# Reinventándose para la Competitividad Post-Covid-19

COORDINADORES

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Reinventándose para la Competitividad Post-COVID-19

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# PRÓLOGO

Bajo las condiciones de pandemia que se han presentado en el mundo desde 2020 hasta fines de 2021, se han detectado nuevas estrategias y modelos de hacer negocios, originado por la virtualidad, donde la inteligencia artificial ha tenido un fortalecimiento conjuntamente con la analítica y big data, creando y abriendo nuevas oportunidades en los mercados y en sistemas más flexibles y esbeltos en la generación de alternativas de valor.

Estas nuevas realidades se presentan en el libro, para ello, se hacen estudios de calidad de vida en los observatorios, los impactos de la inversión extranjera directa en países latinoamericanos, los efectos resilientes en la gestión de los restaurantes, en zonas turísticas rurales y como fuente de ventaja competitiva, qué impactos en el desarrollo se han generado por la política comercial en América Latina, las mejoras de productividad en diversas industrias, además de la cooperación en unidades de producción hortícola, efectos de la digitalización en la industria cervecera, estudios de clústers, la mercadotecnia en la industria del té, efectos de sucesión, la competitividad en comunidades de España, las capacidades tecnológicas en mipymes, así como estudios de éstas desde la ecología organizacional, por otro lado, las brechas  competencias laborales y la Resiliencia y endomarketing en el sector electrónico.

Como segunda parte del texto, se incluyen dentro de la educación, gestión del conocimiento y creación de valor, estudios sobre las incapacidades que inhiben la gestión del conocimiento en miýmes, la producción científica en la investigación educativa, los mapas mentales como estrategia inteligente en educación superior, los impactos del covid en la educación en México, la percepción de la calidad en la educación durante covid, así como la deserción escolar, la aplicación del balance scorecard en educación, la gestión del conocimiento en la industria de autopartes y en la competitividad de las universidades, así como el desempeño organizacional, por otra parte trabajos sobre la incidencia de actitudes y factores socio afectivos en el aprendizaje del inglés, estudios sobre la gamificación de la educación superior, estudios de seguimiento de egresados, para finalizar estos tópicos con  el modelo de competencias docentes, todos ellos considerando los efectos que en la competitividad se generan por las variables ya citadas.

En relación con el tercer capítulo, se analizan las estrategias financieras, el emprendimiento, la cadena de suministro y la perspectiva de la era digital, para ello se realizan análisis de los esquemas de contribución definida en los planes de pensiones, la propuesta para optimizar el capital en el subsector de la construcción, los impactos del comercio electrónico como factor de reactivación económica en los minoristas afectados por el covid, aplicación de TICs para reactivación económica, estudios sobre

el riesgo empresarial y la rentabilidad del sector servicios, por otro lado, los precios de acciones de empresas que cotizan en BMV, los impactos de la industria 4.0 en la cadena de suministro, además de los efectos de los flujos de efectivo en la tasa de crecimiento, el endeudamiento y educación financiera, análisis de productos financieros para líneas de crédito de jóvenes, los factores clave en las importaciones de papaya por parte de EU, añadiendo estudios acerca del emprendimiento femenino, los factores estratégicos de mejora en cadena de suministro y las características socio culturales y género en el emprendimiento.

Como siguiente capítulo se realiza sobre la competitividad global, para ello se efectúan estudios psicosocial de la innovación cinematográfica, las causas de cierre de mipymes en Tecomán, los niveles de satisfacción al consumidor en los restaurantes del norte de México, La gestión del conocimiento en la banca, la influencia de la inteligencia emocional en el cambio organizacional en sector comercio, los impactos de la agricultura digital después del covid, estudios sobre los indicadores de competitividad en la industria automotriz, así como el trabajo home office en la productividad y competitividad de las empresas, trabajos sobre la robótica y automatización con base en ciclo de vida, efectos de la digitalización y competitividad, así como la desconexión digital, agregándose estudios sobre la integración económica y transformación productiva, la resiliencia organizacional en empresas de TICs, además de las diferencias en competitividad del ejercicio de la contaduría pública, la fiscalización en el ejercicio del gasto, la competitividad vs productividad y estrategia.

Dentro del cuarto capítulo con la temática de la innovación, tecnología y datos, se inicia con trabajos sobre las capacidades de innovación en la competitividad de las mipymes, la triple hélice como impulsor de transformación digital, la innovación sectorial y la desigualdad tecnológica, los estilos de comportamiento lifo en mipymes, la innovación y sus oportunidades de mercado de alimentos, las redes de innovación de la BlackBerry, añadiendo estudios la evolución de la web en la industria 4.0, aproximaciones a la construcción teórica de ATLAS.Ti, estrategias de innovación en sector comercio.

