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APPLYING THE PDCA CYCLE FOR CONTINUOUS IMPROVEMENT IN A BOVINE CONFINEMENT SYSTEM: A CASE STUDY

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ABSTRACT

This work aims to describe a project proposal using the PDCA cycle as a driving force for the process of continuous improvement in a bovine confinement system. This is an applied research, operationalized by the case study method, using a rural property in the south of the State of Rio Grande do Sul as unit of analysis. We applied PDCA cycle as an intervention instrument. The main results of the research were the diagnosis of the problems of the confinement process, through the Ishikawa diagram, as well as suggestions to promote the improvement of the quality of the confinement process, taking as reference the indicators from the application of the 5W2H and SEFTI techniques.

Keywords: Quality Management; Confinement Systems; PDCA cycle; Livestock.

1. INTRODUCTION

Tight competition for consumer markets has led many companies to re-evaluate their operations. In the search for the identification of more adequate methods to elaborate products or services, those now needs to map processes and to determine their management tools. It is no different in livestock farming, the rural property, as also a company, needs to transform raw materials into products that meet its consumer market requirements.

According to the Ministry of Agriculture, Livestock and Supply (2014), cattle breeding is one of the highlights of Brazilian agribusiness on the world stage. Brazil has the second largest effective herd in the world. In addition, the country has taken the lead in exports since 2004. Cattle raising is one of the main economic activities of the Rio Grande do Sul state. Thus, the maintenance of the native pasture field becomes a relevant subject, because it is the raw material essential for sustaining the activity.

Brazilian livestock farming is based on extractivism historically-culturally. This practice makes use of the native field for animal fattening, without nutritional complement to cattle. In extractivism, relevant aspects such as adequate dimensioning of herd to the field type, nutritional supplementation, use of confinement system and picketing are excluded. In addition, the necessary rationalization of space to minimize soil and pasture damage is neglected (Silveira et al., 2008).

Given this context, this article aims to describe the proposal to apply the PDCA cycle as a driving force for the process of continuous improvement in a bovine confinement system of a rural property located in the south of the state of Rio Grande do Sul.

To this end, this work is structured in five sections. After this introductory part, section 2 presents the theoretical framework. Section 3 describes the methodology used in the

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research. Section 4 details the case study and, finally, section 5 discusses the final considerations, limitations of the research and suggestions for future studies.

2. 2. THEORETICAL REFERENCE

This section discusses the theoretical basis for the study. In this sense, we discuss the methods for rationalization of pasture, its quality and perspective in the scope of the services, as well as some of its main tools.

2.1 Methods for rationalizing pastures

Specialized literature classifies the methods for rationalization of pastures as continuous grazing, rotational grazing and deferred grazing.

Continuous grazing

According to Moraes (1995), this method consists in using a specific pasture site for a year or even several years. Its variations refer to fixed or variable stocking. The practices adopted to increase efficiency and to promote greater performance of the animal are the following: adjustment of the number of animals to the pasture capacity; Use of the indicated category of animal for each type of pasture and season; construction of fences and provision of water, salt and shade; and use of forage and/or supplementary pastures (Garcez Neto et Nascimento Júnior, 2001). These are its disadvantages: selectivity of species and areas; Irregular excrement distribution (transfer of fertility) and increase of invasive species in the soil.

Rotational grazing

This method is characterized by the periodic and frequent change of the animals from one picket to another in cycle. The animals graze uniformly in the area and, when they leave, the pasture presents the same height, favoring fast and vigorous regrowth (Oliveira et Faria, 2006). Grazing is limited to two or more alternate areas for better utilization of fodder production. The grazing period is variable, from 30 to 7 days or according to the growth of the plants of the next sector.

This system hinders the appearance of invasive plants, thus allowing the use of fodder produced in the rainy season as hay. The number of subdivisions of the area must be carefully calculated to avoid becoming uneconomical and to provide return on investment in fences, drinking fountains and fertilizers (Oliveira et al., 2006).

Deferred grazing

It consists of sealing of aerial part of the pasture, during the period of growth, to reinvigorate it and allow the accumulation of fodder in the field, used during the winter. Some authors consider it a rotational grazing alternative. After the recovery time of the plant and the production of green mass after the last grazing period, the new pasture directly influences the development of the animal and the weight gain, and this method is therefore important in the nutritional control of the animals (Oliveira et al. Faria, 2006).

