## Study of Startups in the cloud to innovate agricultural production in Ecuador (IoT, data in the cloud)

Estudio de Startups en la nube para innovar la producción agrícola en el Ecuador (IoT, datos en la nube)

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#### ABSTRACT

In Ecuador, startups have had a remarkable growth in the last decade due to the extensive amount of benefits they offer by using current technologies in the provision of a service or within production processes such as in agriculture, therefore it is considered necessary to describe them and show what systems they use in favor of innovation and increased agricultural production. Within this document, documentary research will be used to collect information, describe the current situation in Ecuador in this area, demonstrate the benefits that IoT and the use of Big-Data can mean.

**Keywords:** Startups, agricultural production, technology, IoT, Big-Data

#### RESUMEN

En el Ecuador las empresas Startups han tenido un crecimiento notable en la última década por la extensa cantidad de beneficios que ofrecen al utilizar tecnologías actuales en la prestación de un servicio o dentro de procesos productivos como en la agricultura, por ello se considera necesario describirlas y mostrar que sistemas utilizan a favor de la innovación y el incremento de la producción agrícola. Dentro del presente documento se empleará la investigación documental para recolectar





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información, describir la situación actual del Ecuador en este ámbito, demostrar los beneficios que los IoT y el uso de la Big-Data pueden significar.

**Palabras clave:** Startups, producción agrícola, tecnología, IoT, Big-Data

## INTRODUCTION

Businesses and other productive sectors worldwide were drastically affected by the pandemic caused by Covid-19 at the beginning of 2020. In response to this problem, a considerable growth of startups and other companies that provided a specific service through the Internet using the characteristic of automation and direct connection without using human resources in the process began.

The enterprises that were most welcomed were those dedicated to technology, information and communication, as shown in Fig.1, since it was necessary to have it in order to carry out different activities within the productive sector, in addition, institutions emerged that provided technological services in replacement of certain actions where human resources were used.





Within the same field, the agricultural sector became one of the most important sectors due to the mandatory quarantine in Ecuador and in several countries worldwide, all of which negatively affected the national agriculture since it was complicated to acquire the necessary tools and materials for the production and distribution of its products. Statistics indicate that production within agriculture decreased by 9% (RIMISP, 2021). (RIMISP, 2021) approximately, due to various factors such as the application of major inputs and other control procedures that are essential to produce quality products.

This does not take into account the instability of the agricultural sector, which does not allow us to know whether the harvested products will be in demand in the local market. All this was also reflected in the economy of the producers, and due to the lack of liquidity, they decided to reduce their investment, reducing the amount of production and availability of several agricultural products.

In Ecuador, approximately 64% of the production generated by agriculture corresponds to small producers or also called Peasant Family Farming (AFC), but this percentage does not capture even 50% of the national demand, but in turn generates employment for 38% of the economically active population that is mostly located in rural areas, being agriculture their source of work.

Another phenomenon that affects agriculture is the drastic climate changes where droughts occur for long periods of time affecting producers of grains such as rice or corn, where the proper use of resources such as water is reflected in the producer's economy.

The coastal region represents the greatest economic loss since it accounts for 66% of national agricultural production, with Guayas, Los Ríos and Manabí being the areas most affected by the droughts.

In the presence of the circumstances described above, it is considered to describe cloud startups as a way to improve agricultural production in Ecuador; all this through the analysis of the agricultural sector in general and its production level, and then propose recommendations that will favor the increase of production in the agricultural sector.

Among the current technologies that are being reinvented day by day are those that are intended for the agricultural sector with the sole purpose of reducing costs within the process, redistributing efforts and above all improving the productivity of their crops; where you can find a classification according to the type of needs, such as the automation of certain processes together with the use of robotics, biotechnology, E-Commerce together with intelligent systems and Big Data.

Another technology that is making inroads in the industry is the Internet of Things (IoT), which is capable of analyzing the level of humidity in the environment and even recognizing pests, all through automated systems that generate efficient production and reduce risks, all linked in a network structure for the transmission of information, as shown in Fig. 2.

