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Proposition of New Cost Management Models Applied to Agribusiness

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Abstract — *The conscientious use of information about costs must be a constant practice by entrepreneurs, however, there are countless ways of working with them, determined as a costing method. These costing methods allow a more conscious decision-making, making its users aim to gain competitive advantages. This research demonstrated the importance of costing methods, demystifying and breaking possible paradigms regarding their use by agribusiness, more specifically in agriculture, in the condition of the from inside the gate, which is a peculiar term used in the agribusiness chain to refer to those who is dedicated to planting, handling, harvesting and processing. The applied methodology was the simulation in a case study carried out on a farm located between the state of Sao Paulo and Parana, Brazil, with an area of 380 ha, for the 2019/2020 soybean harvest. The comparison was made between the costing methods by absorption, variable and production effort unit (PEU), where the latter were adapted to a condition of mono production, demonstrating that this is one of the contributions of this work, however, the most important, is that it was possible to identify that this method could be a precursor in the generation of competitive advantages for its users if used systematically, allying with its results the search for the cause and effect in the generation and consumption of resources used in production.*

I. INTRODUCTION

Brazilian agribusiness has a fundamental role in the country's development, being responsible for more than 23% of the Gross Domestic Product (GDP) and 61% of the total exports, showing itself to be the only activity with increasing results during the pandemic scenario, so it must be studied and supported in all aspects (Ministry of Agriculture, 2020). It has proved to be one of the safest and most profitable activities that exist in Brazil, given that the fertile and productive land reaches 388 million hectares; water, as an indispensable resource, is found in abundance; and the climate, has fluctuations that are favorable to several productions, giving Brazil benefits for agribusiness and all its productive chains (Silva et al., 2010).

According to the 2017 Census of Agriculture, there are more than five million agricultural establishments in Brazil, which means that the sector generates more than 20 million jobs, half of them coming directly from the family farming sector. In addition, agribusiness is responsible for the largest contribution of Brazilian GDP, as already described (IBGE, 2017). Callado and Callado (1999), already stated that cost management is one of the most relevant administrative aspects for a sector, however, it reveals that after decades the agribusiness sector still calculates costs in a precarious way, without using a standard or appropriate methodology (Schouchana, 2015).

In the strategic and tactical field, it is necessary to advance the use of techniques already established in other economic sectors, such as cost management, recognized as one of the elements that form competitive advantage. Similar conditions to these, such as a dynamic business environment, high technological development, market segmentation, have driven companies in Kosovo to change cost management to a strategic focus, and have allowed many to start to generate competitive advantage (Berisha, 2017). Nevertheless, it is worth remembering that cost management is an important source for the generation of indicators, which should always be present in the analysis of organizations, assisting in the implementation and improvement processes, identifying goals, controlling processes and verifying results (Müller, 2003).

Chen et al. (2016) had already detected these similarities and decided to carry out a research specifically involving the strategic direction of agribusiness in Taiwan, for this purpose, they interviewed entrepreneurs specialized in agribusiness, and using the concepts defended by Pearce and Robinson regarding the strategic management model, the competitive forces defended by Porter, the growth matrix used by Boston Consulting Group and not least the McKinsey model for business portfolio, came to the conclusion that three dimensions must be observed, namely external, internal and sustainability, where cost management is intrinsic part in the process of generating competitive advantage.

Cost management in agribusiness seeks to be efficient, seeking to maximize the resources that are scarce and reduce production costs (Lizot et al, 2016). Lopes and Santos (2019) evidenced in research with 65 small rural producers in the Ivinhema region in Mato Grosso do Sul, Brazil, that although the vast majority of these producers knew the reality of their costs, none of them applied a formal accounting or registration method of the same. Even more aggravating is the decision-making about planting and agricultural financing, which is done without having as basis the expected production costs.

Nunes and Michelin (2019), in a similar survey, in the state of Rio Grande do Sul, in the region of Encruzilhada do Sul, heard small rural producers associated with a credit cooperative, noting that most of them have a lot of skill in conducting crops, however low knowledge in management and little or no use of management techniques for decision-making.

With these initial surveys, it is possible to affirm that cost management for the sector is fundamental, needing to evolve and be applied on a daily basis. Therefore, knowledge needs to have its status quo modified, so that its users can make conscious decisions, seeking improvements not only in productivity, but also in processes that consume resources and generate costs. Thus, the producer starts to have a clearer view of his business, of the predominant factors, solving bottlenecks, optimizing the use of resources, with the goal of generating competitive advantage, supported by one of the bases of the internal dimension, which is management of costs.

Therefore, these premises justify important questions, and that brought to research, should be studied more appropriately throughout this work, analyzing the advantages and disadvantages of some costing methods, aiming to identify in them the condition of being precursors of generating competitive advantage for agribusiness. This research seeks to demonstrate the importance of costing methods, demystifying and breaking possible paradigms regarding their use, since they will be applied to agribusiness, more specifically in agriculture, in the condition of inside the gate, which is a peculiar term used in the agribusiness chain to refer to those engaged in planting, handling, harvesting and processing. Therefore, it is assumed that costing methods, as allocators of expenses incurred in the production of products and services, are more than a repository, in fact they are sources of information for the analysis of cause and effect in the consumption of resources that have been transformed into expenses, and therefore, in addition to being reduced, they can generate some competitive advantage for its user.

To this end, this work was divided into five sections, the first being a brief contextualization of the agribusiness scenario and the objective of the research, the second a theoretical synthesis of the main costing methods in addition to the advantages and disadvantages of each when applied in agribusiness based on in research published in Brazil and abroad. The third section deals with the methodology used so that the results could be brought in the fourth section, and in the fifth and last section, the research findings are presented in the form of final considerations.