Finalmente, se agregan estudios sobre la temática de la responsabilidad social, sustentabilidad y la equidad de género, iniciando con estudios acerca de cómo la responsabilidad social afecta el desempeño en la BMV, el turismo en adultos mayores antes, durante y después de pandemia, las realidades de la sustentabilidad y rendición de cuentas, la responsabilidad social universitaria, la sostenibilidad en la industria geotérmica, además de indicadores de referencia para la gestión integran de la RSU, estudios bibliométricos de estereotipos femeninos en la publicidad, la competitividad y sustentabilidad en sistemas ganaderos de Colombia, análisis de la teoría de las capacidades para la pobreza alimentaria, la agricultura orgánica y el comercio internacional para la sostenibilidad del

sector frutícola, para finalizar con la construcción de la identidad femenina desde la publicidad, la contaminación ambiental como factor de influencia en el WOM y se concluye con el estudios de la RSCV como elementos de la imagen organizacional.

Todos los estudios y análisis que se presentar en este libro, son producto de investigaciones formales que se han desarrollo en los últimos años por académicos, cuya pretensión principal es mostrar los avances en la gestión del conocimiento en la frontera del mismo, para seguir agregando valor a la comunidad donde realizan estos trabajos, con un impacto social.

Dr. José Sánchez Gutiérrez
**Presidente de RIICO**

Dra. Paola Irene Mayorga Salamanca
**Secretaria Técnica**

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# VENTAJA COMPETITIVA Y DESARROLLO ECONÓMICO

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# Beyond the Covid 19: Acceleration of digital agriculture and global berries competitiveness

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**Resumen**

La producción de *berries* posee una gran relevancia global en el desarrollo de la industria agroalimentaria. Las diversas variedades de *berries* se utilizan para el consumo directo o como materia prima en la industria alimentaria. La demanda de frutas en el mercado mundial ha aumentado considerablemente, especialmente durante la crisis sanitaria mundial de Covid-19. La literatura sugiere que la innovación agrícola a través de la agricultura digital resulta ser más urgente que nunca. Si bien todos los sectores económicos tienen esta exigencia, la agricultura y los sistemas agroalimentarios la necesitan más. En esta investigación se emplea un enfoque de métodos mixtos para entender los retos que enfrenta la agroindustria y el valor agregado de la agricultura digital en la producción de *berries*, que es el quinto producto agrícola en México. Finalmente, se presenta un análisis de la competitividad global de México en la producción de *berries* mediante un análisis estadístico basado en datos agrícolas abiertos del periodo 2015-2019 del panorama internacional.

***Palabras clave:*** *Agricultura digital, Berries, Competitividad, Covid-19.*

**Abstract**

The berries production has importance for the development of the agro-industrial worldwide complex. Its varieties are used for direct consumption or as raw materials in the food industry. The demand for fruit on the world market has increased significantly, especially during the global health crisis of Covid-19. The literature suggests that agricultural innovation through digital agriculture is more urgent than ever before. While every economic sector has this need, agriculture and agri-foods systems need it more. A mixed-method approach is employed in this research to understand the challenges agribusiness faces and the value-added by digital agriculture in berry production, which are the fifth largest agricultural product in Mexico. Finally, it presents an analysis of Mexico's global competitiveness in berries production by a statistical analysis based on open agricultural data from the 2015-2019 period of the international panorama.

**Keywords:** *Berries, Competitiveness, Covid-19, Digital agriculture.*

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## Introduction

The emergence of the COVID-19 pandemic has brought the world to a standstill. This health issue has had an unexpected impact on companies in all sectors.

All economic sectors are looking for ways to promote faster recovery during the Covid-19 pandemic. Some industries are struggling, and others are growing through the productivity benefits producers by improving the resilience and competitiveness of their operations. There are ample opportunities in the Mexican agricultural sector because food consumption has not stopped (Hernandez, 2021). COVID-19 has emphasized the need for resilient and efficient agricultural value chains.

At the international level, berries production stands out; since 2017, Mexico rose to second place worldwide as a raspberry producer, providing 128,848 tons, followed by Russia with 174,000. Mexico also has a fourth-place blueberry producer providing 48,999 tons, following the United States with 308,760 tons, Canada with 176,127 tons, and Peru with 142 427 tons (Food and Agriculture Organization of the United Nations, 2021). The added value of Mexican berries is that they are presented fresh to consumers, while the berries marketed by Russia, Chile, or Poland are frozen fruits (Rosales-Soto & Arechavala-Vargas, 2020).

Today, the Mexican horticulture industry is looking for new strawberries, raspberries, blackberries, and blueberries varieties, focusing on a new market that demands fresher products. Due to the health crisis, consumers today ask for healthier food options(East Fruit, 2021), in which fresh fruits and vegetables play an important role. Therefore, the agri-food industry requires some other intelligent processes to improve the dynamism of its production.

