PRECISION AGRICULTURE (PA) SUPPORT OF INCREASING AGRICULTURAL PRODUCTIVITY

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Abstract: This work describes the increasing agricultural productivity challenges in the context of precision agriculture (PA) application in Colombia. To carry out the development of the research, we analysed the application of artificial intelligence (AI) projects in the country. So, performance evaluation metrics considered, both for efficiency, quality in the learning, classification and cost-benefit. Some contributions identified in the development in this work are: A high effectiveness in the precision agriculture system using artificial intelligence techniques in the detection of healthy and infected leaves and the notable decrease in time to detect healthy and infected leaves, increased food security and most likely higher profits to the farmer.

Keywords: Agricultural productivity, Artificial intelligence, Precision agriculture, Potato crops, Security foods.

Introduction

Nowadays, agricultural development plays a major role in improving of life quality in all countries. The precision agriculture (PA) is an innovator and optimum field level management strategy and can be applied in different agriculture crops; this method aims to improve the productivity of resources on agriculture fields using information technology IT (Alcaraz, Jimenez 2018, p1). This work shows the need to formulate strategies to improve the quality of crops, reduce the impact on the environment and increase quality life. Given that the current trend is to align the agricultural sector undertakes with the continuous increase and development and application of new technologies. Reviewing the Colombian environment, it is evident that the immersion of information technology IT is one of the best lessons learned to improve the quality of life in the rural community and especially the use of solutions such as PA. Of course, from the current view of PA as a global trend that implies an emerging technology for agricultural and industrial purposes (Sanchez 2019, p2).

In Colombia PA is used as a management strategy that employ a technology cheap to improve decision-making in crop production. The application of PA to different tools such as the Internet of Things (IoT) facilitates the application of traditional agronomic knowledge or methods in a precise and automated way.

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Literature review

According to the International Society of Precision Agriculture (ISPA), PA is a management strategy that collects, processes and analyzes temporal, spatial and individual data and combines it with other information to support management decisions according to the estimated variability, and thus improve efficiency in the use of resources, productivity, quality, profitability and sustainability of agricultural production (Herrero et al. 2016, p.3). Precision Agriculture (PA) refers to the use of technology to collect and process data from different electronic and optical devices and geographic positioning systems (GPS) to carry out targeted cultivation tasks just in time, with the required doses of the inputs to monitor them (Sanjeevi 2020, p.5). Thanks to the AP, producers can make more efficient decisions about the seeds they are going to plant, the field where they are going to sow, and they are even able to predict the yield of the harvest, which makes the work much more precise (Nicol 2021, p.2). A considerable number of publications have been found that discuss the application of IT in precision agriculture. It was detected that the implementations were driven on applying the technologies in some of the agricultural activities. In our case study: Potato crops in Colombia, the strategies of application of PA is around florescence stage.

Methodology

We recommend that application of PA techniques enables a reduction in the amount of fertilizers and other agrochemicals, the countries can have enormous benefits in terms of reducing greenhouse gas emissions and less pollution of the soil and bodies of water. The goal is provided knowledge, best practices and strategies related about the main information technologies used in PA; and as this strategies can be employed in our country.

Agriculture in Colombia has always been a work of inheritance, the grandparents taught their parents and then their children, they brought them all the knowledge they had learned over the years. This is a slow development, but it has reached a satisfactory performance point, which is why most farmers dominate their daily life. However, in countries that have historically invested in the development of engineering for their applications in the field, they have discovered advances that allow us to achieve productivities three to five times greater than that of our own country. In Colombia, there are some PA applications that allow optimizing the production, fertilization and pest control process in oil palm, rice, coffee, sugar cane, tomato and potato crops, the latter being the main source of income. in cold area of the country. However, there are few or no studies on the benefits in the field in the application of PA specifically in potato crops. For all these reasons, PA is perhaps the most important pillar of sustainable agriculture. It is essential to adopt these new production models in order to guarantee sufficient agricultural production. The proposed PA cycle for potato crops could be summarized in the 4 stages shown in Figure 1:

⇒ *Information acquisition: which allows the collection of data through different sources. Agroclimatic data, harvest data, soil sampling, phytosanitary fertilizers.*

⇒ *Information analysis: which allows evaluating the evolution and incidences of the crops. Generation of predictive models based on historical data and current data.*

⇒ *Decision-making: decision-making for the control and prevention of crops.*

⇒ *Application: Crop Protection, Monitoring and Collection.*

Figure 1. Proposed cycle for PA and applications in Colombian agriculture

Source: Authors.