II. COSTS AS A COMPETITIVE ADVANTAGE

For the elaboration of this section, articles, dissertations, theses and books were consulted that could support the research questions, seeking to understand the logic and applicability of costing methods as allocators of expenses to the products and services generated, since the leadership in cost was defended by Porter (1985) among other recognized authors who approached the subject of competitive advantage as such. Le and Lei (2018) confirmed in research that the majority of Chinese companies achieved competitive advantage through leadership in innovation and low cost.

However, there is a concern with developing countries regarding the formulation of policies on the generation of competitive advantage in the face of the growing competition from global agribusiness. Countries like the United States, Brazil, China, do not compete for the same goals, which causes fear in the world community, as both are extremely important for the supply of inputs from the first chain. The study also revealed that the current system for measuring the generation of competitive advantages used by agribusiness must be modified, expanding the quantity and quality of indicators, which will place greater emphasis on the formation of microeconomic results (Sachitra, 2016).

Corroborating this idea, when analyzing export data for products of agricultural origin between 2000 and 2014, it was observed that Russia has been improving its position in world trade, with emphasis on processed products derived from fish, cereals and oils vegetables (Irena et al., 2017). This finding goes against the results evidenced, reaching the conclusion when analyzing methods of developing competitive strategy in agribusiness, that there are many strategies for this, however, they will necessarily go through differentiation and cost reduction, always focused on market requirements. This implies, not only producing commodities, but understanding the added value that the customer wants (Tynchenko et al., 2019).

In Brazilian agribusiness, strategies that add value to the sector need to deal with price variability, needing to know the instruments present in the market for risk management (Soares & Jacometti, 2016). In a survey carried out on strategic cost management practices and strategic positioning in a survey, involving 169 companies in the 400 largest agribusiness, a higher frequency was identified for the practices of logistical costs, standard cost and quality cost, and, as strategic the most used is focused on cost leadership, followed by logistical and quality costs (Grando, 2017).

However, in all the researches carried out there was no clear relationship stamped between the cause-and-effect relationship. Therefore, it is believed that this can be evidenced by costing methods, and when properly applied, they can generate useful information for decision-making, allowing the idealization of strategies to achieve competitive advantages. It can be seen that organizations need a costing system for their business, as a whole, to be more effective. From this view, the factors that determine the success of the most viable costing method for the company should be explored, bringing to the fore the possibility of generating competitive advantages (Brierley, 2010).

Thus, the following sections will serve to demonstrate the main costing methods, their advantages and disadvantages and the applicability or not for agribusiness.

2.1 Absorption Costing

In Brazil, this is the method of required use for all legal entities in relation to the preparation of corporate accounting, also known as tax or financial, that is, that intended for the external public. This does not prevent these legal entities from adopting other costing methods for the purposes of decision-making or calculation of management accounting, more focused on the internal public of that legal entity.

Absorption costing is characterized as the method where all production costs participate in the composition of the cost of the good or service, so that the expenses are not part of the cost of that good or service. Expenses are charged directly to income, while fixed costs are apportioned to products and taken to inventory for those products not sold during the calculation period (Leone, 2007).

There is an advantage in using this method, mainly in terms of price formation, which is based on a basic principle that consists of the method itself in separating costs and expenses, however it will not be of great value where prices are dictated by the market, such as example in agribusiness, where most products are commodities (Bruni & Famá, 2005).

The application of this method in the determination of costs in a milk production located in the interior of the state of Santa Catarina showed that a great help in the management of production, since the spreadsheets used generated useful information for decision-making, such as, for example, the primary and factory cost, showing that the unsatisfactory performance in the results was not due to the costs, but to the difficulties that the activity encountered (Segala & Silva, 2007).

In a survey conducted in the state of Mato Grosso, considering the corn crops from 2014 to 2017, Da Silva et al. (2016) tested the three ways of applying absorption costing (partial, modified partial and integral absorption), concluding that each one has its usefulness. As for the partial absorption cost, where direct and indirect costs are allocated to the products, they concluded that it is more suitable for fiscal bookkeeping and for purposes of calculating financial statements.

In the modified partial absorption costing, only variable costs and fixed operating costs are allocated to the products, helping to better observe the costs of the products, since structural costs, not inherent to the crop itself, are left out of this calculation. Finally, when testing the applicability of full absorption costing where the total costs and expenses are allocated to products, they reached the same result as the first one tested, that is, partial absorption (Da Silva et al., 2016).

Savic et. al (2014) in research in the Republic of Serbia, identified that absorption costing is more used by that nation's agribusiness as an element of communication with external agents (stakeholders) while for managerial and strategic purposes by agribusiness in that nation are used more activity costing, lean costing derived from lean production, target costing and costing derived from the supply chain. These results had already been pointed out in a survey conducted in the state of Paraná, Brazil (Castanheira et al., 2014).

It can be seen from the quotes presented that the absorption costing method has its ramifications, advantages and disadvantages when used by agribusiness, but in none of the sources researched, it was mentioned that it could be a precursor in the generation of competitive advantages for agribusiness. To arrive at this statement, several sources of research have been used in a considerable period of time, that is, in the last 15 years.

2.2 Variable Costing

The variable costing method is one in which only the variable costs will make up the cost of the good or service, assuming that the fixed costs are already committed by the organization, as they will not suffer changes in value with the pre-established volume produced or contracted (Megliorini, 2012). Used only for management information purposes, it takes into account only the factors and / or volumes that may change with the production or product volume.

The variable costing method can be well-used by producers who, in addition to registering their costs, have control over the establishment for management purposes, the contribution margin of production and also the applicability of their techniques, in order to obtain a greater operational efficiency for your business (Silva et al., 2013).

