.0621442 | ***          |
| Plant 1                             | 0.4448947                    | 0.1661198 | ***          | 0.4151999                    | 0.1799945 | **           |
| Plant 2                             | 0.1333141                    | 0.1598089 |              | 0.1854518                    | 0.1713804 |              |
| Plant 3                             | -0.1674838                   | 0.1561459 |              | -0.1520625                   | 0.1691197 |              |
| _cons                               | -3.207132                    | 0.906192  | ***          | -2.923102                    | 0.839971  | ***          |

Note: all continuous variables are in logarithms except when noted with a +.  
 \*\*\* significant at 1%, \*\* significant at 5%, \* significant at 10%.

Table 1 shows that infrastructure investments had a significant and positive effect on milk quality (or a negative effect on CFU) in both periods considered. Schooling and technical assistance also had the same effect in improving milk quality.

**Table 2**

| ln(yield change)                    | Changes for period 1998-2001 |           |              | Changes for period 1998-2003 |           |              |
|-------------------------------------|------------------------------|-----------|--------------|------------------------------|-----------|--------------|
|                                     | Coef.                        | Std. Err. | Significance | Coef.                        | Std. Err. | Significance |
| Investmet in infraestructure        | 0.0018003                    | 0.0022351 |              | 0.0027575                    | 0.0022836 |              |
| Investment in genetics              | 0.018291                     | 0.0022219 | ***          | 0.0091539                    | 0.0021445 | ***          |
| Investment in prairies              | -0.0305616                   | 0.0431952 |              | -0.1020263                   | 0.037274  | ***          |
| Age                                 | 0.319841                     | 0.124457  | **           | 0.2122296                    | 0.1299272 |              |
| Schooling                           | 0.2301097                    | 0.0696346 | ***          | 0.1886607                    | 0.0682004 | ***          |
| cattle area proportion <sup>+</sup> | 0.2194896                    | 0.1500943 |              | 0.1424148                    | 0.1390953 |              |
| Technical assitance                 | -0.0425691                   | 0.0590087 |              | -0.026741                    | 0.0603598 |              |
| Z_renaico                           | 0.0344516                    | 0.1446192 |              | -0.0719584                   | 0.1617542 |              |
| Z_curacaut                          | 0.1005699                    | 0.1637733 |              | 0.1693501                    | 0.1688131 |              |
| Z_vilcun                            | -0.0449731                   | 0.1411014 |              | 0.0627763                    | 0.1562933 |              |
| Z_pitruf                            | 0.0404042                    | 0.1408897 |              | 0.1121618                    | 0.156319  |              |
| Z_freire                            | 0.1175287                    | 0.162686  |              | 0.2542094                    | 0.1730714 |              |
| Z_gorbea                            | 0.0588291                    | 0.1497299 |              | 0.0590978                    | 0.1625495 |              |
| Z_villarri                          | -0.0454804                   | 0.1657893 |              | -0.0021879                   | 0.1783313 |              |
| _cons                               | -1.08064                     | 0.8506782 |              | 2.010738                     | 0.8088958 | **           |

Note: all continuous variables are in logarithms except when noted with a +.  
 \*\*\* significant at 1%, \*\* significant at 5%, \* significant at 10%

Table 2 shows that investment in genetic improvements and schooling had a positive and significant impact on increasing yield. Age on the other hand only had a significant impact during the first period which was positive. Investment in prairies had a negative impact on yield change, a result that is not expected.

**Table 3**

| ln(price change)  | Changes for period 1998-2001 |           |              | Changes for period 1998-2003 |           |              |
|-------------------|------------------------------|-----------|--------------|------------------------------|-----------|--------------|
|                   | Coef.                        | Std. Err. | Significance | Coef.                        | Std. Err. | Significance |
| sales             | 0.0210642                    | 0.0091659 | **           | 0.0168911                    | 0.0078192 | **           |
| ln(change in CFU) | -0.0847349                   | 0.0126745 | ***          | -0.0795819                   | 0.0118974 | ***          |
| Z_renaico         | 0.0173545                    | 0.0211959 |              | 0.0197015                    | 0.0218374 |              |
| Z_curacaut        | -0.019619                    | 0.0160338 |              | -0.0148089                   | 0.0135617 |              |
| Z_pitruf          | 0.0286692                    | 0.0148673 | *            | 0.035001                     | 0.0128809 | ***          |
| Z_gorbea          | 0.0362918                    | 0.0163417 | **           | 0.0407931                    | 0.0142533 | ***          |
| Z_villarri        | 0.0817277                    | 0.0195282 | ***          | 0.0892669                    | 0.0174728 | ***          |
| Plant 2           | -0.0101935                   | 0.0208802 |              | 0.0004951                    | 0.0211549 |              |
| Plant 3           | -0.0724244                   | 0.0239875 | ***          | -0.0660088                   | 0.0230761 | ***          |
| _cons             | -0.2201749                   | 0.0996797 | **           | -0.1898488                   | 0.0952135 | **           |

Note: all continuous variables are in logarithms except when noted with a +.

