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Article

Planning and executing a research project using the PMBOK guide

Planejamento e execução de um projeto de pesquisa usando o guia do PMBOK

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Abstract: The concern with the sustainability of agricultural production has encouraged the search for alternative management of soil fertility, increasing the use of by-products as filter cake. Despite some studies proved its technical viability, it is not verified the widespread used. The aim of this work was to plan and execute a research project to obtain an overview of the perception of researchers and rural producers about the use of filter cake in the fertilization of sugarcane culture, using the PMBOK guide. The planning and execution of the study project addressed two areas of knowledge in project management: scope and time. A questionnaire was made on Google Forms platform for the main stakeholders's project (rural producers, researchers and employees in the sugar and alcohol sector). The participants understood that the search for sustainability in the sugarcane cultivation is not only a market trend, but also a strategy for their business and/or research, and that they are up-to-date on the trends in the sector in which they work and are in agreement with their aim of achieving a more sustainable production system. The main factors considered as drivers for the use of the by-product, were also mentioned as the main obstacles for its use in agricultural (price and dependence on distributors). We concluded that the project stakeholders have a positive perception about the use of filter cake as a fertilizer in the sugarcane production. We suggest the creation of public policies to support by-products's use since agricultural sustainability is a national interest.

Keywords: filter cake; management; sugar cane.

Resumo: A preocupação com a sustentabilidade da produção agrícola tem incentivado a busca por alternativas de manejo da fertilidade do solo, aumentando a utilização de subprodutos como a torta de filtro. Apesar de alguns estudos comprovarem sua viabilidade técnica, não se verifica sua ampla utilização. O objetivo deste trabalho foi planejar e executar um projeto de pesquisa para obter um panorama da percepção de pesquisadores e produtores rurais sobre o uso da torta de filtro na adubação da cultura da cana-de-açúcar, utilizando o guia PMBOK. O planejamento e execução do projeto de estudo abordou duas áreas do conhecimento em gerenciamento de projetos: escopo e tempo. Foi criado um questionário na plataforma Google Forms para os principais stakeholders do projeto (produtores rurais, pesquisadores e funcionários do setor sucroalcooleiro). Os participantes entenderam que a busca pela sustentabilidade no cultivo da cana-de-açúcar não é apenas uma tendência de mercado, mas também uma estratégia para seus negócios e/ou pesquisas, que estão atualizados sobre as tendências do setor em que atuam e estão de acordo com seu objetivo de alcançar um sistema de produção mais sustentável. Os principais fatores considerados como direcionadores para a utilização do subproduto também foram citados, como os obstáculos para sua utilização na agropecuária (preço e dependência de distribuidores). Conclui-se que os stakeholders do projeto têm uma percepção positiva sobre o uso da torta de filtro como fertilizante na produção de cana-de-açúcar. Sugere-se a criação de políticas públicas de apoio ao aproveitamento de subprodutos, uma vez que a sustentabilidade agrícola é um interesse nacional.

Palavras-chave: torta de filtro; gestão; cana de açúcar.

1. Introduction

Agriculture is responsible for approximately 70% of freshwater use, and 69% of the greenhouse gas emissions[1], [2]. For this reason, there has been a search for agricultural systems that provide food and energy in sufficient quantity and quality with the least possible environmental impact.

Brazil is the major worldwide sugarcane (*Saccharum spp.*) producer, representing approximately 41% of the world's production[3]. Due to the global demand for energy that does not come from fossil fuels, there has been need for productive intensification and expansion of arable areas, with the challenge of controlling environmental degradation related to this expansion. Thus, the sugar-energy sector has looking for technologies that can reduce environmental liabilities related to the cultivation of sugarcane. Currently, 97% of national production adopts mechanized harvesting, eliminating the burning[4] and the cultivation reaches the extent of sequestrating about 20% of all carbon emitted by fossil fuels in Brazil[5]. There is also enormous potential in the use of organic by-products generated by the industry itself, such as vinasse, sugarcane bagasse, boiler ash and filter cake.