Some advantages imposed to the variable costing method are: the practice of apportionment does not occur and obtain the necessary data for the analysis of the cost / volume / profit relationships quickly from the accounting information system. Therefore, some disadvantages of the method are: in practice, the separation of fixed and variable costs is not as clear as it seems, as there are semi-variable and semi-fixed costs, which may incur continuity problems for the company in direct costing; and the increase in the proportion of fixed costs in the cost structure of organizations, due to the continuous investments in technological and productive training (Leone, 1997).

For Segala and Silva (2007), it is extremely important that the rural manager is informed in relation to what happens in his business, as well as the market trends that he must follow and the functioning of the same, which, because it is a rural business, is influenced by external factors such as climatic fluctuations, for example. For them, this costing methodology will help the gatekeeper inward, however, it is not able to show the relationship between cause and effect in the generation of costs, a key factor to leverage a competitive advantage.

Among the advantages and disadvantages of this method, there is the final valuation of inventories, since excluding the fixed costs incurred in other periods, it may cause an understatement. In addition, it underestimates the behavior of fixed costs for a short-term view, as they will tend to change over time (Padoveze, 2010).

It was not identified in the literature mentioning that this method may be the precursor in the generation of competitive advantages.

2.3 Cost per Unit of Production Effort

The costing method per Unit of Production Effort (PEU) is based on the unification of production, in which its objective is based on it, having the creation of a common measurement unit for organizations with diversified productions (Morozini et. Al, 2006). Thus, the method aims to simplify the management control process starting from just two items, the costs of the raw material and the costs of the transformation, and, with this, the performance analyzes of the company, start to be carried out from costs and measured as effectiveness, efficiency and productivity (Bornia, 2010).

Being able to transform a diversified production into a unified one, the PEU method incorporates both economic and technical aspects to the multi-producing companies, providing all the facilities that the companies that manufacture a single product have in their production management (Allora & Allora, 1995).

The PEU method can be characterized as versatile and can serve as a basis for planning, programming and also the control of production processes, facilitating and simplifying the management of the organization's complex production processes as shown in Fig. 1 (Neto, 1995).

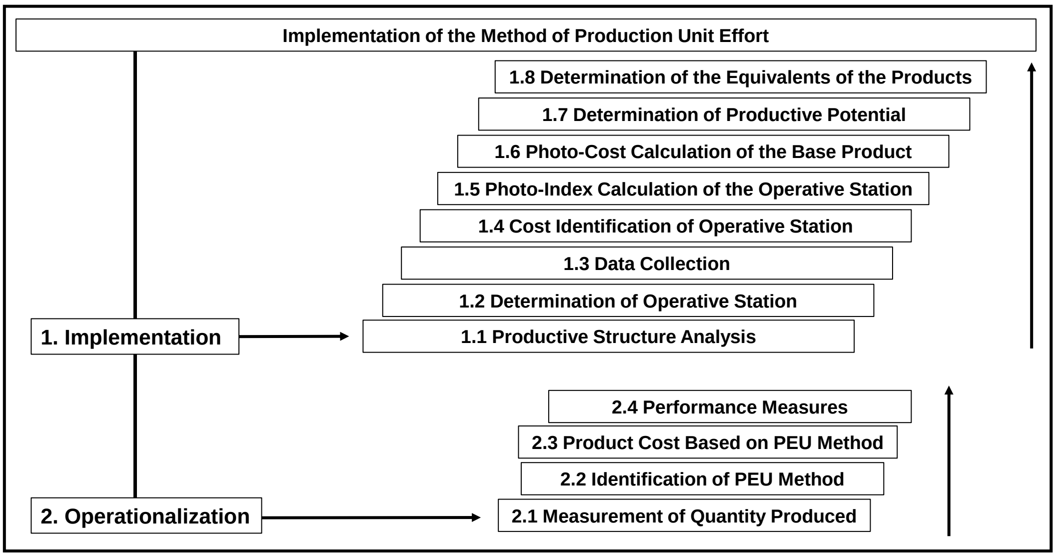

Fig.1: Basic scheme of the PEU costing model

Source: Adapted from Morgado (2003)

The cost per Unit of Production Effort has its priority focus on determining the cost through the transformation of raw materials into final products from the expenses used in the operations (Zanin et al., 2019).

Citing some general advantages of the method, unification of production can be taken into account, facilitating management and comparison of performance between periods; the use of information for financial accounting, among others, and, nevertheless, some of its main limitations are the need for constant review and also about not considering expenses and expenses of the company's structure (Wernke et al., 2020).

Since the PEU can facilitate the analysis of the profitability of manufactured products, according to Lembeck and Wernke (2019), the evaluation of this is able to optimize the marketed mix, giving increasing levels of value and market presence for the institution. In addition, it is possible to account for the measurement of installed, used and idle capacity, as well as to monitor production with the use of fiscal measures (Zanin et al., 2019; Wernke; Junges & Zanin, 2019).

The main advantage of this method consists of its simplicity of operation, where after knowing the productive potentials and equivalents of the PEU of the products, the calculations are easy and fast. Some other advantages of this method are characterized by providing an indexer so that production is more uniform and with fewer variations; allows the visualization of activities that are not adding value to production; it makes it possible to measure the cost-benefit using new technologies (through resources such as benchmarking); adheres to macro strategies seeking costing as a goal and leadership in costs; among others (Bornia, 2010).

Although the PEU method requires commitment and dedication from the producer, it is beneficial for organizations in the agribusiness sector, since it allows a detailed view of the production process of each product and the composition of costs, allowing the manager to monitor these costs and the choices of strategies they should take (Oenning, 2010).

However, some disadvantages of this method are related to the difficulties in treating the organization's waste, since only productive operations are considered, moreover, for agriculture, its use is not advised if there is a large rotation of production crops (Abbas et al., 2012).

For Meyssonnier (2003), hidden operations in the implementation of the method can be seen as a disadvantage, since it assumes that the relation of the operational stations remains over time, disregarding possible improvements in the process, in addition to the subjectivity that the method needs to adopt in relation to the precise time estimates to keep production times up to date (Pereira, 2015).

