ABC costing methods applied to transgenic soybean by conventional and precision farming systems

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Karoline Arguelho da Silva
Doctoral student in Production Engineering
Institute: University of São Paulo
Address: Production Engineering Department – EESC/USP,
13566-590. São Carlos – SP, Brazil
E-mail: **karoline.arguelho@usp.br**
(Corresponding author)

Isotilia Costa Melo
Doctor in Production Engineering
Institute: University of São Paulo
Address: Production Engineering Department – EESC/USP,
13566-590. São Carlos – SP, Brazil
E-mail: **isotilia@gmail.com**

Jéssica Syrio Callefi
Doctoral student in Production Engineering
Institute: University of São Paulo
Address: Production Engineering Department – EESC/USP,
13566-590. São Carlos – SP, Brazil
E-mail: **jessica.callefi@gmail.com**

Daisy Aparecida do Nascimento Rebelatto
Associate Professor in Production Engineering
Institute: University of São Paulo
Address: Production Engineering Department – EESC/USP,
13566-590. São Carlos – SP, Brazil
E-mail: **daisy@usp.com.br**

Anamari Viegas de Araujo Motomiya
Associate Professor in Agricultural Engineering
Institute: Federal University of Grande Dourados
Address: Dourados Itahum, km 12, 79804-970.
Cidade Universitária – MS, Brazil
E-mail: **anamarimotomiya@ufgd.edu.br**

Abstract

Cost management is important for a rural property and a powerful tool for this management is the ABC costing method. The purpose of this paper is to measure the cost of planting transgenic soybean on a rural property using the ABC costing method. Therefore, exploratory research was adopted, developed through a case study, interviews and systemic visits in a property of 76 hectares, located in Mato Grosso do Sul. The costs of agricultural products and

the total of resources involved from tillage to harvest. It was considered: soil preparation, seed variety, pesticide types, among others, aimed at property management. The ABC costing method shows the consumption by activities, which facilitates the management of activities present in the harvest. In this study, it was possible to identify that soybean cultivation has a higher cost per hectare in planting and tillage. Therefore, the relevance of management information through ABC as a support for decision making in agricultural management is verified.

Keywords: ABC costing. Soy. Rural property. Brazil.

1. Introduction

Effective cost control and consistent performance measurement have become essential in business management and these considerations led many industrial and agricultural companies to adopt the Activity-Based Costing (ABC) system. The ABC has emerged as a methodology capable of improving the quality of cost information for both processes and products, as well as providing more accurate information on production activities, supporting managers to know how companies employ the time and resources to achieve their objectives (CHING, 1997).

Along these lines, the companies' ABC strategic cost analyses aim to report the quantity, cause and effect relationship, and the efficiency and effectiveness with each resource are consumed in the companies' most relevant activities (NAKAGAWA, 2001), as well as reducing the distortions provoked by the arbitrary apportionment of indirect costs (MARTINS, 2006). The ABC method also aims to improve processes, providing a horizontal view that captures costs of activities to be carried out in various sectors of the company (MARTINS, 2006).

As Hansen and Mowen (2001) point out, the cost management information system is an accounting information subsystem that is primarily concerned with the production of information for internal users. Similarly, Eldenburg and Wolcott's (2007) conceptualization argues that the focus of cost reduction and strengthening of the company's strategic position, occurring simultaneously. Therefore, cost management should not be seen merely as the use of techniques for costing products and services in monetary terms. The opportunity to develop a broader analysis, of a managerial nature, where the search for improvement of organizational processes is constant. In a process of continuous improvement, the elimination of waste and the pursuit of the minimization of activities that do not add value are pieces of fundamental importance.

Although the ABC is known and consolidated in traditional industrial applications, its use is not yet widespread among the managers of rural properties in Brazil. However, with the technological advance and the increasing complexity of the agriculture production systems, there is a continuous growth of the indirect costs in rural properties. Therefore, appropriate treatment in the allocation of indirect manufacturing costs to the products is indispensable because degrees of arbitrariness and subjectivity of this allocation can cause enormous distortions. In this way, the determination of costs is indispensable in organizations, whether agricultural or industrial. There is an evident need for the use of effective management tools that clearly show the processes and their costs to serve as a basis for decision-making, by allowing evaluation and monitoring of agribusiness management. More than to measure, it is important to use these data to achieve organizational objectives (COOPER; KAPLAN, 1988).

