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DATA MANAGEMENT IN PRECISION AGRICULTURE

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ABSTRACT

This article aims to address the use of technology in agribusiness, which has brought new management possibilities, as well as precision agriculture. Management systems are responsible for recording, measuring, managing, and analyzing geographically referenced information or data. Aiming to encourage the adoption of the precision agriculture practice, a data management system in precision agriculture was created, in a Web environment, maximizing the accessibility of the service to the user while also integrating a broader project, called AgDataBox, aiming to reduce the frontiers of knowledge from the integrated management. This is an exploratory research and the Webmodule of the AgDataBox project was developed using JavaScript, HTML, and CSS. With the availability of a Webinterface, users now have a multifunctional and objective tool to manage their rural property. The use of free technologies, therefore free of charge for the user, made possible the development of a system that is free of charge for users, which allows data management and property management oriented to the areas that need more specific care, aiming a higher productivity and possible preservation of the soil and the environment.

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INTRODUÇÃO

With the technological evolution that reaches all sectors of society, it becomes essential to use new improvement techniques that enable better management of activities and, consequently, improve business results. As a result, we realize that ways to catalog data and extract information are increasingly important in the current scenario, making its use a competitive advantage. Given this, the use of technology in agribusiness, in turn, brings new concepts and ways to manage the most diverse activities. The creation of integrated management platforms has enabled innovations such as data collection, information analysis, and cloud storage directly from the field. The use of already known technologies, such as GPS (Global Positioning System) and GIS (Geographic Information System), when combined with a management system, make it possible to manage rural property in an optimized way, allowing the adoption of the concept of precision agriculture. In the implementation of this type of agriculture allied with technology, the great emphasis goes to the management systems. These include several features that optimize production, such as information about the crop and operations performed in the field, as well as machinery and inputs available. This article aims to describe the functionalities of a data management system in precision agriculture. This data management system integrates a wider project, called AgDataBox, which is composed of several modules, which share tools. Moreover, it is also approached the need and the importance of the adoption of management systems, proposing a management module in Web environment for the AgDataBox project.

METHODS

This research is classified as exploratory and the method used was action research, as defined by Thiollent (2005). The elaboration of the management system made use of Web development technologies, allowing remote access in computers and mobile devices. We used languages such as JavaScript, HTML, and CSS according to the identified needs. The data management system is part of a larger project, called AgDataBox, which is composed of several modules that share tools. The fact of using free technologies, free of charge, made it possible to develop a system that is free of charge for users.

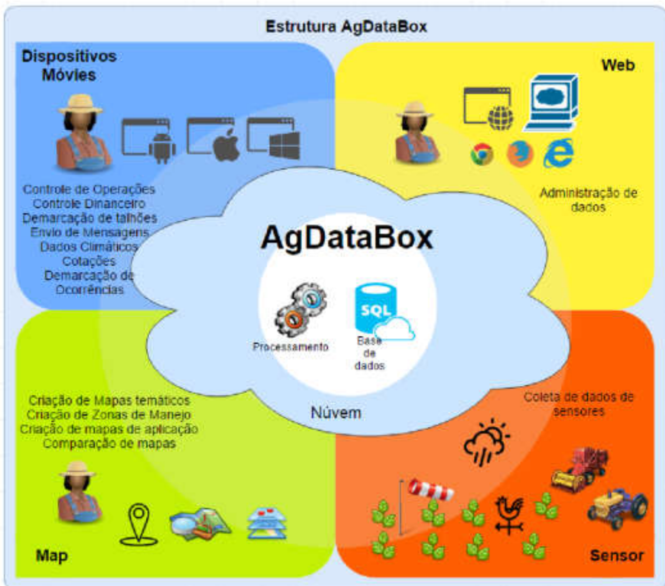
Precision Farming: Precision agriculture, briefly defined, consists of management practices for activities performed in the field, with the aim of optimizing the use of agricultural inputs, thus seeking to increase production capacity and reduce the impact on an environment that is currently already plagued (KOUNTIOS et al., 2018). The basis for the development of the technology that would be used in agriculture occurred in the 1970s when the United States Department of Defense began launching global positioning satellites (GPS) in space that would serve as an aid to military units (HADLEY, 1998). Although it was not idealized for the use observed contemporaneously, over the years, GPS has become an indispensable technology in people's lives, also having a relevant impact on agriculture. On this theme, Bazzi *et al* (2015) emphasizes that in the practice of precision agriculture, the main importance is the optimization of the use of inputs. This has the bias of minimizing possible negative impacts on the environment and human health. Its premise is to establish itself as a more advantageous alternative for cultivation, soil, and environment preservation concerning traditional farming practices. The use of management systems is a fundamental part of the whole necessary for the implementation of precision farming. In addition to enabling the use of precision farming, these systems provide a detailed history of the arable area and the type of crop employed. This history provides important and essential data for future decision-making. Currently, these agricultural data can be generated through several sources, being these: sensors, satellites, weather stations, robots, agricultural equipment, agricultural laboratories, farmers, government agencies, and agribusinesses. The analysis of these data allows farmers, companies, and agronomists to extract high business and scientific knowledge, improving their operational processes and product quality (NGO & KECHADI, 2020). As Pierpaoli *et al* (2013) states, many aspects necessary for the application and implementation of precision agriculture have been studied. These studies addressed the topics as relevant technologies, environmental effects, economic results, adoption rates, and causes of adoption and non-adoption. However, despite extensive studies and widespread dissemination in academic circles, a low adoption rate of precision farming techniques is reported. This low adoption rate has as one of its justifications the need for investment. For Bazzi (2007), one of the biggest obstacles to the development and implementation of precision agriculture is still the high cost of the equipment necessary for its realization. Thus, it ends up becoming more accessible to large rural landowners. This is especially harmful when considering the scenario of small family farmers, so important for the supply of the domestic market. Moreover, Bazzi (2011) further elucidates that precision farming can be considered the ideal form of cultivation if developed in a way that follows all the criteria of recommendations and concepts on which it is based.

