



## Financial viability for milk production of Dutch and Jersey breeds: An analysis through Monte Carlo simulation and Sensitivity Analysis

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### Abstract

Due to the favorable characteristics such as climate and topography, the Agribusiness represents much of the generation of wealth in Brazil. Considering this importance, the objective of this research was to identify how many cows of the Dutch and Jersey breeds are required for a small milk producer get profit with its production of Brazilian. For this, the cash flows and the NPV were calculated. The NPV was calculated under deterministic and probabilistic aspects, performing a Monte Carlo simulation and afterwards a Sensitivity Analysis, illustrating the variable parameters that more influence in the outcome of the NPV. It was noticed that the selling price of a liter of milk and the amount of liters of milk produced per cow are the parameters which most affect the NPV. The results showed that there is a need for at least 33 cows of Dutch breed or 43 cows of Jersey breed for the project to generate wealth to the producer.

**Keywords:** Milk Production. Cows. Investment Analysis. Monte Carlo. Sensitivity Analysis.

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## Introduction

Due to the favorable characteristics such as climate and topography, represents a large part of Brazil's economy. This sector is responsible for approximately 26.7% of GDP, 37% of jobs and 36% of exports, putting the country in first place in the export of alcohol, sugar, coffee, soy, beef, pork and chicken (ZAMBOLIN et al., 2008).

The cattle are included in this context. In 2011 the herd in Brazil was counting on 39.5 million, equivalent to 9.1 million tons. Internal consumption was up 7.6 million tons (83.5% of production), exports 1.5 million tons (16.5%) and imports 30 thousand tons (0.3% of production) (LEMOS, 2013).

Within the cattle sector is the dairy. It moves approximately U\$ 10 billion per year, employing 3 million people annually, earning 20 billion liters of milk. Between 1990 and 2000 the production in Brazil grew 37%. The Midwest is responsible by 35% of the national herd. The country requires approximately 25.5 billion liters of milk a year to meet its domestic market. Due to the high number of economic agents who work in the system and the numerous marketing channels, the dairy market is quite complex (CARVALHO et al., 2002). In this scenario, the goal of research of this article is: what amount of cows of Dutch and Jersey breed are needed to make milk production financially viable?

The study is justified given that even with the increased production of 14.4 billion liters in 1990 to about 26 billion liters in 2007, productivity has increased by only 60%, considered low compared with developed countries. Some factors were the big birthing intervals, the inefficient labor, inadequate management, among others. For these indices to change, the producer/exporter of milk must pay attention to the quality of the product, and several technologies are available at different costs (MIRANDA; DINIZ; ANDREOLI, 2008).

In addition, it is necessary that the producers analyze the viability of the business, since if it is not feasible, production can be discontinued and the country does not move forward in increasing productivity. In the theoretical point of view, several studies has been researching financial viability in the rural context (PERES et al., 2009; LEAL et al., 2009; BROZOZOWSKI; ZMARLICKI, 2010; SEREIA et al., 2010; SILVA; FERREIRA; FERREIRA, 2011; SABBAG; NICODEMO, 2011; SILVA et al., 2012; CATAPAN et al., 2012; RONQUE et al., 2013; SOUZA; GARCIA, 2013; LIMA et al., 2015).

This article is divided in four sections, in addition to this introduction. The second section brings the theoretical framework of research, followed by a third section that illustrates the methodology used for the development of the article. Afterwards the research results are presented followed by the results of the numerical analysis and the conclusions.

## Theoretical Framework

This section brings the theoretical framework necessary to support the theoretical research, addressing first, aspects of milk production and finally, on financial viability.

## Dairy Production

According to the IPARDES (Paraná's institute for Economic and Social Development) (2009) the increase in milk productivity in 1996 to 2006 in the State of Paraná was of 71%. The same Institute (2009) states that 86.7% of producers are satisfied with this activity and 93.5% wish to continue in the business.

Schmitz and Santos (2013) discourse about the growth of the market regarding the UHT milk, which requires a quick treatment and processing of fresh milk what impacts small producers, focus of this research. Investments in new technologies become mandatory for maintenance of the producer.

Investment requires planning. The producer of milk, as well as every entrepreneur needs to know how to manage its activities and resources. The main factors that may interfere with the activity of the dairy product, considering the internal context are: genetics, diet, reproduction and health of animals (MIRANDA et al., 2008).