\*\*\* significant at 1%, \*\* significant at 5%, \* significant at 10%

Table 3 shows that the volume of sales and the change milk quality increased price change in both periods. It can also be noted that farmers in different *Comunas* and delivering to different plants had significantly different milk price changes.

**Table 4**

| ln(cost change)                     | Changes for period 1998-2001 |           |              | Changes for period 1998-2003 |           |              |
|-------------------------------------|------------------------------|-----------|--------------|------------------------------|-----------|--------------|
|                                     | Coef.                        | Std. Err. | Significance | Coef.                        | Std. Err. | Significance |
| ln( change in yield)                | 4.764949                     | 1.938773  | **           | 11.856                       | 1.533383  | ***          |
| number milking cows <sup>+</sup>    | 0.0460336                    | 0.0260834 | *            | -0.0558081                   | 0.0107335 | ***          |
| Investmet in infraestructure        | -0.0144127                   | 0.0076582 | *            | -0.0355739                   | 0.0142622 | **           |
| Investment in genetics              | -0.0725305                   | 0.0361262 | **           | -0.0878162                   | 0.0188752 | ***          |
| Investment in prairies              | -0.1904544                   | 0.1314665 |              | 1.053164                     | 0.2760352 | ***          |
| cattle area proportion <sup>+</sup> | -0.6179202                   | 0.4892339 |              | -1.403332                    | 0.8610764 |              |
| Age                                 | -1.584865                    | 0.8265558 | *            | -2.342172                    | 0.8306347 | ***          |
| Schooling                           | -1.291212                    | 0.5443989 | **           | -2.244139                    | 0.4936748 | ***          |
| Technical assitance                 | 0.1724234                    | 0.1672426 |              | 0.2316117                    | 0.3628683 |              |
| Z_renaico                           | -0.0801107                   | 0.4070104 |              | 0.8770616                    | 0.9701614 |              |
| Z_curacaut                          | -0.0398072                   | 0.4825533 |              | -1.490108                    | 1.033937  |              |
| Z_vilcun                            | -0.0156344                   | 0.395912  |              | -0.8151006                   | 0.9378201 |              |
| Z_pitruf                            | -0.2812246                   | 0.4424338 |              | -1.209975                    | 0.9468875 |              |
| Z_freire                            | -0.8011711                   | 0.5558939 |              | -3.194511                    | 1.116101  | ***          |
| Z_gorbea                            | -0.1568062                   | 0.4470584 |              | -0.55269                     | 0.9721287 |              |
| Z_villarri                          | 0.4273547                    | 0.4748188 |              | 0.4533346                    | 1.063603  |              |
| _cons                               | 10.08189                     | 4.381251  |              | -21.83569                    | 5.83727   | ***          |

Note: all continuous variables are in logarithms except when noted with a +.  
 \*\*\* significant at 1%, \*\* significant at 5%, \* significant at 10%

Table 4 shows the results for the cost equations. As expected costs increased with yield increases in both periods. The number of milking cows owned by the farmer seems to have evolve from having marginally significant and positive impact in cost changes to one with definite reduction in cost per hectare. It also seems that investments impact on cost become more definite in the second period. With infrastructure and genetic investment having a negative effect on cost change, but prairie investment having a positive effect on cost change in the second period.

In the case of beef production the system of equations estimates are presented in Tables 5 and 6. As it can be seen in Table 5 both investment in infrastructure and in genetics have a positive and significant effect on change in yield for both periods. In this case it appears that this result is slightly more robust for the first period.