Therefore, the main objective of this paper is to determine the ABC cost involved in the production of the crop of soy, in a farm of 76 hectares, located in the district of Itahum in Mato Grosso do Sul, Brazil, using ABC costing and absorption costing. This study is relevant because many farmers do not have accounting information about their plantations, which makes long-term decisions difficult. This study is a documented demonstration that the ABC costing method is a viable alternative that promotes information and profitability gains to farmers, especially the smallholders.

The paper is structured in six sections. Besides this introduction, the second section discusses the literature background for cost management, though mainly focused on agribusiness. The third section provides details about the methodology as well as the rural property where the ABC method was applied. The fourth section shows the results divided into two subsections (activities and costs) and discusses the practical implications. The fifth section provides conclusive final remarks and the sixth section is the reference list.

2. Cost Management in Agribusiness

To reach the goal, the correct allocation of costs is necessary, which is not an easy task, since some costs directly affect the product/service that is produced or realized, and others cannot be directly attributed to the product/service. These are the indirect costs, which, like direct costs, must also be allocated to establish the total cost of the product/service (HOFER; SOUZA; ROBLES JR, 2007). According to Hofer, Souza and Robles Jr. (2007), it is also necessary to approach two methods of costing, one considered as a traditional method of costs and the other more contemporary, which has been the focus of discussions in

congresses and meetings of the accounting area. These costs are Absorption Cost and Activity Based Costing (ABC), respectively.

Agribusiness represents all the activity of exploring the land, through the cultivation of crops, forests or animal husbandry, whose objective is to obtain products that meet human needs (CREPALDI, 2012). The cost accounting can be characterized as an information processing center that allows the rural manager to plan, evaluate, and control the activities carried out in the property, providing better decision- making (SEGALA; SILVA, 2007). From the analysis of production costs, it is possible to evaluate the feasibility of making investments, of the profitability of crops or creations on the property. In addition to the analysis of productive structures that can provide better results, considering the characteristics of each property. Similarly, cost management for decision-making in rural activity allows the evaluation of information that presents strategic relevance to the rural manager. The use of cost accounting in the rural environment qualifies the decision-making process of the manager, providing information that can meet the informational needs that arise in rural enterprises/farms (SANTOS; MARION; SEGATTI, 2002).

Absorption cost means that the actual incurred costs must be added to the cost of production obtained by the general accounting and the system by absorption, which means the inclusion of all costs related to production, either direct or indirect concerning each product (MARTINS, 2006). According to Martins (2006), the absorption cost consists of the appropriation of all the costs of production, all the expenses related to the production effort are distributed for all products or executed services. In Absorption Cost, the depreciation of equipment and other depreciable assets used in production must be redistributed to the produced products. Therefore, it goes becomes active in the form of products and only becomes an expense when selling the products.

One of the greatest problems faced by cost management is related to concerns about how to distribute indirect costs to the products and services elaborated. As a way of diluting these problems, several attempts are made, such as departmental cost control or cost center (LEONE; LEONE, 2010). Though a company has significant levels of indirect costs and a homogeneous production with a single product, the allocation of all direct or indirect expenses, fixed or variable, is extremely simple. Simply put all the expenses into one big funnel, associating them gradually to products or services. In this context, ABC is a method of tracking the costs of a business or department for the activities performed and of verifying how these activities are related to the generation of revenues and consumption of resources.

ABC assesses the value that each activity adds to the performance of the business or department (LEONE; LEONE, 2010).

The academic literature applies ABC frequently because it is a detailed method, has been the approach of costing more focused on congresses, meetings, books (LEONE; LEONE, 2010). According to the same authors, among other means that discuss the theme "costs" appropriate to several units through some bases that are not related to the volumes of the factors of production. Therefore, the calculation of activity-based costing calculates the cost accumulated by the activities developed, offering a view of the progress of the process as a whole. To appropriately allocate the activity-based costs executed by the company, in an appropriate way to the products (LEONE; LEONE, 2010).

Considering these concepts, the ABC method has its initial focus not on the product, but on the activities that are necessary for the production of this product or service rendering. Figure 1 demonstrates the operating logic of the activity-based costing method, which directs costs not to the product/service, nevertheless to activities that later transfer their spending to products.