Therefore, all advantages and disadvantages must be weighed according to the characteristics and objectives of the business to be used as the main costing method.

2.4 Other Costing Methods Applied to Agribusiness

The activity costing method, or ABC costing, starts from the idea that it is the organization's resources that are consumed by the activities, and these, consumed by the good or service provided by the organization (Abbas et al., 2012). In turn, this method can be applied both to companies in all economic sectors, since the analysis of the method comprises the examination of the cost structure of each department and the factors that influence the demands of each one.

One of the advantages of this method is found in its relevance in situations where it is necessary to analyze specific processes seeking improvements and restructuring (Souza & Carvalho, 2012). However, some disadvantages of activity costing are that data storage, processing, presentation and survey are expensive. Another disadvantage is that the method is not usable or easily adaptable to new circumstances (Kaplan & Anderson, 2007).

The use of the ABC method is considered suitable for use in the agribusiness sector, since the model enables a cost management system that is capable of providing the rural producer with managerial information regarding decision-making, which increases competitiveness and business sustainability (Almeida et al., 2009).

The research by Kabinlapat and Sutthachai (2017) confirms this position when analyzing the implementation of the ABC method in a food processing company, having chicken as its main input, where they could see that the attribution of the ABC method brings with it the possibility of providing more information accurate on costs for the management of companies, showing that the method can bring competitive advantages, since it will be possible to better understand its bottlenecks.

But the question that may be latent at this moment is, if this can be a costing method that can generate a competitive advantage. The research by Do Nascimento et al. (2016), Ebele and Meshach (2016), Lu et al. (2017), Altawati et al. (2018), Rossi and Von Egert (2019), report that yes, although most of them have not been applied in agribusiness, however, they demonstrate that the system provides the relationship between cause and effect through cost drivers, even modifying on many occasions the way of making a product or service, which adheres to the macro business strategies, especially with regard to leadership in costs and differentiation.

The German Reichskuratoriun für Wirtschaftlichtkeit (RKW) method of costing homogeneous sections, however, has the main characteristic of dividing the organization into a cost center, that is, all fixed and variable costs and expenses and direct and indirect costs are allocated manufactured products (Abbas et al., 2012). This condition is only possible to be achieved, since costs are separated into items, where the company is divided into a cost center with identification of the primary distribution, secondary to the final, causing the costs to be redistributed according to the production stage (Pamplona, 1997).

The RKW method enables and guides the organization so that it reaches the total of products, considering the expenses that occurred before, during and after their production, bringing benefits to the entity once the decision-making of it becomes clearer (Santos & Filho, 2017).

Abbas et al. (2012) identified some advantages and disadvantages in this method, one of the advantages being taking into account all costs incurred in an organization, without exceptions, in addition to justifying prices and arriving at the costs of producing and selling. The RKW method also has the advantage that the method is allocated, in the products, the total expenses related to the effort to produce, manage and sell these (Magalhães et al., 2017).

This advantage in agribusiness was tested through a case study in an agricultural cooperative where it was possible to identify the most accurate application of all costs on the deposited grains, giving the producer a clearer view of the costs of cleaning, storage and commercialization of its production (Backes et al., 2007).

However, according to Abbas et al. (2012), one of the main disadvantages is the power to lead the manager to mistaken decisions for not distinguishing fixed costs from variables, not eliminating the arbitrariness of the criteria for apportioning indirect expenses, even if it suggests tracking as realistically as possible, demonstrating that their vulnerability lies in the risk of distortion in the measurement of the cost per product and also per unit produced (Magalhães et al., 2017).

Among other methods, the Theory of Constraints (TOC), can be understood as a refinement of direct costing joining the technique of linear programming (Cogan, 2002). This method reinforces that the overall performance depends on the efforts that each element that makes up the system offers, concentrating three major measures - earnings, inventory and operating expenses - so that, as a final concussion, the TOC can use the data demonstrating the bottleneck capabilities and organization earnings (Dias & Padoveze, 2007).

III. RESEARCH METHODOLOGY

Based on the definitions of Bromiley and Jhonson (2005), this research is considered to be of an applied nature, as it consists of generating knowledge of practical application for specific purposes. As for the objectives, it is considered exploratory, whose phase is embryonic and its main purpose is familiarity with the problem, being associated with bibliographic research and case study.

The research adopted as a methodological process, replacing the case study, a comparative study, which can also be called simulation. The simulation process can be understood as "the manipulation and construction of an operating model representing all, or part of a system or process that characterize it", thus reflecting on a method in which the central characteristics of a system, process or environment, be it real or proposed (Olsen & Morgan, 2005).

The adoption of the simulation process occurred due to the impossibility of using financial data from the farm, object of study, located on the border between the states of São Paulo and Paraná, Brazil. The production unit has an extension of 380 hectares (ha) and has a working day in accordance with the current labor legislation, totaling 176 monthly hours.

Using the simulation process, we sought to compare the absorption, variable and PEU costing methods, given that the methods synthesized in section 2.4, would require another methodological process, changing the nature of the operations carried out by the farm. Therefore, three simulations were carried out, presented in the next section.

The operational data used are from the farm on fire, and the financial data, available in Annex 1, represent the average occurred in the state of Paraná. This state was chosen, due to the fact that most of its suppliers are located in that region.

As the simulation was carried out from the moment the plants were in the R6 reproductive stage (full pod), the predicted production coincided with the same informed in Annex 1. For valuation and billing determination, quotations from bag according to the Castro / PR region, on the dates when grain production was commercialized (Agrolink, 2020).

There was an adaptation of the PEU method to the reality of agribusiness, for an activity considered within the gate, as this method foresees its application for several products at the same time (Bornia, 2010), however, in agriculture, the adaptation of the product occurs in relation to driving crop, which can occur during two periods in the agricultural year, called harvest, which in most of Brazil, are summer and winter.

