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# A review of three important points that can improve the beef cattle productivity in Brazil

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## Abstract

The production of beef cattle in Brazil already presents high numbers, with a total of 1.53 million tons of beef cattle products exported, resulting in about US$6.28 billion. However, this chain still has opportunities to grow, adopting few attitudes. The main production of beef cattle in the country occurs in pastures systems without the use of technology. Then, there are direct and indirect tools that can be used to increase the efficiency of the beef cattle production in the country. An important direct tool involves the pasture management, with the use of fertilization and the observation of the stocking rate during the year seasons. These conductions allow that forage has adequate nutritional value, which results in better animal performance. However, only the adoption of these actions is not enough to provide the maximum economic results of a farm. Therefore, the introduction of a strict management and the adoption of computational analysis to support the management decisions can be essential to direct the farms to increase the productive indexes. Among many computational supports, the artificial neural network is being used to predict agribusiness information due to the possibility to model the complex relations of biologic process. With the predictions of animal or plant performances is possible to direct the management decisions inside the farm. In addition, due to the vulnerability of the extensive system, a strict farm management is important to maintain the farm active on the beef cattle chain, once the economic responses are associated to the way that farmer executes administrative, technical, financial, commercial, accounting and security aspects. Therefore, due to the importance of these three points of the beef cattle chain, studies in these directions should be stimulated in the country and can bring changes for production system along the years.

## Introduction

The production of Brazilian beef cattle is among the highest in the world. Brazil has around 226 million of animals, which result in 9.5 million tons of carcass weight yearly [1]. These values are responsible to keep positive the gross domestic product in Brazil. The mainly Brazilian product for exportation is *in natura* or fresh beef. During the year of 2017, Brazil exported close to 1.21 million tons of fresh meat [2]. The total of beef cattle products exported by Brazil is close to 1.53 million tons what resulted in about US$6.28 billion.

If considered that the main production of beef cattle in the country occurs in pastures systems [3], without the use of technology, its possible to say that Brazilian beef production has a great potential to improve. However, for this improvement, a lot of changes are necessary, mainly about the acceptability of technologies by the farmers. This low acceptability can causes reduction in productivity and consequently less profitability inside livestock farm. A lot of technologies are available to be introduced in farms. There are direct and indirect tools that can be used to increase the efficiency of the beef cattle production in the country. Some of the important direct tools involve the pasture management (as fertilization and use of best forage species), supplementation, cattle breeding and genetics improvements, while some of the indirect tools involve the introduction of a strict management and the adoption of computational support.

Few producers have changed their concepts about the use of technologies and altered the husbandry standard. These changes are known as "husbandry of precision", associated with upgrading of management system of animal production using pastures [4]. One of these changes is the implementation of pasture management, which allows that forage has adequate nutritional value and produce higher feed quantity, resulting in higher animal performance, when considered a right stocking rate during the year seasons [5]. The use of technologies (fertilization, stocking rate adjusts, and supplementation) could to avoid losses in gain of close to 200 g $day^{-1}$ [6]. Considering that the main specie cropped into Brazilian tropical ecosystem pastures is *Brachiaria brizantha* cv. Marandu [7], the use of nitrogen fertilization and supplementation is necessary to keep animal performance during the wet and dry seasons.

Another change in farm that can increase the beef production is the implementation of the computational analyses as the use of some artificial intelligence [8,9]. The artificial intelligence is an innovative technology that could help producers in many management decisions. The use of different artificial intelligence methods (artificial neural network -ANN, fuzzy logic) allows predicting biological information with a big dataset [10]. However, into the pasture system occurs vulnerability, basically due to management and technic limitations [11], so, just to predict results will not improve the productive indexes [12]. There are a lot of management decisions about livestock, plants and soil that could change the agricultural ecosystem [13]. Indeed, the economic responses are associated to the way that farmer executes administrative, technical, financial, commercial, accounting and security aspects [14].

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## Brazilian beef cattle production using tropical pastures

The Brazil is a continental country with different kinds of weather and pastures. However, most part of the territory situates in a tropical weather. The Brazilian beef cattle production has a tripod to sustain productivity and indexes, which is compounded by Cerrado-Nellore-*Brachiaria* [15]. If considered that Cerrado biome is concentrated in tropical zones, so, the main cultivated specie to use in beef cattle production is *Brachiaria brizantha* cv. Marandu, which presented close 70% of the seeds sold during 90's year [16]. The importance of this forage species is due its characteristics (productivity, good nutritional value - if managed correctly) which support around of 90% of Brazilian beef cattle production [17].