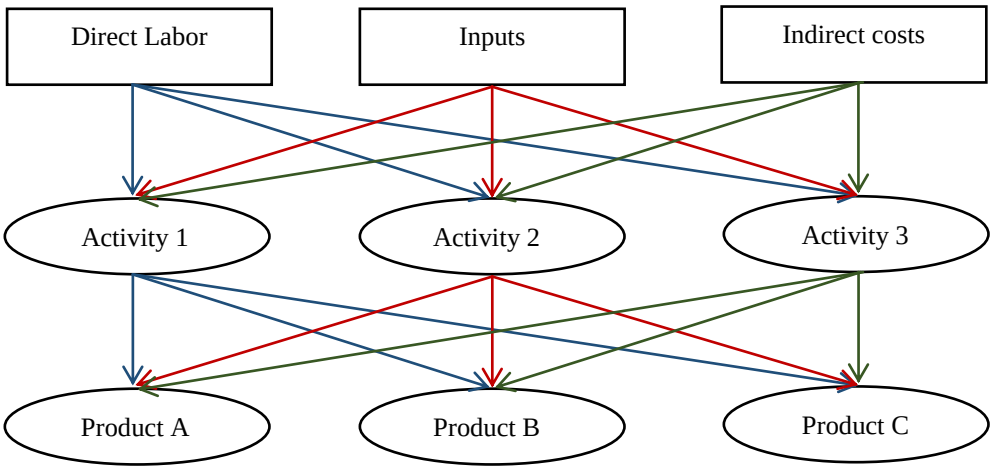

Figure 1: Operating logic of the activity-based costing method

Source: Adapted from Hofer, Souza and Robles Jr. (2007).

The cost of this will be the sum of the costs of the activities that were involved in production or realization, having in the end total cost. Thus, unlike the absorption cost method that uses apportionment criteria to allocate indirect costs, in the ABC method, a process of tracking these costs is developed. The difference is in its allocation, which is not inserted directly into the product/service, but in the activities involved in the execution of the process, and only then, allocated to the products/services. Thus, it can be seen that ABC appears as a

solution to the problem of indirect cost allocation. They are subject to a more delicate part of the costing process of the products / services.

3. Methodology

Science has as its fundamental objective the proximity to the truth of facts and, in order for knowledge to be considered scientific, it is necessary to determine the method that made it possible to arrive at this knowledge (GIL, 1996). Regarding this approach, the current paper is classified as quantitative research because the results can be quantified, which means translating into numbers, opinions and information to classify and analyze them. This research can also be considered qualitative considering the interpretation that will be made after the data collection (TRIVIÑOS, 1987). According to Marconi and Lakatos (2003), this research is exploratory because it has, among other purposes, to increase the familiarity of the researcher with an environment, fact or phenomenon, to carry out more precise future research or to modify and clarify concepts.

The methodology used in this paper was a case study (YIN, 2001). A farm of 76 hectares, located in the district of Itahum in Mato Grosso do Sul was chosen because it is an small property, a type of undertaking common in this region and with few studies. This study is conducted in a rural property in which employees are experienced and have been working in agriculture for more than 25 years. Though they started to plant transgenic soybeans in the harvest year of 2017/2018. The study was done in November 2018.

First, an interview was conducted with one of the employees of the farm to collect data about costs and the used part by each hectare, using recommendations of Boni and Quaresma (2005). This employee is the manager of the company. He has responsibility to purchase and manage resources for planting inputs. Thus, it is who holds information about costs and demands on the farm.

A questionnaire was applied to obtained the following data: (a) total and partial amount which have been spent on seeds, (b) total and partial amount that were spent with fertilizers, (c) total and partial amount which have been spent on agricultural pesticides, (d) total and partial amount that were spent with variable labor, (e) total and partial amount which have been spent on transport, processing and storage, (f) total and partial amount which have been spent with depreciation, (g) total and partial amount that were spent with amortization, (h) total and partial amount that were spent on leases, (i) total and partial amount which were spent by aerial spraying, (j) total and partial amount that were spent with fuel and lubricant,

(k) total and partial amount that were spent with repair of machines, vehicles and agricultural implements, (l) total and partial amount that were spent with variable costs, (m) total and partial amount that were spent with fixed labor, (n) total and partial amount which were spent at fixed overhead costs and (o) total and partial amount which were spent on administrative costs.

The questionnaire was developed considering factors that cause different results in the costing based on ABC activities, the absolute value and the unit value of each question raised in the questionnaire were collected. After collecting the necessary data, the results were analyzed.

In practice, the price of all inputs was raised for each stage of the seed planting process, the values were calculated and these values were deducted.