The race with the highest dairy expertise and therefore the most used is the Dutch race. Although it's the most expensive to start the business, like other animals of European origin, requires more careful both in comfort as in handling, suffering more with the difference of Brazil's tropical climate (MIRANDA; FREITAS, 2009).

Silva et al. (2011), complements that medium-sized Dutch cows are equivalent to large cows from other breeds, in terms of performance in milk production. However the Jersey cows, not so used in Brazil, are very satisfactory in their performances of production in tropical climates (GONZALES, 2007). Being addressed the aspects related to milk production, the next section talks about financial viability.

## Financial Viability

Feasibility analyses projects aim to understand the viability of certain ideas, and so, when there is an opportunity to invest. This process begins with the collecting and processing of information that, later, after properly analyzed, may permit to test the feasibility of an investment opportunity (FRIZZONE; ANDRADE Jr, 2005).

In this perspective, the feasibility analysis is also known as investment analysis and aims to identify the best alternative of financial return for a given investment to be held by a company (CARMONA, 2009; OGATA et al., 2014) and, therefore, any investments need to be evaluated according to their opportunity (OGATA et al., 2014).

To analyze an investment alternative, there is a need for the definition of appropriate criteria to aid in the analysis and decision of choosing between the more advantageous alternatives (CAMARGO, 2007). Thus, understanding the necessity of selection of various indicators to assist in feasibility analysis, this research will measure the Net Present Value (NPV) and Internal Rate of Return (IRR) of the project.

The net present value (NPV) of a project is the expected return on the date zero discounted the initial investment. Whereas the return to be analyzed must be discounted, it is necessary to establish, first, the discount rate.

Casarotto Filho and Kopittke (2010) explains that when it is found and later analyzed a proposed investment should be considered the fact that you're losing the opportunity to obtain the same return capital in another project, that is, the opportunity cost of money. So, understanding that the discount rate or cost of opportunity in a project can be defined as Minimum Attractive Rate of Return (MARR), Souza and Clement (2009) explains that the MARR is the best rate, whereas a low degree of risk, available for implementation of the capital.

Camargo (2007) set the MARR as minimum gain that the company has with a next-best alternative use of capital, when used its own resources to finance an investment. Ogata et al. (2014) explain the basis for your estimate is the interest rate on the market, in which, the ones that most impact are: Basic Financial Rate; the Reference Rate; the long-term interest Rate and System Fee Settlement and Custody. However, there is a difficulty in establishing an accurate value to MARR for use of the de-capitalization of the projected cash flow, due to oscillations and the varieties of these rates, already cited (OGATA et al., 2014).

Presented the MARR, the NPV, according to Frizzzone and Andrade Junior (2005), is an indicator that shows an expected capital gain above (if positive) or below (if negative) the expected return considering the minimum rate of attractiveness. In this sense, will be attractive when the VPL expected was equal to or greater than zero and rejected when the NPV is negative (FRIZZONE; ANDRADE Jr., 2005). The Formula 1 illustrates the calculation of NPV.

$$NPV = \sum_{j=0}^n \frac{[CF_j]}{(1+i)^j} \quad [1]$$

Being:

n = time of the project in months;

CF<sub>j</sub> = cash flow discounted per period;

i = discount factor.

The ease of interpretation of the results of the NPV and the minimization of its interpretive error makes this a robust analysis technique, as the net present value is the sum of the present values of each of the cash flows-both positive and negative-that occur over the life of the project (DAMODARAN, 2004).

Frizzzone and Andrade Junior (2005) point out that the NPV is a measure in currency, which requires the definition of a discount rate since there may be multiple values of NPV, one for each discount rate considered. Thus, the appropriate discount rate for the NPV is the one which increases security in the decision, since it assumes that cash flows generated can be reinvested to discount rate considered (FRIZZONE; ANDRADE Jr., 2005).

Souza and Clement (2008) explain that it is a robust investment analysis technique, which is the most known and used, and can be summed up as the concentration of all the values expected from a cash flow in zero date.

Another index that evaluates the investment project is the internal rate of return (IRR), which to Souza and Clement (2009) is the rate that makes the NPV of a cash flow equal to zero and, therefore, is the rate that makes the value of future profits equivalent to the expenses with the project. So, is characterized as a rate of return

on capital invested (SOUZA; CLEMENTE, 2009). Therefore, considering that this rate sets the NPV to zero, the Formula 2 illustrates the calculation of IRR, considering the NPV formula, but setting in to zero, and using as variable the discount rate.

$$0 = \sum_{j=0}^n \frac{[CF_j]}{(1 + IRR)^j} \quad [2]$$

Being:

n = time of the project in months;

CF<sub>j</sub> = cash flow discounted per period;

IRR = internal rate of return.