Management Systems: The important management systems, previously discussed, are management tools responsible for recording, measuring, managing, and analyzing geographically referenced information or data. For their development, several programming languages and system development tools are used. The first management system for agriculture was introduced in the 1970s and had its use focused on record keeping and operations planning (FOUNTAS *et al*, 2015). Since then, management systems have evolved from simple farm record-keeping systems to large systems shaped in response to the growing need for methods that enable greater communication and transfer of information between databases and meet the requirements of different stakeholders. These new forms of systems were given the acronym FMIS (*Farm Management Information Systems*) (FOUNTAS *et al*, 2015). The market for FMIS covers many farming systems. The goal of today's systems is to meet present demands in order to reduce production costs, comply with agricultural standards, and maintain high product quality and safety. For this, farm soil mapping is one of its prominent functions. Also, according to Fountas *et al* (2015), much of commercial FMIS features a range of generic functions. One of these functions is called field operations management. It covers the recording of farm activities and also helps the farmer optimize crop production and plan future activities. Other functions relate to financial control and inventory, respectively. They perform the cost estimation of each farm activity, as well as the monitoring and management of all equipment, fertilizers, and machinery used on the property.

Also similar to the previously mentioned functions is the FMIS tracking technique. It, similarly to functions mentioned above, is responsible for recording the use of equipment, materials, and assisting in the control of farm employees. Such a function proves especially beneficial on farms with large numbers of workers and machinery, making it easier to control, manage, and direct them (FOUNTAS *et al*, 2015). The use of GPS and GIS technologies contributes to the improvement and use of FMIS and is part of what makes precision agriculture possible. Their use allows field boundaries, roads, irrigation systems, and problem areas in crops, such as weeds or pest-damaged areas, to be mapped (FOUNTAS *et al,* 2015). In this way, management systems enable the producer to manage his property with more precision, optimizing the time and inputs he has available, so that his property becomes more profitable and productive as production costs are reduced. For Nikkila *et al* (2010), it is essential for the operation of all elements of precision agriculture the existence and use of information management systems. These systems, therefore, must be able to store sensor data and the data of the operations generated by agricultural implements. Furthermore, Husemann *et al* (2014) states that accurate and easy-to-use FMIS are of fundamental importance for successful operational exploitation management.

Agdatabox: The use of management systems in this article is also part of the Agricultural Data Box project. This project has been developed with the objective of making free computational tools available to rural producers, researchers, and service providers, focused on precision agriculture. Its main intention is to enable the agricultural branch in the country employing free technologies. Conceived by Bazzi et al. (2015), the project was initially developed and made available as a *desktop* application to generate management zones and thematic maps in precision agriculture. However, aiming to improve its use and integrate more functionalities, its architecture was remodeled for use in a *Web* environment, giving rise to the current AgDataBox project. The purpose of AgDataBox is to assist professionals who use precision agriculture in their agricultural crops, especially in the management of field information, to translate it into easy-to-understand multimedia presentations, which also enables decision making for the execution of agricultural activities (MOREIRA, 2019). Its development also aims to make free computational tools available to farmers, researchers, and service providers focused on precision agriculture, intending to improve the agricultural industry through free technologies. Thus, its use is totally free. All the developed environments were created using free tools in order to make the project viable without the need for additional costs, such as license and support. The project consists of five distinct modules, each represented by a system, these being API, Mobile, Map, Sensor, and *Web.* According to Borges (2020), the structure developed in the AgDataBox project allows users to share their data (study fields) between different applications, developed by different programmers, in different programming languages, for different purposes.

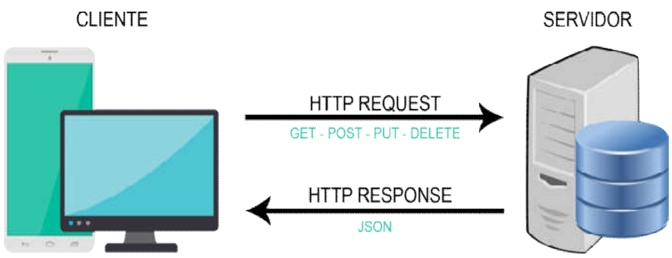
Figure 1 shows the structure of the AgDataBox project.