In the precision agriculture system, the planted area is divided into plots according to the relief, location, and soil type of the planting area, so that each plot receives the necessary correction, fertilization, and control, according to its characteristics. These plots have the most diverse lengths or measures of area, making it impossible – with the available technological infrastructure - to collect individual data regarding the number of pesticides and the number of applications made. Though, with the advance of digital farming, it will be possible to collect and process data (based on internet clouding and big data). In these future and transition scenarios, the ABC costing method increases its relevance, once it determines precisely which operations are most impacting and should be the focus of attention.

In the conventional agriculture system, applications are made by the average of each plot. This causes the dosage to be below (or above) the recommended, resulting in increased costs of application of products. Also, it causes contamination in the environment. In overdosage, the excess product goes to the soil, while at low dosage there is no efficient pest control, making the pests resistant and leading to a new application with a higher dosage to combat them.

The preservation of the environment became a requirement of the international market. Organic pesticides are an alternative solution for the non-contamination of rivers, groundwater, and soil. Soil biodiversity needs to be preserved. In the conventional application of pesticides, the natural enemies of pests and diseases are also exterminated and, without them, there is no natural control, requiring greater and greater dosages of pesticides due to the pests' resistance.

Based on the methodology determined for the study, it was possible to develop a costing questionnaire based on ABC activities, whose objective is to optimize any and all

costs of a business, goods, services, and verify that all activities are related to consumption of resources, adding or not adding value to the procedure adopted.

4. Results and Discussions

4.1. Activities of crops

The activities of crops, obtained for an interview, were separated into eight activities: soil analysis; soil preparation; planting; application of pesticides and foliar fertilization; desiccation for harvest; harvest; transport; post-harvest. Chart 1 shows the descriptions of any steps.

Chart 1: Description of productive process activities

Step	Description
Soil analysis	Removal of a sampling of the area for chemical analysis, to know the deficiencies of the soil for possible corrections.
Soil preparation	Preparing the soil for planting, herbicide application and the application of correctives, which are plaster and limestone. To carry out these activities, it was necessary to contract third-party services, in this case, spraying. For the application of the correctives, the own machines of the farm were used, taking into account, the fuel consumption.
Planting	For the accomplishment of the planting, it was necessary to contract third-party services, being a set tractor-seeder and labor outsourced taking into account the consumption of fuel.
Application of pesticides and foliar fertilization	In this activity, the application of insecticides, fungicides and foliar fertilization is carried out, is necessary to contract third-party services.
Desiccation for harvesting	The application of desiccants to harvest is carried out.
Harvesting	In this activity, the contracting of third parties is carried out and the grains are harvested.
Transportation	In this activity, transportation of the grain from the crop is carried out to a grain receiving unit, that is, a storage unit.
Post-harvest	The grains are received in the unit for the purpose of cleaning and drying.
Sale	After the processing of these grains, the product is in conditions of sale, it is up to the producer to decide whether to sell directly or expect a better price.

Source: Elaborated by the authors.

Soil analysis and preparation activities are carried out in several stages, depending on the need of the soil and/or pest controls. The following steps are shown in Figure 2.

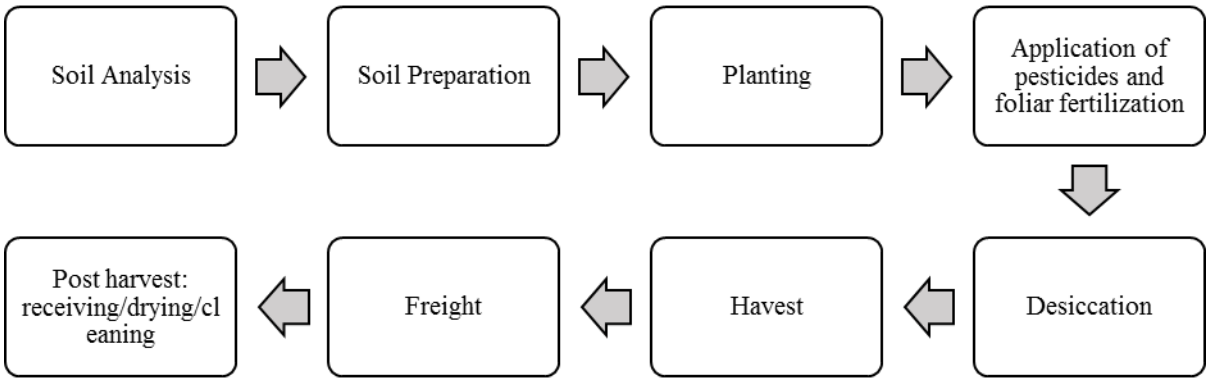

Figure 2 - Sequence of productive process activities

The mapping of the activities allowed comprehension of the activities in the property necessary to the next steps.