**Table 5**

| ln(yield change)                    | Changes for period 1998-2001 |           |              | Changes for period 1998-2003 |           |              |
|-------------------------------------|------------------------------|-----------|--------------|------------------------------|-----------|--------------|
|                                     | Coef.                        | Std. Err. | Significance | Coef.                        | Std. Err. | Significance |
| Investmet in infraestructure        | 0.1153316                    | 0.0550402 | **           | 0.1044227                    | 0.0552948 | *            |
| Investment in genetics              | 0.1044227                    | 0.0552948 | ***          | 0.1153316                    | 0.0550402 | **           |
| Investment in prairies              | 0.0434435                    | 0.0587717 |              | 0.0434435                    | 0.0587717 |              |
| Age                                 | 0.0262399                    | 0.2024636 |              | 0.0262399                    | 0.2024636 |              |
| Schooling                           | -0.0375492                   | 0.0876659 |              | -0.0375492                   | 0.0876659 |              |
| cattle area proportion <sup>+</sup> | -0.0162419                   | 0.1825426 |              | -0.0162419                   | 0.1825426 |              |
| Technical assitance                 | 0.0246137                    | 0.0729121 |              | 0.0246137                    | 0.0729121 |              |
| Z_curacaut                          | -0.0332048                   | 0.3399516 |              | -0.2415507                   | 0.3040224 |              |
| Z_renaico                           | -0.2415507                   | 0.3040224 |              | -0.0332048                   | 0.3399516 |              |
| Z_vilcun                            | -0.2348373                   | 0.3038805 |              | -0.2348373                   | 0.3038805 |              |
| Z_pitruf                            | -0.2408898                   | 0.3117954 |              | -0.2408898                   | 0.3117954 |              |
| Z_gorbea                            | -0.1665289                   | 0.3038788 |              | -0.1665289                   | 0.3038788 |              |
| Z_villarri                          | -0.1243266                   | 0.3422409 |              | -0.1243266                   | 0.3422409 |              |
| _cons                               | 0.1516327                    | 1.082516  |              | 0.1516327                    | 1.082516  |              |

The impact in cost change can be seen in Table 6, where is clear that an increase in yield will bring along a increase in change on cost. Note also that apparently increasing production will reduce per hectare variable costs of production.

**Table 6**

| ln(cost change)                     | Changes for period 1998-2001 |           |              | Changes for period 1998-2003 |           |              |
|-------------------------------------|------------------------------|-----------|--------------|------------------------------|-----------|--------------|
|                                     | Coef.                        | Std. Err. | Significance | Coef.                        | Std. Err. | Significance |
| ln( change in yield)                | 0.774121                     | 0.0819857 | ***          | 0.774121                     | 0.0819857 | ***          |
| meat cattle production              | -0.2907667                   | 0.0997715 | ***          | -0.2907667                   | 0.0997715 | ***          |
| cattle area proportion <sup>+</sup> | -0.2338199                   | 0.1966764 |              | -0.2338199                   | 0.1966764 |              |
| Investment in genetics              | -0.0326513                   | 0.0595737 |              | -0.0326513                   | 0.0595737 |              |
| Investmet in infraestructure        | -0.0327077                   | 0.0597495 |              | -0.0327077                   | 0.0597495 |              |
| Age                                 | 0.0458167                    | 0.0702637 |              | 0.0458167                    | 0.0702637 |              |
| Schooling                           | -0.0091722                   | 0.213104  |              | -0.0091722                   | 0.213104  |              |
| Technical assitance                 | -0.0230084                   | 0.0925662 |              | -0.0230084                   | 0.0925662 |              |
| Z_renaico                           | 0.0679154                    | 0.0795654 |              | 0.0679154                    | 0.0795654 |              |
| Z_curacaut                          | -0.3803015                   | 0.3575443 |              | -0.3803015                   | 0.3575443 |              |
| Z_vilcun                            | -0.170744                    | 0.3206708 |              | -0.170744                    | 0.3206708 |              |
| Z_pitruf                            | -0.0872631                   | 0.3218788 |              | -0.0872631                   | 0.3218788 |              |
| Z_freire                            | -0.2849429                   | 0.3286596 |              | -0.2849429                   | 0.3286596 |              |
| Z_gorbea                            | -0.2610172                   | 0.3198146 |              | -0.2610172                   | 0.3198146 |              |
| Z_villarri                          | -0.137118                    | 0.3601836 |              | -0.137118                    | 0.3601836 |              |
| _cons                               | 2.108162                     | 1.343158  |              | 2.108162                     | 1.343158  |              |

## Conclusions

The main conclusion that can be derived from this study is that the program did have the expected impact, *i.e.* increasing yields and in the case of milk also increasing profits. It should be noted though that investment in prairies did not have in desirable effect on production and profits.

It appear that education does play a role in the improvements in milk quality, yield and cost. There also seem to be some economies of scale in meat cattle and also in milk but in the longer period.

This program that subsidizes half of the investments done by the farmer appears to have definite on profit improvement at least for some of the items of investment and for milk production. Future research should consider the question if these subsidies are really necessary and if there exist a potential bias in the participation in the program. Something that could not be explored here due to data limitations.

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