COVID-19 has exposed the vulnerabilities of agricultural and food systems, particularly in low- and middle-income countries. A mixed-method approach is employed in this research to understand the challenges agribusiness faces and the value-added by digital agriculture in global berries production. Based on FAOSTAT data as a primary information source from 2015 to 2019, the development of worldwide berries productivity indicates growth.

An in-depth literature review is performed in digital agriculture on horticulture to understand the statistical results. This exploratory mixed-method enables understanding the Mexican competitiveness of berries production, and it allows to compare a berry's global competitiveness during these difficult times. The literature suggests that agricultural innovation through digital agriculture is more urgent than ever before. While every economic sector has this need, agriculture and agri-foods systems need it more. Even farmers worldwide have access to an enormous amount of

data for better decision making; without integration and management, it has slight use, and the productivity of the horticultural industry relies on the ability of firms to apply technology.

In this dimension of analysis, this paper aims to present an analysis of the global competitiveness of Mexico in berries production, presenting a statistical analysis based on open agricultural data from the 2015-2019 period of the international and national panoramas. Finally, the findings and conclusions of this work are presented.

**Literature Review**

Over the last 60 years, agriculture, including horticulture, has become increasingly reliant on science and technology to maintain profitable production (Bohdaniuk et al., 2019; Keogh & Henry, 2016). The scientific study of horticulture is divided into various sub-disciplines. Fruit production includes tree fruits, such as apple, orange, peach, and small fruits, such as strawberry, blueberry, and raspberry.

Berries are the fifth largest agricultural product in Mexico, and it has high global importance due to berries exporting to more than 38 countries. The berries, also called small fruits, are delicate and pulpy small fruits (Rimantas, 2020) that grow in wild bushes, including raspberries, blueberries, blackberries, and strawberries.

This unforeseen arrival and far-reaching impact of the COVID-19 pandemic have hit trade shows and other industry expos and limited access to greenhouses and grower facilities as it used to be. The pandemic has helped accelerate the adoption of digital agriculture. Other obstacles need to be defeated to sustain adoption levels in the long term: This global health crisis has exacerbated challenges related to availability and access to technology. A risk of misinformation and digital division will widen if a solution is not taken to address the problem.

A study conducted in China on the impact of the pandemic on agricultural exporting companies (Lin & Zhang, 2020) considered the influence to be most significant were mostly companies with horticultural products, livestock products, and edible mushrooms to face significant challenges.

In Mexico, this industry faced significant challenges as well, implementing some innovations. Growers continue to have close contact with field workers; visits are becoming more virtual, making it possible to contact them anywhere, anytime (Sijmonsma, 2021). Consequently, the agri-food industry, in general, requires some other intelligent processes like this to improve the dynamism of its production.

**The acceleration of digital agriculture.**

The use of new information and communication technologies has the potential to be harnessed to design and implement the next generation of data and decision support tools for agricultural production systems and contribute to solving major agriculture-related concerns such as access to information, knowledge sharing, food safety, and pest control.

No other sector is as attractive for Big Data-based innovations as the agricultural industry. Precision agriculture has evolved into digital agriculture (Ozdogan et al., 2017; Regan, 2019; Rotz et al., 2019).

Digital agriculture refers to the widespread adoption of cutting-edge computational and information technologies to advance profitable and sustainable agriculture(Van Es & Woodard, 2017), which play a role in achieving innovation.

The application of various technologies in the agriculture industry, such as artificial intelligence (Aquino et al., 2018; Li et al., 2019), big data (Gilpin, 2014; Sonka, 2021; Wolfert et al., 2017), and the Internet of Things (Elijah et al., 2018; Shi et al., 2019), makes their way into practice and converges.

At the same time, the application of the Internet of Things can solve problems related to agriculture and the environment like water shortages, cost management, and productivity issues. According to Elijah et al. (2018), several benefits can be derived from the use of the Internet of things in agriculture: i) Community farming; ii) safety control and fraud prevention; iii) competitive advantages; iv) wealth creation and distributions; v) cost reduction and wastage; vi) operational efficiency; vii) awareness of prices and; viii) asset management.

The large amount of data produced by the Internet of things networks can be further explored to perform event prediction using big data analytics and machine/deep learning. For agricultural purposes (Elijah et al., 2018), the Internet of Things provides large amounts of data that can be studied over time to estimate the present environmental conditions.

Before this new use of the information and communication technologies in the agriculture industry, the traditional methods such as manual detection of pests and crop diseases symptoms, analysis to quantify and predict production were generally time-consuming, resulting in human errors due to inexperienced inspectors (Akhter & Shabir, 2021).

An example of digital agriculture applications is that crop monitoring and plant phenotyping were mainly manually measured. With computer vision systems (Aquino et al., 2018; Li et al., 2019),

growers can quickly and conveniently acquire phenotyping information from their vineyards and assess the number of berries in clusters phenological stages between fruit set and bunch closure.