2.2 Quality

The relevance of Quality Management for rural properties is also evident, since it ensures good-quality and adequate raw material to the needs of the agroindustry in order to contribute to the reduction of losses. Campos (1999) defines a quality product or service as one that perfectly meets, reliably, affordably, safely and timely the customer's needs.

According to Juran (1991), management for quality uses administrative processes of planning, control and improvement. Quality planning is about developing products that meet customer needs. The control assists in meeting the objectives of the process and the product, and, finally, the improvement aims at achieving significantly better levels of performance.

2.3 Services quality

The service differs from the industrial product because it is intangible, making it impossible to store and inspect. It involves relationships between people, which makes its quality generally subjective (Martins et Laugeni, 2005). Paladini et al. (2012) identify the following as some of the main characteristics of services: intangibility; heterogeneity; Non-storable work; Need for customer participation; Simultaneity and quality.

2.4 Quality tools

Of the possibilities of quality tools that can be used in the context described in this paper, the SPC, 5S, PDCA, MASP, 5W2H, The Ishikawa Diagram and the Pareto Chart stand out due to their robustness and their low level of application complexity.

SPC

The Statistical Process Control (SPC) aims to check the product or service during its creation. If there is any problem

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in the process, it is disrupted and problems are identified and rectified. The tool provides control graphs to check whether the process develops adequately or whether there is a deviation from the standard in order to make corrections before problems occur (Slack et al., 2009).

The SPC involves techniques of analysis of changes in the production process, determining their nature and the frequency they occur. We perform this analysis by measuring fundamental variables, by the number of defects per piece or by the number of defective pieces per sample (Paladini et al., 2012).

Its main mechanisms are variable control graphs - mean, central tendency of the process, amplitude and deviation - and the control graphs by attributes - graphs p (defective fractions), np (quantity of defective parts in samples), u (quantity of defects per unit of product) and c (number of defects per sample).

5S

According to Campos (1999), the 5S program is a way to lead the company with effective productivity gains. The acronym 5S is derived from the Japanese words: SEIRI, SEITON, SEISOH, SEIKETSU and SHITSUKE, translated, respectively, as: tidiness, organizing, cleaning, organization and self-discipline. It applies to all people in the company, from the president to the operators: to the areas of administration, service, maintenance and manufacturing, and should be led by top management.

PDCA

According to Campos (1999), the PDCA cycle consists of: Plan, Do, Check and Act.

For Tubino (2010), the planning stage establishes target objectives, targets on control items and methods for achieving them. The second step is the execution of standard procedures and starts by training the people who will perform the work. This is followed by the execution of the work and the data collection (Tubino, 2010). The verification step consists in comparing the results obtained with the planned goal (Campos, 1999) from the data collected. Corrective action aims to eliminate the problem in two moments: acting on the result of the problem, putting the process back into operation and acting on the causes of the problem, in order to avoid its repetition (Tubino, 2010).

The PDCA cycle, shown in Figure 1 below, can be applied to a variety of organizational configurations. One of its premise on the scope and maintenance of process improvement. According to Tubino (2010), every time a problem is identified and solved, the production system moves to the upper level of quality, that is, problems are seen as opportunities to improve the process.

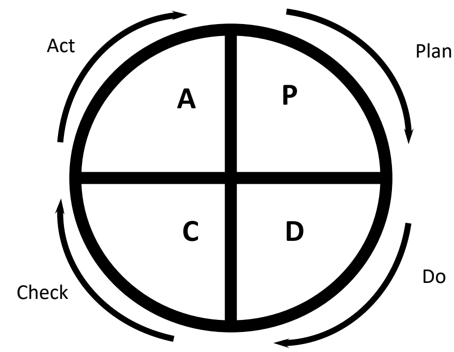

Figure 1. PDCA Cycle.
Source: Based on study by Campos (1999)

MASPa

The method of analysis and solution of problems (MASP), shown in table 1 below, is fundamental for quality control. This is the application of the PDCA cycle for improvements (Campos, 1999). The use of MASP ensures a logical and structured approach to solving problems, addressing them through a stepwise process in which we can analyze the causes of the problem and optimize the solution time, planning activities, monitoring performance, results evaluation and decision making processes.

Table 1. MASP Method

PDCA	FLOW	STAGE	GOAL
	1	Problem identification	Clearly defining the problem and understanding its importance.
P	2	Observation	Investigating specific characteristics of the problem.
	3	Analysis	Discovering basic causes.
	4	Action Plan	Conceiving plan to block basic causes.
D	5	Action/Execution	Blocking basic causes.
C	6	Check	Checking if the block was effective, if not, return to step 2
A	7	Standardization	Preventing against recurrence of the problem.
	8	Conclusion	Recording the entire process of solving the problem for the future.