IV. COMPARATIVE STUDY BETWEEN METHODS

4.1 Steps Taken in Soybean Cultivation

In order to guarantee the feasibility of the simulation, the steps in soybean cultivation on the mentioned farm will be demonstrated. For a better understanding, these steps were divided into tables, which will serve to understand the comparative, described in the previous section. The detail described in the tables summarizes in 90% the activities / operations carried out during the implantation and conduction of the crop, which may vary from crop to crop, or from farm to farm.

The tables represent activities that consumed resources at each stage of the soybean crop, briefly described and monetarily measured according to Annex 1, in the items of mechanized operations, labor and aircraft operations. As this is not the main focus of the article, the details of the operations presented in Tables 1 to 4, present basic characteristics, which can be identified and replicated by other studies or essays. The operations developed in the pre-planting stage are shown in Table 1.

Table 1: Operations performed in the Pre-Planting stage

Specification	Detailing	Equipments
Soil sampling	15 simple samples for every 10 ha of area to be cultivated	Dutch auger, bucket, sample bags
Desiccation	Mechanized application of herbicide	Self-propelled sprayer
Liming	Loading, distribution and incorporation of limestone	Tractor, trailer and limestone distributor
Seed treatment	Seed treatment with pesticides and inoculant application	Inoculator

As for soil sampling, it is done every two years, and requires manual labor, requiring a few days of work, depending on the number of men and equipment employed. This same activity could be replaced by the use of modern soil analysis techniques with equipment aimed at Agriculture 4.0 (Carraro et al., 2019).

Before planting, it is necessary to desiccate the area to eliminate weeds that may compete with the development of the crop to be planted. This activity is carried out by a self-propelled sprayer, which takes five working days to cover the entire arable area, under normal weather conditions, that is, with winds of up to 10 km / h, and obviously without rain. Liming is not an activity performed every year, being demanded according to the results indicated in the soil analysis.

Seed treatment is done as planting takes place, using inoculators coupled to seeders, not requiring extra labor-related activity. Considering an average of one year for the other for the activities described in Table 1, there is approximately 80 hours of work for the entire team to carry out the pre-planting activities in the 380 ha.

The chronological analysis is a very important record for any company, and it must be carried out constantly in order to know what their productive potential is, therefore, it is important to make it clear that the specifications, details and equipment shown in Tables 1 to 4, were raised in the field. In sequence, the operations developed at planting were shown, shown in Table 2.

Table 2: Operations carried out at the planting stage

Specification	Detailing	Equipments
Seeding	No-till system	Tractors and seeders
Fertilizing	Carried out together with sowing	Tractors and seeders
Irrigation	Only in case of lack of rain in the planting window	Center Pivot
Support	Refilling the seeder with seeds and fertilizer	Tractor, winch and trailer

The sowing and planting fertilization stage has two tractors and two seeders, one with nine and the other with six rows. In addition to the tractor drivers, two operators are also used in the seeders to certify the correct drop of seeds per row. The two seeders together, in an 8-hour work shift, reach an area of 6 ha of planting.

Therefore, using a simple mathematical calculation, for planting 380 ha, mathematically rounding upwards, there is a consumption of 507 working hours (380 ha divided by 6 ha / day, multiplied by 8 hours daily). It is true that in agribusiness, especially within the gate, issues related to labor legislation suffer adjustments, because of climatic issues, to achieve a good result in planting, the shifts are increased, in addition to the work teams taking turns. In this way, what would take almost two months is reduced to approximately one month of uninterrupted work, except on days with heavy rain. This is done to take advantage of the ideal planting window, comprised of the photo period, temperature, soil moisture, suitable for the chosen cultivar.

Irrigation is done autonomously, where the equipment (pivot) is programmed for the exact amount of time you want to irrigate. The time spent with the seed and fertilizer seeders recharge operation is computed in the sum of hours of work already presented. The operations carried out in the management of the crop are described in Table 3.

Table 3: Operations carried out in the field of conducting the crop

Specification	Detailing	Equipments
Survey of pests and diseases	Identification of pest and disease attacks	Employees
Insecticides	Pest control application	Self-propelled sprayer
Fungicides	Disease control application	Self-propelled sprayer
Herbicides	Application for controlling invasive plants	Self-propelled sprayer
Cover fertilization	Fertilizer distribution	Tractors and distributors
Irrigation	Water complementation	Center pivot

Inspections are carried out weekly on each planting frame / plot, aiming to raise pests and diseases. In addition to the survey of the responsible agronomist, which is carried out by sampling over 380 ha, teams of collaborators are also drawn up, usually between 3 and 5, at a rate of 1 ha per hour of work, with the aim of locating insects and picking weeds. This activity aims to identify any flaws or inefficiency in the mechanized application of insecticides, fungicides and herbicides by the self-propelled sprayer, whose productivity has already been mentioned in Table 1.

The cover fertilization is made by haul, and according to the equipment used, a production of 5 ha per hour is reached. The sum of all the activities specified in Table 3 reaches 260 hours considering the deployment of the team on work fronts. The harvesting operations are described in Table 4.

Table 4: Operations performed at the harvest stage

Specification	Detailing	Equipments
Harvest	Desiccation and mechanized harvesting	Harvester
Transport	Transportation of grains from the field for processing	Trucks
Pre-cleaning	Removing impurities in sieves	Vibrating screen
Drying	Only if it is non-standard (above	Dryer

	18%)	
Storage	Awaiting commercialization	Metal silos

This farm uses a harvester with a capacity of 10 ha per 8-hour shift. The harvest starts around 9 am, when the dew is gone, and ends at the beginning of dusk, when the dew starts to return. Normally, the harvest is carried out with the grain moisture at around 18%. For commercialization, soybean moisture is accepted with up to 15%, therefore, the moisture difference is extracted in the pre-cleaning, drying and distribution process in the silos, which takes an average of 3 hours for every 12 tons of soybeans.

