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Digital Transformation of Agribusiness in Latin America and the Caribbean

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ABOUT IDB INVEST

IDB Invest, a member of the IDB Group, is a multilateral development bank committed to promoting the economic development of its member countries in Latin America and the Caribbean through the private sector. IDB Invest finances sustainable companies and projects to achieve financial results and maximize economic, social, and environmental development in the region. With a portfolio of $15.3 billion in asset management and 375 clients in 25 countries, IDB Invest provides innovative financial solutions and advisory services that meet the needs of its clients in a variety of industries.

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INTRODUCTION

1.1 EXECUTIVE SUMMARY

Significance of the agricultural industry in the Latin America and Caribbean region

Region needs to reactivate its productive sector and increase its productivity by leveraging innovation and entrepreneurship, the growth of small and medium-sized firms, the adoption of digital technologies, and the strengthening of their value chains[1]. The agricultural industry has tremendous potential to achieve this and presents an opportunity for the development of the region. As some studies have shown, growth in the agriculture industry is two to three times more effective at reducing poverty than equivalent growth in other sectors such as mining, manufacturing, and services[2].

Thus, an advancement of the agricultural industry through a Digital Transformation adoption is imperative to promote the LAC region's development. Because of this, the IDB has led or supported efforts that encourage the development of small and large agribusinesses, such as the generation of relevant capabilities for the Agriculture 4.0 transformation through technical cooperation with National Institute of Agriculture and Livestock Technology (INTA) in Argentina[3]; the Private Markets for Climate Resilience (PMCR) project[4] to systematically evaluate potential solutions in the private sector, with a focus in agriculture and transportation; as well as other investigative efforts to identify and expose available technologies to address incoming challenges the agricultural industry is currently facing.

Furthermore, Digital Transformation is an important tool for agribusinesses to improve their compliance with the Sustainable Development Goals. A sustainable agenda leveraged by Digital Transformation can't only increase an

[1] (Interamerican Development Bank, Interamerican Development Bank - Invest, 2022)

[2] (Christiaensen & Martin, 2018)

[3] (Gauna, Casellas, Márquez, & Puechagut, 2021)

[4] (Lacambra, et al., 2020)

organization's productivity, but also promote inclusion of women in agriculture reducing poverty and hunger and promoting economic development by investing in gender smart policies and practices, as well as increasing financial inclusion with digitalization of processes that give access to financial services in remote and rural areas[5].

The benefits of applying technologies in agriculture are evident, with increased agribusiness organizations in the region using advanced production methods that integrate technology. This is the case of precision agriculture and the adoption of tools such as drones, sensors, and satellite images, through which it is possible to optimize production by controlling the use of water, fertilizers, and pesticides. All this, combined with agile processes, allows for continuous improvement and capacity that can sustain modern value-generating production and turn the agricultural industry into a high-value products business. Furthermore, there is an opportunity to strengthen and integrate formal agribusiness value chains by incorporating thousands of producers into them. This integration may be aided by Digital Transformation, given it provides tools for producers to meet quality standards and commercial conditions imposed by international markets, as well as technologies like blockchain to give consumers the traceability information they demand about how the products they consume are impacting societies and the environment[6].

A first desirable state of Digital Transformation for the agricultural industry

To jump on the train and become a technology-driven industry, agricultural organizations can strive to implement a clear and achievable Digital Transformation strategy. A first desirable state can encompass the use of different digital tools that allow for data capture in different stages of the process. These tools may initially not be fully integrated throughout the whole operation but can provide insights into their respective operating areas. Additionally, an important step is the automation of mechanical tasks to make processes more efficient, safe, and less prone to errors, such as harvesting and packaging. Agribusiness organizations can also aim to incorporate digital solutions that help with client and supplier management by implementing different platforms to facilitate that process.

Once these beginning stages are complete, companies can look towards the next level of Digital Transformation. With seamless integration of all technologies and data, organizations can then have a holistic view of operations that allows more accurate business decisions. For example, leveraging Big Data and artificial intelligence further improves business decisions and risk management. All this gives organizations competitive advantage and the ability to enter new markets where their products can bring better value. Throughout the

[5] (Azevedo & Valencia, 2021)

[6] (Interamerican Development Bank, Interamerican Development Bank - Invest, 2022)

report, different Digital Transformation solutions for different stages are presented, as well as the paramount benefits organizations can gain with a Digital Transformation.

Overview of study´s methodology

To contribute to the transformation of the agribusiness industry, this study is designed to identify firsthand the state of Digital Transformation in the Latin American and Caribbean regions. The countries and regions it focuses on were determined based on the value of production, land area, volume produced, the value of exports, and the GDP of the agricultural sector. The selected countries are Argentina, Brazil, Chile, Colombia, Ecuador, Guatemala, Paraguay, and Peru, and encompass important crops such as Cereals and Oilseeds, Sugarcane, Avocado, Berries, Grapes, Coffee, Citrus fruits, Tomato and Cacao.

The firsthand approach was achieved through an individual Digital Maturity Assessment and a set of in-depth personal interviews with C-level executives of 38 agribusiness organizations. Through these two complementary approaches, different digital maturity capacities and current ways of working with agribusiness organizations were evaluated. This allowed the research team to identify specific needs, pain points and challenges, as well as opportunities and solutions regarding Digital Transformation that are present today in the Latin American and Caribbean region.

Key needs and challenges agribusiness organizations are facing

Throughout the study, a number of key needs and challenges that interviewed organizations are currently facing were identified. Below is an abstract of these key findings:

1. **There is an increasing need for greater operational efficiency and a boost in productivity.** Given the industry´s changing nature, where there are many exogenous variables at play, such as climate, prices, and even other geopolitical factors, it is vital to implement tools that help organizations sustain healthy margins. Additionally, given the tendency toward more sustainable practices and a reduction of agricultural inputs such as land, water, and labor, there is an important need to make the most of all available resources. This allows companies to remain competitive in the agricultural business, ensuring the best possible prices, as well as other competitive advantages, like sustainable practices that permit them to enter other international markets with their products.

2. **There is a need for tools that help with mitigating risks, as well as resilient internal structures that allow for timely and effective responses to market demands and uncertainty.** Both are essential for agribusinesses, given the unpredictability and changing trends of the business, which pushes them to find ways to prepare for any situation that could cause massive losses.

3. **There is both a need and a challenge with having the right talent within the organizations.** The agricultural industry has a traditional workforce that currently resists change and evolution and prevents Digital Transformation from thriving. Organizations face the need of upskilling and reskilling personnel, as well as bringing in new and ready-to-go talent. However, there is a challenge in acquiring new talent, either because of a lack of qualified individuals in the hiring pool, there is difficulty attracting the right people who command highly competitive salaries or have a generally unfavorable perception of working in the industry.

4. **There is a nonexistent or fragmented strategic vision and poor governance of Digital Transformation.** This prevents a clear Digital Transformation path in agribusiness organizations, which results in unaligned initiatives with little value-added. Additionally, it stops organizations from properly prioritizing and driving forward the Digital Transformation project in their day-to-day activities.

5. **Organizations do not allocate the necessary budget and financing for Digital Transformation.** Given a difficulty in building a traditional business case, with corresponding financial indicators, organization leaders have trouble defining the real value of the transformation. In turn, this causes a lack of budget prioritization for Digital Transformation programs, making its financial support dependent on business results in the short term. Additionally, agribusinesses have a conservative approach to outside financing, which prevents them from acquiring funds for risky projects, or initiative with a delayed output when their own cash flows are not sufficient.

6. **Poor connectivity infrastructure is a common problem in many countries of the Latin America and Caribbean region.** Rural areas where most agribusinesses are based do not have satisfactory connectivity service, where coverage, quality, and reliability are critical. This is an important obstacle for the adoption of many Digital Transformation technologies that depend on connectivity.

7. **The lack of ecosystem collaboration and coordination hinders the advancement of Digital Transformation.** The varying degrees of Digital Transformation among key players in the value chain can cause incompatibility and a diminished value which halts organizations from embracing digital solutions. Additionally, because of the lack of a Digital Transformation agenda, the available results from individual digital initiatives implemented currently do not satisfy the needs of the organizations, which also results in a decreasing perceived value. There is likewise an unrealized opportunity for industry peers to work together and develop new Digital Transformation solutions specific to their country and crop characteristics.

Furthermore, the report identifies in more detail the different methods and recommendations to help organizations overcome these challenges and realize the full potential of Digital Transformation.

1.2 OBJECTIVES

The main objective of this study is to provide findings, insights, and recommendations that contribute to the Digital Transformation of the sector to benefit regional productivity and global relevance and to impact the economic development of the region and wellbeing of the agribusiness population. By understanding the main benefits that Digital Transformation brings to the organizations in the industry, the study intends to promote a wider and faster adoption of digital technologies that result in increased benefits for the private business in the region.

To achieve the above, the study aims to have a deep understanding of the current state Digital Transformation of the companies that are part of the agricultural sector in Latin America and the Caribbean. Through a comprehensive discovery of the main needs and pressures for transformation, including the most relevant challenges that they face to transform and leverage digital technologies, and by identifying some of the most innovative solutions currently applied, the study aims to contribute a perspective that supports regional dialogue to impact the pace and scale of transformation that global markets require.

Finally, this study provides an initial set of steps and recommendations for organizations in the agricultural sector to have an initial framework to structure or to accelerate their transformation efforts. By understanding the Digital Transformation journey followed by some of the most advanced organizations in the regional industry, this study pretends to be a guide for private organizations in the LAC region to reflect upon how Digital Transformation programs meet the business needs and prepares organizations for the new digital economy requirements.

2

METHODOLOGY

2.1 OVERVIEW

To achieve the objectives, the study utilized a combination of primary and secondary research. The primary research consisted of two fieldwork stages with a wide range of organizations in the industry. As a starting point, a Digital Maturity Assessment questionnaire was answered by those collaborators in organizations that had both a business and technology perspective. On the other hand, a deep dive into the specific organization's Digital Transformation situation was achieved by interviewing C-level executives, who assessed the state of their Digital Transformation, as well as their business strategy and vision. The central observations and insights of the primary research were augmented by secondary research, consisting of desk investigations about different, prioritized value chains, as well as other macro aspects. This provides a holistic industry view and gauges the maturity of organizations in their Digital Transformation efforts in the region.

2.2 PRIMARY RESEARCH

A key objective of the study is to understand the current state of Digital Transformation in agribusiness in Latin America and the Caribbean. This was achieved by a Digital Maturity Assessment and by conducting direct interviews of a sample of thirty-eight companies. Although some of the companies included in this research study are IDB Invest's clients, the selection criteria were defined by the Agribusiness team and match the particular goals of the study.

To have a representative sample of organizations that may be considered as a valid reference for a wider set of private corporate businesses in the agricultural sector in Latin America and the Caribbean, participating companies have been selected with different levels of digital maturity, access to capital and knowledge, scale, and appetite for Digital Transformation. Furthermore, the sample includes companies across the entire value chain from cultivation to retail, and a reduced representation of agritechs or start-up companies in the industry, as well as relevant organizations of the sector such as unions or guilds from different crops, subsectors, and countries.

The main goal behind this selection is to address the challenges and needs from a broader pool of companies in their Digital Transformation journey. This approach is also used to include some qualitative conclusions by comparing more digital advanced companies to others that are taking their initial steps with a lower digital maturity.

Digital Maturity Assessment (DMA)

The Digital Maturity Assessment was designed to understand where each of the selected companies fell on the Digital Transformation spectrum through a questionnaire of seven dimensions. The DMA aims to evaluate more than the IT capabilities of organizations, given Digital Transformation covers a broader spectrum of capabilities that have a greater impact throughout the business. Because of this, the seven dimensions or capabilities considered were: Strategy and Governance, Organization and Collaboration,

Customer Experience and Interaction, Technology and Platforms, Information and Insights, Growth and Innovation, and Security and Privacy.

The DMA was self-administered, so participants assessed their company's level of maturity for each question on a scale of one to five. A free-form textbox allowed for additional input, providing valuable context to the given ratings. The ratings for each question were grouped by dimension, and a total average was calculated for each of the seven categories. These averages were then used to calculate a global Digital Maturity score to compare companies with other participants in the study of the value chain and develop a ranking of leaders and laggards.

Interview Process

To gain greater insight into the Digital Transformation status of the organizations considered for this study, one-hour virtual interviews were conducted as the second step of the primary research. Questions for each interview were selected considering the results of the Digital Maturity Assessment, additional information about the company found in public sources, and the input of an Interamerican Development Bank Investment Officer, when relevant. Specific questions were chosen from a question bank and adapted for each role within the company and each level of digital maturity evidenced in the results of the assessment[7]. Additional questions were formulated to address any inconsistencies or specific aspects of the organization on a case-by-case basis.

Interviews were conducted with key C-level executives from each company. Primary participants were the Chief Executive Officer (CEO), who provided an overview of the strategy and vision of the organization; the Chief Operating Officer (COO), who offered insight about the core business and its operating model (processes, governance and talent); the Chief Financial Officer (CFO), who delved into the investments and funding vision, as well as the value framework of the transformation; and the Chief Information Officer (CIO), who explained how the organization leveraged technology to achieve business outcomes. It is important to mention not all perspectives were achieved for every organization. Nevertheless, there was a minimum of two interviews that offered two different perspectives for each organization.

Upon completion of the interviews, insights were analyzed with the DMA responses, and companies were clustered as leading, following, or lagging based on a combination of quantitative (DMA score, capital investment) and qualitative (interview responses) factors, as well as other new information (relevant information, use cases where technology was leveraged to bring a new solution, or specific needs, etc.).

Based on our own definition, digital leaders are defined as organizations that build a digital muscle, ranging from becoming familiar with foundational tools, like Robotic Process Automation (RPA), artificial intelligence (AI) and Cloud, developing the cultural and process expertise, enabling the pivot to true agile development, and raising the metabolism of the organization[8]. Organizations driven by top-down commitment tell a compelling

[5] (Azevedo & Valencia, 2021)

[6] (Interamerican Development Bank, Interamerican Development Bank - Invest, 2022)

internal and external story to convince both employees and investors they are serious about digital efforts. On the other hand, digital followers are those that consider the Digital Transformation as an important step for their organizations and have done work to include it in their strategic vision. However, they are not proactively seeking new solutions that can help further advance their business and usually guide their initiatives by trends they have seen become generalized in the market. Followers have mid-level capabilities relevant to Digital Transformation development. Finally, digital laggards are companies struggling with whether and how to build a structured Digital Transformation program. These organizations are lagging in certain capabilities that are important to define, prioritize, and advance a digital agenda.

Primary research analysis

To have a holistic view and diagnosis of the current state of Digital Transformation in the agricultural industry in Latin America and the Caribbean, the information gathered was clustered in the following categories:

1. **Needs:** needs identified during the interview process that can be categorized as burning platforms that lead to transformations and changes that can leverage and enhance the growth of the organizations. These can be either external or internal pressures:

    a. **Internal:** Pressures that come from agents or processes inside the company like leadership, talent, investment, and funding plans.

    b. **External:** Pressures that come from agents or situations outside the company like clients, providers, government, and markets.

2. **Challenges and barriers to Digital Transformation:** challenges that should be addressed by the company to enable a Digital Transformation plan. These barriers are currently hindering the adoption of Digital Transformation initiatives in the agribusiness.

3. **Digital solutions:** Solutions that companies may implement and adopt, driven by the need of business outcomes and to internal and/or external pressures (e.g., precision agriculture to improve input efficiency and crop yield), contributing to the Digital Transformation of the organization.

2.3 SECONDARY RESEARCH

Secondary sources were selected to complement the primary research. For agriculture data, the preferred source was the Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), where information was analyzed by crop and by country. The main variables used were:

- **Value:** Value of production[9]
- **Land:** Land dedicated to primary production[10]
- **Volume:** Volume produced in metric tons[11]
- **Exports:** Value of exports[9]
- **GDP:** GDP of the agriculture sector[12]

Countries and Value Chain Prioritization

After a thorough analysis of the five variables stated above and additional qualitative input from the IDB Invest Agriculture team, eight crops with corresponding countries were determined. It is important to mention that given the number of companies considered for this study, not all crops are equally represented. Nonetheless, some of the contacted companies were associations or cooperatives that provided an integrated vision of the situation of their members. The prioritized crops and countries are:

[9] All value or monetary indicators in constant 2015 USD

[10] In ha.

[11] Tons

[12] Idem

- **Sugarcane:** Brazil, Guatemala, El Salvador, Nicaragua
- **High value crops (grape, avocado, berries):** Peru, Chile, Mexico, Colombia
- **Coffee:** Guatemala, Nicaragua, Peru, Brazil, Colombia
- **Cereals and Oilseeds:** Brazil, Argentina, Paraguay
- **Banana:** Ecuador, Guatemala, Costa Rica, Colombia
- **Cocoa:** Ecuador, Guatemala, Brazil
- **Tomato:** Mexico
- **Citrus:** Argentina, Brazil

To determine the prioritized crops stated above, a ranking was developed to identify the most relevant. The values for Value, Land, Volume, and Exports, were considered to assign each crop with a score between 1 and 3, one being the most relevant. The ranking showed the most relevant crops, globally and in the region, are soybeans and sugar cane, both of which account for more than half of the global production volume with almost 20% of the world's production.[13] Complementing this group are crops that, without being among the first in global importance, are relevant in the region. This is the case with coffee and avocado mainly, followed by other tropical, subtropical, and temperate fruits such as banana, pineapple, citrus, and berries. Finally, some crops such as quinoa and Brazilian nuts are of little relevance in world consumption, but with a high percentage of exports, as they are produced exclusively in Latin America and the Caribbean.

As an additional consideration, the largest producers of grains in Latin America and the Caribbean, which cultivate mainly soybeans and corn, also grow wheat, sunflower, barley, and sorghum as a rotation scheme. As soybean and corn were prioritized, other grains were included in the study as well under the Cereals and Oilseeds category. In the same way, given the similarities between the nature of crops such as avocado, grape, and berries, these crops were grouped into a category defined as High Value Crops.

[13] (FAOSTAT, Various years)

Crop	Value	Land ranking	Volume ranking	Exports ranking	% LAC / Volumen Global	Score
Soy	39.3	1	2	4	52%	1
Sugar cane	24.9	3	1	8	48%	1
Corn	22.9	4	3	6	18%	1
Coffee	10.4	6	25	7	55%	1
Banana	8.4	15	6	9	27%	1
Grape	7.2	22	14	10	11%	1
Rice	6.7	7	5	24	4%	1
Potato	6.3	17	10	38	6%	1
Tomato	5.9	35	12	20	7%	1
Vegetables	4.8	5	22	30	11%	1
Avocado	3.8	26	27	13	72%	1
Pome and stone fruits	3.7	30	18	14	5%	1
Wheat	3.1	4	7	15	4%	1
Leaf & stem vegetables	3.1	19	13	22	2%	1
Citrus	2.6	16	9	18	34%	1
Spices	2.5	37	30	23	4%	1
Cassava	2.4	11	8	44	9%	1
Berries	2.4	49	36	21	12%	1
Nuts	2.1	14	32	17	5%	1

Table 1: Ranking of relevant variables for each crop
Source: Own analysis of FAOSTAT[13] data

Furthermore, to determine the prioritized country for each crop, two variables were analyzed:

1. **Regional relevance:** Proportion of the crop produced in the country over the total produced in Latin America and the Caribbean

2. **National relevance:** Contribution of the crop to the total production of crops in the country, normalized by GDP of the agricultural sector.

The main goal was to have a representation of the most relevant countries. Unfortunately, even though Brazil is an important country in the LAC region, contacting and engaging Brazilian companies was difficult, even when executing the engagement process in exactly the same way as in the other countries. This reduced Brazil's firsthand perspective in the study.