Lemes Júnior, Rigo and Cherobim (2010) explain, in line with the Formula 2 presented, that the Internal Rate of Return is the rate which equals the cash flow in relation to the amount to be invested in the project.

The practical use of the IRR method is typically used in deployment projects or industrial expansion as compared to the regular indexes of the sector to which the project refers (CASAROTTO FILHO; KOPITTKKE, 2010). Thus, the robustness of this method increases, since it allows comparability.

## Research Methodology

This section includes the research methodology and is divided into: (i) Research Outline; and, (ii) Processing of data.

### Research Outline

All researches aim to find a solution to a problem, investigation, questioning the reality to generate knowledge (PÁDUA, 2014). According to Bassett Jr. and Feres Jr. (2011) there are three stages of research: bibliographical research, observation of facts and data collection. To carry out this research, it was used these three steps. The literature research can be performed with already published materials (books, scientific articles) (SILVA; MARK, 2005).

The first part, concerning bibliographical research of this study, began with questionnaires sent to the Brazilian Agricultural Research Corporation (EMBRAPA) to begin the search for materials on the topic. With the collected material the two breeds were chosen (Dutch and Jersey). After this initial step, bibliographic searches were made in order to contextualize the subject and study the work produced in the area.

The second step is the observation of facts, to this end, was necessary the preparation of questionnaires to be sent to producers. According to Nogueira (2002), the questionnaires are used to raise information and, in this research, it was used three ways of acquiring the information, being those: (i) open: show all possible answers; (ii) direct: offers directly the desired response; and, (iii) assisted: enables the monitoring and coordination of direct questions to the interviewed.

According to Miguel (2010), the purpose of a detailed interview is not to provide or identify responses only to specific questions, but attempt to understand the

experience of other people. In this case these were important for the knowledge and iteration of the researcher with the object of study. The interviews are important to data collection for a more clearly preparation of tables (FERRER, 2012), which were the base for the completion of the study.

The second step had as main objective the identification of factors that alter the profit of dairy production as investments, inputs, outputs, taxes. The calculation of these values was based on interviews with dairy farmers of São José dos Pinhais, metropolitan region of Curitiba, in Paraná State, Brazil. The choice of this city specifies the easy contact with these professionals.

The interviews were recorded, transcribed and had their content analyzed. For better understanding, visits were carried out in rural properties, where there is production of milk and subsequently analyzed spreadsheets provided by owners. With the data gathered, the tables were organized, with cash flows for each race.

For definition of the number of cows required to achieve financially viable dairy production, were projected monthly cash flows foreach cow (it was a predetermined Minimum Rate of attractiveness of 1% per month), defined the fixed initial investments, dependent on the structure for the milk production, and the variable initial investment, dependent on the number of cows. Thus, it was determined that when the Net Present Value (NPV), which represents the wealth generated by the project. The number of cows required to achieve Net Present Value equals to zero is the minimum required number of cows for financial viability, i.e. the farmers won't lose money with this minimum number. To calculate this value all the equations were programed in MATLAB® and the equation for NPV was solved for number of cows. The next section presents the data treatment.

### **Data Treatment**

The data treatment was performed in order to evaluate the influence of the main parameters on the success of the milk business. To do that, it was specified a range of variation for each of the parameters, then it was possible to simulate a real variation that might occur in reality and the effect of it on the effectiveness of the business. The names, values and range of variation for each of these parameters are listed on Table 1.

**Table 1** - Parameter names, values and range of variation

Parameter	Investments	Dutch Cow	Variation	Jersey Cow	Variation
1	Cow's Price [R\$]	8.000	±10%	6.000	±10%
<b>Cash In</b>					
2	Liters of Milk Produced by 1 Cow in a Day [L]	30	±10%	18	±10%
3	Poorness Factor [#]	0,25	±10%	0,25	±10%
4	Price of 1Liter of Milk [R\$]	1,15	±10%	1,13	±10%
<b>Variable Cash Out</b>					
5	Kg of Ration per Cow a Day [Kg]	10	±10%	3	±10%
6	Price of 1 Kg of Ration [Kg]	0,95	±10%	0,95	±10%
<b>Fixed Cash Out</b>					
7	Electric Energy [R\$]	700	±10%	700	±10%

Source: prepared by the authors, 2015.