Source: Based on study by Campos (1994)

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5W1H and 5W2H

Silva et Souza (2014) describe this technique as a document that points out priority actions through questioning. It consists of equating the problem describing it in the following aspects: what will be done (steps); how it will be done (methods); why it should be done (justification); where each step will be performed (site/place); when the task will be executed (time); who will perform the task (responsibility); and how much each task (cost) will cost.

Ishikawa diagram

Also known as fishbone or cause-effect diagram, this intends to analyze the operations of the processes. Its structure is similar to a fishbone, where the main axis shows the basic flow of information and the spines, which converge to the axis, represent secondary contributions of the process. This diagram illustrates the main causes of an action, an outcome or a situation, for which minor causes are addressed, allowing the visualization of the relationship between causes and their effects (Paladini et al., 2012). It is possible to group the causes and the subcauses, dividing them, generally, as follows: machine, method, labor, raw material, environment and measurement (Silva et Souza, 2014).

Pareto Diagram

According to Paladini et al. (2012), this diagram is used to classify causes that act in the process with greater or less intensity and in different levels of importance. The diagram suggests that there are critical elements that should receive analysis priority. Thus, there may be two types of graphs: the 'phenomenon', which seeks the cause of the problem, and the 'causes', which points out the main causes of the problem, identifying whether they are vital or trivial (Cardoso et al., 2014).

SEFTI

As Campos (1999) points out, the SEFTI technique is a prioritization tool used in decision making. It allows prioritizing problems through an individual analysis, according to the following aspects:

- **S**afety evaluates the safety compromise, the risks involved in the problem;
- **E**mergency evaluates the urgency of solving the problem;
- (F) Ease evaluates the ease of execution of the problem;
- **T**rend evaluates the trend of aggravation of the problem;
- **I**nvestment: Evaluates the level of investment involved.

Using this evaluation, we can cover a wide range of considerations that will allow a greater reliability in the decision process.

3. METHODOLOGY

The methodological design of the research follows the classification of Roesch (2012) regarding the purpose, method, collection technique and analysis technique. Table 2 presents this classification.

Regarding its purpose, this can be classified as an applied research study which, according to Roesch (2012), aims to generate potential solutions to problems.

As for the method, this qualifies as a case study, a research strategy that examines contemporary phenomena within its context, suitable for the study of processes and the exploration of phenomena at various angles (Roesch, 2012).

In this sense, the unit of analysis of this work is characterized as a small rural property in the southern part of the state of Rio Grande do Sul. The property is family owned, approximately 100 hectares, and 80 of these are dedicated to the activity of confined grazing for cattle breeding and maintenance.

For the data collection, we used in loco and documentary observation, in order to study the process of application of the PDCA cycle and extract information necessary for the development of the research.

Data analysis was predominantly qualitative. We elaborated the Ishikawa diagram, the 5W2H and the SEFTI for the study situation based on the information collected.

4. CASE STUDY

This section details the case study. It describes the process of using quality tools based on the sequence of the PDCA cycle, from the identification of the problem and its possible causes and the construction of the plan for solution to the control of the activities to solve the problem.

The problem identified was low productivity in the confinement activity. In the first stage of the PDCA cycle we used the Ishikawa Diagram which, in turn, were classified in cau-

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Table 2. Methodological classification of the research

Project purposes	Method	Collection technique	Analysis Technique
Applied research (Generate potential solutions to human problems) Results Evaluation (Judging the effectiveness of a plan or program) Formative Evaluation (Improve a program or plan, track its implementation) Research-Diagnosis (Explore the organizational and market environment, raise and define problems.) Proposing Plans (Present solutions to problems already diagnosed)	QUANTITATIVE RESEARCH		
	-Experiment field. -Descriptive search -Exploratory research	-Interviews -Questionaries -Observation -Tests -Indices and written reports	- Statistical methods (frequency, correlation, association ...)
	QUALITATIVE RESEARCH		
	-**Case study** -Action research -Perspective research	-Interviews in depth -Use of journals - Participant observation - Group Interviews -**Documents** -Projective techniques -Life stories	-**Content Analysis** -Construction of theory (Grounded theory) -Review analysis

Source: Roesch (2012)

ses and subcauses, obtaining, then, the visualization of the relation between causes and effects, as shown in figure 2 below.