4.2. Costs

Table 1 shows the total costs incurred in Reais (Brazilian currency) in the production of the soybean crop, listing all the resources used from planting to harvesting.

Table 1: Total direct costs

Inputs	Fertilizer	57,798
	Corrective soil	27,740
	Insecticide	7,342
	Fungicide	15,011
	Herbicide	4,422
	Leaf fertilizer	593
	Variable labor	1,200
	Soil sampling	2,888
	Fixed labor force	2,400
	Third-party services	42,488
	Diesel	12,312
	Desiccation for harvest	2,584
	Seed	21,600
Total	**198,377**	
Other costs	ITR (Rural Territorial Tax)	539,6
	CCIR (Certificate of the rural property registration)	167,2
Total	**706,8**	

Direct expenditures may be more easily appropriated in cultivation since purchases are made for that purpose and the use of each input is controlled by the producer. Indirect costs, such as depreciation, require technical knowledge to calculate and direct the resource. Thus, a 15-year useful life was considered for each machine. The residual value considered here was

10% of the value of the good. Finally, the depreciation that occurred due to the decrease in the value of the good and the residual value divided by the useful life follows the expectation of sale of the good after the use of the same, as shown in Table 2.

Table 2: Machines and equipment

Assets/Machine	Value of Property (R$)	Residual Value (R$)	Depreciation Value (R$)	Life cycle (year)	Annual Depreciation (R$)
Tractor	105.000,00	105.000,00	94.500,00	15	6.300,00
Seed Tractor	5.000,00	500,00	4.500,00	15	300.00
Reamer	35.000,00	3.500,00	31.500,00	15	2.100,00

Although Table 1 presents data on the cost of each resource used, it does not provide information that can contribute to cost management. It is precisely in this aspect that the ABC should contribute to the management, presenting information about the cost of each activity.

The choice of resource drivers to the activities was according to the producer's appointments, to facilitate and facilitate the control. Table 3 shows the resource drivers used, according to the input characteristic.

Table 3: Resource Drivers

Input	Resource Drivers	Control
Diesel oil	Quantity of liters/ hour	Average consumption as a function of machine efficiency
Fertilizer	Amount of tons/ha	Application Control
Herbicide	Quantity of liters/ hour	Application Control
Seed	Amount of kg/ha	Application Control
Fungicide	Quantity of liters/ha	Application Control
Insecticide	Quantity of liters and kg/ ha	Application Control
Randap	Quantity of liters/ hour	Application Control
Leaf fertilizer	Quantity of liters/ hour	Application Control

Drivers of indirect costs, labor, and depreciation, as well as direct costs, were calculated per hectare. For each activity considering eight hours per day of work, at a value of R$ 12.50 per hour worked (with taxes). In the planting period, when it is not in the planting season, the hour worked is R $ 5.00. Thus, a value was obtained of how much the labor costs for each hectare in the culture of the transgenic soybean.

In depreciation, only the machines involved in the study were used, as shown in Table 2. The property has other assets that were chosen not to mention since they do not affect the costs of the analyzed activities. For the calculation of the depreciation, the rate of 10% per year of the value of the machinery was considered.

Table 4: ABC Costing

Activities	Unitary value (R$)	Total (R$)
Activity 1 - Soil Sampling		
Conducting the analysis of samples	38.00	2,888.00
Activity 2 – Soil Preparation		
Third-party services (Spray)	17.00	1,292.00
Herbicide Application	58.19	4,422.44
Corrective Application - Plaster	150.00	11,400.00
Fixed Labor Force	5.00	2,400.00
Corrective Application- Limestone	215.00	16,340.00
Diesel	108.00	8,208.00
Activity 3 - Planting		
Fertilizer	760.50	57,798.00
Seed	284,21	21,600.00
Third-Party Services (Seeder Tractor)	150.00	11,400.00
Variable labor	12.50	1,200.00
Diesel	54.00	4,104.00
Activity 4 - Application of defensives and foliar fertilization		
Leaf Fertilization	7.80	592,80
Insecticide and fungicide	294.11	22,352.36
Outsourced service (Spray)	17.00	1,292.00
Activity 5 - Drying for harvest		
Desiccant application	34.00	2,584.00
Outsourced service (Spray)	17.00	1,292.00
Activity 6 - Harvest		
Outsourced service	2.75 sacks/ha	12,540.00
Activity 7 - Transport		
Freight	1.00 R$/sacks**	4,180.00
Activity 8 - Post-Harvest		
Receipt/Drying/Cleaning	2.51 R$/sacks***	10,491.80
TOTAL		198,377.40