With these parameters a Monte Carlo simulation (CHINNECKET et al., 2006) was performed. Monte Carlo is a full factorial analysis, which analyzes all the available parameter combinations, for each of those combinations it was evaluated the effectiveness of the business using a constant number of cows equals to thirty. When this routine was completed a sensitivity analysis was performed, the goal was to quantify which of the parameters are the most influential on the result.

The range of variation of the parameters was determined through possible variations of these parameters and from the data collected by the interviews. The range of variation was chosen to be constant so the results would only represent the influence of the parameters strength on the result, since parameters with different ranges of variation generates different results.

The main principle of the analysis is to isolate the effect of the variation of a parameter, to do that, an algorithm was developed. It creates a matrix that lists all available combinations of the seven chosen parameters, in this case it was  $3^7$  combinations, since it was evaluated the base value, the value plus the variation and the value minus the variation, the result is, three possible values for each of the 7 parameters. For all those combinations the effectiveness of the business, measured by the NPV, was evaluated.

Afterwards another algorithm that identifies the sets of combinations where the parameter being analyzed is varying and all the others remain constant was made. The routine was performed for each of the combinations of constant parameters, then an average of the results is done, these values are divided by the total variation and the result is a quantification of how influent a parameter is.

After the Sensitivity Analysis the number of cows required in order to achieve success in the business was determined. To do that, the equations were programed in MATLAB® and solved for number of cows (the variable). The results were plotted for the Dutch and Jersey cows.

## Results

The results of the analysis of the data supplied by EMBRAPA (Brazilian agricultural research Company) and interviews with workers in the area, what according to Alves and Silva (1992) is highly used, it takes into account the speech, the context of the interviewee to achieve maximum accuracy. With that, the next section shows the result for the Dutch breed.

### Dutch Breed

The initial investments were measured based on a number of 32,37 cows, which is the exact number that makes the net present value null, or zero. This number was obtained with the goal seek tool of Excel and verified by solving the equations into MATLAB®. In this case, according to Table 2, the total value of the initial investment to enable financially viable milk production from cows of the Dutch breed is \$ 384.962,72.

**Table 2** - Initial investments for the Dutch breed

Description	Values
Value of each cow	R\$ 8.000,00
Number of cows	32,37
Total value of cows	R\$ 258.962,72
Milking machine	R\$ 8.000,00
Milk cooler	R\$ 4.000,00
Two gallons of milk collection	R\$ 2.000,00
Plumbing and fittings	R\$ 3.000,00
Barn 100 m2 for milking	R\$ 100.000,00
Rotating pickets and fences system	R\$ 3.5000,00
Troughs for food and salt in field	R\$ 500,00
Deployment of well	R\$ 5.000,00
Total investment	R\$ 384.962,72

Source: prepared by the authors, 2015.

To determine the net cash generation of the production, it is necessary to calculate the inputs of production, which is the revenue from sales of milk. Table 3 illustrates the calculation of the monthly revenue, which for 32 cows was of R\$ 25.127,48.



**Table 3** - Inputs for the Dutch breed

Entries	Values
Liters of milk per cow per day	30 L
Number of cows	32,37
Total liters of milk a day	971,11 L
Poorness factor	0,25
Total liters per day produced	728,33 L
Value per liter	R\$ 1,15
Diary Revenue	R\$ 837,58
Monthly Revenue	R\$ 25.127,48

Source: prepared by the authors, 2015.

The poorness factor, that describes the parcel of milk that is unproductive, was calculated based on the interviews, and is 25%. It depends on the period of gestation and the periods that come before and after it, which affect the milk quality. According to the respondents, it is necessary that the cow has its normal gestation, to improve the quality of milk marketed. Defined the inputs from the cash flow, Table 4 shows the variable outputs from the purchase of rations.

**Table 4** - Output variables for the Dutch breed (ration)

Description	Values
Kg of ration per cow per day	10 kg
Number of cows	32,37
Total of ration	323,70 kg
Value of Kg of ration	R\$ 0,95
Total value of ration per day	R\$ 307,51
Total R\$ monthly ration	R\$ 9.225,55

Source: prepared by the authors, 2015.

Cows in its period of high milk production have their diet adjusted. Animals producing over 28-30 kg per day should receive protein of low degradation (bran, flour) (BABU et al., 2002), which justifies the high expense with ration for the Dutch breed. The reference weight of 10 kg of ration per cow per day was provided by EMBRAPA, through the questionnaire sent. The value of kg of ration was defined from the interviews, and the value was compared in surveys conducted in the agricultural region of São José dos Pinhais, Paraná State, Brazil.