Crop	Country	Regional relevance	National relevance
Cereals and oilseeds	Brazil	58,81%	1,98%
Cereals and oilseeds	Argentina	25,42%	3,03%
Cereals and oilseeds	Mexico	6,05%	0,58%
Cereals and oilseeds	Paraguay	5,07%	7,91%
Sugar cane	Brazil	77,53%	0,99%
Sugar cane	Mexico	5,53%	0,21%
Avocado	Mexico	45,48%	0,26%
Avocado	Dominican Republic	13,42%	0,95%
Avocado	Peru	10,51%	0,34%
Banana	Brazil	21,07%	0,09%
Banana	Ecuador	19,12%	4,35%
Banana	Guatemala	14,21%	2,54%
Coffee	Brazil	60,78%	0,32%
Coffee	Colombia	13,69%	1,08%
Citrus	Mexico	29,85%	0,10%
Citrus	Brazil	22,72%	0,03%
Citrus	Argentina	22,01%	0,09%
Grape	Chile	35,99%	1,13%
Grape	Argentina	26,69%	0,41%
Grape	Brazil	18,64%	0,07%
Tomato	Mexico	34,69%	0,30%
Tomato	Brazil	31,40%	0,10%

Table 2: Regional and national relevance of prioritized crops
Source: Own elaboration based on data from FAOSTAT and World Bank Open Data, 2020.

Finally, a more detailed explanation of the prioritization process, along with all relevant data, can be found in the appendix section.

3

AGRIBUSINESS DIGITAL TRANSFORMATION CURRENT STATUS

3.1
AGRICULTURAL MACROECONOMIC LANDSCAPE

The Latin America and Caribbean region plays a fundamental role in agricultural production at a global level. Some of the region's agricultural systems are among the most dynamic[14], complex, and relevant[15] in the world, given its significant latitudinal range, abundant biodiversity, diverse topography, and share of the global agricultural volume. These systems have been able to feed a rapidly growing population[16] and facilitate economic development by generating economic value and large exports.[17]

Because of this, the LAC region is among the most important sources of agricultural production in the world. According to figures from the Food and Agriculture Organization of the United Nations (FAO), this region produced 18% of the world production in volume on 12% of the land cultivated globally.[18] Between 2017 and 2020, on average, Latin America and Caribbean countries collectively produced more than 1.8 billion tons of agricultural products using around 170 million hectares, spread over more than 170 products.[19]

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[14] The region increased its agriculture trade surplus from $12B USD in 1998 to $54B in 2018. (OECD-FAO, 2022)

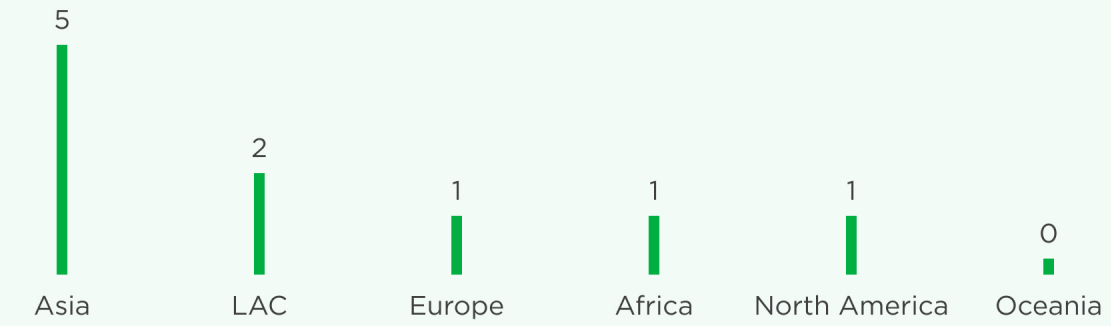
[15] More than half of the global soybean production comes from LAC. (FAOSTAT, Various years) 2020

[16] Between 8 and 6 million more people every year since 1985. (World Bank, Various years), 2021

[17] The share of net export value in the region's agriculture production should approach 50% by 2031. (OECD-FAO, 2022)

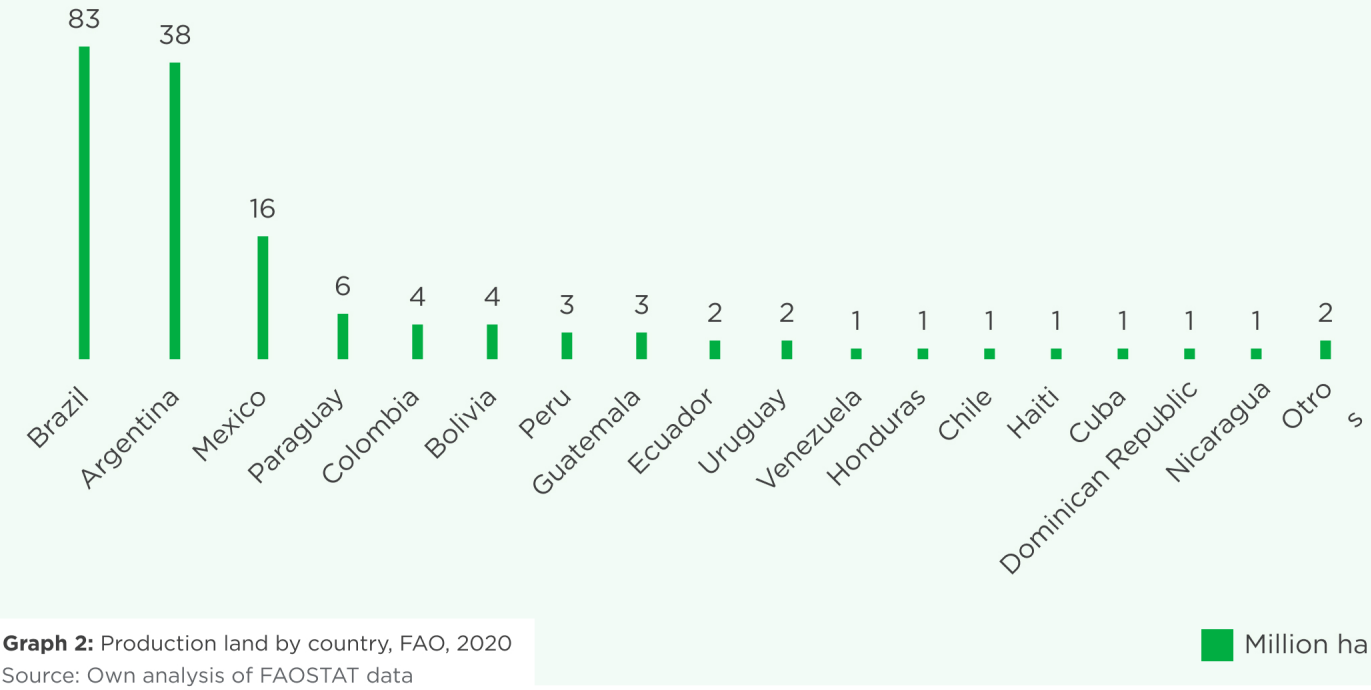
[18] (OECD-FAO, 2022)

[19] (FAOSTAT, Various years), 2020



Graph 1: Agriculture production volume by continent, 2020
Source: Own analysis of FAOSTAT data

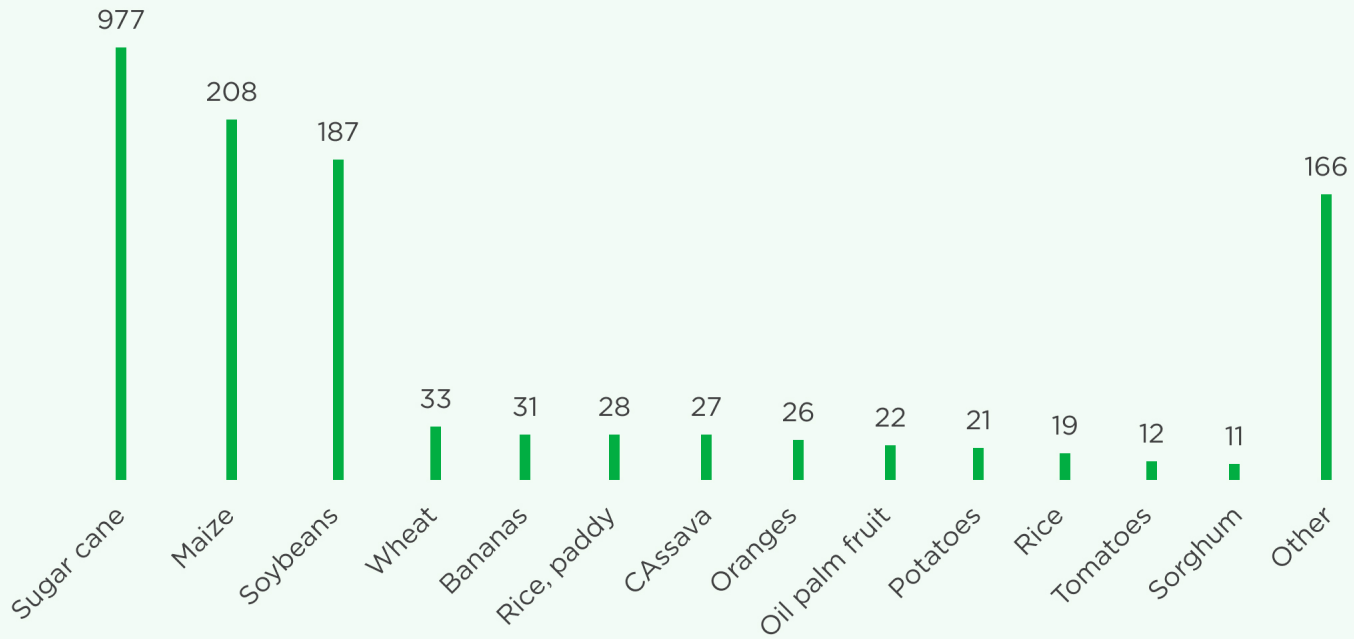
On the other hand, even though agriculture is relevant in most countries, its relative relevance in the LAC region depends mostly on each country´s arable area, concentrating production in the largest nations of the region. Consequently, Brazil is the country with the highest volume of production (63%) in the region, cultivating 48% of the region's total arable land. Argentina and Mexico follow as the most important producers in the region, with 10% and 8% of production in 22% and 9% of the arable land, respectively[18].



Graph 2: Production land by country, FAO, 2020
Source: Own analysis of FAOSTAT data

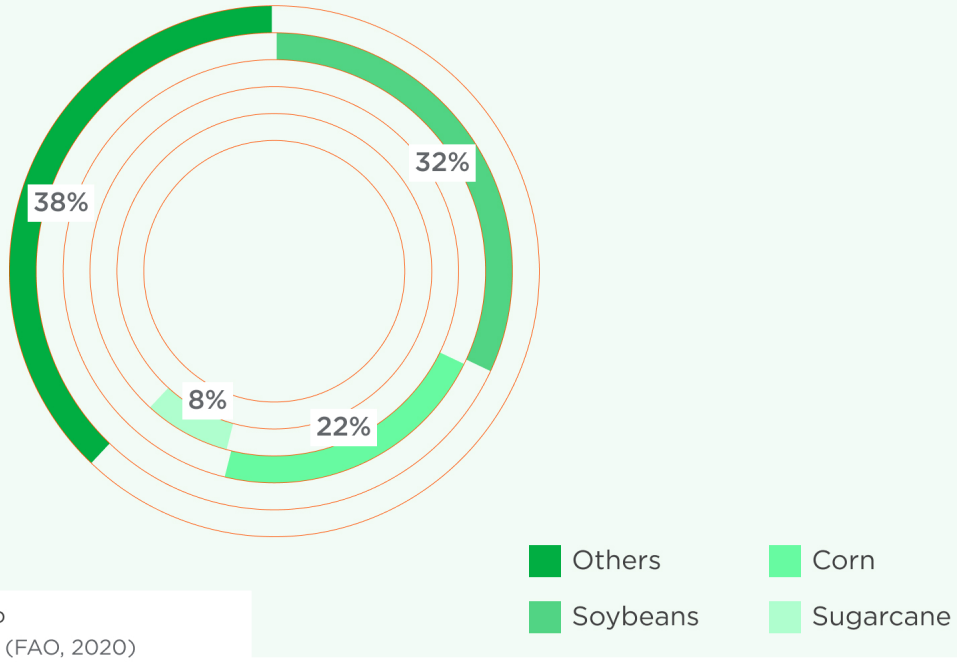
Interestingly, more than half of the production by volume corresponded to the sugarcane complex, with an additional 20% in equivalent parts contributed by corn and soybean complexes. Thus, taking together more than three quarters of the total production in the region[20].

[20] (OECD-FAO, 2022)



Graph 3: Production volume by crop, 2020
Source: Own analysis of FAOSTAT data

Additionally, the predominant crops per land used are soybeans, corn, and sugarcane with 35%, 22% and 8% respectively, of the total area used in the region for agriculture.[21]



Graph 4: Arable land distribution by crop
Source: Percentage of land used by crop (FAO, 2020)

[21] (FAOSTAT, Various years), 2020

The significant weight that sugarcane, corn, soybeans, and other similar crops hold in the regions, could be a result of less expensive labor in the region coupled with the crops nature, where they have a high nutritional value (proteins and carbohydrates) and are primary inputs for many food staples in the world, such as bread, pasta, oils, sweeteners, and even many types of alcohol. Because of this, these crops are needed to guarantee food security all over the world. Moreover, with recent disruptions to traditional value chains, such as the COVID-19 pandemic and the ongoing war between Ukraine and Russia (important exporters of cereals and grains), countries have been looking to secure cereals and grains supply by developing new value chains and increasing productivity in current plantations, which could present an opportunity to leverage Digital Transformation.

Besides the figures mentioned above, agribusiness makes an important contribution to the region through growth and trade, as well as by generating employment, increasing incomes, and reducing poverty.[22] Further, they guarantee food and nutrition security, and create and/or preserve ecosystem services like agriculture inputs, technology and machinery for production, housing, education, and transport for labor.

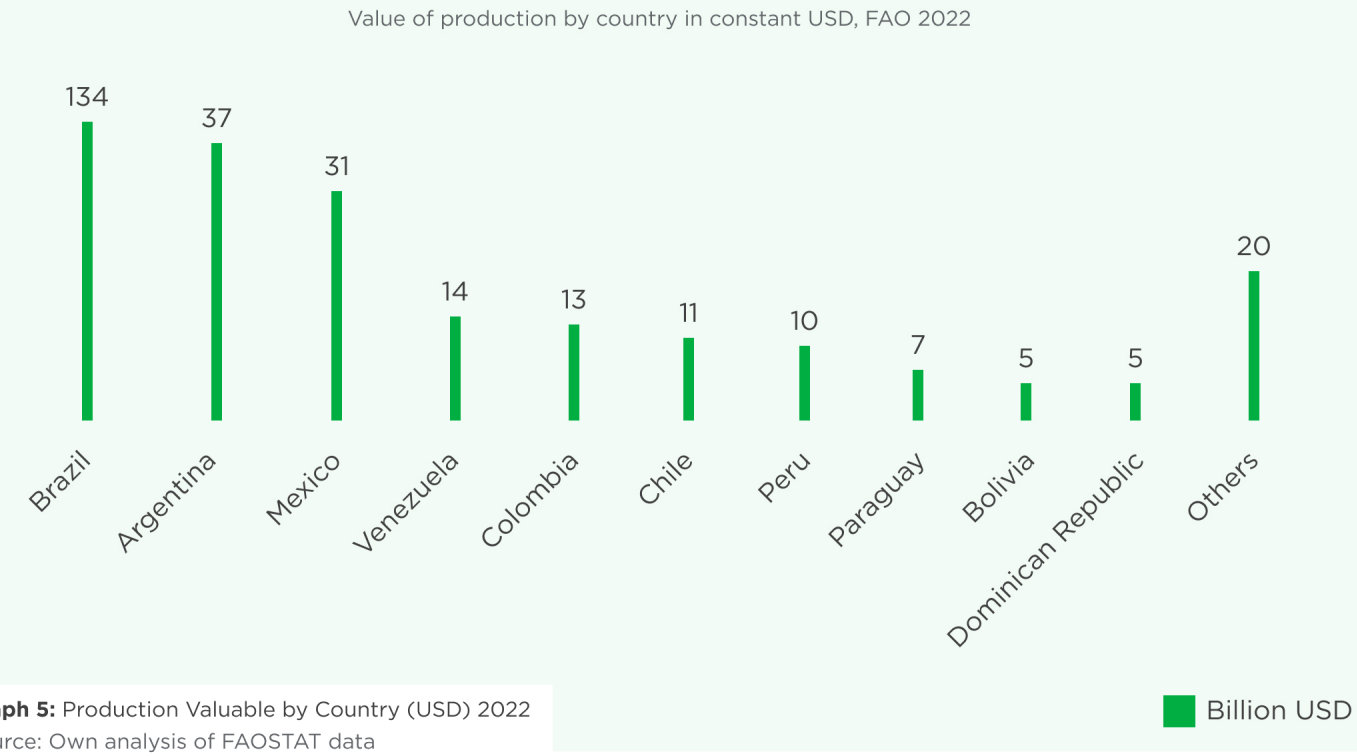
Production value

From an economic point of view, Latin America and the Caribbean have a concentration on high-volume, low-value crops, which makes them a less land use. Only Mexico and Chile, out of the fifteen largest producing nations in the region, have a higher proportion of this production value indicator, thanks to the production of high-value, non-commoditized crops which are less land-intensive than cereals and sugarcane, which are also being widely demanded in importing markets.

Agriculture's economic production value is more concentrated in larger countries - and

[22] (Morris, Ashwini, & Perego, 2020)

economies - than the average of economic activities. The eight largest producers account for 90% of the region´s production economic value. Brazil, Argentina, and Mexico account for 70%. For reference, the GDP of the eight largest agriculture producers represents 86% of the LAC GDP, being Brazil, Argentina, and Mexico, the three largest countries that account for 67%[23]. Conversely, when considering productivity countries like Colombia, Peru, and Mexico, have a higher agricultural Total Factor Productivity (TFP) [24]index, 128, 110 and 108 respectively, than countries like Brazil, Argentina, and Paraguay, 107, 98 and 92 respectively[25].