In conventional agriculture, the productivity is maintained based on the use of soluble mineral fertilizers whose production requires expensive ores with a high degree of purity – materials scarce in the world[6] – putting environmental and economic sustainability at risk. It is necessary to find a middle ground between the soil management systems commonly used and a system that seeks to maintain soil fertility using nutrients from organic materials. In this sense, the use of filter cake has been referred as a promising source of nutrients, replacing total or partial some mineral fertilizers[7], [8].

The filter cake is a residue of sugar and alcohol industry produced in large volume (30 to 40 kg per ton of crushed cane) during the process of treatment and clarification of the sugarcane juice[9]. Its use as a fertilizer has expanded since it supplies organic matter, macro, and micronutrients[10], destines waste and adds value to the industrial process. Studies have indicated that with the use of this material it is possible to reduce phosphate mineral fertilizers in the first two years of cultivation[11], or in the first whole cycle, with doses of 10 to 20 t ha^{-1} [12], [13]. There are also evidences that its use acts in the selection of certain groups of enzyme-producing microorganisms that solubilize nutrients found in forms not available in the soil[10], [14].

Although the technical feasibility of using filter cake as a fertilizer has been established and organizations and rural producers are looking for practices that will lead them to sustainable development, it is not verified that the use of this by-product in sugarcane fields is widespread, with many doubts from interested parties as to its advantages. Thus, a study on the user's perception of the use of filter cake is necessary.

The aim of this work was to plan and execute a research project to obtain an overview of the perception of researchers and rural producers, about the use of filter cake in the fertilization of the sugarcane culture, using the Project Management Body of Knowledge guide (PMBOK).

2. Material and methods

The planning and execution of the study project were carried out following the good project management practices described by the PMBOK guide[15], having addressed two areas of knowledge in project management: scope and time. Thus, following this set of good management practices, the project was initiated based on the project's charter. The main function was to justify the project and define its aims, the need for preliminary studies, restrictions, requirements, stakeholders and finally, the impacts of the project.

2.1 Project planning stage

After the project charter, which formalized the existence and the beginning of the project, we proceeded to the planning stage. In this phase, the project deliveries were subdivided into smaller components, giving rise to the work breakdown structure (WBS)

(Figure 1), which was created using the MS Project 2016® software. The definition of the duration of the activities described in the WBS was also part of the planning stage, which allowed the generation of the project schedule (Figure 2). The project was planned to last 26 weeks, starting on apr. 10 and ending on nov. 10.