Based on this tool, 5 possible causes of low productivity were identified, divided into 9 subcauses and 22 influential variables as follows:

4.1. Nutritional Management Cause

Forage

(1) Quality: related to forages available to animals, to plantations or to native pasture, with pasture rotation being a basic aspect in this item.

(2) Availability: ideal quantity of animals per hectare for better use of the field.

Rations

(3) Individual needs: availability of daily ration to each animal to achieve the expected yield defined by the responsible manager or veterinarian.

4.2. Genetic Cause

Races

(4) Angus: better indicated for confinement, presents fast gain of weight and better utilization of the diet. Its downside is the high cost.

(5) Jersey: destined to dairies, confined by the ease of sale, takes advantage on the confinement and quickly gets to the selling weight.

(6) Undefined: from crossbreeding, its advantage is the low purchase cost, good use of confinement and sold for slaughter.

Improvement Program

(7) Herd quality: aims at a homogeneous herd, acquiring animals with lower nutritional need, fast dietary utilization and better carcass yield.

(8) Selection and disposal: related to buying at the right time for the right price, and dispose of animals below the desired standard.

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4.3. Sanitary Management Cause

Disease Prevention

(9) Brucellosis: infectious disease caused by bacteria; Creates health problems and economic losses. It is acquired through ingestion of contaminated food and water.

(10) Verminose: an illness that causes economic losses as a decrease in meat and milk yield. The young animal is more harmed. Deferred grazing reduces this risk.

(11) Hydrophobia: transmitted by carrier bats. The affected bovine presented hypersensitivity to external factors, occurring death from 4 to 8 days after symptoms.

(12) Foot-and-mouth disease: viral disease, highly contagious, mainly affecting bipartite hull animals. It can manifest at any age, and the first symptoms involve fever and decreased appetite. Growth, fattening and milk production are undermined.

4.4 Climatic Condition Cause

Temperature

(13) Shed ventilation: efficient in order to reduce heat, which causes stress and reduces appetite and leads to lower yield.

(14) Excessive temperatures: availability of abundant water and shelter from the sun in confinement space and pickets.

Rain

(15) Maximum value: excess rainfall causes flooding in the field, reducing usable forage, to be supplied by feed or purchased forage.

(16) Minimum value: lack of rainfall causes poor-quality forage, being necessary to adopt measures equal to the previous variable.

4.5 Economic Aspect Cause

Prices

(17) Meat: identify appropriate time for slaughter to plan the process.

(18) Animals: the purchase price of animals to be confined and the selling price of animals not slaughtered.

(19) Production Cost: medicine, feed, pasture plantation, fertilization, among others.