Graph 5: Production Valuable by Country (USD) 2022
Source: Own analysis of FAOSTAT data

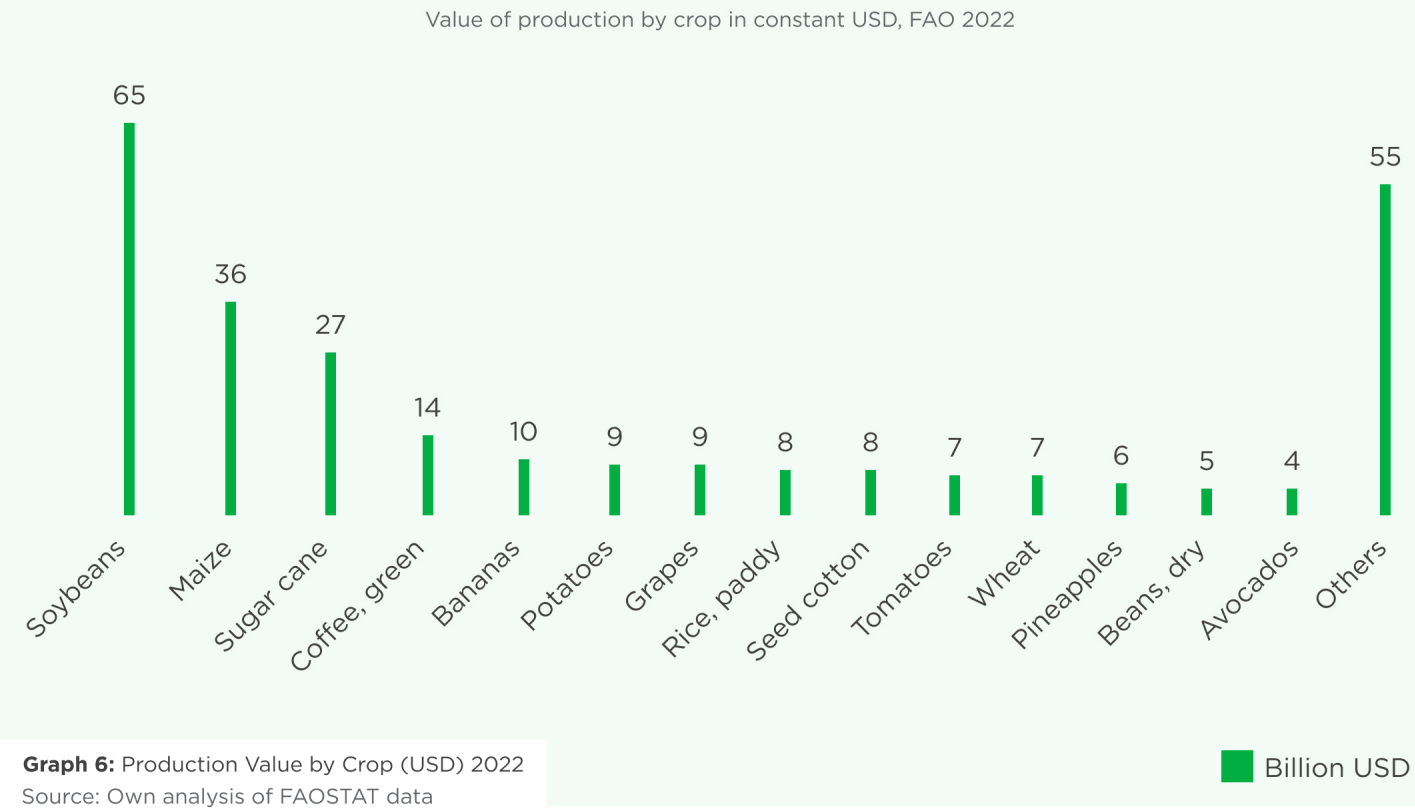
On the other hand, regarding the importance of different crops in terms of production value, soybeans account for almost a quarter of total agricultural crops, while together with corn (12%) and sugarcane (9%), this number comes to half of the value of total production.[26]

[23] Idem

[24] "TFP measures the amount of agricultural output produced from the combined set of land, labor, capital, and material resources employed in farm production. If total output is growing faster than total inputs, then the total productivity of the factors of production (i.e., total factor productivity) is increasing" (U.S. Department Of Agriculture, 2021)

[25] (U.S. Department Of Agriculture, 2021)

[26] (FAOSTAT, Various years), 2020

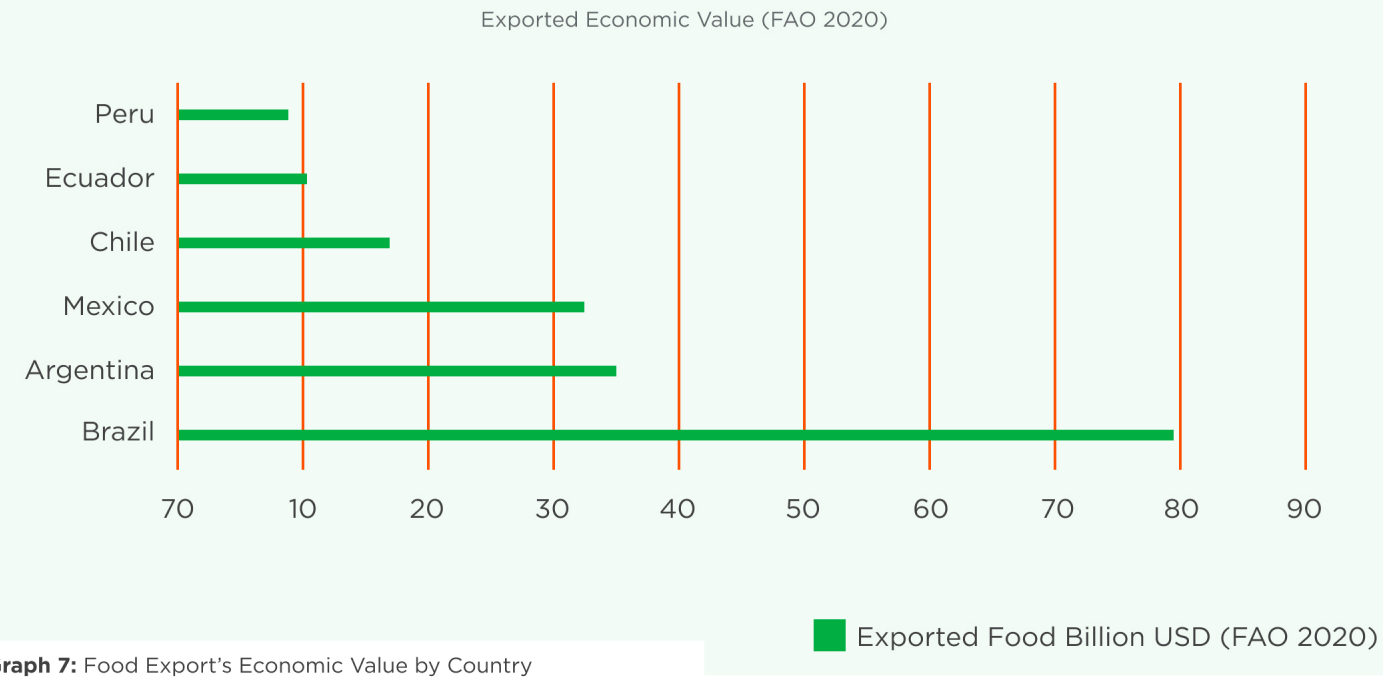


Graph 6: Production Value by Crop (USD) 2022
Source: Own analysis of FAOSTAT data

Exports

Just as in other macroeconomic variables (total production volume, cultivated land and economic value) Brazil leads as the largest agricultural and food exporter (USD 79.3 billion in 2020) in the region, followed by Argentina (USD 35.0 billion), Mexico (USD 32.5 billion), Chile (USD 17 billion), Ecuador (USD 10.4 billion) and Peru (USD 8.8 billion). In general, Latin America and Caribbean countries are major exporters of soybeans, animal feed, sugar, coffee, and fruits and vegetables.[27]

[27] (FAOSTAT, Various years), 2020



Graph 7: Food Export's Economic Value by Country

When analyzing the value of exports, which include products of the first transformation for each chain, soybean reaches on average 30% of the value, and together with the corn, sugar, and coffee account for 50% of the value of exports. The remaining 50% is distributed in almost three hundred products. According to the FAO and OECD, this will increase during the next decade and regional production will account for 61% of global exports of soybeans, 59% of sugar, 43% of corn, and 25% of ethanol (an important byproduct of sugarcane).[28] Moreover, when looking where are all agricultural products of the Latin American and Caribbean region being shipped to, it is found that the main importers of the agricultural exports are the United States (21%), China (13%), and the LAC (15%) region itself, accounting collectively for 49% of the region's exports[29].

Furthermore, region's traditional fruit and vegetable production and exports (e.g., Mexican tomatoes and avocados, Chilean grapes and peaches, Central American bananas, and pineapples) have risen considerably and have expanded to include, for example, Chilean cherries and cranberries; Central American chilies, peppers, and eggplant; and Mexican blueberries and raspberries, positioning them in a global perspective[30].

Interestingly, despite the high-volume but low-value crops that are predominant in the region which prevents it from being a

[28] (OECD-FAO, 2022)

[29] (Morris, Ashwini, & Perego, 2020)

[30] (FAOSTAT, Various years), 2020

more relevant player in the trading scene, the Latin America and the Caribbean region manage to gain relevance and differentiation in the international agricultural scenario with high-value crops. In recent decades, the region has firmly established itself as the world's primary supplier of both bananas and tropical fruits, accounting for approximately 80% of global shipments of bananas, pineapples, papaya, and avocados, and approximately 50% of global mango exports[31]. From the total export value of around USD 15.5 billion for tropical fruits, combined in 2016-18, bananas and avocados accounted for USD 6 billion and USD 3.5 billion, respectively[32]. Meanwhile, Costa Rica's exports of tropical fruits account for approximately one-third of its entire agricultural export earnings.[33]

Thanks to more favorable climate and water conditions and reflecting the labor-intensive nature of production of these high-value crops, the region may continue to enjoy a comparative advantage in exporting products like these in the future. This advantage could be strengthened and scaled by improving storage technology, infrastructure, and production practices[34].

Other macroeconomic variables

Agriculture has been increasing its relevance in the Latin America and the Caribbean region´s GDP, from 4.5% in 2012 to 6.9% in 2021[35]. As expected, in more developed economies, agriculture relevance in GDP is lower than in developing countries. While agriculture accounts for even less than 4% of GDP in Mexico and Chile, it exceeds 11% in Belize and Nicaragua and even 20% in Paraguay, compared with a 1.5% average the contribution of the OECD members in 2021[36]. Nevertheless, regardless of the individual country's situation, the importance of agriculture rises when upstream[37] and downstream[38] activities are added to primary production. Applying this broader definition of agriculture, the sector accounts for a share of more than 20% of GDP in most of the economies in the region[39].

Moreover, agriculture is a significant employer of the labor force in many countries. In 2018, 14.1%[40] of the total labor force in the region was employed in agriculture, nonetheless, countries such as Peru, Ecuador, and Bolivia employed close to a third of their labor force in the agricultural sector.[41] Share of employment by agriculture is much higher in men, except for Peru and Paraguay

[31] Idem

[32] Idem

[33] Idem

[34] (FAOSTAT, Various years), 2020

[35] (The World Bank, 2022)

[36] (World Bank, Various years), 2021

[37] E.g., inputs and machinery

[38] E.g., processing and commercialization

[39] (World Bank, Various years), 2019

where women's share is almost as high as men's.[42] It is important to emphasize that agriculture is a catalyst for employment among the most vulnerable strata (living with limited public services in rural areas), contributing directly to the development and distribution of wealth.

Additionally, land distribution across producers has large variation between countries, and even within a country. While Guatemala (4.5 ha), Ecuador (14.7 ha) Colombia (25 ha) have an average farm size below 25 ha, Argentina's average agricultural holding size is above 500 ha. Brazil on the other side, has average farm size in Mato Grosso close to 1,250 ha, while an average farm in Paraná has a land around 50 ha.[43] It is important to notice that not all small farmers suffer from economies of scale issues, those producing high value crops might be competitive players enjoying relevant revenue, for example, 80% of avocado cultivation in Mexico is carried out by smallholder farmers who are endowed with land of 5 ha or less[44].

Agricultural outlook

According to the OECD-FAO Agricultural Outlook for 2031, agriculture output in Latin America and the Caribbean is expected to grow for the next decade by 9%. This growth will mainly come from intensification, double cropping[45] and better yields[46]. Almost half of the expected increase in planted land will come from soybean and corn. Because the region's share in global soybean production is more than 50%, prices could be heavily impacted by unexpected weather conditions.[47]

Productivity in the region grew at a fast pace during the last decade[48], going from 93 to 104 Total Factor Productivity (TPF)[49], and is expected to continue for most major crop commodities. This could improve the net value of production per hectare and reduce the greenhouse gas emission per unit of output.

Finally, the OECD and FAO mention that the region has enjoyed a trade surplus twofold over the past decade, and although Brazil's export growth will decelerate, Mexico, Costa Rica, and Ecuador will show robust growth in the fruit and vegetable international market. Likewise, commodity exports will also gain shares in the international market. Nevertheless, the agricultural industry has high price volatility given its dependence on several independent variables like weather, including natural disasters and climate change, and macroeconomic and political factors, including international trade agreements and social instability[50]. Because of this, input products for agricultural production like water, fertilizers, and worker salaries can increase in price, presenting a challenge for agribusinesses to maintain margins.

[40] (World Bank, Various years), 2019

[41] (FAOSTAT, Various years), 2020

[42] Idem

3.2

THE CURRENT STATE OF THE DIGITAL TRANSFORMATION

Based on the primary and secondary research conducted, this study found that the agribusiness sector in Latin America and the Caribbean is at an early stage in the Digital Transformation journey, where, although not leaders by international standards, there are some relatively advanced organizations leading the way.

This section will deepen on the findings starting by unveiling the needs and pressures for Digital Transformation, then explaining some of the most relevant barriers and challenges that organizations face in the process of transforming digitally, and finally, presenting some of the digital solutions and applications that were found in the region.

It is important to note that, in most countries and sub-sectors (crops), the primary research found digital leaders and digital laggards, the latter outnumbering the more fore. Most agro-industrial chains have some degree of digitalization, which in the case of the laggards consists of the use of isolated digital technologies but lack a universal view of the transformation as a business imperative for the future. Digital leaders are rare in the region but are evidence of the power of Digital Transformation in key business outcomes, such as increasing productivity yields and innovation for the future.

3.3
NEEDS TO BE ADDRESSED BY THE ORGANIZATIONS

Agribusiness organizations are facing key challenges that need to be promptly addressed to achieve an effective evolution for the value chain stakeholders. Some of these challenges relate to important macrotrends. For example, an increased demand for productivity, to cope with world population demands[51] and a globalized economy which increases competition and places price pressure on agricultural inputs. Additionally, a more sophisticated demand as the consumer pays more attention to and is willing to reward how their goods are produced, relating to food safety, health, environmental protection, and adequate working conditions[52].

Similarly, there is a challenge in climate change where, given the LAC region´s importance in shaping the global weather patterns, it is crucial to adapt crops to new climate conditions and to manage trade-offs of maintaining a stable food supply, which includes additional carbon emissions, resource depletion, and biodiversity loss[53]. Furthermore, agribusinesses are facing pressures because of low business margins and an unskilled workforce, in addition to a low interest in a generational renewal. Finally, an important pressure is a technological revolution, where new innovative digital solutions are transforming agriculture practices that require new talent and skills to be developed to take advantage of its benefits.

[51] (Loukos & Arathoon, 2021)

[52] (Interamerican Development Bank, Interamerican Development Bank - Invest, 2022)

[53] (Morris, Ashwini, & Perego, 2020)

Out of all the challenges mentioned above, some were specially glaring through the Digital Maturity Assessment and the interviews with C-Level executives. The five key needs that were identified through the study are:

- Achieving greater operational efficiency
- Increasing productivity
- Mitigating risks
- Responding to market demands and uncertainty
- Finding the right talent

Most were prevalent across the crops and countries.

Achieving greater operational efficiency

In the agricultural business, there is an imperative need to have greater operational efficiency to achieve desirable margins. Adequate monitoring of dependent and independent variables in each part of the production process is essential to making the right decisions at the right time. This allows organizations to maximize and effectively capture value, even when many uncontrollable variables are in play. There are several examples of organizations that face this need. One became known during a conversation with a High-Value Crops producer in Chile, where executives shared that one of the reasons they had started their Digital Transformation journey was because of the unfavorable climate conditions they had in the region. This pressured them to implement intelligent water irrigation systems, allowing them to keep their crops healthy through periods of low rain levels.

On the other hand, greater operational efficiency gives organizations higher investment capacity to finance different initiatives, increasing their competitive advantage over other players in the value chain. One important competitive advantage is price. Through the interview process many organizations, especially some sugar cane producers in Ecuador, mentioned price as a crucial factor to stay competitive, saying final consumers still base their purchasing decision purely on price. The latter made reducing costs imperative to reach the lowest price that would capture the largest market share.

Furthermore, even though price is still the driving factor in the agricultural industry, in crops like bananas and other high-value harvests, emerging sustainable practices have been identified as a new competitive advantage in

the international market. In some cases, it was found that organic certifications drive the implementation of digital solutions that help the organization to reduce and control the use of agrichemicals and water, and therefore cost. One example came from a banana producer in Colombia, who mentioned its organic products had expensive inputs that put pressure to find cost reductions throughout the value chain, such as timely identification of crop diseases, and precise application of herbicides and fertilizers to reduce waste.

Overall, although there are some organizations that have already addressed the need for efficiency, the study showed most have low standards in the control of production processes that ensure savings. The foregoing is reflected by the lack of integration with the capture, management and use of production process data, the low automation level in operational control, and the low level of real-time visibility available for the correct optimization of operations. This demonstrates the latent need organizations have for digital initiatives, providing greater operational efficiency.

Increasing productivity

An increase in agricultural productivity is essential for the sustainability and growth of the industry. It is necessary to look for innovative alternatives to increase the production factor, obtaining greater and better results with fewer essential resources involved in agricultural production: labor, land, and capital.

As a result of a new tendency toward more sustainable practices, there has been a decrease in the resources needed for agricultural production. The availability of land, water and labor has been decreasing and organizations face a need to do more with less. Because of this, the need to increase productivity leveraged on digital technologies is becoming stronger every day. For example, in a conversation with sugarcane producers in Ecuador, they mentioned new governmental policies regarding employee work conditions, requiring them to reduce their maximum weekly working hours. Because of this, the organization was pressured to find digital alternatives that complemented the workforce, such as a new security system that reduced the number of personnel needed to patrol the extensive crop fields.

Furthermore, the growing demand for agricultural products and by-products[54] in the world represents an expansion opportunity for the agribusiness industry in Latin America and the Caribbean, especially for organizations that manage to boost productivity. Currently, most of the organizations that took part in the study recognize innovation as a tool to increase productivity across all processes. However, many do not articulate adequate efforts in the right initiatives, either because of a lack of an appropriate vision or because they do not have the required capabilities.

[54] Agricultural by-product means discarded organic materials produced from the raising of plants as part of agronomic operations including plant stalk, leaves, other vegetative matter, and discarded product from the on- farm processing of crops

Mitigating risks

The agribusiness industry needs greater control and risk management practices and tools within its operation. Given the nature of the agricultural industry, unexpected changes mean for massive losses. For example, a bad logistical operation can cause tons of produce to go to waste and millions of dollars to be lost.

Unpredictability and risks, which affect the productivity and competitiveness of the business, are represented by the uncertainty generated by external factors like weather change, the inadvertent presence of pests, supply chain shortages or other factors that can have a negative impact on business results. Therefore, agribusiness organizations should look for procedures and tools that help take back some of the control. Technologies that help with weather forecasting and measuring of crop health can be incredible allies when battling volatile conditions. Several organizations in the study, encompassing all crops and countries, saw the potential to implement digital technologies, supported by geolocation, sensors, data analytics, and artificial intelligence, to help plan their harvest results. For example, a Peruvian organization of High Value Crops, shared they needed to determine harvest expectations to properly stock up on primary inputs. But findings show few organizations and value chains in the region consider these technologies to help mitigate uncertainty generated by climate factors that affect crop productivity, leaving risk unaddressed.

Furthermore, given that the operation of the agribusiness industry in the region is highly related to the international market, there are variables such as negotiation power and geopolitical factors that can directly and indirectly affect purchase prices and, by extension, business competitiveness. Consequently, it is crucial to help organizations get real insurance regarding the value of their product through price. For instance, an organization in Mexico that produces berries and citrus fruits, expressed the need for tools to help identify optimal price windows to plan their harvest accordingly and capture the highest value for their product. Another organization in Guatemala focused on sugarcane production, had problems acquiring the right future contracts. This resulted in suboptimal outcomes to those they would have gotten in the actual market, showing the need for better predictive and planning tools. Study findings show the use and analysis of various sources of information for the mitigation of this risk is just beginning, currently responding only in a reactive manner.

Responding to market demands and uncertainty

Agribusiness organizations must develop the capacity to operate in an agile way to respond and adapt in a timely fashion. The study discovered agribusiness organizations in Latin America and the Caribbean do not have the organizational structures, ways of working, and agile methodologies to pursue pioneering initiatives or other opportunities for expansion that allow them to respond adequately and timely to market needs.