In the processes specified in Table 4, three workers are used, one for the combine, one for the truck and one for the dryer, totaling approximately 300 hours of work.

In the next section, simulation and comparison between costing methods is demonstrated.

4.2 Simulation by Absorption Costing

Using the concepts and observations described in section 2.1, in addition to the information provided in section 4.1 and in Annex 1, it was possible to elaborate the simulation by the absorption costing method, presented in Table 5.

Table 5: Absorption cost

Item	Amounts (US$)	Calculation memory
Revenues (R)	522.500	380 ha x 55 bags/ha x US$ 25.00/bag
Total cost (TC)	175.491,30	380 ha x US$ 461,8192
Operating profit	347.008,69	OP = (R – TC)

It is noticed that this method does not take into account the information in Tables 1 to 4, that is, it works only with the accounting of the monetary values spent during the harvests, thus meeting the legislation in force in Brazil. This finding corroborates the results pointed out by Castanheira et al. (2014), showing that the method can be beneficial with its ramifications and advantages for the agribusiness sector.

Due to the fact that it has a very simplistic view, since the method unifies all costs (fixed and variable), the results presented do not generate adequate management information for a more effective decision-making, especially with regard to the optimization of the resources used. in production, contrary to the results found by Segala and Silva (2007).

In addition, according to Leone (2007), two factors weigh against this method, which is the apportionment used arbitrarily to allocate indirect costs to products and the allocation of part of the fixed costs incurred in the period when there is a stock of products in preparation or finished.

There are numerous studies in the literature that point out advantages and disadvantages about this costing method, but none of them was categorical in stating that it is a precursor in generating competitive advantage to its users.

4.3 Variable costing

Using the concepts and observations described in section 2.2, in addition to the information provided in section 4.1 and in Annex 1, it was possible to elaborate the simulation by the variable costing method, presented in Table 6.

Table 6: Variable costing

Item	Amounts (US$)	Calculation memory
Revenues (R)	522.500	380 ha x 55 bags/ha x US$ 25.00/bag
Total variable cost	(121.245)	380 ha x US$ 319,0653/ha
Total contribution margin	401.255,15	
Total fixed cost	(54.246,46)	380 ha x US$ 142,7538
Operating profit	347.008,69	OP = (R – TC)

The first observation to be made is that there are no stocks on the property referring to the soybean harvest that was conducted between 2019/2020, for this reason, the absorption and variable costing methods show the same result for the operating profit line.

It is clear that the variable costing method is able to bring more useful information to decision-making, mainly the separation between variable and fixed costs (Megliorini, 2007).

Taking into account that the great part of the Brazilian agriculture makes two harvests per year (summer and winter), for Silva et al. (2013) there is an advantage in using this method, which is the information generated about the contribution margin of each harvest for the payment of fixed costs during the year. The contribution margin, in turn, is part of an analysis called cost, volume and profit, which can be linked to other managerial artifacts, such as operational leverage, thus determining the degree of operational leverage used by the farm.

However, there is a limitation in the method regarding the analysis of fixed costs, because according to Leone (1997), the fact of accumulating them and isolating them in the result, does not allow the understanding of how they behave, thus hindering their management. Corroborating this condition, the results of the research by Segala and Silva (2007), demonstrate that this method has difficulty in treating the relationships between cause and effect in the generation of costs.

Thus, it is worth mentioning that this method has its contribution to cost management, however, according to what was evidenced, the condition of being a precursor in the generation of competitive advantage was not identified in it.

4.4 Cost per Unit Production Effort

In the cost simulation using the PEU method, it was necessary to make some adaptations to the scheme presented by Morgado (2003) in Fig. 1.

Initially, there was a transformation of the operational posts in phases / stages of the crop, the main one being that it is a single product (soy). Therefore, in item 1.6, which is the calculation of the photo-cost of the base product, where for a multi producer company, it would be the time to choose a product that best represents the average of the passage times, using the passage time chosen as the denominator in a division where the numerator will be the hourly cost per post, thus showing the calculation of the cost of the base product.

Having presented these initial considerations, it is shown from Table 7, the calculations performed to determine the phases required by the method and shown in Fig. 1.

Table 7 presents two phases carried out together, which is an adaptation for the demonstration of the measured results, that is, the disclosure of the division of the operational stations (Phase 1) and the passage times in hours that according to the method are called photo indexes (Phase 3) in a single table.

Table 7: Phases 1.1 to 1.3 of the basic scheme of the UEP costing model (Figure 1)

Agriculture	Pre-planting	Planting	Driving	Harvest	Time
Soy	80	507	260	300	1,147

Table 7 shows the productive structure, following the determination of operating stations and data collection. These steps may seem obvious, but in many cases, because they are so usual, agricultural producers end up not giving much importance to operations, but only to processes and the final product, not performing a chronological analysis of the times consumed during operations that occurred during the harvest. This is declared as a big mistake, as a first reflection on productive capacity and the implementation of improvements is lost there.

Therefore, Table 7 began, a first relevant point of this costing method, because by dividing the farm into operational posts (adaptation to the method), a detail was obtained of how the hours of work are consumed, considering not only labor, but all fixed expenses as described in Annex 1.

Ascertaining the passage times in hours for each operating station, according to the division (crop phases) already presented in Tables 1 to 4, in section 4.1., The first step was taken to build the indexer called UEP. This first step must be detailed and formalized, as from this division, it is that the performance of the operational posts will be planned and controlled, seeking a reduction in the value obtained for the UEP, from the initial survey in monetary standard, represented by Table 8.