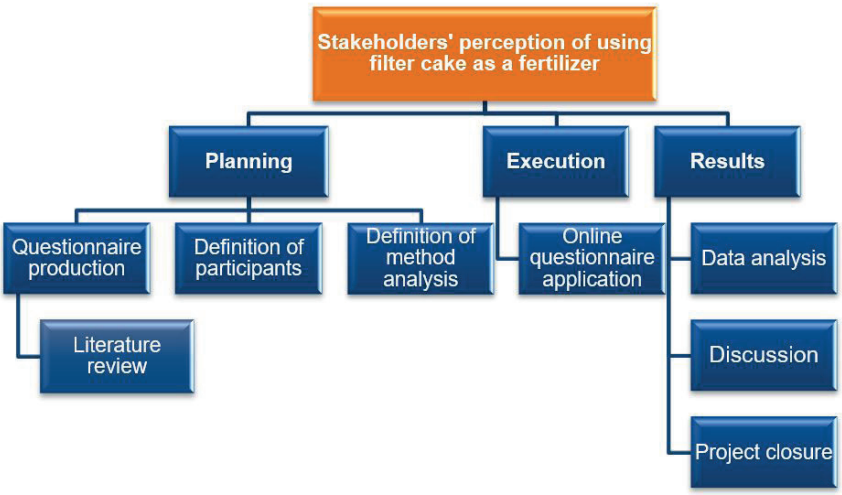

Figure 1. Work breakdown structure (WBS)
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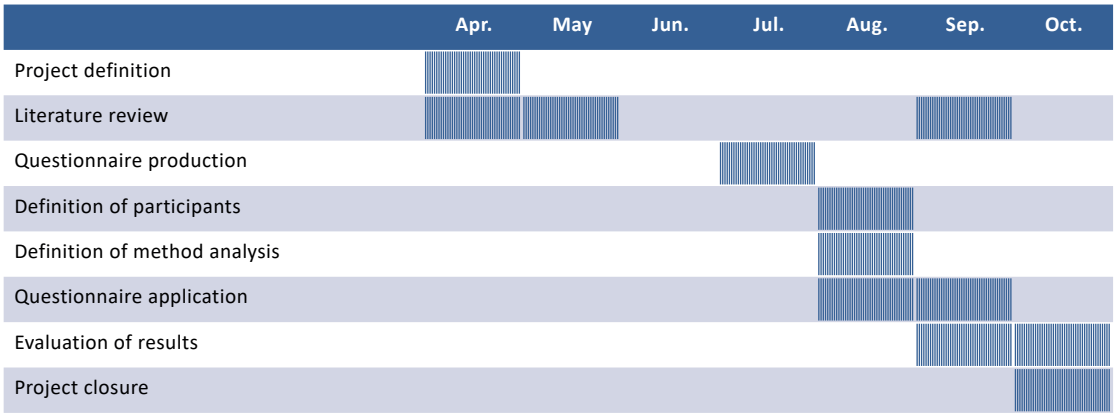

Figure 2. Research project schedule
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2.2 Project execution stage

A questionnaire was prepared on the Google Forms platform, aimed at the main stakeholders defined in the project's charter (rural producers, researchers and employees in the sugar and alcohol sector). The aim of the questionnaire was to determine what, in the opinion of the stakeholders, drives or hinder the use of filter cake as a fertilizer in the cultivation of sugar cane.

The first step in preparing the questionnaire was to identify the variables most likely to affect the perception of stakeholders about the product. This identification was carried out by based in technical and scientific reports and informal conversations with professionals in the agricultural area. Then, the questions were formulated seeking to use a simple and direct language, so that they were easily understood and avoid the induction of answers.

Ten multiple-choice or intensity-scale questions were proposed, following the model proposed by Likert[16]. The choice of this model of questionnaire was because it allows the reader to make a comparison between the questions and their respective answers. The interpretation of the answers obtained by this model can be done individually or together, allowing a better understanding of the

respondent's opinion.

The questionnaire was divided into four sections: i) Profile of the interviewee; ii) Perception of sustainability; iii) Risks of using filter cake and iv) Opportunities for using filter cake. At the end, a space was made available for the participants to make any comments they deemed pertinent to the best understanding of their answers. The questionnaire was available for access during the period from aug. 12 to sep. 9.

The inclusion of questions such as age, industry (farmer, researcher, employee in the sugar and alcohol sector, or other) and location, aimed to outline the profile of the participants and verify a possible relationship with the positive or negative perception about the use of the filter cake in soil fertilization.

The main restrictions related to the questionnaire were outlined in the project charter and are shown below:

- The questionnaire must be answered exclusively on the "Google Forms" platform, and information obtained through informal conversations, whether face-to-face or digital, is not computed;
- All participants will have their identity preserved;
- Each participant can answer the questionnaire only once;
- None of the answers obtained can be changed or excluded from the results section;
- All opinions issued in the comment area, without exception, should be published in the results section.