The Brazil has close to 163 million ha of pastures, where are kept around 222 million animals, just of bovine herd, which results in a stocking rate close 1.3 AU $ha^{-1}$ (AU is animal unit, equal 450 kg body weight - BW) [2]. These numbers showed that Brazilian beef cattle are improving mainly by the use of technologies. The technologies increased productivity during the last years, wherein at 1997, the productivity was 2.16 @ $ha^{-1}$ $year^{-1}$ (@ is equal 15 kg BW) and at the last year (2017) the same variable reached 4.01 @ $ha^{-1}$ $year^{-1}$ [2]. Even with this increase, Brazil has a lot of opportunities to follow increasing these indexes.

The main Brazilian husbandry is extensive, which characterizes a system without the use of technologies, where animals usually gain weight during wet season and loss weight at dry season caused by seasonality of tropical pastures [18]. The weather in wet season is based in high average temperature, rainy, and high humidity. These conditions are ideal to forage development and, consequently, results in better animal performance. In other hand, dry season has lower average temperature, sparse rainy days and low humidity. This results in low or none forage development, and in extensive system, low animal weight gain, or even animal weight losses.

The pasture management means apply the knowledge when using the forage, with a balance between development of the forage and the intake by animals [19]. Thus, satisfactory animal production is possible when considering the maintenance and sustainability of system production. If considered the seasonality, there is necessity of a lot technology (fertilization, supplementation, and others) to keep the animal production in system that use pastures with main food source. These technologies had been studied for some researchers [18,20-22], which evaluated use of supplements and fertilization into tropical pastures for beef cattle production.

A study that evaluated supplementation effect during post-weaning and its consequences in finishing phase reported that animals fed with supplementation level 0.6% BW and kept in low sward height (15 cm) during post-weaning, obtained average daily gain (ADG) equal 0.66 kg $bull^{-1}$ $day^{-1}$; animals fed with 0.3% BW and kept in medium sward height (25 cm), gained 0.45 kg $bull^{-1}$ $day^{-1}$, and animals fed without supplementation but kept in high sward height, had ADG equal 0.22 kg $bull^{-1}$ $day^{-1}$ [21]. These results determine the supplementation importance and according to the authors no difference was observed from these results.

## Nitrogen fertilization into beef cattle production using pastures

Considering the fertilization for different crops, the forages used to beef cattle production correspond to 1.5% of the total fertilization used in Brazil during the year 2016 [23]. The fertilization practices should be performed during the establishment of pasture and the maintenance [24]. This report mentioned that the main nutrients used into fertilizer practice are nitrogen (N), potassium (K) and phosphorus (P). The use of these main nutrients is because the fertilization in maintenance is not a usual practice in Brazil. The nitrogen fertilization is a punctual technology used into beef cattle production and can improve productivity increasing stocking rate caused mainly by higher mass forage production. However, the fertilization needs to be done considering some important points (nitrogen source, dosage and application) [25].

Whereas that the total area of pastures on Brazil is close to 150 ha millions, being 50% artificial (cultivated), and the total of nitrogen fertilizer used was 520 thousand tons, it is possible to define that the use of nitrogen fertilizer per area is 3.46 kg $ha^{-1}$ in total area and in cultivated areas this use is close 7.0 kg $ha^{-1}$ [23]. In this way, it is possible to conclude that the nitrogen to fertilize pastures used in systems of beef cattle production is low. Therefore, the efficiency using this nutrient needs to be high to make possible to improve animal productivity. However, some studies had showed that the efficiency using nitrogen to fertilize pastures is low [20,26,27]. The nitrogen losses increase with the increase on level of nitrogen fertilization, and this fact should be noted during the process of fertilization of pastures [20].

The intensification of beef cattle production, which can be achieved using nitrogen fertilizer, can change the farm productivity level. A study mentioned the data from other research about productive index according intensification levels in beef cattle chain [24]. The authors showed that a system without technologies obtained an animal production equal to 120 kg $animal^{-1}$ $year^{-1}$ with a stocking rate equal to 0.5 AU $ha^{-1}$, and with the introduction of some intensification in this system, as maintenance fertilizer, the index changed to 180 kg $animal^{-1}$ $year^{-1}$and 1.5 AU $ha^{-1}$, respectively. Increasing the intensification of the system, if an intensive fertilizer is used, the same index could be 221 kg $animal^{-1}$ $year^{-1}$ and 4.5 AU $ha^{-1}$, respectively. This study reinforces the importance of intensification of the system in beef cattle chain.