Vilela et al. (1996) and Barbosa et al. (2002) state that the feeding of the animals, with high quality and consumption, has great importance to ensure a high milk production. So, it was used the quantity indicated by EMBRAPA. In addition, it is necessary to feed the animal with mineral salt. The outputs related to this are showed in Table 5.

**Table 5** - Output variables for the Dutch race (mineral salt).

Description	Values
Grams of salt per cow per day	30 g
Number of cows	32,37
Total grams of salt per day	971,11 g
Cost Kg of salt	R\$ 10,00
Total cost of salt per day	R\$ 9,71
Total monthly costof salt	R\$ 291,33

Source: prepared by the authors, 2015.

The value of mineral salt necessary for the completion of the animal nutrition was collected in questionnaires sent to EMBRAPA. Therefore, the total cost with mineral salt per month is R\$ 291,33. So, adding the cost on rations and mineral salt, considering 32,37 cows, the total value is around R\$ 9.516,88. There are also fixed costs in nature for the maintenance of the herd, which are shown in Table 6. All values measured in Table 6 were obtained from interviews.

**Table 6** - Fixed Outputs for the Dutch breed.

Description	Values
Energy (rural rate)-lighting, milking machine and pump well	R\$ 700,00
Labor	R\$ 2.500,00
Payroll taxes of the employee	R\$ 1.175,00
Maintenance equipment (2%)	R\$ 340,00
Monthly Inspection Veterinarian	R\$ 750,00
De-worming medication and medicines (0.05% on value of cows)	R\$ 1.294,814
Italian ryegrass	R\$ 162,50
Millet	R\$ 125,00

Source: prepared by the authors, 2015.

The value measured on the payroll taxes of the employees are the employer's social security contributions, including: the National Institute of Social Security, the Guarantee Fund On the Length of Service, Thirteenth Salary (which must be provisioned month by month) and Vacations plus Third of the Vacations (which should also be provided for month by month). Thus, Table 7 illustrates the taxes and their percentages applied to the gross salary of the employee.

**Table 7** - Payroll taxes

INSS	20%
FGTS	8%
13. Salary	8,33%
Vacation + constitutional Third	11,11%

Source: prepared by the authors, 2015.

So, considering the initial investment measured, calculated inputs and outputs, it was projected the cash flow of the project to calculate the NPV of the same, with a period of 60 months or 5 years. The choosing of the period was based on interviews, since the productive period with maximum efficiency and quality of milk is 5 years satisfactory. After this period the cow starts to decrease their production, which affects the revenue generated for the same. So, it is feasible to purchase new cows. Residual values were not considered in the project. Table 8 illustrates the cash flow projection.

**Table 8** - Projected Cash flow for the Dutch breed

Month	0	1	2	...	60
Inputs	0	R\$ 25.127,48	R\$ 25.127,48		R\$ 25.127,48
Outputs	R\$384.962,72	R\$ 16.564,19	R\$ 16.564,19		R\$ 16.564,19
Cash Flow	- R\$ 384.962,72	R\$ 8.563,28	R\$ 8.563,28		R\$ 8.563,28
Discounted		R\$ 8.478,49	R\$ 8.394,55		R\$ 4.713,65

Source: prepared by the authors, 2015.

Table 12 has an NPV equals to 0 and IRR equals MARR, which illustrates that with 32 cows the producer won't lose money on this project. Also, if you choose to use an amount higher than 32 cows, the project will generate cash and, therefore, becomes financially viable. Presented the survey results to the context of the Dutch race, the next section illustrates the results for the Jersey breed.

### Jersey Breed

Following the same methodology than for the Dutch cow, for the Jersey breed are required 42.38 cows so that the net present value is null or equal to zero. Table 9 shows that the total value of the initial investment to enable financially viable milk production from cows of the Jersey breed is of R\$ 380,322.83.

**Table 9** - Investments for the Jersey breed

Description	Values
Value of each cow	R\$ 6.000,00
Number of cows	42,39
Total value of cows	R\$ 254.322,83
Milking machine	R\$ 8.000,00
Milk cooler	R\$ 4.000,00
Two gallons of milk collection	R\$ 2.000,00
Plumbing and fittings	R\$ 3.000,00
Barn 100 m2 for milking	R\$ 100.000,00
Rotating pickets and fences system	R\$ 3.500,00
Troughs for food and salt	R\$ 500,00
Deployment of well	R\$ 5.000,00
Total investment	R\$ 380.322,83

Source: prepared by the authors, 2015.