3. Results and discussion

3.1 Interviewee profile

At the end of the questionnaire application period, 30 responses were obtained, with 47% of the participants declaring themselves as researchers, 23% as employees of the sugar-energy sector, 23% as rural producers and 7% as consultants. Respondents were in an age group between 20 and 70 years old, showing a wide diversity in this regard, as well as in the number of municipalities covered by the survey, having been 15 in total. This diversity is desirable for discussing the results obtained.

3.2 Knowledge, use, perception about sustainability, risks and opportunities of using filter cake

When asked about their level of knowledge about the filter cake, approximately 47% of the survey participants said they had average knowledge, 30% knew a lot and 17% said they knew deeply. Only 7% of the participants know very little about the material (Figure 3). This result indicates that the answers obtained in the questionnaire were not limited by low level of knowledge about the object of study, regardless of the line of activity in which the participants work.

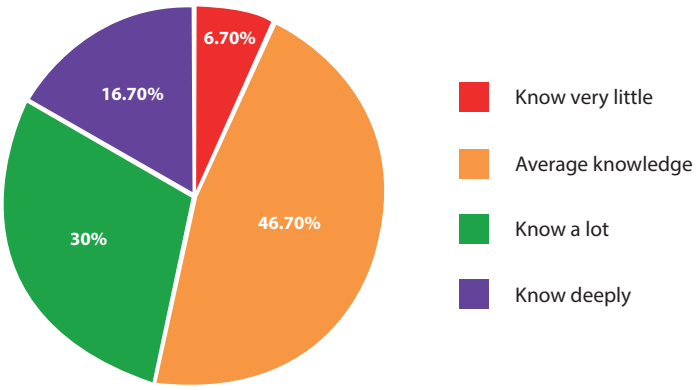

Figure 3. Level of knowledge of research participants in relation to filter cake
Search: Elaborated by the authors.

Approximately three quarters of respondents say they use filter cake on their property or in a project in which they participate or are managers. The two main reasons indicated as an incentive to use this material were: believing in its effectiveness and the search for alternatives to conventional fertilizers (Figure 4). This result reflects the global demand for environmentally and economically more advantageous fertilizers. The indiscriminate use of industrially produced fertilizers as a way of ensuring that crops express their maximum productive potential, leads to the appearance of undesirable environmental impacts due to the excessive dispersion of nutrients in aquatic and terrestrial environments, mainly related to high levels of phosphorus and nitrogen. It is estimated that of the total manufactured fertilizers applied to the soil, 40-80% are lost to the environment by chemical, physical and biological processes[17]. There is, therefore, a need to increase the efficiency of the use of nutrients in order to avoid losses and manage the sustainability of the system[18]. In this context, the addition of organic materials such as filter cake is beneficial because its nutrient content is gradually released through the mineralization of organic matter[19], reducing the possible loss of nutrients through runoff, erosion and percolation in the soil.