The costing by activities allows the knowledge of the cost of each activity. In this study, the intention of costing is each activity per hectare cultivated, that is, one has the information of the cost of each activity. In this way, the total cost of preparing the soil is given by the sum of the activities carried out whose purpose is to prepare the soil. The same procedure was adopted for the other activities (soil analysis, soil preparation, planting, defensive application and foliar fertilization, desiccation for harvesting, harvesting, transport, post-harvest, and labor).

Table 5: Crop costs of the hectare (soybean)

Activities	R$/ha	%	R$/Total	%
Soil preparation	398.19	18.2	30.262,44	18,2
Planting	1.248,71	57.1	94.902,00	57,1
Harvest	165.00	7.5	12.540,00	7,5
Application of pesticides and foliar fertilization	318.91	14.6	24.237,16	14,6
Transport	55.00	2.5	4.180,00	2,5
Total	2.185,81	100.0	166.121,60	100

Table 5 shows the cost of activities in each crop, per hectare and total. This information can help in managing the activities once you have the knowledge of the cost that will have to harvest.

In this study, it is identified that soybean cultivation has the highest cost per hectare in the plantation and that has a higher total cost in soil preparation and planting.

It is an aid to the producer, for having the information of the cost of each activity, and to allow verifying that the activity contributed or not to the cost of the plantation. Once this identification is made, a more detailed analysis is possible, such as the price of seeds and fertilizers, among others.

Table 6: Statement of Income for the Year 2016

Description	Values
Operating income	R$ 250,800.00
(-) Deductions	R$ 194,777.40
(=) Net Revenue	R$ 56,022.60
(-) Variable cost	R$ 1,200.00
(-) Fixed cost	R$ 2,400.00
(=) Gross Revenue	R$ 52,422.60
(-) Taxes	R$ 706.80
(=) Net Income	R$ 51.715,80

As shown in Table 6, the Statement of Income for the Exercise of the soybean crop was carried out, taking into account the values indicated by the owner. Operating income was estimated at R$ 60.00 per bag, and 55 bags. And the tax, the owner described paying in the ITR (Rural Territorial Tax) R$ 7.10 per hectare and CCIR (Certificate of Rural Property Registration) 2.20 per hectare.

The costs presented bring clarity on which inputs and phases in which the most expenses occur. In this case, fertilizer was the one that spent the most, followed by insecticide

and fungicide, and, thirdly, by seed. And the phase of Planting was the most expensive. Obtaining this type of information helps the producer to organize himself better in finance.

5. Conclusions

The objective of this study was to measure the cost of planting transgenic soybeans in a rural property using ABC and activity-based absorption costing. For this, a case study was carried out on a property of 76 hectares. Regarding the application of the ABC method, considering the complexity of the implantation of the same in industries, it is considered the method is applicable to a rural property, since the rural activities can be defined more clearly due to the reduced number in relation to others segments. ABC contributed with better management of activities in the industrial sector. This contribution can be important in a rural property since the measurement of the same would enable the producer to decide clear to carry out such activity. Since it would have the information of how much it costs and what the benefits brought by each activity.

This study enabled the farmer to identify the activities carried out in the production of transgenic soybeans. With this paper, it was possible to identify the costs by activities and the total cost of each crop. The results, in terms of application of the ABC method, are considered satisfactory, since, by reducing the number of activities, the complexity of the model can be reduced.

Despite the limitations of the study, since it is a single case study, it can be inferred that in the studied rural property, the application of the ABC costing method provided relevant information about costs. The activities that most consume were identified: soil preparation and planting.

Analyzing the values, we can see that the total of resources that we consider as costing of absorption, since it involves all the resources used from the preparation until the harvest. That is, the value of the absorption cost is equal to the total of the cost ABC, the difference of the two methods occurs when implementing the ABC method. Because it is a more exemplified method, ABC is preferred because it shows the consumption by activities, which facilitates the understanding of what is happening with the crop in a general way for the producer.

As one of the contributions, there is a parameter that farmers and researchers can use the results found here to analyze the costs on their properties. Besides, the variables used to compose the cost analysis can be extended to the cost analysis of other crops.

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