In summary the investment with race Jersey cows is close to the Dutch-bred cows, with the exception for the cost of the cows, which in the case of Dutch breed is \$ 8.000,00 per animal and for Jersey breed is \$ 6.000,00 per animal, though it is required a larger number of Jersey cows to achieve a financially stable business. Table 10 illustrates the calculation of the monthly inputs of Jersey breed, which with 42 cows was of R\$19.489,77 monthly.

**Table 10** - Inputs for Jersey breed

<b>Entries</b>	<b>Values</b>
Liters of milk per cow per day	18 L
Number of cows	42,38
Total liters of milk a day	762,96 L
Poorness factor	0,25
Total liters per day produced	572,22 L
Value per liter	R\$ 1,13
Diary Revenue	R\$ 649,65
Monthly Revenue	R\$ 19.489,77

Source: prepared by the authors, 2015.

In Table 10 the difference between the races is the quantity of milk produced daily. The Dutch cows produce on average 30 liters and the Jersey cows around 18 liters. Table 11 shows the costs of ration for the Jersey cow.

**Table 11** - Variable outputs for Jersey breed (ration)

<b>Description</b>	<b>Values</b>
Kg of ration per cow per day	3 kg
Number of cows	42,38
Total of ration	127,16 kg
Cost of kg of ration	R\$ 0,95
Total cost of ration per day	R\$ 120,80
Total monthly cost of ration	R\$ 3.624,1

Source: prepared by the authors, 2015.

In the interviews conducted it was found that the daily amount of ration needed for the Jersey cow is lower. In the case of the Dutch cow, 10 kg per cow per day, while in the case of the Jersey cow, are required, as shown in Table 11, 3 kg per cow per day. Table 12 shows the monthly expenses with mineral salt.

**Table 12** - Variable outputs for Jersey breed (mineral salt).

Description	Values
Grams of salt per cow per day	30 g
Number of cows	42,38
Total grams of salt per day	1.271,61 g
Cost of kg of salt	R\$ 10,00
Total cost of salt per day	R\$ 12,71
Monthly cost salt	R\$ 381,48

Source: prepared by the authors, 2015.

Expenses on mineral salt are the same for both breeds. Therefore, the total variable expenses to produce milk from Jersey cows is of R\$ 4.005,58 monthly. Table 13 illustrates the fixed outputs for the Jersey breed.

**Table 13** - Fixed outputs for Jersey breed.

Description	Values
Energy (rural rate)-lighting, milking machine and pump well	R\$ 700,00
Labor	R\$ 2.500,00
Payroll taxes of the employee	R\$ 1.175,00
Maintenance equipment (2%)	R\$ 340,00
Monthly Inspection Veterinarian	R\$ 750,00
De-worming medication and medicines (0.05% on value of cows)	R\$ 1271,61
Italian ryegrass	R\$ 162,50
Millet	R\$ 125,00

Source: prepared by the authors, 2015.

The fixed outputs for the two races are similar, what differs is the cost on de-wormers and medicines, because the value is 0.05% on the price of cows. Since the Dutch race is more expensive, the average spending in this case is of R\$ 805,83 and with the Jersey breed is R\$ 616,37. Table 14 illustrates the cash flow for the Jersey breed.

**Table 14** - Projected cash flow for the Jersey breed.

Month	0	1	2	...	60
Inputs	0	R\$ 19.489,77	R\$ 19.489,77		R\$ 19.489,77
Outputs	R\$ 380.322,83	R\$ 11.029,70	R\$ 11.029,70		R\$ 11.029,70
Cash Flow	-R\$ 380.322,83	R\$ 8.460,07	R\$ 8.460,07		R\$ 8.460,07
Discounted	R\$ 8.376,30	R\$ 8.293,37	R\$ 8.211,26		R\$ 4.656,84

Source: prepared by the authors, 2015.