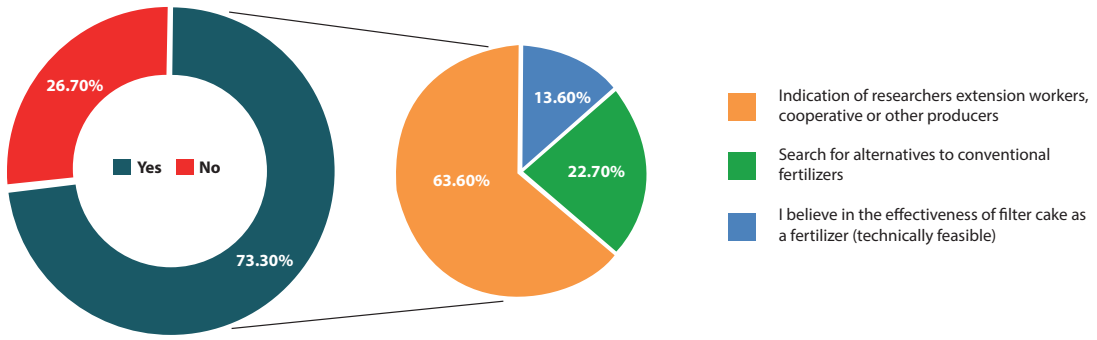

Figure 4. Research participants's main reasons for using filter cake in the projects in which they participate
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Brazilian agriculture is heavily dependent on imports of mineral fertilizers. The reduction of this dependence can be achieved with the recovery of nutrients found in agricultural residues. Withers et al.[20] created a management model for the use of P in agriculture that also can be taken as an example for other nutrients. The model, called "5R stewardship", proposes five measures to improve and increase the efficiency of the use of nutrients in agriculture in order to reduce the dependence on imported fertilizers, namely: realignment of inputs; reduction of nutrient losses; nutrient recycling; recovery of nutrients from waste and redefinition of the use of nutrients in food systems. In view of the apparent demand from stakeholders for alternative fertilizers to conventional fertilizers, the use of filter cake on soil fertility management is in line with the model mentioned.

The search for an alternative to conventional fertilizers could be confirmed when participants were asked about the sustainability of using filter cake. Among the possible answers (totally disagree, partially disagree, I do not know, partially agree and totally agree), 77% said they totally agree that its use is environmentally advantageous and 53% that filter cake is a good strategy to replace mineral fertilizers (Table 1). This demand also appears in the section of questions that dealt with opportunities related to the use of filter cake (Table 2). Most participants considered that the price volatility of mineral fertilizers and the greater independence of the rural producers in relation to their suppliers are opportunities. That is, for the research participants, the use of filter cake brings the possibility of less dependence on the prices exercised by the fertilizer market.

The majority (80%) of stakeholders agree on some level that the use of the waste treated here is a way of managing soil fertility that is sustained over time. In fact, organizations form sugar-energy industry has been looking for technological innovations towards sustainability and supported by public policies, such as RenovaBio, a state policy to help Brazil achieve the goals of reducing greenhouse gas emissions through increased production of renewable fuels[21]. This increased production, in turn, will lead to greater quantities of waste produced, which can be used as organic raw material to improve the quality and productivity of the soil[22], [23].

The growing market demand for sustainable products and processes can be seen as a problem or as a managerial strategy[24]. Given the answers obtained by this research, it can be seen that the participants understand that the search for sustainability in the cultivation of sugarcane is not only a market trend for which they will have to adapt, but also a strategy for their employees, business and/or researche. Only 7% of survey participants claim to disagree that the use of organic waste, is a good marketing for their companies or research and that the environmental advantages related to the use of this material are seen as opportunities (Table 2). This result reveals that respondents are up to date on the trends in the sector in which they operate and aligned with their goal of achieving a more sustainable production system, being willing to adhere to new cultivation practices when they see that they can function as potentialities for their projects, and business, not as managerial problems.

For a business, productive process or product to be considered sustainable, it is necessary to consider not only the environmental dimension, but also the economic and social dimension. This is the idea proposed in the management model called Triple Bottom Line, proposed by John Elkington[25], in which an innovation or modification in a production process is expected to contribute to the three dimensions mentioned. In the case of the economic dimension, the possible dependence of the sugar and alcohol plant to supply and price the filter cake, were seen as risks related to the use of this product (Table 3). Some researcher participants expressed their concerns about it in the area intended for comments, such as: "[...] The supplier has little access to the filter cake, has more of the vinasse [...]"; "What weighs in the use of the filter cake is the price of transportation [...]"; "[...] The industry has the machinery to apply and the availability of the material for itself."; "The acceptance is great, I think the biggest problem is the question of the plant being a supplier [...] producers do not have access."; "[...] I think the filter cake should be partly returned to the sugarcane suppliers." Such comments revealed a certain dissatisfaction with the material's distribution model, since the sugar cane supplier to the mill has difficult access to the filter cake, being subject to the price variation of the freight and the product itself.