Table 8: Phase 1.4 of the basic scheme of the PEU costing model (Fig. 1)

Cost item / Operating station	Pre-planting	Planting	Driving	Harvest	Total
Labor	24	17.60	104	16	161.60
Mechanized operations	78.75	110.96	237.08	137.93	564.72
Airplane Operations	0	0	16.00	0.00	16.00

Total (US$)	19.76	24.72	68.67	29.60	142.75
Number of hours/month	80	507	260	300	
Cost per hour (US$) per ha	1.28	0.25	1.37	0.51	

The information on labor, mechanized operations and operations with aircraft were extracted from Annex 1, and totaled in columns by the farming phases, which subsequently served as a numerator in a division where the denominator became the hours consumed in each phase, thus, obtaining the hourly cost of fixed expenses per hectare, ending phase 1.4 of the basic scheme of the PEU costing model, shown in Fig. 1.

The tendency is for the costs measured by inflation to rise, given inflation and the indexation of wages, among other fixed costs. Therefore, it is a mistake to compare costs between periods monetarily. According to Oenning (2010), this is the first indication that the method can build a competitive advantage. The next step is to multiply the result obtained in Table 4 by the passage time of the base product, which is one more adaptation made to the method, represented in Table 9.

Table 9: Phases 1.5 and 1.6 of the basic scheme of the UEP costing model (Fig. 1)

Operating station	**Pre-planting**	**Planting**	**Driving**	**Harvest**	**Total**
Cost / hour put (US$)	0.2461	0.0480	0.2635	0.0981	0.6557
Transit time (hours)	0.75	0.75	0.75	0.75	0.75
Base product cost (US$) per ha	0.1846	0.0365	0.1981	0.0730	0.4942

These two phases represent the crucial point in the application of the method. In a multi productive industry, a product would be chosen that best represents the time spent in operating stations, and would be used as a multiplier (middle row in Table 9), in an operation where the product (result of multiplication) is the cost in monetary standard of the base product, which means that, according to the method, this is the index to be worked on by business management. One could also use a time that is understood as ideal for the various products produced.

Table 9 presents yet another adaptation, by unifying two phases of implantation of the method, adjusting them to the reality of the inside of the gate, where one product is produced at a time in a specific plot, where two products are usually grown per year, respecting the agronomic calendar for summer and winter crops.

The passage time used in Table 9 was calculated by dividing 1,147 hours by four operating stations, thus reaching an average result of 286.75 hours for each operating station. It is true that this average is much higher, for example, than what is spent in the pre-planting phase, however, it represents well the last two phases of the crop. This result was divided by the size of the property, which is 380 ha, reaching a multiplier of 0.75.

Using this average transit time in hours (0.75), the cost of the base product per hectare was US$0.4942. This value, shown in the last column of Table 9, is quite different from the sum of Table 8, which, if evidenced, would be U$$0.6557 (US$0.2461 + US$0.0480 + US$0.2635 + US$0.0981). Therefore, in the next phase (Table 10), this result ends up becoming the denominator, where the higher, the worse the result, that is, the lower the total number of PEU consumed for the period, giving a false impression that had been obtained operational efficiency. This is another contribution of the method, which forces managers to seek a reduction in time and application of fixed resources in production.

Table 10: Phases 1.7 of the basic scheme of the PEU costing model (Fig. 1)

Operating station	**Pre-planting**	**Planting**	**Driving**	**Harvest**
Cost/hour put (US$)	0.2461	0.0480	0.2635	0.0981
PEU (US$)	0.4942	0.4942	0.4942	0.4942
Productive potential (PEU/hour)	0.50	0.10	0.53	0.20

By dividing the hourly cost in monetary standard of each operating post by the monetary value of PEU in the first application of the method, there is the creation of the indexer called productive potential (PEU/hour), which in the next soybean harvest, will be converted into a standard after accounting for fixed costs.

The result shown in Table 10, is the performance to be achieved, which must be analyzed from the first moment of planning, seeking to reduce it. Even if there is an increase in fixed costs due to the indexation of various expenses such as salaries, electricity, among others, even so, seeking to reduce the values of the productive potential, a reduction in costs will be obtained. This condition is in line with the results presented by Sachitra (2016) and Le and Lei (2018), who argued that the method seeks to generate advantages from the constant analysis of the consumption of resources in production, especially those from fixed expenses.

Table 11: Phase 1.8 of the basic scheme of the UEP costing model (Figure 1)

	Pre-planting	**Planting**	**Driving**	**Harvest**	**Total**
Transit time	80	507	260	300	
Productive potential of the post	0.50	0.10	0.53	0.20	
∑ PEU equivalent	40.00	50.70	137.80	60.00	288.50

The result of 288,50/ha, calculated as the sum of the equivalents in PEU, is another adaptation of the method to the purpose that is being outlined for this study, that is, in the traditional method for multi-producer companies, at that moment the consistency between the equivalents would be analyzed in PEU of products. Here the consistency between the operational stations is analyzed. In this case, the driving phase ended up largely overcoming the planting phase, even the latter using a higher consumption of hours.

Certainly, this difference will be analyzed and measured by means of an indicator, providing the manager with a concrete goal, regardless of the monetary cost, which will become a consequence and no longer cause as in most analyzes made by other costing methods. It is certain, therefore, that the determination of the equivalents in PEU for the farming conduction phase, will take greater care, as it ends up consuming more units of production efforts, that is, 2.7 times more than the predecessor phase.

When analyzing the last paragraph under the agronomic aspect, in fact the result calculated by the sum of the equivalents in PEU for the phase of driving the crop, although it does not consume so many hours actually worked, is the most expensive of them, where various equipment is used, increasing spending on machine hours, in addition to the cost of hours of specialists (agronomists and technicians) for analyzing the stages of crop development, as well as its phytosanitary status.