The cash flow shown in Table 14 is for 42 Jersey cows, it was calculated for null NPV and IRR equals MARR, if the producer chooses to produce milk with this

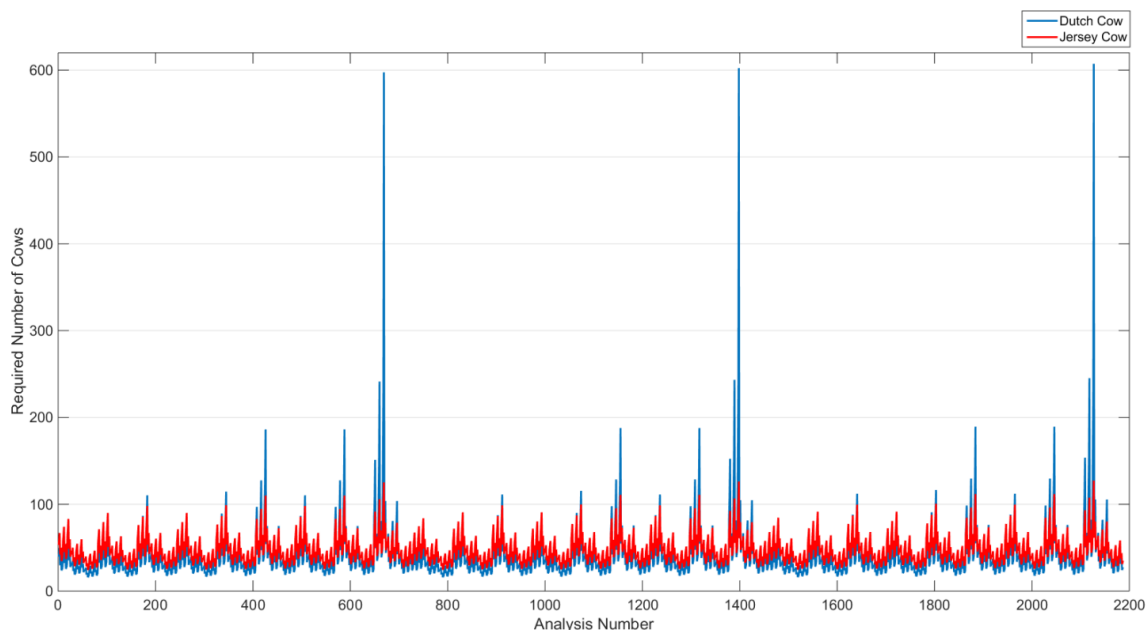
amount of cows, he won't lose or make money. If he chooses a higher amount, it will add value to the project.

### Numerical Analysis Results

The needed number of cows for each of the combinations was calculated and the results are shown in Figure 1. The horizontal axis refers to each of the analysis run with a set of combinations.

It is possible to see that, in the majority, the required number of Dutch cows (in blue) is lower than the number of Jersey cows (in red) for similar conditions, but in certain combinations of parameters the number is much higher. These peaks represent the worst case scenarios for the analysis, where the costs are the highest and the income is the lowest. Since the values of the costs are higher for the Dutch cow than for the Jersey cows, the outcome of the variation is a much higher number of cows needed in those cases.

The solution, number of required cows, showed to be really sensitive to the price of milk, a small variation of this quantity causes a big deviation of the solution. The analysis done with the Jersey cow proved to be more numerically stable than for the Dutch cow, this is a result of the values and range of variation of the parameters used. The average number of cows is 40.1196 and 46.4195 for the Dutch and Jersey cows respectively.

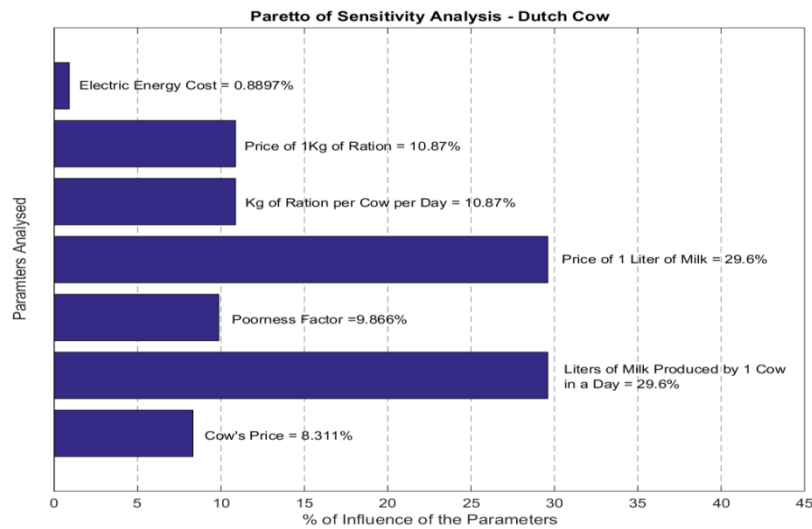


**Figure 1** - Number of cows needed vs. combination number  
Source: prepared by the authors, 2015.

The sensitivity analysis results are shown in Figure 2 and in Figure 3. Some of the parameters have the exact same value of influence on the result. This is explained by the fact that they are multiplied linearly in the equations used to evaluate the success of the business, so the influence must be the same. The Price of a Liter of Milk