Source: Jasse *et al.* (2017).

Figure 1. Architectural model of the AgDataBox project

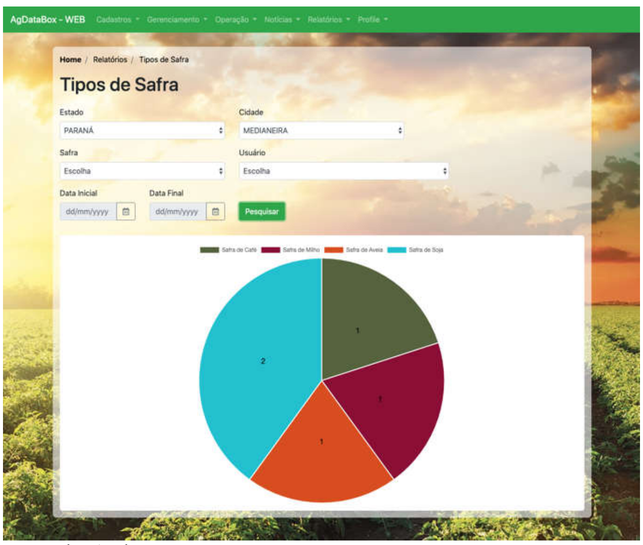
These modules work independently, having the AgDataBox API as a common point. This API uses a *REST Web Services* pattern to enable integration between modules. Therefore, through an HTTP request, the modules consume the API using methods such as GET, POST, PUT and DELETE to perform operations. Each functionality in the API is defined and made available for consumption through its HTTP method and its URL. Figure 2 shows the resource consumption flow of the *REST Web Service*.



Source: The authors.

Figure 2. *REST Web Services* consumption flow

This data flow starts by authenticating the user. When consuming the authentication functionality, using email and password, the API validates the information and, in case of success, returns an access token to the client application. With each new request, client applications must inform the access token in the HTTP request *header*. Upon receiving the requests, the API checks whether the token is valid and then can proceed with the requested request. The API, in turn, represents the central module of the project. It contains the business rules and access to the database. Thus, all data collected by the project modules are provided to the API, which processes the requests and stores them. This storage is done in the cloud, allowing access to the data in real time, working as a centralized, secure, and highly available repository. An important quality of the project stands out, which is the fact that it is based on a security control where the user, through the authentication interface, informs his e-mail and password to then gain access to his data. In the general administrator scenario, the user is allowed unrestricted access to all API data, having access to all information related to all users and their respective use of the platform. You can also manage content and evaluate usage metrics by viewing management reports. Another important tool present in the project are the reports, which are essential tools in management systems. Through their use, it is possible to obtain filtered and grouped information by areas of interest, providing a clearer and more detailed view of the evaluated scenario. The reports are presented in tabulated form. This allows the evaluation of the results coming from the research in the form of paginated tables. In the case of quantitative reports, the information is presented in pie or bar charts, allowing the user to interactively view the data presented. Figure 3 represents the graphic reports.



Source: The Authors.

Figure 3. Quantitative graphical report

Thus, by using the reports, the rural producer can more efficiently identify the areas of his property that need more specific or differentiated care. This allows resources to be used according to the degree of need for each area. It is a dual-purpose function. It allows the user to assist in using the system to evaluate results, as well as making it possible to extract general usage metrics from user-defined comparisons. In this way, crop data management allows a more informed action by the producer, in order to optimize the use of the property resources and improve the quality and quantity of production. With this, a management that also generates positive impacts on the preservation of soil quality and the environment is made possible.

CONCLUSION

This article discusses the characteristics and application of a data management system for precision agriculture in a Webenvironment, accessible through any computer or mobile device with Internet access. Through it, it is intended that the user has a multifunctional and objective tool to manage his property. Through the use of technologies and tools available in the market, the integration between the modules that make up the AgDataBox project allowed to unify the users' data in an environment that aims to be unique, intuitive, and easy to use. The centralized data API in thiswebsystem provides a practical way to manage the information collected by mobile applications and sensors. With more space available for data presentation, the user experience becomes richer when viewing reports and performing data analysis. In turn, the use of free technologies, free of charge, made possible the development of a free system for users. This way, the user has the possibility to use all the tools available in the AgDataBox project to manage his activities, thus reducing damages to the environment, minimizing production costs and consequently increasing his profitability. Moreover, the availability of reporting and data management resources allows a better use of resources, as well as a more targeted management of the property in the areas that need more specific care, aiming for greater productivity and possible preservation of the soil and environment. The possibility of data management from the general manager's perspective offers a practical way to assist the user in using the system, aiming to decrease the user rejection rate and thus stimulating the practice of precision farming.

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