The analysis and interview process identified the necessity for organizations to include present trends and future needs in their strategic vision. Although many organizations indicated they had a plan to adapt to emerging requirements, many lacked a step-by-step structured approach, as well as a robust governance model to effect change. In turn, this stopped businesses from promptly developing new processes that answer market demands.

Internally, the analyzed organizations showed a lack of alignment and coordination between the different operational areas. As a result, many initiatives developed to respond to uncertain and changing conditions were disconnected and had an insignificant effect to adapt and capture any real benefit. For example, an organization in Argentina specializing in cereals stated that it had implemented several individual technologies in operation, but it was still lacking a strategic integrated plan to deliver real value to the different stakeholders of the value chain.

Also, the study indicates the organizations that implemented agile work teams and methodologies were more digitally advanced and more likely to advance faster. This reinforces how businesses need to design nimble processes that allow timely communication and collaboration to successfully respond.

Finding the right talent

To achieve a successful transformation and capitalize on its benefits, it is essential to have the right human talent. The industry in the region has suffered setbacks for following a traditional path. This is based on outdated talent and technical capabilities, which block emerging transformation practices for advancement. To facilitate change, it is key to embrace innovation and a growth mindset within all levels of the organizational structure. Rewarding mechanization and encouraging leaders is also important to nurture these capabilities.

The study found that employees of agribusiness organizations in the region do not have the skills and digital readiness for an adequate use of technologies that could otherwise be utilized. Consequently, the adequate generation of value that Digital Transformation can provide is diminished. For example, a banana business in Colombia perceived the need for programmers and developers, but because it is an agricultural organization, there were none on staff. Similarly, an organization in Ecuador indicated they lacked qualified talent to operate new machinery and technologies they wanted to implement. This demonstrates finding the right talent and capabilities enables the evolution of agribusiness organizations.

3.4
CHALLENGES AND BARRIERS TO DIGITAL TRANSFORMATION

There are several challenges agribusiness organizations in Latin America and the Caribbean face, preventing them from structuring and implementing a Digital Transformation program with a sharp vision and expectations. Some of these challenges may be fixable by the organization itself, while others are more complex and require interventions by other groups of stakeholders.

Internal main challenges include:`

- Nonexistent or fragmented strategic vision and poor governance of the transformation
- Lack of proper budget and financing sources articulated with a case for value
- Inappropriate culture and difficulty with talent acquisition

Challenges outside the organization's reach include:

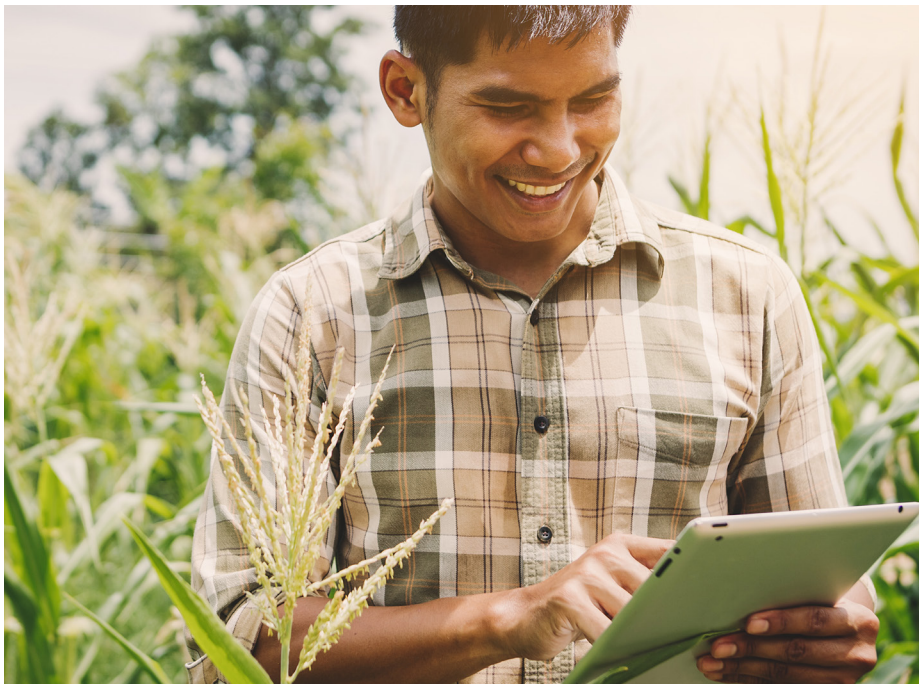
- Deficient infrastructure and connectivity
- Lack of an ecosystem view of Digital Transformation
- Poor alignment between market solution offerings and organizational needs

Depending on the varying degrees of digital maturity, these challenges may be present in organizations. However, identifying them within and around the organizations is a key step to further develop the Digital Transformation strategy and achieve its full potential. A deep dive on each challenge shows how they prevent the Digital Transformation from taking place or achieving its full potential for organizations.

Strategic Vision and Governance

The lack of a strategic vision (or its fragmentation) and clear governance of the Digital Transformation program hinders its proper implementation. A top-down approach, where Digital Transformation starts with C-level executives' strategic vision, plays a critical role in the organization´s future and extends to leaders in other areas. It is what allows a structured and aligned transformation process to take place. Additionally, only with a clear definition of roles and responsibilities, may ownership over the program happen so it can be constantly prioritized.

By analyzing responses to the Digital Maturity Assessment, many organizations considered they have a plan for Digital Transformation. Yet, during the interviews this consideration rarely translated into a clear narrative or a consolidated approach, through which leaders of different areas would be able to articulate a sharp vision of the why and the how of the transformation. The lack of clarity and alignment in the transformation journey, appears to result in the implementation of only small digital solutions in the organization that have insignificant effect. A clear example came from a High Value Crops producer in Peru. The organization expressed their current, reactive approach that had no structured plan, and led them into making wrong decisions regarding digital technologies. This translated into inefficiencies with many "grey zones" and significant rework was required. The lack of a structured plan prevents digital solutions synergies from surfacing in a way organizations can fully achieve Digital Transformation potential, which in turn belittles the perceived value.



Additionally, a pattern surfaced where an innovation-prone environment was related with the existence of a specific area with Digital Transformation as its sole purpose. Organizations that had strong C-level sponsorship and clear roles in charge of the Digital Transformation program, were often able to prioritize their needs better and allocate their time and money to the correct initiatives. Those that did not struggle in this aspect. For example, a cereal producer in Argentina, revealed during an interview there was trouble prioritizing and conducting digital initiatives because of the absence of a team to take charge. They explained day-to-day activities caused Digital Transformation projects to take a back seat, given that individuals did not have time to work on them. This illustrates, that without a clear leader for Digital Transformation, organizations seem to have trouble defining and driving forward their Digital Transformation agenda and its value.

Budgeting and Financing

A lack of proper funding for Digital Transformation is a fundamental barrier that prevents even perfectly designed plans and strategies from being conducted. Many organizations considered in this study did not assign a proper budget for their Digital Transformation program. The main reason for this was a difficulty in understanding the real value of Digital Transformation initiatives, which holds back C-level executives from investing and prioritizing a budget for them.

Throughout the study, there were several examples of organizations that had a Digital Transformation plan in place but did not have the proper budget to carry it out. For instance, a High-Value Crops organization in Peru disclosed, that given the volatility in the industry´s market, when the company´s bottom line was affected, the first to take budget cuts were IT departments, as well as Innovation and R&D departments. Because of this, in years where results were particularly good, the Digital Transformation program advanced, but when results were poor, it was forced into survival mode and unable to carry it out. Another Guatemalan sugar organization, also expressed a budget challenge, stating its Digital Transformation budget was only 1% of that destined for the agricultural department. This lack of proper budget presented leaders of Digital Transformation with a challenge to have a long-term Digital Transformation journey, given that the budget structure usually allowed only for short-term solutions.

The lack of a proper budget seems to be a consequence of difficulty perceiving the actual value of Digital Transformation initiatives. A common denominator found in the interviews showed those who proposed innovative solutions and technologies had difficulty convincing the top management to prioritize their investments in Digital Transformation programs. The primary difficulty is justifying considerable investments with the corresponding financial indicators (i.e., ROI), which makes it difficult for a traditional business case to be presented. The same Guatemalan sugar producer indicated having to resort to outside sources, such as Digital Transformation case studies, to try and make the case. Additionally, a Guatemalan banana producer had a very conservative culture where costs and short-term returns were the most important measures when evaluating an alternative. This meant Digital Transformation initiatives that usually have long-term results were not attractive. This difficulty in accurately determining economic returns makes C-levels wary of investing in expensive equipment or digital solutions.

But even after implementing digital solutions, agribusiness organizations find it hard to financially quantify the benefits. Given the variable nature of the agricultural industry, where many factors, such as climate, plagues, handling,

and traceability, affect the harvest or crop quality, it is challenging to attribute either negative or positive changes in results to a single digital transformation initiative. Therefore, with the support of benchmarks and best practices like the ones provided by IDB Invest's Advisory Services team organizations may find a good partner to guide themselves when making an investment decision related to their Digital Business Journey.

Even though very few organizations expressed financing as a real stopper towards digital transformation, a conservative approach to debt and outside financing was prevalent among agribusiness organizations. As a result, many organizations in Colombia, Guatemala, and Ecuador, mentioned they prefer to finance their transformation initiatives with their cash flows and do not leverage on loans and other types of debt. This represents an important challenge when agribusiness corporates do not have enough budget to finance their digital transformation program on their resources. This conservative approach allows organizations to reach only a basic level of digital transformation and opens a future collaboration opportunity of being financed by IDB Invest, to take advantage of the benefits that a digital transformation journey can deliver, as well as make use of the advisory services that come together with the financing products, which increases IDB Invest's value proposition to its clients.

Culture and Talent Acquisition

The lack of the right talent and culture in an organization prevents Digital Transformation from thriving. A collaborative and adaptive environment, the proper knowledge, and key capabilities are crucial enablers, and are one of the most relevant barriers businesses encounter when thinking about starting or implementing the Digital Transformation journey.

The DMA analysis revealed several organizations lacked collaborative processes where employees were encouraged to look outside the organization and propose innovative initiatives. Additionally, although many claimed to be open to taking risks, most admitted failure was often penalized. The inability to freely collaborate with people in all areas of operation, prevents businesses from identifying new ways processes can be improved to increase both efficiency and productivity. This void in cultural practices stops innovative ideas from forming and, therefore, Digital Transformation from happening.

Additionally, while talking with agribusiness leaders, we found one of the first challenges comes from resistance by employees themselves to adopt new practices in their daily work. Many are comfortable using the tools they already know well and see little sense in changing. Change resistance is a common thread that shows how employees do not think innovative technologies offer added value to their processes and prefer to stick with what they think works. A sugar organization in Ecuador even said that when trying to implement a technological platform their employees were frustrated and eventually reverted to their old practices. This left a newly acquired technology unused at the side. The lack of a meticulously designed and executed change management program leaves executives frustrated, seeing how a significant investment they made is discarded, and as consequence the investment of resources lost. A High-Value Crops organization, as well as other sugar organizations in Ecuador, attributed this resistance to the fact their workers come from rural areas and are of older ages.

Resistant attitudes seem to result from deficiencies in the digital skills and capabilities of current employees. Organizations primarily consider two options: internal training of personnel and outside hiring. While internal training is a good approach, it requires time and patience and may sometimes not be enough when the current personnel simply resist change. Because of this, organizations are forced to look outside to bring new talent to their organizations, fostering a more transformational-prone environment.

When seeking new and young digital talent, many organizations struggle to find people with the right qualifications willing to come work for them. As mentioned by a High-Value Crops organization, younger generations usually have the right disposition for Digital Transformation, but no longer see a career in agriculture as desirable or attractive. Furthermore, organizations in Ecuador recounted places and communities where they usually hire, have people with little beyond mid-level education, and therefore do not have the required capabilities. As a solution, the organization opened and fully subsidized training center, open to the community, increasing the pool of qualified talent pool. Another difficulty, exposed by an organization in Colombia, pointed out that a national policy regarding technical careers made it difficult for them to obtain qualified candidates. While the country has overqualified professional people, for jobs such as heavy machinery operators, there seemed to be a scarcity of people with the right technical careers. This inability to acquire talent with the right disposition and qualifications is a barrier agribusiness must overcome.

Additionally, agribusiness organizations have difficulty attracting qualified, available talent. A Guatemalan sugar

producer shared a lack of budget-restricted competitive salary offers for the required Digital Transformation positions. This stopped new talent from coming in and caused current talent to look elsewhere. Similarly, a Mexican citrus organization disclosed it had trouble competing for salary-wise with larger and more established organizations. Because of this, the company resorted to hiring young people, just out of university, and further developed their capabilities, which created a sense of loyalty and longevity within the organization. Some organizations have identified different strategies to attract new and qualified talent, by offering different incentives, however for many, it is still a critical challenge to overcome.

Infrastructure and Connectivity

Deficient infrastructure in the region limits organizations in the use of applicable technologies. Because most digital solutions require a reliable connection to the internet, a lack of connectivity will render them useless for organizations. The study found that coverage, quality, and reliability were frequent problems for most agribusiness organizations, with the majority in countries like Argentina, Colombia, Ecuador, and Peru stating it as a problem when applying digital solutions.

This barrier affects not only the agribusiness, but the entire population of the region. In 2020, a study on rural connectivity in Latin America and the Caribbean, by the Inter-American Development Bank (IDB) and Inter-American Institute for Cooperation on Agriculture (IICA), showed that only 37% of the region has connectivity options, which are not always of the best quality. This study is aligned with what was seen in the interviews, which showed that countries such as Peru, Argentina, Ecuador, Mexico, Paraguay, and Guatemala showed almost no rural connectivity[55].

Moreover, two High-Value Crops organizations in Colombia, said connectivity problems were caused by an absence of telecommunications providers who offer a good enough service at a reasonable price. There are few providers available, resulting in a monopoly-like power and no incentive to improve service or lower prices. Many organizations complained, that even if they wanted to migrate towards infrastructure based on the cloud, the lack of connectivity prevented them from doing so, and stopped short of their digital objectives. Given a private effort to build or improve the connectivity infrastructure is unaffordable for businesses, poor connectivity is one of the most basic barriers to surmount.

[55] (Interamerican Development Bank; IICA, 2020)

Lack of an ecosystem view of the Digital Transformation

The absence of collaboration and coordination in the ecosystem is stalling Digital Transformation in the agricultural industry. The ecosystem around organizations is just as important as the organization itself. Digital solutions require a joint effort among all players in the value chain, in a way that they can be effectively integrated, completely deployed and proactively developed.

An important challenge when introducing a digital solution, is making sure it joins seamlessly with the other value chain stakeholders' ways of working. Through the study, many organizations expressed discouragement in implementing innovative solutions because of the perception it would not generate an added value to their process unless their supplier/client counterpart implemented compatible approaches. For example, a sugar exporter in Brazil, was skeptical that a Digital Transformation would provide added value for their suppliers or their clients, and therefore it didn´t make sense for them to change.

Similarly, other organizations found their Digital Transformation could harm the relationship when the new solution did not fit with their counterpart's current processes, and therefore the supplier or client was unable to collaborate with them. For example, a sugarcane processor in Ecuador, had automated the packaging process, resulting in a change of packaging from a sack of small sugar packages to larger pallets. While some clients, such as big chain supermarkets that used forklifts to move their inventory found the change helpful. Others, like traditional marketplaces with little space to store their products, found it impractical and did not appreciate that change. This incompatibility underscores how a joint approach is necessary for a Digital Transformation transition.

Another crucial factor has to do with the client and final consumer's perceived value of an organization's innovative solutions. As the world slowly progresses toward including sustainable practices in their operations, even when is still not largely required by public policy, some agribusiness organizations are preparing for when it becomes mandatory, leaning toward Digital Transformation solutions that enable sustainable practices.

However, these solutions may come with added costs that clients and final consumers are not yet willing to pay. During interviews, many

sugarcanes producer stated their overall objective was to reduce costs to reduce prices. They indicated consumers were primarily price driven, when they offered more environmentally friendly packaging with just a small price increase, they did not get a positive response and were forced to revert to old practices. Given that the agricultural industry has primarily small margins and intense competition, pricing is still one of the key factors. This forces organizations to forgo innovative, sustainable solutions to stay competitive. There are, however, some businesses that do not perceive this as a barrier, but as an investment for the future. For example, a Chilean producer and exporter of High-Value Crops, mentioned while still not receiving a price premium for their sustainable practices, they are confident they will make it shortly.

Finally, a lack of collaboration among peers in the value chain hinders Digital Transformation in agribusiness. When analyzing the organizations' interviews, some of the most digitally mature had some way of collaborating with peer entities allowing them to actively develop and deploy digital solutions with economies of scale. An interesting example is a Guatemalan organization that leads innovation processes and solutions for the sugarcane industry, by generating business models in new and transformative areas that promote the development of skills technologies and infrastructures. A case study for this organization can be found further down the report in Figure 6: An example of powerful collaboration between peers.

Poor alignment between market solution offerings and organizational needs

The excessive cost of adapting and/or lack of alignment between the characteristics of current offered solutions and technologies and the specific needs of Latin American and Caribbean agribusiness organizations is an important barrier to digital adoption. Through the study it is apparent there is an ample offering of digital solutions available to organizations in the region. Nevertheless, many expressed frustrations saying they could not find solutions fully addressed to the needs and characteristics of their business.

One common factor challenging this alignment was the topography in some countries. For example, organizations in Chile emphasized they could find technologies that met their needs, but they were developed in countries such as Australia and the United States with quite distinct characteristics. Organizations in countries like Colombia pointed out that certain characteristics of their terrain were not compatible with drone solutions on the market. Because solutions need to be adapted, some organizations in Colombia and Peru required in-house customization developments before using acquired technologies, incurring unexpected costs. As few organizations have the capacity for developing the required adaptations, they view this as a barrier when considering the acquisition of available innovative tools.

3.5 DIGITAL SOLUTIONS

The Latin American and Caribbean agroindustry currently has several needs that need to be addressed such as pressures to have great operational efficiency to keep sustainable business margins; pressures to increase productivity to feed a growing population with dwindling resources; a need to mitigate risks in volatile conditions; a necessity to promptly respond to market demands; and acquiring the appropriate talent to deal with all of the above.

To address these pressures and challenges, the agricultural industry is experiencing an important transformation that has been referred to as Agriculture 4.0. The term has been used to encompass the change from traditional agricultural practices to the leveraging of digital solutions such as automation, remote sensing, precision agriculture, Big Data analytics, and artificial intelligence. Through this agricultural digital revolution, agribusinesses will not only seek innovation but will use it to improve and address incoming pressures from consumers and reengineer the value chain. Modern agribusinesses will use these advances to be more efficient, productive, safe, and environmentally friendly[56].

The above could potentially be the key to unlocking the region's potential and allowing it to maintain global production and export relevance. Solutions like precision agriculture can help increase input per hectare more efficiently (e.g., fewer inputs per ton of product). ESG[57] aligned technologies can help mitigate risks and respond to new market demands, while remote work tools can facilitate access to talent.

Throughout the study, it was found that Latin America and the Caribbean agribusiness have distinct levels of adoption of the digital solutions for shared problems mentioned above. The following are either in implementation, piloting, or planning stages in companies of the LAC region[58]. These solutions have been grouped depending on the digital maturity level at which organizations usually implement them: Basics, Enhancers, and Next Level, nonetheless, it is not restrictive, and they can be adopted at various stages depending on the specific needs of the agribusinesses.

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[56] (De Clercq, Vats, & Biel, 2018)

[57] ESG stands for Environmental Social and Governance, and refers to the three key factors when measuring the sustainability and ethical impact of an investment in a business or company

[58] The objective of this section is to provide a broad perspective of feasible solutions available to agribusinesses in the LAC region to help address the needs that were evidenced by the sampled organizations, therefore, some of exposed cases may correspond to regional companies, not necessarily included in the study sample.