That is why, based on knowledge and prediction of its entire competitive environment, the agroindustry must act "smartly" and develop the technologies, processes, products, forms of organization, and markets that will enable it to generate competitive advantages systematically.

Precision agriculture challenges include integrating big data into a single platform, interpreting remote sensing, and scouting data through crop consultant apps that use artificial intelligence (Muller & Campos, 2021).

Data can create significant value for the world economy, enhancing the productivity and competitiveness of companies (Manyika et al., 2011). Agricultural data, particularly farm data, have gained importance with the gradual progression of precision and digital agriculture (Lassoued et al., 2021).

**Digital agriculture in horticulture.**

The horticulture industry is ideal for applying digital technologies to develop production information and aid decision-making (Keogh & Henry, 2016). The use of digital information and the application of technology in horticulture extends from monitoring and management inputs to monitoring the plant.

Some horticulture applications are: i) water and fertilizer the crop with telemetry-controlled fertigation systems; ii) monitor the plant, insect, soil conditions, and flowering; and iii) fruit setting analysis through robotic harvesting and automated grading, packing, and cooling systems.

Digital technologies have been part of agriculture since well before the Covid-19 pandemic (FAO, 2021). Still, the current crisis has given further impetus to finding a new application for the technology in food production.

Big data analytics, digital technology, and precision agriculture are frequently used in society and among farmers (Muller & Campos, 2021). In figure 1 it presents the five components of digital agriculture.

**Figure SEQ Figure * ARABIC 1. Five components of digital agriculture.**

It is necessary to present their application to better understand these five components, as shown in table 1.

**Table 1. Potential application of Digital agriculture**

| Component | Application | Key references |
|---|---|---|
| The Internet of things | Sensors monitoring conditions in the field can inform managers about the present and past status, and they can initiate action when warranted irrigation decisions. IoT empowers farmers with decision tools and automation technologies for better productivity, quality, and profit. | (Elijah et al., 2018; Rosales-Soto & Arechavala-Vargas, 2020) |
| Precision agriculture | Sensors embedded in the field can now sense soil moisture, depth, and other factors in each furrow to optimize seed placement as planting is being done. The collection of real-time data from the weather, soil, air quality, and crop maturity use predictive analytics for smart decisions to maximize yields, minimize environmental impact, and reduce cost. | (Muller & Campos, 2021; Rosales-Soto & Arechavala-Vargas, 2020) |
| Remote sensing | It is being employed to overcome the historic challenge of monitoring long distances. The data source can be aerial, from satellites, unmanned aerial vehicles, ground-based, or some combination. | (Chetan Dwarkani et al., 2015; Kentsch et al., 2021; Tang et al., 2002) |
| Big data | Farmers can be provided with very accurate weather information or, in addition to their own experience, receive agronomic guidance based upon insight gained from analysis of production on thousands of acres, | (Lassoued et al., 2021; Manyika et al., 2011) |

| | | |
|---|---|---|
| On farm-research | Farmers can apply digital technologies to improve their operations individually, cooperatively, or collaborate with input providers. These efforts make the possibility of gain and the potential for enhanced managerial control, which previously was never available to farmers. Agricultural Extension and Advisory Services facilitate farmers' access to knowledge, information, and technologies and minimize the impact of Covid-19 through raising awareness in rural areas. | (FAO, 2020; Miller et al., 2019) |

Big data and Precision agriculture emerge from the advent and application of information and communication technologies (Sonka, 2021). Alongside land, labor, and capital, big data is already considered the fourth production factor.

Providing an example of the power of cyber-physical supply chain systems in berries productions (Misra et al., 2020), consider a food truck equipped with temperature, humidity, and GPS location sensors carrying fresh strawberries. The perishability of strawberries is 10 days (González-Ramírez et al., 2020). Through the power of this virtual system, logistics providers can accurately track the food truck's location at any point at any time. Besides, a temperature fluctuation may occur, affecting the strawberries' shelf-life (Misra et al., 2020). The operator can be noticed and diverted to the closest market for immediate sale at a discounted price. In this way, the Internet of things could not only help growers of help to meet the product demand but also prevent food wastage.