Articles



**Figure 2.** Structure of information transmission. Figure taken from (Xu, Gua, & Tian, 2022).. Information taken from (Jinyuan; Baoxing; Guangzhao, 2022).

All this set of technological innovations is offered by startups, which offer great possibilities for growth within agriculture, making them one of the business models that tend to scale and progress more easily.

Startups also generate sources of work and opportunities for other technological sectors such as drone institutions, which can fulfill various procedures within the agricultural sector, providing accurate data and better resolution compared to satellites or even supplying insecticides or other chemicals needed to ensure a good harvest. Among the countries that have technology within their production processes in the field of agriculture are Japan, Germany and the United States, which use materials for soil, weather control, water control and monitoring of plants, which collect as much information as possible for crop optimization (Xu, Gua, & Gua, & Xu, Gua, & Xu, Gua, & Gua, 2006). (Xu, Gua, & Tian, 2022)..

Knowing the potential that the "IoT" Internet of Things can provide, it can be indicated that its scope and development within existing applications can be infinite; all this is possible with the complementation of sensors, chips, hardware, databases and much more; the use of the appropriate component will depend on the category in which the company is located, whether industrial, environmental or to the community. (Anand &

Sharmab, Comprehensive analysis of services for improving safety in IoT-based agriculture, 2022)..

The Hybrid Energy-Efficient Distributed Clustering (HEED) protocol is considered an indispensable tool that provides several benefits within the network system needed to power the IoT for extended periods of time. (Anand & Sharmab, Comprehensive analysis of services to improve security in IoT-based agriculture, 2022)..

- Increased performance: Provides greater power within the network of linked computers.
- Improved scalability: Information and resources can be expanded considerably according to the complexity and population of users and the reports they require.
- Simplified administration: Clustered clusters and massive systems can be easily managed and rapidly expanded.

Networks based on IoT technology help an efficient consumption of energy resources and depending on the implemented system even provides the ability for owners to generate their own energy eliminating dependence on public or private institutions, this is reflected in the economy of the company avoiding charges or additional costs. (Yang, Yu, & Hu, 2021).

Within the real-time data transmission architecture, the components must have a distributed structure to follow three consecutive steps, which are:

- Data acquisition
- Data processing
- Display and storage

The design will have the objective and function of moving the information to all devices that require it, reducing the processing time and data transmission in real time, providing a great utility for the interests and benefits of the company that applies it (Malek Y., et al., 2017).

In agriculture, sustainable practices are required, especially in irrigation, in order to meet the constant growth of the population, being water the most important resource used in agriculture. With the use of IoT, water consumption can be reduced by 46% in relation to its conventional use; this is possible thanks to the technology that manages to detect the amount of water needed by the plant to provide a good production, supplying it automatically to keep the plant in optimal conditions. (Lakshmi, et al., 2022)..

There are challenges that arise when wishing to implement these technological systems in rural areas, which is where the work of agriculture predominates, the most potential challenge being access to the internet or technological elements where most of the population in these sectors is unaware of the proper use of all these tools. (Anand & Sharmab, Comprehensive analysis of services to improve security in agriculture based on IoT, 2022).. Implementing these systems within agriculture without prior planning tends to fail if not properly instructed, since constant manipulation of hardware and software is performed in order to obtain desired production results; therefore, training in the use of tools is necessary to implement all systems in large or small agricultural sectors. (Anand & Sharmab, Comprehensive analysis of services to improve safety in IoT-based agriculture, 2022).

Drones are also associated with opportunities and great challenges within agriculture, among them the monitoring of the plantation and its monitoring, but in addition to that there are other applications such as the distribution of the necessary chemical components in the plant (Van Der Merwe, Burchfieldb, D. Wittb, P. Price, & Sharda, 2020)..

Unmanned aerial vehicles (UAVs - Drones) help a lot within agriculture, as they perform the function of spraying and/or spraying pesticides, fertilizers or insecticides effectively, benefiting crop production improvement (Subramaniam, et al., 2021).