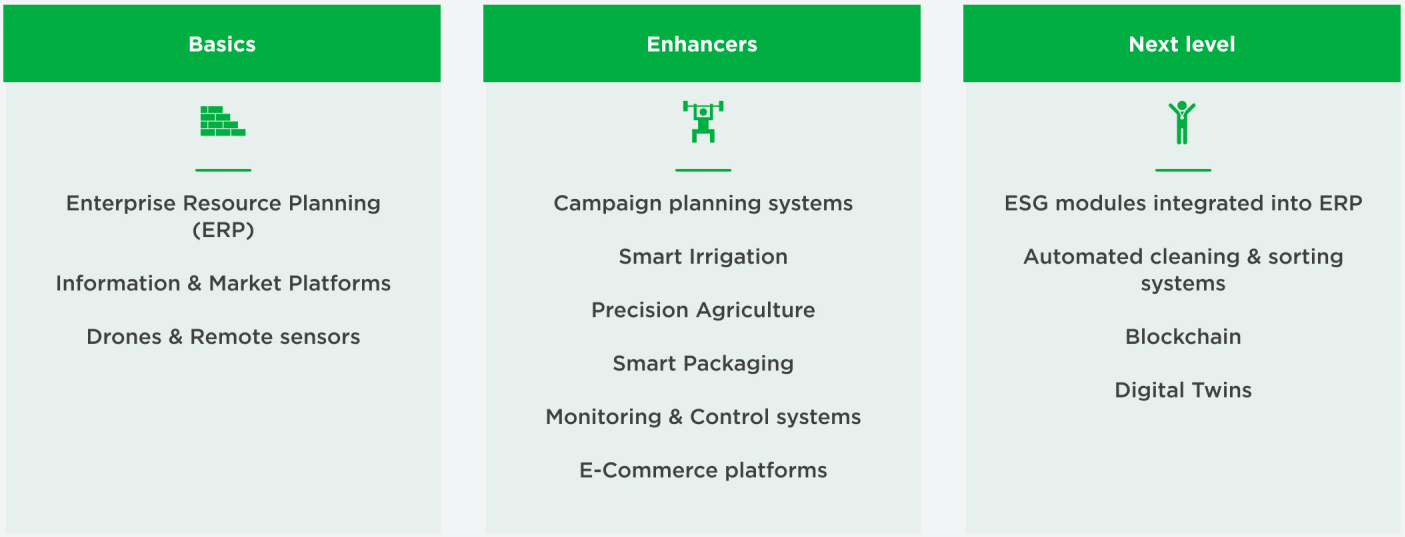


Figure 1: Digital solutions by digital maturity level

Basics: digital solutions to begin a Digital Transformation

Under the Basics category, we identify those digital solutions that address the primary needs of agribusinesses. Specifically, those solutions are vital to effectively managing an organization's resources and gathering relevant data. For those organizations that have yet to begin their Digital Transformation journey, this can be a good place to start.

Enterprise Resource Planning (ERP)

Enterprise Resource Planning (ERP) is a software system that helps organizations effectively manage most of their business processes by integrating important parts of the operation. ERPs are essential to efficiently manage data from multiple business sources and optimize every process from procurement to distribution. This digital solution typically incorporates different modules that are useful to manage accounting, sales, purchases, inventory, and many other aspects of the business. It streamlines every process including procurement, production, and distribution.

Benefits:

The main benefits expected and observed by agribusinesses are seamless integration with sensors and modern vehicles for data analysis and improvement of operational visualization, thereby reducing manual errors; single source to monitor and track the quantities or kinds of resources, including fertilizers, pesticides, machinery, assets, and any other equipment; better forecasting of resources and facilitating to scale inventory and production. All the above can help organizations address their needs for greater operational efficiency, increasing productivity and mitigating risks.

Level of adoption in the LAC region:

In the sample of organizations for the study, practically all companies regardless of size, activity, value chain and country were familiar with the use and benefits of ERPs. Nonetheless, most of them were using outdated systems that were originally implemented 20+ years ago and have been evolving according to immediate business needs, without a strategic perspective or integration capabilities with third-party systems. At least half of the interviewees reflected a high interest in migrating to a more advanced and updated ERP system to leverage all the data available in silos from the different digital solutions in use.

Specifically, large and global companies have been able to migrate to leading available ERP solutions, and were comfortable with its reporting and monitoring capabilities. They identified opportunities in the analysis and integration of data for decision-making, although data is generally still accessed and used in silos. On the other hand, medium-sized companies are evaluating the costs and benefits of available market solutions, with interest in the larger providers but are looking for agriculture-specific modules that properly tackle their needs and characteristics. Meanwhile, smaller companies struggle to convince leadership about the benefits or value of migrating to new ERP solutions that require a large capital investment and are in the need to find benchmarks and return of investment (ROI) ratios that support the justification of this investment.

Moreover, some high-value crops companies in Chile, Peru, and Colombia, which rely heavily on labor, have implemented Human Resources Management System (HRMS) modules to track seasonal workers and look after their payments and taxes more efficiently, as well as other costs associated with facilitating proper care of their workers.

Interestingly, safeguarding company information and data from security breaches of these systems (cybersecurity services) was not an imperative subject during discussions. From our perspective, this position will change over time as the agribusiness organization becomes exposed to potential future vulnerabilities as it enters new markets or becomes part of broader customer/supplier platform-based ecosystems.

Barriers to adoption:

The main barrier identified during the conversations with organizations, was the high cost of implementing leading ERP solutions, as well as a narrow access to financing. It is clear it is difficult to allocate and prioritize resources for this sort of enterprise tool without a clear ROI analysis, given it prevents high-level executives from approving an investment budget when the return

of competing investment needs is easier to quantify (e.g.: additional land cultivated, or tons of product produced). An additional barrier identified during the study was organizations found available solutions were too complicated to get full value for their business needs and therefore too expensive for what they would get out of the solution. Similarly, organizations felt current providers in their respective countries did not have the flexibility they required to adapt their solutions to their specific business operations.

Information & Market Platforms

Information and market platforms are tools that provide information and direct connection between the need, availability, and price of a required product. The use of these digital commercial platforms is a business and technology advantage that applies to all the links of production and can increase cost efficiencies. The platform advantages are reaped from both, the buyer, who has the possibility of improving costs, and from the seller or service provider, who can optimize availability more dynamically. Novel examples are shared shipping platforms to transfer loads more efficiently or platforms with information on the availability of harvesters in crops, based on manual harvesting with migrant harvesters.[59]

[59] (Accenture, 2020)

Benefits:

Several benefits can be obtained by using information and market platforms. First, these platforms can help organizations expand their customer bases, enter new markets, and increase their exports. Furthermore, it can help agribusinesses to obtain more competitive prices for their products. Additionally, when integrated with ERP systems, these platforms can enable different payment methods, as well as facilitate export documentation management, such as maritime routes, customs, import tariffs, documentary credits, exchange insurance, etc.

Overall, the adoption of Information & Market platforms can increase operational efficiency by aiding in the decision process for harvest planning, ensuring the product is available at the right time where it will get the most value. Similarly, an important benefit can be related to mitigating risks, given the use of the available information in these platforms can alert organizations to certain situations and allow them to react promptly and appropriately.

Level of adoption in the LAC region:

The adoption of these platforms comes mostly from trading companies, which rely on third-party information platforms to optimize pricing and volume allocation. Nonetheless, throughout the study, these intermediaries stated they interact only with a small number of producers and buyers; therefore, they emphasize no need for a market platform and prefer to make use of personalized communication (e.g., WhatsApp, phone calls, and sometimes emails). Producers of non-commoditized products behave similarly to traders, relying on a few large clients in the internal and international markets.

Barriers to adoption:

An important barrier to adoption comes from a sophisticated and complicated process for international commercialization (with tariffs, legal compliance burden and supply chain issues). LAC producers prefer to make use of specialized intermediaries or have a few large clients that they feel do not merit the use of these platforms. Similarly, regarding

internal markets, most interviewees stated the impossibility or low interest in B2C models because of the associated costs of managing each client. Additionally, it was also found there is high vertical integration on crops like sugarcane (and soy to some extent), where first and second processing outcomes (e.g., sugar and ethanol, respectively) are generally sold in bulk to larger clients, which further hinders the use of these platforms.

Drones & Remote Sensors

Remote sensing consists of being able to acquire information and monitor the state of crops from a distance. Particularly, remote sensors, both of active (radar) and passive (without signal emission) use, can monitor and diagnose the presence of pests, diseases, weeds, heat sources, and nutritional and water deficits. These can be installed directly on fields or fields supports, including tillage machinery or unmanned aerial vehicles such as drones or satellites.

Some relevant and differentiating factors in these technologies are the spatial resolution (allowing precision in the execution of tasks), temporal and radiometric (providing accurate diagnoses for better differentiation between attributes of the crop and the soil)[60]. Additionally, different sensors can deliver information with varying degrees of processing: from raw data – sets of georeferenced pixels with reflectance data at each pixel, which the customer must interpret – to advanced analytics, where integrated algorithms transform the gathered data into the variables of interest required by the producer. Similarly, within the broad spectrum of generalist sensors, there are detectors developed based on remote sensing, with algorithms calibrated for the identification of specific elements, such as the lack of a particular nutrient or the ability to distinguish pests, diseases and weeds present through Artificial Intelligence.[61]

This digital tool is an important foundation for the implementation of other technologies like smart irrigation systems and the adoption of new business models like agriculture 4.0, where organizations are transitioning from a traditional to a data-driven strategy, leveraging technologies like precision agriculture that use the information to be more efficient, profitable, and environmentally and socially conscious. This transition is important to adequately answer to the needs and pressures previously mentioned that agribusinesses are currently facing.

Benefits:

Several benefits can be realized from the implementation of drones and remote sensors. First, drones and sensors support targeted applications of insect, weed and disease-control products, as well as water and fertilizers, which reduces waste and enhances farm productivity. These technologies can provide precise identification of a small field area that requires particular care, therefore, there is no need to apply said input to other field

[60] (Pérez Colón, Navajas, & Terry, 2019)

[61] Idem

areas that do not require it or can even be negatively affected by it. Similarly, in addition to efficiency and productivity gains, these solutions can help producers with the ESG targets by making sure valuable resources like water are not wasted and that harmful substances like herbicides and fuel are kept to the minimum, which in turn reduces the environmental impact. In short, it allows agribusinesses to grow more with less. On the other hand, cost and time efficiency through reallocation of labor is also a relevant benefit, where some field workers can be reassigned to jobs where they can enjoy better working conditions and higher compensation, such as drone operators.

Level of adoption in the LAC region:

In the study's sample, drones seemed like one of the most accessible sensor solutions across geographies and crops. Even though these solutions are widely adopted, capturing data is still mostly limited to field operations. There is an opportunity for sensor adoption expansion in other parts of the value chain operations such as processing, packaging, and transport to constantly monitor the product's condition and identify inefficiencies or value creation opportunities. On another note, due to general connectivity issues in the LAC region, data is not generally available in real-time, it is stored on the device and transferred for analysis when in an area with connectivity. As it stands, this transferring process is done in short time intervals that can allow for acquired information to still be relevant for decision processes. In cases where data analysis takes extended periods, acting on outdated information can lead to inaccurate and detrimental decisions.

Throughout the study, there were various instances where organizations made use of these technologies. For example, interviewed producers of high-value crops, cereals and sugarcane use drones and on-site sensors to measure the health of crops, from the individual plant to complete fields, including soil conditions and the presence of weeds and insects. A high-value crop producer from Chile, with low access to water found special benefits from using drones and sensors to measure harmful conditions to vegetation, the soil composition as well as water quality. Further, the Chilean producer has just finished a pilot program with a completely autonomous drone and is planning to increase asset utilization and reduce labor costs and human error. Finally, important examples of remote sensor use outside the production process, come from organizations in Ecuador and Colombia. A

sugarcane producer in Ecuador uses remote sensors in their processing plant to monitor the weight and other relevant characteristics of their finished product. Meanwhile, a Colombian High-Value Crop producer has different sensors inside shipping containers that monitor temperature, light exposure, and other relevant variables during transport, which help to have information when a batch of produce arrives in bad conditions at its destination.

Barriers to adoption:

Although the adoption level is high, there are still relevant challenges organizations face when trying to implement this digital solution. On the one hand, the lack of on-field connectivity is a challenge across the region that forces companies to collect data offline, which requires an additional effort of integration and analysis that must happen at the base. Furthermore, crops with long field extensions require a large number of sensors that can represent an important investment for organizations, both to acquire and provide maintenance through their lifespan; not to mention fields usually have low levels of security and are prone to sensors being stolen. Additionally, many organizations cannot realize the full benefits of these technologies because they are not able to properly integrate them with their management systems. On the other hand, there is a challenge to have qualified talent that can both manage the digital tool and then interpret the resulting information to truly extract the value it provides. Similarly, convincing operators of the value of this sort of solution to get them to extensively use them is a difficulty that organizations encounter; for this, modular training or upskilling efforts tailored to specific audiences is essential for success.

Finally, regarding drones, some organizations have trouble using them given topographic conditions in their crop fields that are incompatible with current drones available, specifical organizations in countries like Colombia and Peru.

Enhancers: digital solutions to enhance agribusinesses

Included within this section are those digital solutions that can be used as business enhancers by agribusiness organizations. These solutions can help organizations reach further levels of efficiency and productivity by proactively leveraging most of the available data that is generated throughout the value chain. This is the next step for those organizations that have already started their Digital Transformation agendas and already have the necessary foundations such as data collecting tools and business managing platforms.

Campaign Planning Systems

Campaign planning systems take all relevant information regarding field capacity, crop, and harvest characteristics, as well as market conditions to plan a campaign proactively and effectively. Although useful for all types of crops, campaign planning systems are particularly powerful in seasonal crops, where producers must plan their campaigns by combining margin maximization with soil conservation. This requires an estimation of the projection of variables, such as the costs of the campaign's primary inputs and labor, medium-term climate forecasts (risks), history of crop rotation, history of yields, and expected harvest prices. For this last variable, in sophisticated commodity markets, includes projecting the value of futures and options. The combination of this information should help agribusinesses make the corresponding strategic decisions such as determining the area that should be devoted for each crop, appropriate times for harvest, labor requirements and product allocation (which product batches should be dispatched to which clients).

All decisions above should be done to maximize expected crop yields, input efficiencies, value acquired from sales, and consequently projected net cash flow for the year. Campaign Systems can also provide organizations with the opportunity cost of certain decisions compared to available alternatives, such as leasing the field and proposing the best finance method (credits, cash, payments for services to harvest, payments through participation in production) and its marketing strategy, and future contracts collection. Finally, it must provide a monitoring system for both physical and financial variables, throughout the entire campaign.

Furthermore, campaign planning systems are very correlated with the adoption of on-field solutions such as agricultural vehicles equipped with GPS and advanced sensors, which are connected online through Internet of Things (IoT) and help collect real-time data from the fields. Organizations that have important some advancement in the technologies mentioned above, can further leverage campaign planning systems given that they have the necessary data input they need to effectively provide value.

Benefits:

The primary benefits of campaign planning systems include maximizing production value and better risk management. On the one hand, campaign planning can help organizations make sure their products reach the market at the time and place where they generate the most value, increasing their margins. Alternatively, this digital solution can minimize costs by providing enough information to agribusinesses to adequately allocate their resources,

thereby maximizing efficiency, as well as allowing organizations to prepare for certain undesired situations, like unfavorable weather, in a way that risk is managed and potential losses reduced.

Level of adoption in the LAC region:

Through the study, it was identified the adoption of campaign planning systems is wide across regions and value chains in LAC, however, there are different levels of sophistication across interviewed organizations. Some of the most advanced campaign planning systems come from high-value crop organizations in Peru. The first and most advanced of Peruvian organizations, have powerful campaign planning systems that allow them to coordinate logistics and optimize the production of all their productive fields around the world, which all have different crop seasonality. With their campaign system, which incorporates advanced mathematical algorithms, they can effectively supply their clients all year long optimizing realized value by capturing better prices. This organization also mentioned, that they perceive this important optimization process is usually done manually by other organizations, which requires a lot of people.

Additionally, the second Peruvian organization mentioned their campaign planning process was one of the most critical of the operation, to maximize the obtained value of their production. They mentioned they used elaborate campaign systems that considered variables such as pesticide presence in their crops to determine batch allocation, given certain markets have different requirements that may block some batches from being commercialized; similarly, some markets may better compensate for certain organic characteristics making correct batch allocation vital for value maximization.

Finally, organizations that are in the beginning stages of digital transformation, have already identified campaign planning systems as an important digital solution to enhance their business. Organizations such as a citrus producer in Mexico and a sugarcane producer in Guatemala, mentioned they saw an incredible opportunity in being able to plan their harvest and acquire appropriate hedging

instruments like futures contracts to maximize their production value, and identified digital technologies as the next step to achieve it.

Campaign system implementation methods also varied across value chains, on one hand, companies that started their digital transformation journey 5+ years ago, such as grain companies from Brazil and Argentina and larger high-value crop producers in Peru, started with in-house development of their campaign planning systems, due to lack of off-the-shelf options, on the other hand, these same organizations have recently seen faster and better results migrating to as-a-service models that cover their needs, with no-code or low-code maintenance.

Barriers to adoption:

Some barriers are preventing organizations from acquiring campaign planning systems. First, there can be a lack of alignment between available off-the-shelf solutions and agribusinesses' specific requirements. Some organizations perceive available solutions do not adapt to their business characteristics or do not integrate easily with currently implemented solutions. On the other hand, a relevant barrier comes from a lack of budget allocation, given organizations can have trouble quantifying the economic value of potential benefits.

Smart Irrigation

Management of scarce resources, such as water, is of vital importance to the agricultural industry. Agribusinesses located in areas where rainfall and/or the water availability needed for their type of crop is scarce require smart irrigation systems to ensure a healthy and abundant harvest. Smart irrigation systems optimize the use of water by applying only the necessary amount to precise crop areas. It uses weather and soil conditions data to maximize irrigation efficiency, where the irrigation prescription is done automatically based on predetermined ranges and information from remote sensors in the field and drone or satellite imaging. The sensors include both soil moisture sensors and grid-connected dendrometers on the fruit or shaft of the plant or spectral sensors to analyze images of the crop. Irrigation is usually conducted by installing fixed structures for drip irrigation or pivot spraying, semi-mobile or mobile. In cases where the infrastructure used is a mobile pivot, the irrigation prescription can vary the flow accordingly, which is not possible in fixed installations[62]. Furthermore, even though usually only water is dosed, in some cases specific fertilizer doses are included inside the water systems when necessary.

Benefits:

There are key benefits that can be achieved through the implementation of smart irrigation systems. First, there is an optimization of water and agrochemical consumption while maintaining crop health, given it knows exactly the right amount of water and fertilizer needed for each plant. Similarly, there are yield and quality improvements that come with a healthier plant and soil. Additionally, there is a reduction in assets, labor, and energy utilization, given smart irrigation requires less time than the use of tractors, and there is a reduced need for labor for analysis or monitoring of the health of soil and plants

[62] (Días & Sentelhas, 2018)

which in turn reduces human error and less energy required for water pumping and vehicles.

Level of adoption in the LAC region:

Across the interviews conducted for this study, low levels of adoption were observed, with higher interest coming from high-value crop producers, in countries with better connectivity infrastructure and less water availability like Chile and, to some extent, Mexico. On the other hand, coffee producers in Brazil have experienced good results from precision irrigation, while Colombian (and Central American) companies have a more traditional approach and fewer economies of scale, as most coffee growers live on farms no larger than two hectares. Meanwhile, given the nature of commoditized crops like cereals and sugarcane (extremely large and mechanized fields, less fragile crops), producers of these crops find this solution less suitable or cost-effective.