Table 11 represents the last phase of the implementation of the PEU method. After this trajectory of calculating operations that consume time and financial resources, converting them into an index, the operational phase begins, as shown in Table 12.

Table 12: Phase 2.1 of the basic scheme of the PEU costing model (Fig. 1)

	Soy
Quantity bags produced	20.900
PEU equivalent	288.50
Total PEU	**6.029.650**

By multiplying the quantity of bags produced by the PEU equivalents, an amount of PEU used for the crop under analysis was created. This amount should be the target to be exceeded for the next harvest. Obviously, this will not happen without the proper planning and analysis of the relationship between cause and effect, corroborating the results presented by Brierley (2010). Table 13 shows the conversion of PEU as an index to monetary standard.

Table 13: Phase 2.2 of the basic scheme of the PEU costing model (Fig. 1)

(a) Total Production Cost	380 ha x 139.68/ha = US$53.078,40
(b) Total PEU consumed in production	6.029.650
Unit value of PEU (a/b)	US$0.0088

The result found in Table 13 should be analyzed from crop to crop, obviously seeking to reduce it.

It will also serve for the formation of the guiding price for the sale of the product, described in Phase 2.3. In the case of agricultural commodities, this result will determine the safety margin that the producer will be obtaining, this being the difference between the marketed price and the guide selling price determined by the PEU method.

The last phase of operation, identified as 2.4 (Performance Measures) in Fig. 1, is the beginning of the feedback of the data obtained between past, present and future harvests. Therefore, according to Bornia (2010), the method has great potential for improving operational performance for users who have serial products, allowing the benchmarking of operations and processes, making it possible to know the real production capacity, consequently the determination of machines and people for supply identified bottlenecks, balancing operational posts, seeking global production efficiency.

V. CONCLUSION

Before showing the results obtained with this study, it should be noted that the simulation used, took into account the specifications, details and equipment described in Tables 1 to 4, which are exclusive to the case studied. When seeking to replicate this work in other properties, adjustments to the method must be made, depending on the size, operations and processes performed, quantity and quality of available equipment. In this case, the adaptation to the mathematical reasoning developed in the comparison of costing methods must be made.

Once this condition is understood, the results found in this study allow us to affirm that the costing method called PEU may be a precursor of competitive advantage to Brazilian agribusiness, mainly for those who are "within the gate", commonly suppliers of serial products, becoming if its application is ideal, as the search for cost reduction becomes a premise that focuses on the cause of costs, aiming at the optimization of resources used in production.

The comparative study, methodology to present the application of costing methods, together with the presented literature, assist producers in their decision-making regarding the use of costing methods, becoming a guide for their replication.

This was possible thanks to the adjustments presented in the study, specifically those related to the PEU costing method, for a serial product, but unique during the current harvest for the same plot, adapting it to mono production, this being one of the contributions presented throughout that study.

The adaptation of the method in phase 1.6 demonstrates the importance of the average time used for the construction of the PEU, thus seeking to reduce consumption in the use of resources that make up fixed costs, mainly the depreciation and maintenance of agricultural machinery, since the determination of maintenance periods and resale values of this equipment are determined, among other factors, by the hours of work recorded by the machines' hour meter.

Another advance demonstrated by the study is the adaptation of phase 1.8, which deals with the determination of product equivalents (sum of equivalents in PEU), where in the original method the results were compared between the various products that a company produces, in this study, the adaptation took the comparison between the operating stations, as if these were the products. Therefore, we start from the assumption that are the phases of conducting the crop, the operations that consume resources, in this method called PEU.

Therefore, the results of 288,50 for the sum of the equivalents in PEU and 6 million PEU consumed for the soybean harvest of the period of 2019/2020, are results that should be incorporated in the planning of the next harvest, and, therefore, become points of discussion as important as cultivars, inputs, agricultural insurance, financing, among other vital points for a good result of a harvest. It is believed that with the results presented, that the PEU costing method can be a strong ally in the generation of competitive advantages for agricultural producers.

As future contributions, we highlight the application of Phase 2.4 Performance Measures of Fig. 1 as a complement to the study on the same property, however, starting with another research method, probably an action research. In addition to this contribution, this study allowed mechanisms for reflection and replication of the method by other researchers and producers.

From experience, it is also believed that it is possible to merge the PEU method with other methods, especially those that deal with the view on cause and effect, in addition to those that work restrictions (gaps) in the production system, thus opening up more opportunities for research.

Annex 1: Table of costs incurred in the 2019/2020 soybean harvest in the state of Parana-Brazil

PARANA			
Description	**US$/ha**	**US$/bag**	**%**
Pre-planting			
Mechanized operations	15,1442	0,2750	3.3
Employees	4,6154	0,0847	1.0
Agricultural correctives	7,3847	0,1347	1.6
Pesticides	9,9327	0,1808	2.2
Step total	37,0770	0,6750	8.1
Planting			
Mechanized operations	21,3385	0,3885	4.6
Employees	3,3847	0,0616	0.7
Pesticides	6,5385	0.1193	1.4
Fertilizers	66,2981	1,2058	14.4
Seeds	37,0193	0,6731	8.0
Step total	134,5789	2,4462	29.1
Driving the crop			
Mechanized operations	45,5923	0,8289	9.9
Employees	20,0000	0,3635	4.3
Pesticides	174,3366	3,1693	37.7
Airplane operations	3,0770	0,0558	0.7
Step total	243,0058	4,4193	52.6
Harvest			
Mechanized operations	26,5250	0,4827	5.7
Employees	3,0770	0,0558	0.7
Freight	17,5577	0,3193	3.8
Step total	47,1597	0,8577	10.2
Total operating cost	461,8193	8,3962	100.0
Reference for soy in state of Parana, average productivity of 55 bags / ha			

Source: Adapted from Scot Consultoria (2020).

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