## Results and discussion

### Global overview of berry production

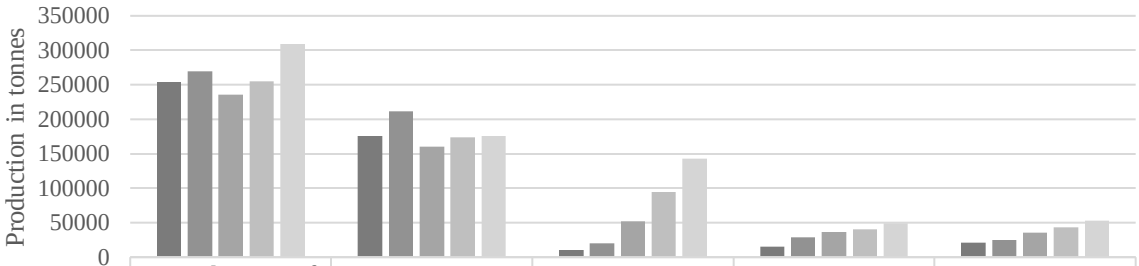
The exportation of agricultural products has tremendous importance from the national economic perspective. It is the key indicator of the development of the agriculture and food industry (Bojkovska et al., 2021). Many factors such as quality, price, competitiveness, and administrative measures of states bodies take the place of the agricultural products in the international market (Kljajic, 2017).

A digital agriculture implementation studies for blueberries harvest in North America is the use of an unmanned aerial system (Patrick & Li, 2017) to determine the morphological characteristics of blueberries business like bush height, extents, canopy area, and volume (Kentsch et al., 2021), aiding producers in crop management.

**Blueberry global overview 2019**

Blueberries are much less perishable than raspberries and strawberries, facilitating long-distance international trade (Cook, 2011). According to the Food and Agriculture Organization of the United Nations (2021), in 2019, the production of blueberries was 823 328 tonnes. The most productive countries are in North America with 50% of world production among twenty-nine countries, as shown in figure 2.

**Figure 2. Top five blueberry-producing countries 2015-2019.**




| | United States of America | Canada | Peru | Mexico | Spain |
|---|---|---|---|---|---|
| 2015 | 254012 | 175530 | 10300 | 15489 | 21060 |
| 2016 | 269257 | 211190 | 20000 | 29067 | 24945 |
| 2017 | 235210 | 160246 | 52301 | 36700 | 35355 |
| 2018 | 255050 | 173641 | 94805 | 40251 | 43520 |
| 2019 | 308760 | 176127 | 142427 | 48999 | 53380 |

In figure 2 are presented the top five world blueberry-producing countries. In 2019, the United States of America provided 37.5% of total world blueberry production. Canada accounts for 29.31%, Peru has the 17.29%, Spain the 6.48%, and Mexico 5.95% of total world blueberry production.

North American countries are the two leading countries in blueberry production worldwide. Peru had the most dramatic growth to become the third-largest producer behind the United States and Canada, with 142 427 tons. These top-three countries had 76.19% of the world total in 2019 (Food and Agriculture Organization of the United Nations., 2021).

Peruvian blueberries production has increased its annual production twofold. According to Foreign Agricultural Service (2021), it started exporting fresh blueberries in minimal quantities in 2010. Since then, production and export have grown from just about zero to more than 140,000 tonnes, with exports valued at more than $800 million in 2019.

It is worth recognizing the good practices and fastest results of growers in Latin America, too, as Mexico has managed to triple its production in the last five years with 316%. Peru implements an alternative technique for conventional cultivation, hydroponic agriculture (La Torre-Ramirez, 2021).

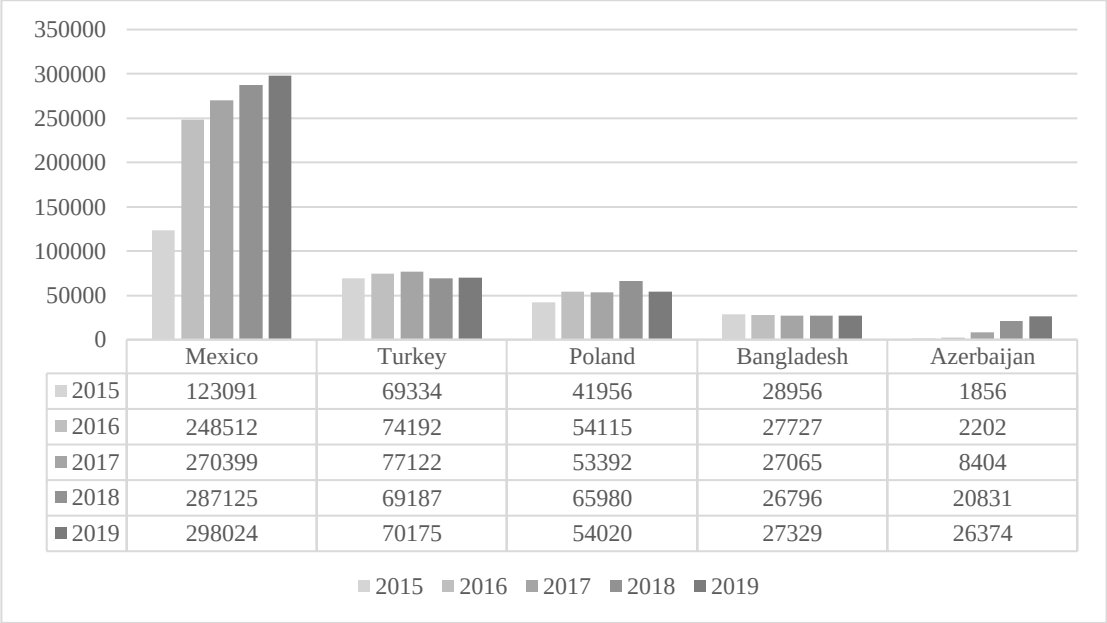
It has gained popularity and consists of growing the blueberry plant outside the soil by placing it in a base or bag that contains a substance called substrate, which has all the right components for the development of the plant. Then, water and fertilizers are added through drip irrigation.