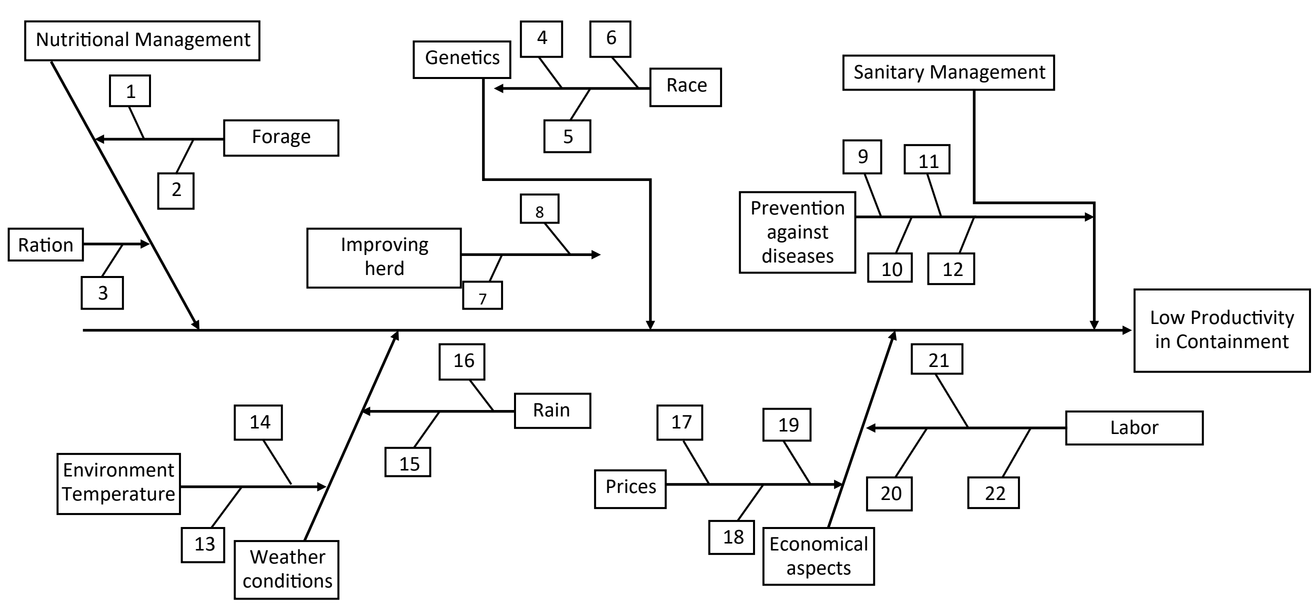

Figure 2. Ishikawa diagram for the problem of low productivity in bovine confinement

Source: Authors' study

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Labor

(20) Remuneration: must be motivating, increasing satisfaction and avoiding turnovers.

(21) Training: planning investment in training or training, improving processes and minimizing errors.

(22) Motivation: to offer participation in results to increase dedication to the process.

In the second stage of the PDCA, to elaborate the action plan, we grouped the variables identifying them by their main cause and using the 5W2H tool, according to Table 3 as follows.

Regarding the Nutritional Management cause, each type of animal has minimal nutritional requirement to guarantee its performance, aspects that must be considered in the planning. As for Genetics is improvement, aiming homogenous herd for better use and profitability of the animals. Regarding Sanitary Management, the focus prioritizes disease prevention, preventing weight loss or death of animals. On Climatic Conditions, it is necessary to invest in the infrastructure to protect the herd from the weather. Regarding the Economic Aspects, two points should be analyzed: market prices and labor.

In the third stage of the PDCA (verification), the SEFTI tool was used to analyze the priority of corrective actions. The prioritization tools were used in decision making processes, analyzing the following aspects: Safety, the danger that involves the problem; Problem solving emergency; Ease of execution of actions; Tendency of aggravation of the problem; And Investment involved.

To use this tool, we assigned a grade from 1 to 5 to each alternative, according to the criteria. Subsequently, we multiplied the grades for each action and the resulting product (S x E x F x T x I) was recorded in the total column. The higher the result, the higher the execution priority of the activity. This process is shown in Table 4.

In the Safety criterion, the highest score action, "Preventing diseases", implies a greater risk to animals; The actions "Identify individual nutritional needs" and "Protect the herd from bad weather" obtained a medium score, thus not representing such imminent risk; They obtained a minimum score for the actions "Improvement of the herd", "Minimizing costs" and "Motivate the employee", since they do not represent risk to the herd.

As for the emergency, the most marked were the actions "Identify individual nutritional needs" and "Prevent diseases", aspects to be addressed immediately.

In the Facilitation evaluation, the "Motivate the employee" action received the highest score, considered the easiest one to perform, while the others received average scores, because they are more complex.

Table 3. Action plan with 5W2H

Control items	What?	Where?	When?	Who?	Why?	How?	How much?
Nutritional Management	Identify individual need	Project	Before the start of the process	Manager and vet	Avoid food shortage	Plan confinement	Up to R$ 500,00
Genetics	Improve herd	Supply	During the renovation of field	Manager	Better yield and homogenous herd rearing	Race selection Develop efficient selection and disposal program	Up to R$ 15
Sanitary management	Prevent disease	Property	Feed forage Ration Infrastructure Up to R $ 10 thousand	Foreman	Avoiding death and waste	Vaccinate cattle Dock picketing	Up to R$ 1 thousand
Climatic conditions	Protect herd from weather	Property	Certain seasons	Manager or vet	Avoiding weight loss	Include Feed forage Ration Infrastructure Up to R $ 10 thousand	Up to R$ 10 thousand
Economic aspects	Minimize costs Increasing motivation	Property	Always	Manager	Greater profitability Avoiding employee turnover	Buy and sell well Profit Sharing	% results

Source: Authors' study

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Table 4. SEFTI tool to check priorities

Nr	Action Description	S	E	F	T	I	TOTAL
1	Identify individual nutritional needs (Nutrition Management)	3	5	3	3	3	405
2	Herd Breeding (Genetics)	1	3	3	1	1	9
3	Prevent diseases (Sanitary Management)	5	5	3	5	3	1125
4	Protect the herd from weather (Climatic Conditions)	3	3	3	3	1	81
5	Minimize costs (Economic Aspects)	1	3	3	3	5	135
6	Motivate the worker (Economic Aspects)	1	3	5	1	3	45