## Artificial intelligence: neural network

Among different artificial intelligences that can be used, the artificial neural network has been used in agribusiness due to the possibility to model the complex relations of biologic process. The artificial neural network (ANN) model belongs to a powerful class of empirical modeling algorithms that are capable of computing, predicting and classifying data and provide more versatility than regression models [28,29]. The ANN is a computational support that has been used in some business to predict future results [9,30,31]. There are a lot of structures of ANN and one of them is the multilayer perceptron (MLP), which presents the structure that includes input, intermediate (hidden) and output layers.

One of the algorithms of MLP is the backpropagation and this algorithm has been used to estimate forest biomass [32,33] and crop yields, e.g., corn and rice [34]. A data set to be used into ANN analysis needs to be divided into three subsets (training, validation and test set) and this practice is important to prevent overfitting during analysis [35]. Overfitting is a problem caused when the ANN presents high performance in prediction when the neural net is established but presents low performance to predict future responses. This machine learning could be useful in analyzing nonlinear behavior, with the aim of finding casual relationships [35]. In general, the ANN has been used to obtain information from different products in agribusiness. This model can be used to predict the protein fractionation of tropical pastures (*Brachiaria brizantha*) [30], following the methodology [36].

Another study aimed to estimate the corn production and used ANN - MLP composed by tree layers (one input, one hidden and one output), with backpropagation algorithm, and concluded that ANN – MLP was an efficient toll to estimate the productivity of corn grain [37]. The ANN also was used to predicted breeding values to a line of corn with satisfactory results [38]. Similar performance of ANN was reported to cattle when predicted phenotypes of complex traits in dairy cattle [39] and predicted breeding values for marble scores in beef cattle [40].

### Economic evaluation

Every production system needs to be economic viable to be considered by producers of beef cattle. The lack of costs information prevents that the producer knows how much the system is profitable or how variables should be changed to reduce costs and improve this system profitability [41]. In this way, the husbandry needs more studies about economic indexes in the properties to define each condition that can results in more profitability.

Production costs are defined as all monetary expenditure occurred during the production period. The knowledge of these costs allows to control and to organize the farms, aiming the reduce cost, which would result in higher profitability [42]. Therefore, the profitability of beef cattle production is directly related to productive efficiency and costs. However, a lot of farms of beef cattle production are managed with empiric methods, without to know efficiency levels and production costs [43,44]. The Brazilian beef cattle costs are lower than the costs of animal production from other countries. This helps the economic results of farms, but just this is not enough to keep the efficiency in beef cattle farms [45].

A study evaluating different beef cattle systems reported that rearing and finishing phase farms had the main cost represented by animal purchase, and this cost is close 60% of total operating cost [46]. The second higher cost is with the feeding, which represent 20%, when the animals are finished in feedlot system [45]. If thought that finishing phase when developed in grazing uses big quantities of supplement levels between 1.5 and 2.0% BW, so, the costs with fed will be high too.

The increase on intensification systems, caused by some factors as fertilization and animal supplementation, also increase the system complexity and promote changes in costs structure [47]. These changes provide higher risks, which are necessary to improve profitability, but these results are only achieved if the system management is ideal. In this way, a study reported the notion of production function, wherein an increase on input inside some chain will result higher production until a point; after this point, the increase on inputs will not change the production [48]. This idea needs to be studied and implemented in beef cattle production to be possible increase animal indexes until the limit, which probably will result in the best economic responses.

The production function curve can be used to describe an evaluation of millet pasture using five levels of nitrogen fertilizer (0, 100, 200, 450 and 600 kg $ha^{-1}$), which obtained benefit equal US$393.70; US$515.81; US$612.91; US$734.70 and US$653.17 for levels previously mentioned [49]. The results showed that increase the nitrogen fertilizer levels increased benefit until 450 kg $ha^{-1}$ and after this level, the benefits decreased independently of fertilizer level. So, this is an example of the importance of the production function curve previously showed.

Although Brazil presents high numbers of animals raised and meat produced, the beef cattle productivity still has potential to improve with the adoption of few attitudes. Among these attitudes are the inclusion of technologies on field, especially the fertilization, due to the importance of extensive system used in the country; the increase in the practice of data collection to conduct a right management of the properties; and the inclusion of data analyzers, including algorithms that can predict productions and consequently helps to direct the decisions. Therefore, studies in these directions should be stimulated in the country and can bring changes for production system along the years.

## Authorship and contributorship

All the authors made substantive intellectual contributions to the published review.

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## Competing interest

The authors declare that they have no competing interests.

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