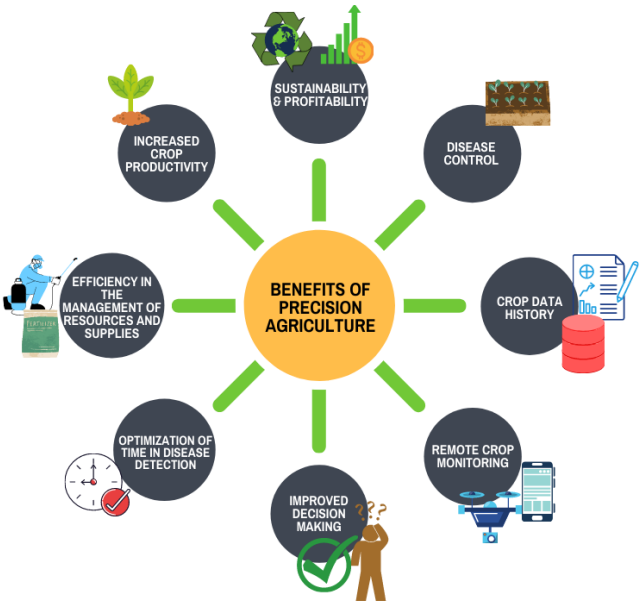
The proposed cycle begins with the acquisition of data from the crop and its environment. For this, sensors, cameras, visual observations and conventional samples to georeferenced are used. These data can be on the geometry of the crop, on the amount of biomass, on its vigor, on its state of health, on the characteristics of the soil, etc. Once the data is obtained, useful information must be extracted for the farmer and / or the technician. One of the information obtained is whether the crop is developing correctly and uniformly throughout the plot. This information will be used in the Decision-Making stage. This stage is where the agronomic management operations to be carried out and in what way are decided. Finally, it is

possible to act in the field in order to apply the necessary resources or carry out the necessary operations.

Results and Discussion

The benefits of using PA in potato crops can be considerable in technical, ecological and economic aspects. The recognition and detailed evaluation of variables at specific sites make it possible to monitor and correct identified problems. This technology contributes to producing a more efficient and ecological agriculture. It allows you to save on plant protection products, fertilizers and reduce the amount of nitrogen used. This reduces costs and makes it possible to optimize agriculture, see figure 2. It reduces the environmental impact by optimizing the use of water, pesticides and machinery fuel; Thus, with fewer resources, greater production is obtained.

Figure 2. **Expected benefits with PA**



Source: Authors.

Making the most of the productive potential of soils is one of the advantages of applying this technology in agriculture. Farmers are more efficient thanks to the use of sensors because they only use the amount of inputs necessary for the production of crops. In addition to reducing the use of fertilizers, reducing the waste of resources and maximizing the yield capacity of the land lead to increased profitability by reducing economic risk in the decisions of farm owners. Another benefit of precision agriculture is the ability to achieve responsible water management, which is made

possible by variable leveling and irrigation systems that can be operated remotely and in real time by farmers using mobile devices.

Conclusions and future work

There is a paradigm that the benefits of PA are only for large crops with large capital investments and expertise in information technology. It is necessary to break this paradigm, since currently there are techniques and different types of analysis and economic methods that are easy to apply and develop for any producer regardless of the number of hectares the land has, this aspect involves potato crops.

Potato crops are one of the main economic activities in Colombia, which is why they are vital for the country's agricultural development. In addition, information and communication technologies (ICT) have begun to be used and implemented throughout the life cycle of crops. Therefore, they are very important when defining a system based on PA that has the ability to increase crop yield and optimize the use of economic resources such as fertilizers, water and pesticides, among other functions.

We can conclude that this work provides an analysis of the AI technologies applied in PA for sustainable agronomy. PA is a useful insight about the ways of technical development in smart farming. This paper has a significant and useful contribution for emerging areas in PA research such as: To be Environmentally friendly, optimize rates of fertilizer, seed and chemicals for soil. To ensure the goal of sustainable agronomy, following future research areas are identified from this systematic review. Every day new technology is cheaper. New intelligent software platforms and advanced technologies like machine learning can further help in development of PA.

References

1. Alcaraz, J., Jimenez J. (2018). La aplicación de la agricultura de precisión en el proceso de fertilización: un caso de estudio para el sector bananero del Urabá-Antioqueño, https://repository.eafit.edu.co/bitstream/handle/10784/12581/JuanGonzalo_JimenezTrespalacios_Joh nJames_AlcarazRestrepo_2018.pdf? (access: 30-04-2021).
2. Sanchez, G.(2019). ¿A dónde nos llevará la agricultura de precisión?, https://www.agroneg.cios.co/analisis/gabriel-sanchez-2830947/a-donde-nos-llevara-la-agricultura-de- precision-2830945 (access: 25-04-2021)
3. Herrero, I., López, Y., Alfonso, P., & Roach, E. F. (2006). *La aplicación de la Agricultura de Precisión: su impacto social.* Revista ciencias técnicas agropecuarias, 15(3), 42-44.
4. Sanjeevi, P., Prasanna, S., Siva Kumar, B., Gunasekaran, G., Alagiri, I., & Vijay Anand, R. (2020). *Precision agriculture and farming using Internet of Things based on wireless sensor network.* Transactions on Emerging Telecommunications Technologies, 31(12), e3978.
5. Nicol, L. A., & Nicol, C. J. (2021). *Adoption of Precision Agriculture in Alberta Irrigation Districts with Implications for Sustainability*. Journal of Rural and Community Development, 16(1).