Peru has consolidated its leadership as the global leader in blueberry exports (Eastfruit, 2021). Since 2015, Peruvian blueberry exportations increased to a five-digit number due to the investment in genetics from diverse companies (La Torre-Ramirez, 2021). This investment allowed new blueberry species that were more suitable for warm climates.

**Blackberry global overview 2019**

According to the official data of the Food and Agriculture Organization of the United Nations (2021), in 2019, the world production of blackberries was 823 328 tonnes. Mexico is the top country of blackberries production with 32.67 % among fifty-seven countries, as shown in figure 3.

**Figure 3. Top five blackberry-producing countries 2015-2019.**




| | Mexico | Turkey | Poland | Bangladesh | Azerbaijan |
|---|---|---|---|---|---|
| 2015 | 123091 | 69334 | 41956 | 28956 | 1856 |
| 2016 | 248512 | 74192 | 54115 | 27727 | 2202 |
| 2017 | 270399 | 77122 | 53392 | 27065 | 8404 |
| 2018 | 287125 | 69187 | 65980 | 26796 | 20831 |
| 2019 | 298024 | 70175 | 54020 | 27329 | 26374 |

According to figure 3, Mexico ranks first in world blackberry production with 922 681 tonnes, one-third of world production. From 13534 tonnes in 2000 to 298 024 tonnes in 2019. It represents that Mexico is growing at and an average annual rate of 28.31%.

Based on the Food and Agriculture Organization of the United Nations (2021) official data, in 2019, Mexico is followed by Turkey, providing 7.61%, Poland owns 5.85%, Bangladesh 2.96 %, and Azerbaijan 2.86 % of total world blackberry production.

Poland is one of the most important fruits and vegetable producers in Europe. In recent years, polish blackberry production and pricing have fluctuated (EastFruit, 2021b) substantially. In 2019 it decreased -18.13%.

Despite the relatively small production of Blackberries in Azerbaijan, in 2018, data show a significant increase in blackberries production, more than 300% compared to 2017. The country located at the boundary of Eastern Europe and Western Asia is taking significant measures to promote the production of berries to achieve high economic efficiency.

In 2018, the Fruit-Growing and Tea Growing Research Institute and a British company established a joint venture (Mammadova, 2019) to promote the adaptation of strawberries, raspberries, and blackberries to the local climatic conditions and productivity (United States Agency, 2020).

It is important to remark that since 2006, Mexico's leading producing blackberry state is located in Michoacan (Rosales-Soto & Arechavala-Vargas, 2020), with 94% national production. Through the Covid-19 pandemic, the commercialization channels have been impacted (FreshFruitPortal, 2020). This health crisis has been affecting all the product exportation substantially due to lockdowns and border closures.

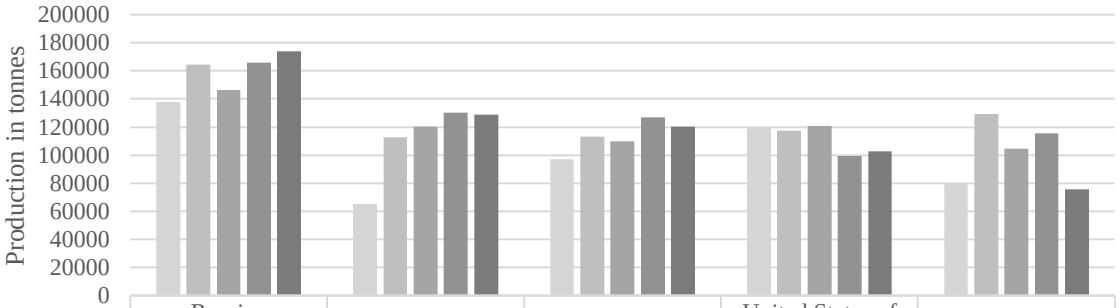
The health contingency has affected fruit and vegetable markets in Europe in several ways. European consumer behavior changes (FruitLogistica, 2021), increasing the attention paid to healthier eating and the origin of fruit and vegetables. The importation of blackberries grows +11%, blueberries +20% and raspberries +14%. Producers faced higher costs when cases of Covid-19 occurred. They must reduce the number of people working in harvesting and fruits processing.