The percentage of those who consider that the price and dependence of the sugar and alcohol industry are not risks was also high (43 and 40%, respectively). However, when evaluating this result in more depth, it is noted that there was an influence on the level of knowledge of the research participants about the product on their perception of these rich people. As the level of knowledge increased, the agreement with the statement that the price of the filter cake is a risk, reduced. That is, there was an inversely proportional relationship. The same trend was observed for the statement that the fall in sugar cane productivity is a probable risk when using filter cake. Apparently, the more the respondents know about the subject, the greater is their understanding that the benefits of using this material outweigh the possible problems related to price. Once again, the interviewee's comments help in understanding this result. One of them says: "[...] I worked a lot with filter cake [...]. Where it is used, productivity is higher in relation to mineral fertilizer."; and another: "I am in favour of using natural organic products, even at high costs".

Current agricultural practices have increased the environmental vulnerability of agroecosystems[26], requiring that the parameters under which soil management decisions are made, be questioned and reassessed. There is an increasing pressure from the market for products produced in a sustainable way, demanding innovations in processes and management systems to keep the country competitive worldwide in the sugar-energy sector. The adoption of eco-innovations in an organization has the potential to reduce the negative impacts and risks generated by conventional practices of using natural resources[27].

Table 1. Participant's perception (%) regarding the sustainability of the use of filter cake

	Totally disagree	Partially disagree	I don't know	Partially agree	Totally agree
	----------%----------				
The use of filter cake is environmentally advantageous.	0	0	3	20	77
The use of filter cake is a good strategy for replace mineral fertilizers.	0	3	7	37	53
The use of filter cake is a sustainable management long-term.	0	7	13	20	60
With the growing demand for sustainable products, there is a tendency to increase the use of filter cake.	0	7	3	10	80

Search: Elaborated by the authors.

Table 2. Participant's perception (%) regarding opportunities for using filter cake

	Totally disagree	Partially disagree	I don't know	Partially agree	Totally agree
	----------%----------				
The price volatility of mineral fertilizers is an opportunity to use the filter cake.	7	7	7	37	43
As it is an organic residue, the use of filter cake is a good marketing for my company or research.	0	7	13	30	47
The use of filter cake reduces dependence on the product mineral fertilizer suppliers.	3	13	7	33	43
The environmental advantages of using filter cake are opportunities.	0	7	0	37	53
There are no opportunities for using filter cake.	73	17	3	7	0

Search: Elaborated by the authors.

Table 3. Participant's perception (%) regarding the risks of using filter cake

	Totally disagree	Partially disagree	I don't know	Partially agree	Totally agree
	----------%----------				
The possible price volatility of the filter cake is a risk to its use.	30	13	13	33	10
The lack of technical knowledge on the part of the product is an important limitation to the use of filter cake.	0	23	7	40	30
The fall in crop productivity is a likely risk.	50	17	13	13	7
Obtaining the filter cake is dependent on the plant sugar and alcohol is a risk for the producer.	20	20	0	27	33
There are no risks in using the filter cake as fertilizer.	10	37	10	17	27

Search: Elaborated by the authors.

In order for nutrient recovery technologies to become eco-innovations, they must be economical, efficient from an agronomic point of view and free from contaminants[28], [29]. In view of the results set out above, the only requirement for the waste treated in this research to be considered an eco-innovation is that it remains competitive from an economic point of view. Therefore, the creation of policies to support this technology and that observe the indirect environmental costs involved in the current management of soil fertility in the production of sugarcane, must be taken into account.

4. Conclusions

Based on our results, we concluded that the stakeholders's project showed a positive perception about the use of filter cake as a fertilizer in the sugarcane production. However, the main factors considered as drivers for the use of the by-product, were also mentioned as the main obstacles for its use in agricultural, which is price and dependence on distributors. In this sense, actions are needed to better conciliate both the interests of industry and rural producers. We suggest of the creation of public policies to support by-products's use since agricultural sustainability is a national interest.

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