Critérios/ Pontuação	1	3	5
S (Safety)	The problem does not imply any life risk for animals	The problem implies some risk of life for the animals	The problem implies serious life risks to the animals
E (Emergency)	The solution can wait for the time needed. There is no rush.	The solution should be performed as fast as possible	Immediate action is required to solve the problem
F (Facilitation)	The problem is very difficult to solve	There is some difficulty in solving the problem	The problem is very easy to solve
T (Trend)	The problem will not get worse or even tend to improve	The problem tends to worsen in the medium term	The problem tends to worsen quickly.
I (Investment)	It takes more than $ 1,000 to solve the problem	It takes up to R $ 1,000 to solve the problem	No investment needed to solve the problem

Source: Authors' study

In the Tendency foundation, the most marked action was "Preventing diseases", because its negligence affects the herd in a negative way; "Identify individual nutritional needs", "Protect herd from weather" and "Minimize costs" and low scores at "Herd improvement" and "Motivate employee", which, if not performed, do not worsen the problem.

The Investment criterion provided a maximum score for the "Minimize Costs" action, which least requires investments; Actions with average scores were: "Identify individual nutritional needs", "Prevent diseases" and "Motivate the employee", implying higher costs; actions that presented the lowest score and that need more investment were "Improvement of the herd", since raising the standard of the herd implies acquiring more expensive animals, and "Protect the herd from weather', due to the investment in infrastructure.

In this way, we defined the order of priority of the actions, as shown in Table 5:

In the last step of the PDCA (Correction), the tool 5W2H, previously illustrated in Table 3, was used, analyzing the last column, which describes the variable How much does it cost? (How Much), which demonstrates the level of investment or the cost of each action.

Table 5. Action priority

Nr	Action description	TOTAL
1st	Prevent diseases (Sanitary Management)	1125
2º	Identify individual nutritional needs (Nutrition Management)	405
3º	Minimize costs (Economic Aspects)	135
4º	Protect the herd of weather (Climatic Conditions)	81
5º	Motivate the employee (Economic Aspects)	45
6º	Herd Breeding (Genetics)	9

Source: Authors' study

The value assigned to the action "Identify individual needs" refers to the veterinary consulting carried out in the planning, its absence will imply in higher future costs; the action "Improvement of the herd" presents the largest independent investment of the phase that occurs, referring to the purchase of superior animals; To the action "Preventing diseases" is assigned value referring to medicines to prevent or treat diseases and costs with veterinarians; The action "Protect the herd from weather", with high cost, due to investments in infrastructure; Finally, the actions "Economic aspects" represent a lower apparent cost, since they aim to minimize expenses.

5. FINAL CONSIDERATIONS

The goal of this article was to demonstrate the application of the PDCA cycle to the confinement system, as well as

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its usefulness for solving problems and continuous improvement in the property under study.

For this, the literature review addressed the methods for rationalization of pasture, quality and its perspective in the scope of services. In addition, its main tools have been contextualized.

As for the methodological procedures, we conducted an applied research using the case study method. The approach, predominantly qualitative, made use of in situ and documentary observation.

In relation to the case study, when applying the PDCA cycle, the main problem was identified the low productivity of the confinement system. At the beginning of the PDCA cycle, 5 possible causes of low productivity were identified, divided into 9 subcauses and 22 influential variables, from the application of the Ishikawa diagram. In the second stage of the cycle, the 22 variables with their causes were related by the application of the 5W2H method. In relation to the third stage of the PDCA cycle, the SEFTI method was used to establish priorities among corrective actions. In the last step of the cycle, the 5W2H method was applied again, thus verifying the cost of each corrective action identified.

In relation to the case study, when applying the PDCA cycle, the main problem identified was the low productivity of the confinement system. At the beginning of the PDCA cycle, we identified 5 possible causes of low productivity, divided into 9 subcauses and 22 influential variables, from the application of the Ishikawa diagram. In the second stage of the cycle, we listed the 22 variables with their causes through the application of the 5W2H method. In relation to the third stage of the PDCA cycle, the SEFTI method was used to establish priorities among corrective actions. In the last step we applied the 5W2H method again, thus verifying the cost of each corrective action identified.

The research presented as limitations the restriction of the sample, being executed in specific property with own characteristics, like size and location, as well as the use of limited number of Quality tools in the elaboration of the PDCA cycle.

For future work, we suggest a new study in properties of different sizes, with a greater number of processes and in other locations, with other market realities, helping in the continuous improvement in the agricultural sector.

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