**Raspberry global overview 2019.**

Raspberries are the most marketable fruit because of the juice of the plants. In the industry, they are used for direct consumption or as raw material. Likewise, the profitability and competitiveness of raspberry production depend both on a set of economic and climatic factors and the individual decisions of producers (Di Vittori et al., 2018).

According to FAOSTAT (2021), in 2019, the production of raspberries was 822 493tonnes. Russia is the most productive country with 21.16% of world production among forty-two countries, as shown in figure 4.

**Figure 4. Top five raspberry-producer countries 2015-2019.**




| | Russian Federation | Mexico | Serbia | United States of America | Poland |
|---|---|---|---|---|---|
| 2015 | 137800 | 65388 | 97165 | 119295 | 79895 |
| 2016 | 164602 | 112661 | 113172 | 117177 | 129063 |
| 2017 | 146377 | 120184 | 109742 | 120840 | 104482 |
| 2018 | 165800 | 130187 | 127010 | 99250 | 115610 |
| 2019 | 174000 | 128848 | 120058 | 102510 | 75660 |

The data in figure 4 shows that Russia provides 21.16% of total world raspberry production. Mexico accounts for 15.67%, Serbia has the 14.60%, the United States 12.46 %, and Poland 9.20 % of total world blackberry production.

Russia has been the leading country in Raspberry production, with a 26% growth in the last five years. In comparison, Mexico has positioned itself as the second-largest raspberry-producing country since 2017 and maintain that position during 2018, displacing Serbia, the United States of America, and Poland.

Mexico has doubled its production compared to 2015. Unlike Russia, consumers prefer Mexican raspberries because the fruit arrives fresh to the markets. In terms of the value of frozen raspberry exportation, Serbia is the world's leading country (Kljajic, 2017). Most of its production, around 95% of raspberry exportation, is frozen. Only a small amount is exported fresh.

Agreeing to the United States International Trade Commission, Mexico is competitive in the production and export of raspberries, and it does not represent a serious threat or danger to American consumers (Morales, 2021). In 2020, Mexico exports to the United States 106, 517 tons of fresh raspberries, 17.2% more than in the previous year.

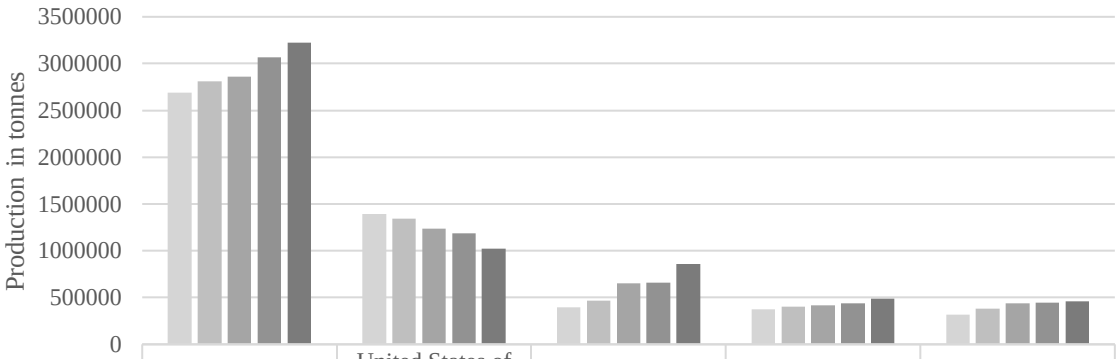
In the case of Poland, even is relatively new to the commercial production of raspberries, in 2020, Polish raspberry production amount to 116 000 tons (Foreign Agricultural Service, 2021b), 145% more than 2019 with 75,600 tons, this amount of production has reached its highest level in the last three years. Most Polish raspberry farms are not irrigated and depend on favorable weather conditions.

Polish raspberries are harvested by hand. Unfortunately, in 2020, because of Covid-19 restrictions, farmers have experienced a seasonal labor shortage that prevented many Ukrainian workers from entering Poland, which increased labor costs for local producers.

**Strawberry global overview 2019.**

Based on the Food and Agriculture Organization of the United Nations (2021) official data in 2019, the production of strawberries was 823,328 tonnes. China is the most productive country with 36.22% of world production among seventy-six countries, as shown in figure 5.