## I) Intelligent agriculture

Within agriculture, new technological trends are being incorporated that help to make better decisions and optimize resources, which entails multiple advantages when implemented or included in the agricultural sector.

International organizations such as the United Nations Food and Agriculture Organization (FAO) expect that in the next 25 years agricultural production could increase by at least 65%, which would be necessary to cover the overpopulation up to that time, in addition to which the population increase also decreases the available space for agriculture.

Among the benefits of including technology in agriculture is the generation of greater profitability, due to the reduction of costs in the resources to be used such as water, fertilizers, fertilizers, among others; where only what is necessary for the crop is used, which means increasing the quality of the product and the quantity produced.

The control of all activities allows to generate a record of information within a database that will help to know the state of the crop in general and which characteristics can be improved to take the necessary corrective measures, having absolute control of its production and the resources that have been used.

This type of systems are efficient and sustainable, which produces a favorable impact on the environment, contributing to the processes and reducing their impact, improving the quality of life of the environment where they are implemented.

This type of innovations implies having a collaborative relationship with companies, government and citizens to function as open societies caused by the exchange of information and knowledge within the digital space and to be able to store them within the Big Data, being one of the drawbacks the insufficiency of internet access within the

areas to be used that are generally located away from cities and in rural areas. (Parada, 2017).

# 2) IoT and Agriculture

IoT (Internet of Things) is directly linked to precision work because of the features it displays such as data storage, monitoring and evaluation that starts from the time the seed is sown until the fruits are harvested.

Among the operations that can be carried out with this technology within agriculture are:

- Establish the characteristics of the soil, humidity, composition, among others, and the conditions in which each of them are found.
- It establishes, according to the previous point, how to start the agricultural process, from the selection of adequate seed, furrows and other information necessary to obtain a quality product.
- Establish suitable forms of risk for planting, pesticides and fertilizers.
- Define the sustainability generated by the entire cultivation process.
- Provides continuous monitoring of crops from planting to harvest.
- It provides information to correct irregularities present in the crop.

All the features described above allow plant cultivation to be controlled and analyzed with automated technology that can be reviewed on any device from any location with an internet connection.

One of the great benefits of using technology in agriculture is the time savings, since the information arrives directly to the device without the need for a detailed review of the plantation, and the system itself provides corrective alternatives that can be applied automatically.

## 3) The Big Data

It refers to the combinations of data sets and information that are stored for visualization or statistical relation used for a specific purpose, being organized structurally to obtain immediate answers. Generally, this type of systems are used to collect data and identify the inconveniences that allow a quick solution to the detected problem, even helping to prevent the inconsistencies found from recurring.

Within agriculture, Big Data involves analyzing large amounts of information efficiently and quickly, information that is useful in the field to make more accurate predictions, improve crops and optimize the yield of resources; it also helps the sustainability of the environment with the necessary use of pesticides and / or fertilizers of chemical origin. Among the benefits that Big Data brings to agriculture are the following:

• Reduce operating costs by improving input utilization.

- Decision making based on the information obtained and its respective interpretation.
- Accurate field decisions based on climatic data collection.
- Immediate monitoring and access to crop status.
- Increased production as a result of sound crop management decisions.

### 4) Startups and the Cloud

The cloud has improved the way of working in general, being the Startups who use it from day one for its work structure, allowing to innovate and grow in secure, agile and flexible systems. The use of the cloud avoids excessive costs when a company or institution starts, allowing them to pay for the services they use, but this does not mean that they cannot access to countless functionalities since startups offer that accessibility to information allowing a level playing field for every company.

In summary, the cloud is very favorable for Startups, since it allows for the optimization of existing systems, growth capacity, increased efficiency of operations and greater agility. Unlike physical servers that can take time, the cloud does it in minutes providing benefits to startups in general. (Sanchiz, 2019).