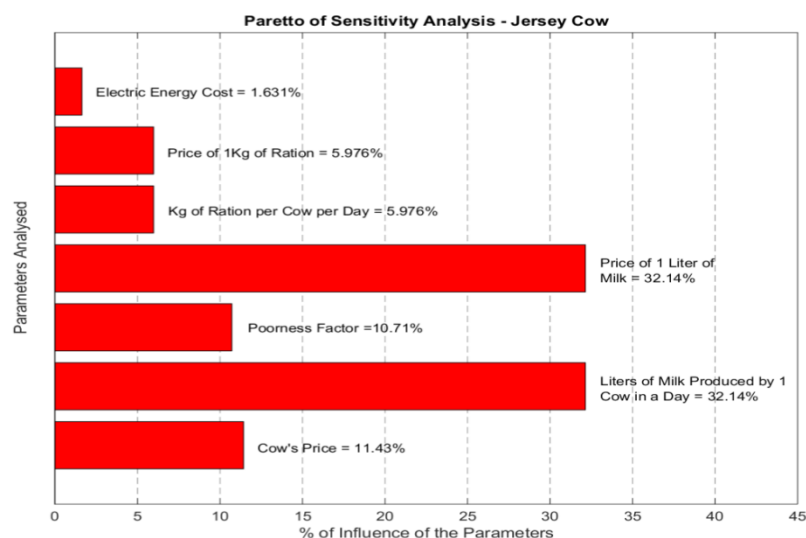
has the same influence than the Liters of Milk Produced per Cow per Day and they are the most influential parameters for both cows.

The parameters related to the ration (price and quantity) influence more the Dutch than the Jersey cows, this is explained by the difference of ration per day that each cow consumes, the Dutch cows eat much more ration than the Jersey ones, due to that, the effect on cost is higher.



**Figure 2** - Sensitivity analysis results for Dutch cow  
Source: prepared by the authors, 2015.

The cost of each cow is more influential in the case of Jersey cows than for the Dutch cows, the explanation comes from the fact that are needed more Jersey cows than Dutch to have profit in the business. Because of it, a positive variation on the price of each cow is more significant when it affects a large number of cows than a small number of them.



**Figure 3** - Sensitivity analysis results for Jersey cow  
Source: prepared by the authors, 2015.

The parameters related to the price and quantity of milk produced are the most important in the outcome of the business for both cows since they affect directly in the income.

## Conclusion

The work had the objective of identifying how many cows of the Dutch and Jersey breeds are necessary to ensure that a milk producer obtains profit from his production, taking into account all the investment, inputs, outputs with each of the races and also taxes imposed on payroll.

The cash flows and the NPV were calculated. Considering a deterministic scenario, where there are various parameters, such as, the selling price of a liter of milk, that have variations determined by the market, and depends on the supply-demand relationship, the number of cows necessary to gain profit varies, so it is needed to account for those variations.

After calculated for each of combinations of values of parameters, the answer, minimum number of required cows to achieve profit, can be understood as a border line value. When a producer has the number of cows lower than that number he will lose money and above this number he will obtain profit.

The impact analysis, carried out through Monte Carlo simulation and Sensitivity Analysis, showed that the two parameters that affect more the outcome of the NPV are the selling price of the milk and the amount of liters of milk produced per cow per day. Thus, one can see that, considering a probabilistic scenario, the biggest influence on the calculation of NPV is due to the monthly revenue generated.

From this sensitivity analysis pareto one must identify the parameters that can be controlled by the producer, these must be optimized while the ones that cannot be controlled must be watched carefully to build scenarios in a way that the producer knows the outcome of their variation. Parameters related to price (such as Electric energy cost, price of the cows, price of milk, price of ration) cannot be controlled, but liters of milk produced by each cow and the poorness factor can be controlled by buying cows with certified genetics and capacity to deliver a good production, or by studying environmental aspects that influence the milk production.

This research was limited to analyzing Jersey and Dutch breeds, both in the context of the city of São José dos Pinhais/PR. A suggestion for future research is to analyze other breeds that allow data comparison. Still, it is suggested that the same analysis is performed in other regions of the country, showing the rural investor which is the best place for milk production.

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