**Figure 5. Top five strawberry-producing countries 2015-2019.**




| | China | United States of America | Mexico | Turkey | Egypt |
|---|---|---|---|---|---|
| 2015 | 2687687 | 1390410 | 392625 | 375800 | 318950 |
| 2016 | 2811751 | 1342947 | 468248 | 400167 | 378960 |
| 2017 | 2860008 | 1234130 | 653639 | 415150 | 435344 |
| 2018 | 3069110 | 1183870 | 658436 | 440968 | 445106 |
| 2019 | 3221557 | 1021490 | 861337 | 486705 | 460245 |

The data in Figure 5 shows that China is the largest strawberry-producing worldwide amid the United States, Mexico, Turkey, and Egypt. China provides 36.22%% of total world strawberry production. The United States accounts for 11.49%, Mexico has the 9.68%, Turkey 5.47 %, and Egypt 5.17 % of total world strawberry production.

The Strawberry industry has become one of the most important industries in agriculture in East Asia. Strawberry production volume is the largest of all berries. China has become a major strawberry producer over time.

In recent years the Mexican strawberry industry increased too. In 2019, it achieved the production capacity raised to 130% compared to the previous year. In 2018, China, the United States of America, and Mexico stood out as strawberry producers, with 59% of the 8.3 million tons produced in these countries (González-Ramírez et al., 2020).

On a global scope, China is the leading producer of strawberries. There are several strawberries production systems in China, including greenhouses, plastic tunnels, and open fields, but recently there has been substantial progress in using biotechnological techniques (Zhang et al., 2014).

Mexico has benefited from planting varieties from the United States, especially from Florida and California. Like America, this crop in Mexico is planted in double rows on soil mounded into raised beds (Wu et al., 2018). Raised beds have internal soil drainage to provide roots sufficient oxygen for survival during periods of heavy rains.

During the early days of the pandemic, there was high anxiety in rural communities, partially fueled by the misinformation circulating by word of mouth or through instant messaging platforms such as WhatsApp. In Mexico, an agri-tech tool, a digital advisory tool, was used by Agrana Fruit Company (GSMA, 2021) to send strawberry farmers information about new guidelines being implemented on the packaging and transport of strawberries

A study made in Florida presents a potential opportunity for using remote sensing in strawberry farming (Zheng et al., 2021). The development of ground-based devices is advancing the potential for monitoring strawberry growth throughout the entire growing cycle, from planting to final harvest. Remote sensing can provide massive crop condition and health data and postharvest evaluation via plant and fruits characteristics.

## Conclusions

Agricultural innovation has been a key factor in the improvement of individual and societal well-being. The implementation of digital technologies and big data in the agroindustry can contribute to generating competitive advantages.

No other sector is as attractive for Big Data-based innovations as the agricultural industry. The most recent theories on innovation in agribusiness point that precision agriculture has evolved into digital agriculture.

To obtain higher efficiency in agribusiness, it is necessary for companies to continuously adapt to changes and rapid market developments; to achieve this goal, it is necessary to mobilize all the company's knowledge resources to achieve this goal.

Before applying the digital technologies in the agriculture industry, several traditional methods, such as manual detection of pests and crop diseases symptoms, analysis to quantify and predict production,

were generally time-consuming, resulting in human errors due to inexperienced inspectors (Akhter & Shabir, 2021).

Food production faces new challenges. Environmental factors and their adaptability to different climatic conditions influence the berry's quality, depending on weather conditions, soil quality, the pricing of inputs, raw materials, water, and recently on labor restrictions due to health contingency.

The covid-19 pandemic changes consumer behavior. They are asking for healthier food options. The global berry performance analysis shows an increase in berries consumption during 2020.

In summary, the results are the following:

First, North American countries, The United States and Canada, are the blueberries world-leading countries. Peru had the most dramatic growth to become the third-largest blueberry producer. Mexico is the top country of blackberries production. Also, Mexico ranks in second place as a raspberry leader and third place as a strawberry leader. Peru has consolidated its leadership as the global leader in blueberry exports. Fresh berries have become widely recognized as all-natural healthy, especially in this pandemic era. There is a globally increasing demand for wholesales. The opportunities for smallholders and commercial berry farmers are undeniable. The promotion of the diversification of the berries such as blueberry, blackberry, raspberry, and strawberry continue to be an opportunity for Latin America.

Then, the adoption of digital agriculture and the recollecting data from sensors and crop monitoring through precision agriculture has resulted in the high profitability of the global berry industry. Digital agriculture can solve agriculture and environmental problems like water shortages, cost management, and productivity issues. Some of the challenges to face with Digital agriculture are cybersecurity and data protection, labor replacement, and the risk of creating a digital divide to technologies adoption between economies.

Finally, big data and digital agriculture represent an unprecedented opportunity to attend the agenda of the second and ninth sustainable development goals. Find new ways to end hunger, achieve food security, promote sustainable agriculture, build and support sustainable industrialization, and foster innovation by applying data-driven solutions.

Some limitations of this study should be mentioned: the data search was focused mainly on the FAOSTAT databases, which were limited to 2019. The post-pandemic analysis is likely to be possible in the coming years.

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