An important example of smart irrigation system adoption came from a Brazilian coffee producer who decided to try it out in their 300+ ha field. Due to the productivity increase achieved, the producer was able to pay the investment after one year and have a yield impact of 80%. Similarly, a Chilean multi-product company was able to optimize water, fertilizer, and energy consumption while increasing yield and crop quality.

Barriers to adoption:

Access to this solution is limited to some LAC regions and requires a specific talent for daily operation and maintenance. The lack of access comes from a supply-side problem with fewer technicians or technical degrees in rural areas, but also the demand side, as many LAC countries enjoy good weather and water availability which reduce the producer's perception of needs. Finally, access to capital was identified as an important barrier to overcome, as many agribusinesses have cash flow restraints and lack financing alternatives.

Precision Agriculture

Precision agriculture is one of the exemplary digital solutions within Agriculture 4.0. It consists of the utilization of high temporal and spatial resolution data for decision-making in the management of crop production operations. In simple terms, precision agriculture aims to increase crop yields and profitability while reducing the use of agricultural inputs such as land, water, fertilizer, herbicides, and pesticides, through a precise application. To achieve this, several individual technologies need to be implemented such as remote sensors, which provide information on weather and crop and soil health; drones or satellites, which provide images to monitor overall crop health; fleets with incorporated GPS and field georeferencing, to have precise location information, as well as other complementary technologies that provide all relevant information for precise application of resources. Precision agriculture takes all the aforementioned information to determine the precise input requirement for specific plots of land, which ensures each plant is getting exactly what they need, no more or less, and results in higher crop yield, less contamination of the environment and less water usage.

Furthermore, precision agriculture can incorporate artificial intelligence like Machine Learning to interpret and execute tasks without assistance or with minimal human supervision. Some examples can be the identification of crop diseases through imaging processing, as well as semi-autonomous harvesters and seeders whose route and dosage inputs are optimally determined and conducted without human intervention. In addition, there are specific developments, such as drones, which can detect pests and apply biological controllers which can improve working conditions for workers by reducing their exposure to toxic substances[63]. Furthermore, artificial intelligence can provide farmers with insightful recommendations, having learned patterns from previous crop results.

Benefits:

Precision agriculture has similar benefits to those of smart irrigation but at a higher level, given it does not only allow for planning and operational optimization of water but also for most agricultural inputs and resources, which provides an even higher level of operational efficiency. Furthermore, the optimal planning and precise allocation of inputs and assets, boost per plot productivity. Specifically, there is yield maximization and product quality improvement through higher knowledge of soil and biome health.

Finally, precision agriculture helps organizations be more sustainable by reducing environmental impact through the reduction of energy, agrochemicals, and water use.

[63] (Fell, 2019)

Level of adoption in the LAC region:

Precision agriculture encompasses a broad spectrum of the digital transformation journey, therefore, few interviewees from the study's sample have fully implemented it across their fields. It was found a key driver for precision agriculture has been the scarcity or expensiveness of agricultural inputs. Therefore, countries like Chile or even some regions in Peru, mentioned scarce water availability was an important driver toward the implementation of these technologies. For example, a Chilean producer and retailer of high-value crops have implemented digital solutions for irrigation, soil and crop monitoring, automated inputs applications, satellite image analysis and climate forecasting. Operators are using mobile devices in the field to gain access to AI insights and recommendations and are starting an upgrade in ERP to integrate operational data with administrative and retail activities.

Additionally, crops that have high margins such as coffee in Brazil and High-Value crops in Mexico, Peru, and Colombia, are also adopters of this solution. For example, a Mexican greenhouse tomato grower has advanced implementation of irrigation, monitoring, and intelligent input application thanks to its controlled production system and high-value generation per ha., a characteristic of this crop's market. Overall, the pressure to obtain efficiencies and maintain business margins has been a strong motivator for its adoption across the LAC region.

It is important to note that most agribusinesses that have seen the impact of IoT, drones, analytics, and planning systems stated that precision agriculture is already in their roadmaps for the future, exhibiting examples of pilots and testing. For example, an integrated organization from Ecuador has a plan and is starting the foundations of precision agriculture. They have already implemented or piloted the digital solutions implemented by the previously mentioned Chilean company but have not yet been able to gain visibility and operate at the desired granularity of one square meter plots.[64]

Barriers to adoption:

Barriers to the adoption of precision agriculture depend on the sophistication level of the solution itself. In the first place, organizations with low maturity levels have not yet perceived the real value behind precision agriculture and therefore do not include them within their strategic vision. Similarly, there are those organizations that do not prioritize a budget to invest in the required technologies because they struggle with quantifying the potential benefits. On another hand, organizations can also face internal resistance where current

[64] It is currently planning and executing plots of 20 ha, without precises knowledge of biomes and soil characteristics at that level.

workers keep working the land through traditional methods and have trouble adapting to new digital technologies. Moreover, organizations struggle with finding qualified talent that can properly operate and manage this digital solution. Finally, a lack of reliable connectivity infrastructure in some regions require organizations to incur additional data integration processes, as seamless information transfer is not possible.

Smart Packaging

Smart packaging refers to the incorporation of digital technologies in agricultural product packaging that permit monitoring and provide relevant information regarding product location, freshness, and quality.

For example, the use of RFID[65] printed tags on product packaging is an increasingly common practice that facilitates traceability and attributes from origin to consumption or incorporation into mass consumption products. Additionally, the packaging industry is developing the incorporation of temperature and gas concentration detectors printed on packages to allow the monitoring of the status of perishable products, minimizing losses in the chain and avoiding reputational claims and damages.

[65] Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify, and track tags attached to objects. An RFID system consists of a tiny radio transponder, a radio receiver and transmitter

Benefits:

Relevant benefits that result from smart packaging utilization have to do with mitigating risks, achieving greater efficiency, and responding to market demands. Specifically, smart packaging can provide higher efficiency through automation and reuse of returnable plastic containers (RPC) and better protection for the fruit because of specific design, as well as the streamlining of certain administrative tasks in the logistics process by providing all relevant information upfront. Additionally, the risk of large losses can be mitigated by reducing claims about damaged goods, because of better shelf life. All the above have an overall impact on top-line growth and customer satisfaction.

Level of adoption in the LAC region:

During the interview process, it was clear smart packaging acceptance is low and currently limited to some advanced high-value crop producers. For example, a Mexican greenhouse tomato producer partnered with a returnable plastic container (RPC) company with specifically designed crates (and a cleaning and sanitized process) combined with an automated sorting, grading, filling, and packing modular solution, to transport products to retail grocery customers in the United States. Meanwhile, Chilean avocado and berries producers are using a third-party solution that provides QR codes for packaging that travels from harvesting to retail. This solution provides information about each harvester to facilitate productivity monitoring and payroll efficiencies. It is relevant to mention, that due to scale, some smaller operations leverage supply chain companies that pack and provide cold chain services for shipping and distribution.

Barriers to adoption:

There are three main barriers to smart packaging adoption. On one hand, producers do not currently perceive value added, given they do not receive a price premium for traceability efforts and find it difficult to measure payback from claims reduction. Secondly, these technologies are usually produced abroad, and it is hard to identify local distributors that can provide adequate service and maintenance. Finally, companies face friction from workers who find digital technologies as a negative disruption to their daily tasks, and it is difficult to find the right generation of talent to perform effectively.

Monitoring and Control Systems for Safety and Process Variables

In the same way that the levels of variables are detected in primary production, sensors for monitoring key variables in production processes are fundamental elements to improve safety, efficiency, and results represented by improved product quality. Additionally, in industrialized and retail environments, robotization also allows the control of these variables autonomously.[66]

[66] (EMBRAPA, 2021)

Furthermore, monitoring and control systems are an essential capacity in links of the value chain that require the control of safety variables, such as temperature and gas concentration in grain storage; as well as variables like temperature, pressure, and concentration of gases in mills with distillate lines to produce alcohols[67]. Moreover, it is also key in direct-to-consumption product chains that seek differentiation through quality levels associated with all organoleptic characteristics that are influenced by processing. A clear example comes from crops like berries or even coffee where processing requires detailed precision in environmental management. In the case of berries, the control of the cold curve from harvest to sale to the consumer is crucial for the preservation of value. Meanwhile, the case of coffee provides an example of how customer preferences need to be addressed through a modification of the roasting process.

Being able to control all these process variables, combined with the utilization of information such as supply projections by variety and origin, costs, and market prices, can help organizations optimize production and maximize the value of their harvest.

Benefits:

Implementing digital tools that allow for monitoring and control of various process variables can primarily provide quality assurance, which translates to greater financial gains. Players that have not implemented monitoring and control systems usually suffer from low bargaining power and lower prices paid by customers, due to quality issues that become known when products reach their destination.

Level of adoption in the LAC region:

The level of adoption of this digital solution depends on the level of sophistication demanded by product characteristics, as well as the economies of scale inherent to the company size. In commodity production, processing and distribution, there is a high level of adoption, particularly to measure and control variables in grain storage, such as temperature, humidity, and gas concentration. For example, a large Argentinian cereal producer has advanced temperature and gas concentration monitoring for grain storage, which provides information to other integrated systems through an ERP. Unfortunately, this company relies on traders and third parties to export its products, so it loses visibility of these variables after filling the container. These traders usually use global shipping companies that provide temperature and monitoring services along the route; however, these are mainly used only for an ex-post report or in case of discrepancies.

Similarly, for sugarcane production and processing, variables like temperature, pressure, and concentration of gases are monitored, however, digital solutions are not always leveraged. For instance, there is an integrated sugarcane company, present

[67] E.g., ethanol

in sugarcane production, sugar, and ethanol processing, and the generation of electricity, which implemented safety measures through proper monitoring of temperature, pressure, and concentration of gases. Nonetheless, the organization achieved this monitoring through non-digital methods (implemented 10-to-20 years ago) and is just planning for an update.

Alternatively, for coffee production digital solutions for decisions making regarding roasting or pricing could not be identified, however, this could be due to the fact these tasks mostly happen at the processing step where the main players are global CPGs that were not included in the study's sample. Moreover, there is a mild adoption of this digital solution in high-value crops, where the most advanced players have controlled atmosphere, gas, and temperature monitoring across the supply chain. Overall, high-value crop companies that incorporate monitoring and control systems across the value chain, enjoy fewer losses, and get better sell-in prices.

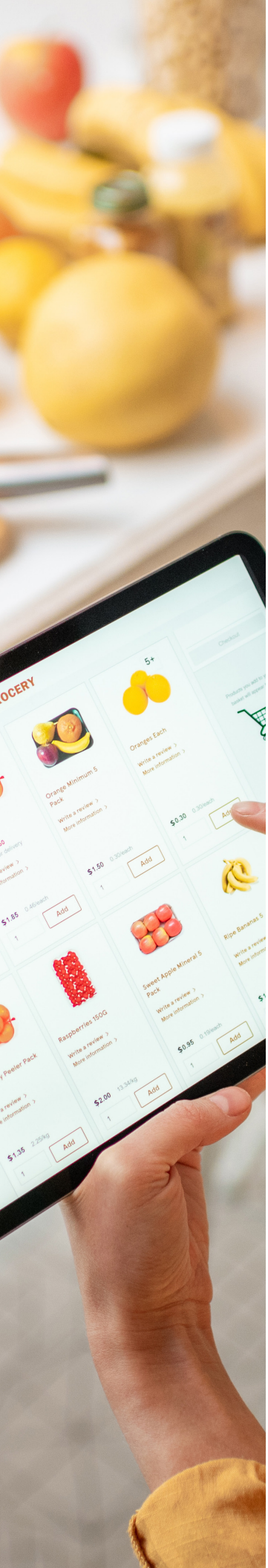
Barriers to adoption:

Similarly to challenges faced by the adoption of other digital technologies, there are difficulties perceiving value and prioritizing budget allocation for the implementation of monitoring and control systems. At the time, most producers do not perceive the potential value of this solution either, because current supply chain providers do not offer monitoring and control systems (or are too expensive) and they cannot see the value of implementing this control upstream on the value chain. Additionally, financing for these solutions is hard to find, given producers struggle to allocate resources for digitalization of production or processing due to the absence of reliable benchmarks for payback ratios[68].

E-Commerce Platforms

E-commerce platforms work by enabling the registration of natural and legal persons with transaction-making tools, including electronic security protocols to validate the identity of registered individuals and transactions. These systems are adopted or used by organizations that do not have their distribution infrastructure and want to make direct purchases or sales. The foregoing usually means companies that produce or distribute inputs on a medium to small scale and, rather than having a

[68] Time required to recover the investment.



small number of big clients, have a large number of clients that buy in smaller quantities. Broader platforms range from inputs, machinery, and infrastructure to financing lines and crop insurance.[69]

This type of digital solution can be particularly useful for organizations interested in the B2C markets, particularly the emerging Farm-to-Table concept, where consumers are directly connected with producers to easily purchase fresh and healthy food. To effectively manage this type of business model that has a higher level of complexity, given the high number of transactions and additional requirements like marketing, distribution, customer service, etc., organizations need to leverage E-commerce platforms coupled with customer relationship management (CRM) systems to be able to grow and compete in these markets. This business model is most attractive for crops like Coffee, Citrus, and other High-Value crops, given the higher margins they can achieve as well as a greater demand for their organic quality.

Benefits:

Implementation of e-commerce platforms can provide a better client experience that can be translated into a competitive advantage. Consequently, having this digital tool can allow access to a more diversified portfolio of clients and markets that can increase margins within organizations. Furthermore, organizations can benefit from an increase in their operational efficiency by streamlining processes associated with relevant transactions.

Level of adoption in the LAC region:

As it was discovered in the study, e-commerce platforms and customer relationship management platforms (CRM) are poorly represented in the region. This could be attributed to the fact that practically every organization in the sample relies on a small number of large clients. However, there are a couple of organizations, which have considered or consider this as the next step in their Digital Transformation agendas. An interesting example comes from a grains and cereal organization in Guatemala, that recently designed and implemented an E-commerce platform after a thorough investigation of their customers' needs. In less than a year, the organization managed to have doubled the sales in the e-commerce channel, those of their traditional ones. Furthermore, a Peruvian cocoa organization currently looking to develop strong customer service and experience to be able to enter international market chains without the need for third-party intermediaries to manage the relationship with the client.

[69] (Accenture, 2020)

Barriers to adoption:

The primary barrier to e-commerce platforms adoption has to do with low interest in B2C due to fierce competition from retailers, as well as a preference for a small number of high-volume customers that allow organizations to reduce acquisition and management costs and focus on productive tasks.

Next Level: digital solutions to elevate agribusinesses

Under this category, the digital solutions considered are those that can further elevate an organization's productivity and even go a step further to help them gain a considerable competitive advantage, as well as get ahead of emerging market trends. The adoption of this next level of digital technologies can be achieved by organizations with a long-term vision and ambitious mindset for their Digital Transformation agenda.

ESG modules integrated into ERP

Agribusinesses are now starting to face pressures to incorporate sustainable practices within their operations to keep access to their current markets, enter new ones, and keep up with new customer-imposed sustainability requirements. Moreover, what is currently a competitive advantage that improves the sustainability rating of an organization compared to its peers, will gradually become a standard baseline. The foregoing is a direct result of emerging requirements, that financial control bodies will incorporate in reports necessary for public companies to operate on stock exchanges. Because of this, the traceability of sustainability attributes is an increasingly relevant practice to ensure compliance with regulatory and voluntary requirements, which may come from financial, non-financial, and other integrated reporting standards.

At this time, most companies collect sustainability information, included in annual sustainability reports (ESG) or integrated reports, on an annual basis through manual, non-standardized methods, which requires a great effort from the entire organization. The providers of management systems (ERP) for companies are working on the incorporation of sustainability modules that directly integrate information from each record generated in the system, so that it is possible to easily obtain ESG information when needed.

Benefits:

Additional to all benefits already mentioned for ERP systems, ESG modules can help organizations track and measure the impact of their sustainability initiatives efficiently and accurately, by reducing errors and additional effort needed from

collaborators. Thus, organizations can easily share their sustainability accountability and compliance with relevant stakeholders, which can provide organizations with different benefits such as entry to new markets and access to other financial alternatives with less expensive capital. Overall, ESG modules can give organizations an important competitive advantage as well as prepare them for emerging sustainability requirements.

Level of adoption in the LAC region:

Within the sample, none of the companies had integrated data for ESG reporting or decision-making. There were a couple of corporations that had some reporting practices; however, they were collecting data once a year on a spreadsheet separated by each of the relevant business areas. The level of interest and awareness of sustainability tracking seemed to be correlated with an organization's digital maturity level. Agribusinesses that had more advances in Digital Transformation practices were the ones that have already implemented methods to measure sustainability metrics such as carbon footprint and water usage. Two clear examples came from Peru and Chile. On one hand, a Peruvian cocoa processor and exporter mentioned they are preparing themselves for future sustainability requirements and have already measured the carbon footprint. Similarly, a Chilean High-Value Crops producer has been taking steps to prepare for sustainability requirements, even when they are not currently economically compensated, via prices, for their efforts. The same Chilean organization mentioned they had trouble communicating and showcasing their sustainability efforts, which could increase their reputational brand if done properly.

Barriers to adoption:

On one hand, a key barrier to the adoption of ESG modules has to do with traditional mindsets and a lack of perceived internal or external pressures in many agribusinesses in the LAC region. Regarding internal pressures, due to the private nature of family ownership of most companies, agribusinesses are not currently required to report ESG to investors or regulators, and some have trouble prioritizing it by their own account within their strategy. Additionally, regarding external pressures, although some companies have requirements from national labor and environmental agencies, certification organizations and a few clients, the frequency and level of requirements do not incentivize the use and cost of advanced digital solutions.

Automated Cleaning & Sorting Systems

Automated classification systems are based on detection by sensors of parameters associated with quality classes generally standardized from certification systems. The systems are calibrated with different variables for each product, such as size, color, and hardness, usually from standardized systems. The use of automated sorting improves the level of accuracy and speed of sorting, with the addition of greater hygiene as it prevents the handling of products. This is especially important in products such as berries, where the number of individual berries is a limiting variable. In automated systems it is an important consideration to have Artificial Intelligence applied to machine learning so that the cleaning and classification process can improve its accuracy and minimize its errors.

Benefits:

As with other types of mechanizations, these solutions can improve operational efficiency by increasing speed and reducing costs and human error. Furthermore, data collected during this process can be used to better understand input-output correlation and causation to optimize planning and production processes.

Level of adoption in the LAC region:

There are different levels of adoption of these automated systems, which depend on the required level of technology sophistication given each crop's characteristics. For example, crops like coffee are not classified based on quality or ripeness but by size, therefore, large producers and processors have adopted automated systems that answer to said specific characteristic. Meanwhile, all commodity producers in our sample have some level of automated cleaning and sorting systems, but the technical sophistication or number of classification variables is lower. Because of this, most cereal and sugarcane producers have adopted mechanized cleaning and sorting systems that do not leverage AI or ML technologies.

On the other hand, high-value crops have inherent characteristics that complicate classification, sorting, and handling of the product, making the development of these technologies difficult and expensive, which negatively impacts the level of adoption in the region (and globally as well). Consequently, we could not identify a high-value crop producer or processor that has a fully automated system in the region. Most still rely on people to select the ripeness, color, size, and quality of the product. Nonetheless, some are starting to use drone images to estimate the share of products in each plant that complies with defined characteristics (for example, readiness for harvesting). Most of these high-value crops are packed in the field by humans, so the sorting systems are used mainly to sort packaged goods.[70] One Mexican berry producer is testing a digital solution that incorporates cameras that take pictures of each part of the fruit to identify defects down to 0.2mm, and then sort the product based on different qualities such as size, color, hardness, bruising, decomposition, dehydration and scarring[71].

[70] Some avocado producers in Mexico and Chile have cleaning and sorting solutions but the products have already been sorted or inspected by humans

[71] Specifics of the digital solution (TOMRA Fresh Food, s.f.)