Currently, there are technologies that join together to develop and provide solutions to those who require them, among them are the Startups that seek to innovate on the traditional industry with technological ideas that for some sound unattainable; given the high potential offered by the Startups in the market, investment has increased in recent years in Latin America, as shown in Fig. 3.

**Figure 3.** Increase in Startup Investment. Information taken from (Malagón Arturo; Treviño Rodrigo; 2022).



International companies such as Uber, Rappi, Netflix, among others have achieved their business boom through the use of the cloud, providing important benefits such as:

- Provide multiple solutions in a matter of minutes.
- Operate through secure environments that back up information.
- It uses ways to scale and launch the requested information.
- Streamlines the provision of alternative solutions.
- Constant innovation in an agile and economical way without affecting previous information.

Regardless of the organization, the management of the cloud varies and depends on each Startups, causing the balance between the type of information stored and the necessary services and depending on it will show its competitiveness within the market.

## MATERIALS AND METHODS

The collection of information and data needs to be employed by a methodological process appropriate to the type of research being conducted, this being a theoretical/documentary type of work the process of acquiring information must comply with three basic characteristics which are; document review - reading and recording information - elaboration of the final text. (Tovar Soto, Solórzano Suárez, Badillo Rodríguez, & Rodríguez Cainaba, 2019)..

Each of the characteristics fulfills a specific function; the first corresponds to the collection of information in the different search engines and/or available texts that provide data related to technology in agriculture and how it affects this sector in Ecuador and South America.

The second phase searches for the specific subtopics and other components involved in agriculture and their relationship with the technological and automation components, as well as data related to the research topic and whether there are statistical data that show such information. The third phase expresses all the data found and shown in this document.

### B. Type of research

For this document we used documentary and descriptive research, where through publications, journals, articles and bibliographic documents we obtained the necessary information from different national and international repositories such as Scielo, Redalyc, Dialnet, Líderes Magazine, Espacio Magazine, Primicias, among others; essential to select the appropriate and necessary information for the topic of study.

## I) Documentary research

Documentary research has qualitative characteristics, in addition to the fact that it can be associated with historical research, allowing the sampling of past data or future projections, but maintaining the logical order of the information.

### 2) Descriptive research

The descriptive form as a type of research has the function of explaining all the reasons that take place within the research work and the chosen sample, being used even in future research, regardless of its type. The information provided by descriptive research must be truthful, precise and systematic. Inferences about the phenomenon should be avoided. (Guevara Alban, Verdesoto Arguello, & Castro Molina, 2020)..

## C. Study sample

When talking about agriculture in general within Ecuador and its relationship with technology for the improvement of its production, it is not possible to use a random or probabilistic approach that indicates a specific number of elements considered within a chosen population; therefore, the type of sampling that is coupled to the characteristics of the type of research employed, is the non-probabilistic sampling with a tendency to intentional or called by judgment, since they depend exclusively on the researcher's judgment (Gallardo Echenique, 2017).

This type of sampling is ideal for this research work, which shows a generalized topic and does not require specific data as in other types of research, where only those elements that meet the characteristics of analysis and the objectives will be selected.

### D. Techniques and instruments

The collection of data and/or information can be qualitative or quantitative, so it is important to know what type of information you want to know; regardless of its type, it is necessary to use the appropriate techniques to obtain the desired data within the research being carried out.

By using a documentary and descriptive type of research, it can be indicated that this characteristic is also reflected as a technique, where the information described in the different sources of consultation is reviewed in order to analyze and express the current conditions of agriculture at the national level and how the implementation of new technologies can be beneficial for the increase of production in this field.

The instruments employed and used will be all those that can show physical or digital documents, necessary for the selection of the text or part of it that contains information relevant to the topic of study within the present research, while the techniques used as the observation and analysis of the texts will be in charge of reviewing the content and identifying the most relevant and necessary parts within a specific document.

# RESULTS

It is estimated that with the use of the traditional production methodology in agriculture by 2030, important foods such as basic grains consumed locally and globally will be considerably reduced, because they will not be able to meet the needs of the population, which is increasing considerably over time and at the same time reducing the amount of land available for agriculture, as shown in Figs. 4 and 5.

**Figure 4.** Relationship between population (red) and area available for agriculture (blue). Information taken from (Plantae Agro; FAO, 2020).



*Figure 5.* Projection of Agriculture towards the year 2030. ). Information taken from (Plantae Agro; FAO, 2020).



This represents a major national and also global problem affecting not only the agricultural sector and the population in general, in the face of these negative projections and in the search for appropriate alternative solutions appear Startups companies with

technological resources based on the internet such as Big Data and IoT that can be implemented in agriculture to improve production.

The benefits of using the Technology of Things within agriculture is that it has a wide variety of tools that can be adapted to any type of plantation with the same objective, which is to increase production, reduce costs and improve the use of chemical resources and water, as shown in Fig. 6.

*Figure 6.* Inclusion of Sensors in Agriculture. Information taken from (Tovar; Solorzano et al., 2019).



In Ecuador there are few cases of technology use in the agricultural sector, but those who have already implemented it show that there are many benefits that this type of system can provide. Marco Reinoso V. (Reinoso Villamil, 2012) in a publication, carried out a study between two agricultural companies with the implementation of the technology, showing that not only did production improve, but also the flow of income increased.

*Figure 7.* Increase in Cocoa Production. Information taken from (Reinoso Marco; Zabala Victor, 2012).





*Figure 8.* Increased Revenue Stream. Information taken from (Reinoso Marco; Zabala Victor, 2012).



Fig. 9: Increase in the production of "Co." cereals. (Alcaraz Restrepo & Jiménez Trespalacios, 2018).. Information taken from (Alcaraz Jhon; Jimenez Juan, 2018).

Figure 10. Increase in the production of Cereals "Co." (Alcaraz Restrepo & Jiménez Trespalacios, 2018).. Information taken from (Alcaraz Jhon; Jimenez Juan, 2018).

Articles



The document contains important and detailed information despite the fact that there are almost no results of the implementation of technology or systems by Startup in Ecuador, showing the reality of the current situation of the country, where most of the people engaged in this work are in rural areas who do not have sufficient economy to invest in technological systems, due to the increase of unemployment in the country added to the fact that poverty increased by approximately 7.4% in relation to previous periods, forcing the population to sell their assets or use their savings to face the current crisis. (Schling, Salazar, Palacios, & Pazos, 2020)..

All this despite the fact that public management with its institutions has developed several innovations within the agricultural sector for different plantations that are developed in the Ecuadorian territory. Since technology is one of the best ways to optimize and improve almost any type of productive process, it is no exception in agriculture, where it can improve the quality of life in rural areas where it is practiced and at the same time generate sources of employment within them; However, it is also necessary to consider the economic factor that is indispensable to implement technological systems and that represents a challenge for the rural population, since the country's economy decreased by 13% and continues to increase. This, added to the low academic formation of the rural population, makes the insertion of technology in agriculture difficult, since people who have been working in the traditional way for several years find it difficult to apply another methodology than the one they already know.

## CONCLUSIONS

Technological innovation is one of the ways that can help the growth of agriculture due to the sustainability and the different benefits it offers, being the increase in production one of the most outstanding, in addition to the optimization of the use of resources within the plantation and the support to the environment; therefore, it is considered necessary to create economic funds within agricultural companies to invest in innovation and technology.

The insertion of these systems in agriculture adds value to the final product and to all the actors involved in the process. Ecuador, being an eminently agricultural territory, should seek alternatives that provide greater productivity and added value to its products, which are even exported internationally, in addition to constant training that allows the proper management of the technology implemented.

Startups in conjunction with systems such as Big Data and IoT applied to the agricultural sector, represent greater control, monitoring and automation of crops that also guarantee increased crop yields and opportunities for constant growth. Internet service becomes a necessity for the implementation and management of systems, but also for the rural population, where connectivity must be managed with companies that guarantee the quality and stability of the service, which started their growth locally after the pandemic.

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