Barriers to adoption:

For the adoption of automated cleaning and sorting systems, the main problem may come from the supply side. At this time, technological developments in cleaning and sorting for crops with multiple discrimination variables are not ready for industrialized operation. Additionally, given the level of technological sophistication for some crops, cost-effectiveness is not usually positive, especially in the LAC region where labor costs are relatively low. Alternatively, the most relevant barriers for mechanized solutions that are less sophisticated, are CAPEX levels and access to financing.

Traceability, supported by blockchain and Asset Tokenization

A blockchain is a database whose information is replicated and distributed among the nodes of a virtual network. The database information is added in blocks over time and validated before being incorporated into the chain and replicated. The information recorded in a blockchain can refer to attributes of replaceable and non-replaceable goods, to safely trace aspects such as quality or sustainability. In agriculture, the tokenization of the product allows its transfer, not only real but also digital, adding blocks of information with each transformation or transfer of the product. The benefit is that any intermediary until the end of the chain can know the complete history of the product safely.

The application of this technology in agro-industrial chains is an opportunity to ensure the traceability of quality and sustainability attributes from the origin, and to know the status of the products at any point in the journey. It also serves as a backup for electronic transactions, to ensure harvests, increase liquidity and obtain loans.[72]

This technology is complementary to other systems, since it guarantees the fidelity of the physical and digital attributes whose characteristics are recorded and optimized by other technologies, and can be used for different needs:

- **Traceability of quality attributes:** Blockchain technology is useful in chains whose market strategy is based on differentiation by the quality and denomination of origin, such as coffee. This type of value chain requires strict monitoring of quality parameters to ensure their value at the end of the chain, for which blockchain technology can be valuable, given these product and process parameters are supported by certifications from third-party evaluations and also constitute a cost that becomes part of the value of the marketed product.

[72] (Accenture, 2022)

- **Traceability of sustainability attributes:** As well as in the verification of quality attributes, the assurance of compliance with minimum sustainability requirements can be recorded through blockchain technology. Sustainability requirements include social aspects, mainly linked to working conditions and inclusion; and environmental aspects, related to the conversion of environments for agriculture, the conservation of biodiversity, and in some cases, the conservation of water and soil.

- **Support for insurance and credits:** Blockchain technology can provide the possibility of knowing with certainty volumes, location, and other attributes linked unequivocally to products and organizations. The foregoing facilitates the evaluation of the risks associated with the allocation of credits or coverage through insurance.

Benefits:

There are several benefits that blockchain technology can give to agribusinesses. First, it provides organizations throughout the value chain with reliable and trustworthy information regarding a product's origin and posterior handling, which ensures traceability. Similarly, the technology can help to ensure and prove compliance by recording and grouping all relevant information. Additionally, operational efficiency can be increased given all of the above is achieved through automated record keeping; even more, by complementing smart contracts transactions processes can be streamlined and transaction costs reduced. Alternatively, asset tokenization can provide producers with liquidity by allowing for fractional asset ownership, as well as provide access to investors or capital by eliminating the need for third-party intermediaries.

Level of adoption in the LAC region:

With the sampled organizations in the study, the adoption of blockchain technology was non-existent. Although, it was seen as an interesting topic there seemed to be low interest in pursuing this subject, as many organizations perceived it as something too complicated for their current business needs. Nonetheless, some organizations mentioned blockchain technology as the next step they were planning to pursue. For example, a large cereal organization in Argentina is looking to implement different disruptive technologies like asset tokenization, digital wallets and Blockchain. Similarly, a Guatemalan banana producer and a Brazilian sugarcane trader identified Blockchain as an emerging trend in the agricultural industry and understand the future will lead them towards its implementation.

Barriers to adoption:

Through the interview process two main barriers were identified that seem to prevent the adoption of Blockchain technology. On the one hand, organizations perceived this technology as too advanced or complicated for their current business needs, therefore, they recognized little value in its implementation. On the other hand, those that did identify the potential value said it could only be feasibly achieved when the technology is adopted by the entire value chain. Thus, there seems to be a negative feedback loop hindering the adoption process, given organizations that identify the potential and powerful benefits of the digital solution are stopped from adopting it by those that do not recognize its full value or have not been able to implement it because of other constraints. This shows how in Digital Transformation collaboration and synchronized advancement is key.

Digital Twins

A digital twin is a technology that uses the capabilities developed by virtual reality, to create digital copies of products and processes, and is used to improve product design and processes. These digital copies can be useful to run simulations of different scenarios to analyze the influence and impact variable modification can have on the organization's operation. Furthermore, these technologies can be developed to incorporate Big Data & Analytics and Artificial Intelligence, to generate insightful recommendations based on all available information[73].

Specifically, in the agricultural industry, digital twins can be used to provide a map that provides a holistic view of all the organization's operations, with different information layers depending on the level of detail required. To achieve what is mentioned above, digital twin leverages other digital solutions to collect all relevant information, such as drone imaging and remote sensors throughout the entire operation. Agribusinesses can use this digital solution to have a complete picture of machinery maintenance state, fleet and workers allocation, overall crop health (moisture, nutrients, diseases, etc.), weather conditions, etc. All information mentioned above, that is made readily available, can be combined with Big Data & Analytics and AI to get powerful recommendations through predictive machinery maintenance; smart application of irrigation, fertilizer, and herbicides; optimal allocation of resources; as well as the possibility to run different simulations modifying variables to understand the impact on crop yield. Similarly, it can aid in campaign planning systems by providing all relevant information to project the evolution of perishable products' state, optimize harvest time frames and produce client-allocation.

Benefits:

Digital twins can provide cross-cutting benefits ranging from increasing both operational efficiency and productivity to risk management. The holistic view this digital tool provides can help organizations visualize the operations

[73] (Accenture; Dassault Systemes, 2021)

in several plantation fields without needing to visit them, allowing them to make decisions at a distance and promptly act when needed. Furthermore, leveraging AI can help organizations prepare and make better decisions when faced with difficult scenarios, to avoid important losses.

Level of adoption in the LAC region:

Given the digital maturity advancement needed to implement digital twins' solutions, its adoption is non-existent in the interviewed sample. However, there was a particularly advanced High-Value crops producer and global exporter base in Chile that already has similar technologies, which allow them to have all relevant information about their crop fields around the world by only looking at a computer screen. On another level, other advanced organizations included in the study showed interest in having this type of visual and integrating technology that leverages Big Data to further advance their businesses. Specifically, another smaller High Value Crops producer in Chile mentioned, that although they are currently working on perfecting and integrating current digital technologies in their organization, the implementation of digital twin-like technologies that provide a complete view of their operations is considered as the next step, that leverages the massive amounts of data they are generating to apply predictive analytics. They mentioned they felt they already had the necessary digital foundation to start working on it and seemed to have a clear understanding of implications, technical requirements, use cases, and benefits. Conversely, some less advanced companies explained the concept without a clear roadmap for results.

Barriers to adoption:

At the time, most companies are at a digital maturity level that lacks the technical, operational, and strategic requirements to implement a digital twin feasibly and successfully, in a way that potential benefits are fully realized. To implement this level of digital solutions, organizations need to have: an integral and structured Digital Transformation strategy that properly integrates all digital initiatives within the organization; qualified and innovation-driven talent to both implement and manage the sophisticated digital solution; proper budget allocation to advance the implementation; and also, good network connectivity to ensure proper and timely communication between all parts of the solution.

CASE STUDY

Agrotareo: Operational Optimization at Camposol

Agribusiness organization Camposol

Location: Peru, Chile, Colombia, Uruguay and Mexico

Crop: Blueberry, avocado, mandarina, table grape and mango.

About

Camposol is a multi-Latin company, with 10,000ha of production in 5 countries and a field workforce of 14,000 people. They are fully vertical integrated throughout the value chain wich enables complete internal control of the supply chain from their farms to supermarket shelves and provides clients with sustainably produced fruits their customers can trust.

Source: http://www.camposol.com/

Solution provider hispatec agrointeligencia

About

Hispatec is a digital technology company for the agriculture sector with headquarters in Spain and active subsidiaries in Mexico, Central America, Peru, Colombia, Chile, Brazil and Portugal. The company has more than 35 years of experience and projects implemented in more than 30 countries around the world. Among their clients are some of the world leaders in the production of fruits, vegetables, nuts, olives, vineyards, as well as suppliers of agricultural inputs. Hispatec has a comprehensive proposal that covers from seed to delivery to the customer at destination and the entire industry supplying inputs and services for production.

Problem to solve

In an environment of labor shortages, Camposol sought to transform all personnel operations into transportation and tareo. Camposol carried out all the processes manually or with ex-post excel files. Some of the inefficiencies in activities they sought to solve were:

- Bus fleets without access control
- Slow accesses and paper manifests
- Analog and exposts management of tareo and field work
- Manual productivity indicators with a low level of certainty
- Management access to information days or weeks later

Solution implemented

Hispanic worked with Camposol in an initial assessment of all the processes in scope to identify opportunities for optimization. Hispatec then implemented Agrotareo, a digital solution to automate the entire operation and to allow management to visualize in real time the situation in all the estates to make decisions immediately.

Agrotareo allows the supervisor of each farm to assign the tasks and the use of resources to each employee and make that information available on the spot to anyone responsible for the organization.

Archive results

Agrotareo allows the supervisor of each farm to assign tasks and resource usage to each employee and make that information available on the spot to any manager in the organization.

- Reduced costs by more than $4 million in a single campaign
- All availability indicators increased substantially
- Accelerated employee productivity times
- Discretion was eliminated thanks to the parameterized system
- Facial recognition on bus onboarding
- QR code scan with information from all bus passengers
- Identification cards for immediate supervision
- Accurate and immediate productivity masurement
- Real-time information for management

Figure 2: Example of a successful application of a Digital Solution

3.6
NEXT STEPS IN THE ADOPTION OF DIGITAL SOLUTIONS

As was mentioned at the beginning of the report, organizations across the study were categorized as laggards, followers, or leaders depending on their current level of digital maturity. These three categories can be strongly associated with those exposed during the previous section, Basics, Enhancers and Next Level, respectively. Consequently, Laggards should start by developing a digital plan that includes those solutions included under Basics; more advanced organizations should consider and prioritize digital solutions under Enhancers; while leaders should investigate perfectionating those solutions under Enhancers and develop a structured plan considering current or future business necessities to incorporate digital solutions under Next Level, especially those that can further advance sustainable agendas. Additionally, organizations of all digital maturity levels should consider the potential and observed benefits agribusiness peers have obtained through the implementation of digital solutions, to further encourage their own Digital Transformation advancement as well as identify relevant opportunities they might have not yet considered. Finally, to overcome the identified barriers to adoption, it is recommended to carefully consider the next chapter.

Agritech ecosystem in the region

In the Latin America and Caribbean region there are different digital solutions providers that organizations can use for their Digital Transformation agendas. As stated above, these solutions can fall within three different categories: Basics, Enhancers, and Next level. Depending on the maturity level of the businesses, as well as their specific crop and geographic conditions, each of these solutions may vary. Below is a map with some of the providers available, while the full list with links for more information can be found in the appendix.

Basics

Enterprise Resource Planning

Eiwa C.O: Argentina C.Op: Argentina, Brazil	Agro Business C.O: Mexico C.Op: Mexico	JETBOV C.O: Brazil C.Op: Brazil, Paraguay, Bolivia, Paraguay, Peru	agroprime C.O: Chile C.Op: Chile, Peru, Argentina	aegro C.O: Brazil C.Op: Brazil	agtechapps C.O: Guatemala C.Op: LATAM

Information and market platforms

agree C.O: Argentina C.Op: Argentina, Paraguay	LUXELARE Digital Agrinsurance C.O: Mexico C.Op: Mexico	CC COSECHA CONNECT C.O: Ecuador C.Op: Ecuador	ifinca C.O: Colombia C.Op: Colombia	Picsel C.O: Brazil C.Op: Brazil	AgroMatch C.O: Chile C.Op: Chile	SiembraCo C.O: Colombia C.Op: Colombia

Remote sensors

DeepAgro C.O: Argentina C.Op: Argentina, Brazil, Uruguay	tarvos C.O: Brazil C.Op: Brazil	MORPHO C.O: Chile C.Op: Chile	Advector, unmanned systems C.O: Colombia C.Op: Colombia	VIT sensors C.O: Colombia C.Op: Colombia	K **KleffmannDigital** C.O: Germany C.Op: Uruguay, Brazil, Argentina, Paraguay
METOS® C.O: Mexico C.Op: Mexico	LASER Y GPS C.O: Mexico C.Op: Mexico	ABT **Agrio Biotech** C.O: Mexico C.Op: Mexico	APPGRICOLA C.O: Mexico C.Op: Mexico		

Enhancers

Campaign Planning System

Agritracer C.O: Peru C.Op: Peru	AGROS C.O: Peru C.Op: Peru	SPACEAG C.O: Peru C.Op: Peru	CLIMATE FIELDVIEW C.O: Canada C.Op: Argentina	agroware C.O: Mexico C.Op: Mexico	AEDROTEC C.O: Mexico C.Op: Mexico
puma C.O: Argentina C.Op: Argentina	NeoAg C.O: Chile C.Op: Chile	reset C.O: Chile C.Op: Chile	caburé C.O: Argentina C.Op: Argentina	AgroPro C.O: Argentina C.Op: Argentina	

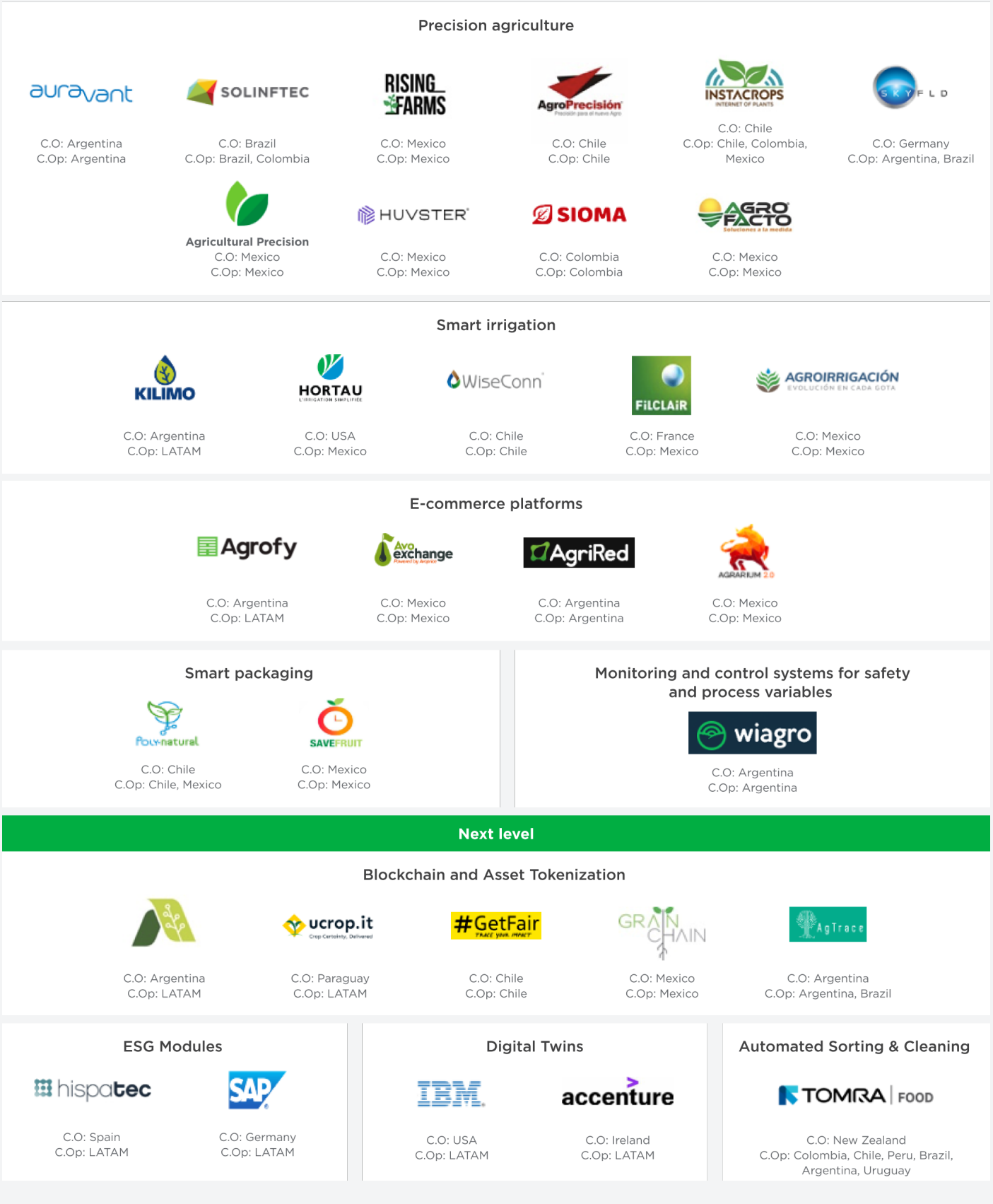


Figure 3: Map of agritechs in the LAC region
Source: Own investigation and compiling of available agritechs in the LAC region

3.7
OBSERVED AND POTENTIAL BENEFITS OF DIGITAL TRANSFORMATION IN LAC

Digital Transformation in agribusiness can bring major benefits to Latin American and Caribbean organizations. Specifically, digital technologies can provide organizations with helpful tools to address the needs, challenges, and pressures they are currently facing, such as a need to increase operational efficiency, mitigate risks, promptly respond to market trends, and others. Through the study, several benefits of Digital Transformation have been identified. Some of these, are benefits the interviewed organizations have already achieved, while others they are still seeking to obtain in the future with their ongoing digital initiatives.

Overall, these advantages can be grouped into three main categories:

- Maximized efficiency
- Increased productivity
- Alignment with sustainable practices

The benefits stated above can be captured progressively as the level of digital maturity increases.

Maximized efficiency

Digital tools in agribusiness organizations actively reduce inefficiencies across several processes of the value chain. These inefficiencies can be eliminated by reducing waste, mitigating losses, and preserving

value. Throughout the study, these benefits were both the primary motivator for Digital Transformation adoption, as well as the ones first captured by most organizations, which are at the beginning stages of their Digital Transformation journey.

First, digital solutions, along with the appropriate complementary process, can bring down the costs of goods in agribusiness organizations. In the agricultural business many different inputs go into the production and processing of a product, such as labor, land, and water. Digital tools allow organizations to reduce the use of these resources by applying them precisely and with little waste. For example, one organization in this study uses sensors distributed along a vast crop field to identify specifically which areas need fertilizers. This solution reduced their crop segmentation from approximately twenty hectares to one square meter, allowing a more precise application of fertilizer. On the other hand, different technologies can reduce the need for some workforce, which is one of the highest costs in the industry, by replacing some manual tasks with automation. Before Digital Transformation, organizations needed several workers to prepare a field for seeding, however, with the help of automatized tractors with autopilot, this process is taking little worker input, which allows organizations to have upskilling and reskilling programs for their workers and allocate them to more value-added tasks. This also improves working conditions for workers by requiring less hard physical labor.

Digital technologies help reduce maintenance costs by allowing a proactive and preventive approach. Organizations that implement digitalization can use predictive tools, providing information on machinery conditions and ensuring preventive maintenance on time. An unexpected failure in an important machine in the operation can cause it to crash. This could create problems like product loss or failure to meet agreed delivery times, which translate to great economic losses. Additionally, preventive maintenance can also increase a machine's lifespan and reduce the need for unexpected capital investments by allowing organizations to foresee these situations and act accordingly. Even though the level of adoption of predictive maintenance is still low in the LAC region, it is relevant to consider given the significant benefits that can come from it.

Additionally, with the help of different digital solutions, organizations can adequately plan production. With Digital Transformation organizations can get data as input for more sophisticated technologies and models that provide proper production planning. "How much should be seeded?", "When should harvest happen?", are questions that can be answered with data and information provided by digital solutions. For example, the interview process revealed that through GPS route planning and harvest forecasting, organizations were able to plan transportation for over 10,000 workers, generating cost reductions with pre-paid logistic services.

On top of that, it is worth mentioning two external cases outside of the interview process, as examples of where predictive analytics is used to help farmers face uncertainty. First, the Florida Climate Center together with the Center for Ocean-Atmospheric Prediction Studies (COAPS) developed a website called Agroclimate, that uses historic and forecast climate data and crop simulation models so that farmers can compare results under different climate conditions and prepare for different scenarios[74]. Similarly, the Australian Agricultural Forecasting System from the Australian government is a system designed to produce forecasts for Australia's agricultural markets, where it can be used to plan what crops could be more profitable throughout the year, depending on the expected value, volume, and price[75]. With forecasting tools, organizations can prepare for variable weather, as well as for a volatile market, enabling them to reduce losses, capture the maximum value and satisfy any change in demand.

Furthermore, Digital Transformation is a powerful tool for the preservation of the product value, throughout the value chain. Many crops considered in this study require careful handling to preserve those characteristics valued in the market, for example, High-Value Crops usually have delicate sensitivities like humidity and a tendency for bruising, while other crops like sugarcane may have fewer and less demanding ones. Organizations have found great benefits when implementing digital technologies in their operations, which help them track and control the conditions of the product. This allows them to take action

[74] (FLORIDA CLIMATE CENTER, 2022)

[75] (Department of Agriculture, Fisheries and Forestry - Australian Government, 2022)s

when some conditions are nearing preconfigured unacceptable standards. Additionally, a more efficient operation enabled by Digital Transformation reduces time in transit, so the product can be sold as fresh as possible. For instance, a Peruvian-based berries producer mentioned digital technologies had been crucial to coordinate and determine time leads between processes to make sure their produce reached the freezing containers from the harvest fields in the shortest time possible to preserve the fruit's quality. On the other hand, there is an interesting case outside of the sampled organizations, where a Chinese agritech called Pinduodo has developed a platform to help agribusiness plan the optimal logistics route to eliminate unnecessary transits and optimize the cold chain process. The platform helped garlic farmers in China to reduce travel by 16.1% less distance, 38.1% in fuel per ton and cut food loss and waste to 25%[76].

Increase in productivity

While the benefits previously exposed are mainly to reduce costs and unexpected losses, there are important benefits from Digital Transformation represented by an increase in productivity for organizations. According to IDB and IICA research of the Latin American and Caribbean region, it is estimated that a 1% increase in the digital ecosystem development index results in an expansion of 0.13% of GDP per capita due to an increase in productivity[77]. Benefits of this type are usually captured by organizations that have important advancements in their Digital Transformation journey. With the study, it was identified a few organizations in the agricultural industry of Latin America and the Caribbean are currently at this stage. Only those organizations that have a complete and structured Digital Transformation plan have begun to implement enhancing solutions, such as automation and monitoring and control systems that provide the benefits explained below. Organizations with a lower digital maturity level can expect to achieve these benefits once they have implemented the foundations needed as input for this next level of Digital Transformation.

On the one hand, Digital Transformation allows organizations to take full advantage of their resources by allocating them to the correct tasks where they generate the most value. To achieve the foregoing there are digital solutions such as the automation of back-office tasks and the integration of operative processes and information systems, which allow for data-driven decisions, contributing to the increase of an organization's productivity.

[76] (World Economic Forum, 2022)

[77] (Interamerican Development Bank; IICA, 2020)

Firstly, organizations can save a huge amount of time through the mechanization of back-office or administrative tasks. By automating mechanical and repetitive processes that are currently done by human manual labor, such as payroll, budget and expense reports, employees can spend their time on more productive and enriching activities. Through the study, we found this was one of the first benefits organizations perceived when implementing the next stage of their Digital Transformation initiatives.

Furthermore, by integrating all areas and processes, Digital Transformation can offer a complete visualization of the entire organization to help identify most optimization opportunities. For example, one organization shared they built a monitoring center where they could live track their entire vehicle fleet and see the location and speed of each vehicle, allowing them to have proper control and movement promptly. Moreover, another interesting example exposed during the interview process of how visualization can improve productivity, was how some organizations used sensors and satellite images to find unused land spots which could be used for a new production plant. The foregoing examples showed how integrated systems allow for data-driven decisions that are crucial to maximizing productivity.

One last external example comes from a platform developed to help farmers make conscious and data-driven decisions by providing detailed insights about their crops. This service could help the farmer increase overall profitability by 55-to 110-dollars per acre depending on the crop[78]. This broad visualization provides all the information needed to optimize the allocation of resources.

On the other hand, digital tools can support the organizational agility of agribusinesses by better

[78] (Accenture, 2020)

interconnecting all areas of the organization. With the help of collaborative tools, walls that currently separate different areas can be broken down, which streamlines processes and eliminates redundancies. Additionally, they allow greater communication between areas allowing for timely responses and fewer miscommunication mistakes. Overall, these tools allow employees to work better and more effectively, taking full advantage of the employees' working hours. For instance, during an interview conducted in this study, an organization based in Mexico explained how it was in the process of implementing digital collaborative tools for easier and faster communication between managers in charge of projects in different geographies. Specifically, the Mexican organization requires digital tools that streamline the information flow between offices which allows for relevant insights to be shared promptly, as well as for redundancies to be eliminated, all while keeping separate certain workflows so they do not have irrelevant information. This will generate faster alignment on the project's necessities to together create the appropriate solutions.

Finally, Digital Transformation can increase productivity and gain a competitive advantage by adding value to their products or customer experience. Through the interview process, some of the more digitally mature organizations mentioned they were using state-of-the-art machinery to develop new products with higher quality and value, bringing them higher margins. Meanwhile, others mentioned they had or were in the process of implementing digital solutions to improve their customer experience, such as digital marketplaces or customer service platforms, an important next step to generating a competitive advantage.

Alignment with sustainable practices (ESG)

The agroindustry is entangled with environmental, social, and governance (ESG) subjects. Therefore, a strong ESG proposition can create value for the business, the community, and our planet. Benefits observed in LAC agribusiness from alignment with ESG practices come mainly from the environmental and social sectors. And while many organizations are skeptical about sustainable and organic practices, most of them have an interest in learning environmental and social best practices. In general, the benefits that may come from a sustainable agenda vary depending on the level of implementation.

To begin, an important goal of a sustainable agenda is to be compliant with external regulations where there are different observed benefits such as ensuring continuous access to current markets, as well as the possibility to offer products of higher quality and have access to new markets. For example, many commodity producers face strict guidelines from large CPGs regarding the use of agrochemicals, deforestation, pollution, water, human rights and OHS[79] standards. Compliance with these guidelines reduces the risk of losing the largest consumers of commodities. Similarly, high-value crops companies from LAC have been able to connect with new retailers in North America and Europe through ESG disclosures and certifications, although in neither example they found a price premium from these practices.

Additionally, organizations can see the rewards of a sustainable agenda leveraged by Digital Transformation by making sure they adhere to working conditions requirements. Currently, LAC governments have put in place labor policies that look for fair salaries, better working conditions, minimum working age, payroll, and tax automation. Agrobusiness organizations face fierce scrutiny, given the high level of labor dependence, the hardship of physical work, the contracting of migrants, the use of hazardous machinery and chemicals and poor working conditions in rural environments. Law abidance ensures business continuity and avoidance of fines, but also increases workers' health and productivity and reduces labor turnover and reputational risks are given a higher collaborator's satisfaction. Additionally, companies have enjoyed a reduction in payroll and tax-filling costs with digital solutions.

On the other hand, organizations can improve their reputational brand and have a competitive advantage by including sustainable practices within their operations. Having a strong reputation can give access to green capital, attract investors that prioritize sustainability in their investments, and even increase stock market value.

[79] OHS meaning is occupational safety and health

Finally, some organizations commented that sustainability is a good driver for experimentation with innovative technologies like drones, intelligent machinery, and precision agriculture. They use these solutions to reduce the intensity of fertilizers, water, and other agrochemical inputs, while maintaining plot productivity. Furthermore, digital solutions can be used to run simulations that can help organizations identify those initiatives that generate the greatest sustainable impact. The results are higher productions with impacts positively on the top and bottom line.

Overall, the main goal behind leveraging Digital Transformation for sustainability aspects is to develop a way of operation that allows agribusinesses to keep feeding a growing population without damaging our planet, have fair working conditions, and at the same time keep being profitable.

These benefits highlight the potential digital transformation has in the agricultural industry of Latin America and the Caribbean. Although most organizations in the study are only just capturing the advantages mentioned under Maximized Efficiency, others are starting to capture greater values mentioned under Increase in Productivity and Alignment with sustainable practices which advance and enhance organizations.

4

RECOMMENDATIONS AND CONCLUSIONS

4.1
DIGITAL TRANSFORMATION JOURNEY

Although the path to any Digital Transformation is not straightforward and is dependent on multiple variables particular to each organization, it is possible to identify some steps to successfully achieve the desired objectives. The actions presented below are aimed at developing the digital capabilities of organizations progressively, as long as they increase their digital maturity level.

It is worth mentioning that Digital Transformation is a continuous and iterative process, where the results must be analyzed, evaluated, and improved attending to the particular ambition and capabilities of each organization. Practices must be updated and “the art of the possible” will always be in constant evolution, as well as the disruptive innovations that support new digital solutions.

The five main steps recommended are:

- **Discover:** Set your ambition
- **Design and Plan:** Having a digital mindset
- **Evaluate:** Proof of Concept and Minimum Viable Product
- **Scale:** Enhance capabilities
- **Expand and Manage:** Growth and Digital continuity

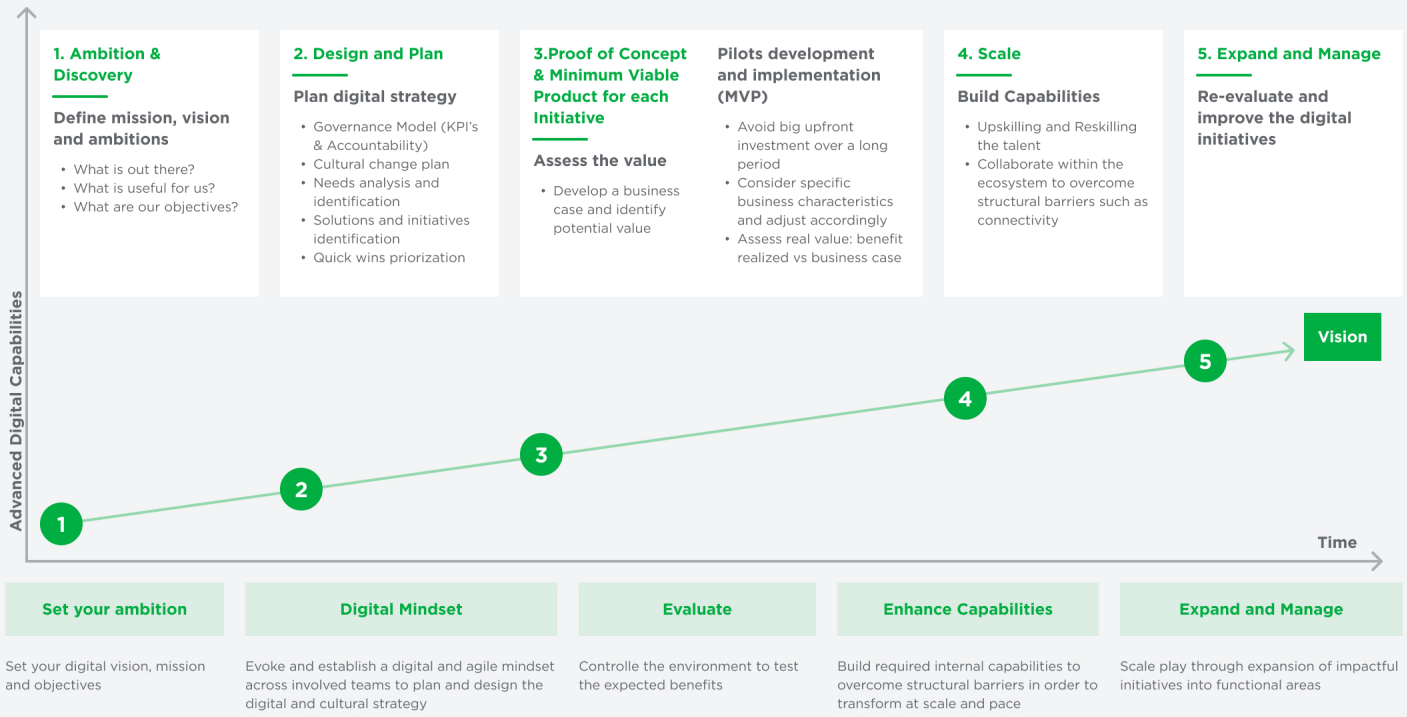


Figure 4: Digital transformation journey overview

Discover: Set your ambition

The Digital Transformation journey should always start at the top. It is essential that organizational leaders set the agenda and constantly keep it updated. Questions such as “what is important to our business and customers?”, “what are industry leaders doing?”, “where do we want to go with Digital Transformation?”, “what is the best digital fit for us?”, “what new capabilities and skills do we need to develop or acquire?” and “what is a reasonable roadmap to create value and deliver results?”, should be asked repeatedly. This allows organizations to identify and incorporate into their global strategy new goals leveraging Digital Transformation to achieve overall success.

Once there is an ambitious vision, the judicious process of searching for inspiration and industry benchmarks is essential. The goal is to establish achievable deadlines and clear objectives that fit the real needs of the organization and effectively manage the expectations of all stakeholders. In terms of Digital Transformation there are endless possibilities, but it is imperative to analyze a strategic transformational program from each unique organization’s perspective and determine what is most appropriate to solve the key challenges for the organization.

Design and Plan: Having a digital mindset

After demonstrating the ambition and defining the specific objectives, it is necessary to design and plan the Digital Transformation strategy. This will be the vehicle that takes the organization from its current state to the desired destination.

For strategy, the following relevant points must be considered:

1. There should be a robust governance model providing ownership and accountability to the Digital Transformation initiatives. Clear responsibilities and adequate leadership must be defined to ensure established goals are monitored and progressively accomplished. Additionally, the governance model should clearly articulate all efforts, so that all appropriate areas of the organization are included.

2. It is necessary to think about a cultural change plan that embodies an open and adaptive mindset for what is to come. Experience shows that 85% of Digital Transformations fail because of inappropriate organizational change management[80], making it crucial for the organization to effectively communicate with its people, reassuring them and emphasizing why change is underway.

3. Specific needs and opportunities that can be addressed and approached by digital initiatives must be identified. It is essential to consider potential discomforts at all levels of the organization. Those identified by the C-Level may be quite different from the middle management who are mostly immersed in the core processes of the daily business operation. With the proper leadership, all areas in the organization must work together to determine how needs and pain points within individual departments interconnect. Then, appropriate digital solutions that resolve these needs should be pinpointed. To identify solutions, it is valid to refer to sources of inspiration and what the industry leaders are doing. Surely some have already faced these challenges and found adjustable solutions and best practices that can be considered.

4. Once needs and proper digital solutions or transformations have been detected, it is necessary to build a Digital Transformation roadmap that prioritizes and determines which challenges are most pressing or which could be the 'quick wins' to gain momentum. The quick wins are initiatives, that when deployed, denote less effort or complexity, and represent early benefits for the organization – also, those that can pave the way for future and more complex initiatives. After this, it is necessary to continue with those that bring greater benefit and less effort or level of investment in an optimal mix between desirability, feasibility, and complexity. All this allows organizations to adequately allocate their efforts to advance faster and more effectively in their transformation journey.

[80] (Accenture, 2018)

Evaluate: Proof of Concept & Minimum Viable Product

Following a prioritization of all the desired initiatives that embody the entire Digital Transformation plan, it is necessary to identify the potential value a solution will represent. This will allow the organization to adequately measure the impact of results, in terms of benefit vs. investment. While a traditional "business case" may be difficult to build, a close approximation should be prepared, where value levers that can enhance the solution are determined, and the amount they will be enriched is identified. In the end, it should be possible to visualize the potential value of the solution implementation. This value should be compared with the estimated investment to accurately determine the feasibility of the endeavor.

Before any significant upfront investments, the next step is to develop a pilot that represents the Minimum Viable Product of the initiative. The scope of the pilot is not the complete or definite solution, and it should be used to assess the initial hypothesis and further develop or adapt the specific functions and characteristics of each solution. This stage allows for a more tailored solution to be developed in a way that captures more benefits. Through each iteration of the pilot development, an evaluation of realized advantages should be made and compared with the original business case. Only when the pilot process is complete and the benefits still make sense with the original business case, should the organization work towards the next step to scale the solution.

Scale: Enhancing Capabilities

Considering the results and lessons learned from the pilot, the next step is to categorize capabilities for the solution to deploy it and incorporate necessary changes that will benefit the rest of the organization. Generally, the capabilities to be built or reinforced at this stage are assigned to the team that will be using the new digital solution. Upskilling efforts may be necessary to improve the capabilities of employees facing challenges associated with the application of innovative technologies and operating models. Furthermore, consider reskilling efforts to focus on the acquisition of new competencies to adapt to changes, new tasks, and responsibilities.

Other kinds of capabilities that usually need to be built or strengthened at this stage are technological capabilities or enablers. Aspects such as technological infrastructure, networks, and computing capacity, among others, are factors that may be required to ensure the success of the implementation. This should be considered in the calculation of the investments assigned to each initiative, always bearing in mind the estimated potential benefit and the positive impact that the initiative will have in the short- and long-term effects upon full implementation.

Expand and Manage: Growth and Digital continuity

Finally, once the required capacities have been strengthened and the initiative is successfully in place, it is time to look back and analyze the entire implementation process. It is necessary to recognize the points that could have been executed in a better way, identify those that were conducted properly and establish good practices or points to be considered for future initiatives. Some questions to ask may be: “do our customers, providers and employees perceive the new value?”, “did the governance model established for the Digital Transformation work?”, “did the procedures and ways of working favor the good pace of the implementations?”, “is the team prepared for the following initiative implementations?”, “Have we managed the transformational initiative according to meet original time and budget requirements?”. It is essential to reach a good level of self-criticism, which will allow for considerable improvements in the process of innovation and implementation of Digital Transformation.

Now, it is relevant to consider barriers or slowdowns that organizations may have identified throughout the process. Some of these can and must be faced by various stakeholders in the ecosystem, and not only depend on the organization´s efforts. For this, it is crucial to have an ecosystem vision, allowing necessary connections and relationships for different stakeholders, so that the implementation path and the capitalization of Digital Transformation benefits are achieved in a better way. This enhances the capabilities of the organization and increases the likelihood of generating digital momentum within the organization.

CASE STUDY

Transformation of a family farm to sustainable agroecology

Agribusiness organization

Alguimar Balsora

Location: Balsora-Madre Vieja Farm. Municipality of Candelaria, Valle del Cauca, Colombia

Crop:
- 240 hectares planted in sugar cane
- Average production 135 ton/ha organic-sustainable

About

Alguimar/Balsora is a company characterized for being a pioneer in the implementation of new developments focused on continuous improvement based on improving productivity and reducing costs, allowing it to be increasingly profitable, reducing environmental and social impacts. In the beginning it was a farm dedicated to cattle but in 1991. sugarcane began to be grown. Since then, they have gone through 4 stages of development making the transition from conventional to sustainable agriculture using precision farming practices.

Solution provider

Avenzza

About

Avenzza is a consulting firm in sustainable business based on international experience at a comprehensive practical level that helps convert agricultural land in sustainable enterprises that generate future. The sustainability approach that we aim, in addition to measuring profitability, analyzes the impact of the business practices with the environment and the community. We follow international principles and indicators, we apply corporate social responsibility criteria, we make improvements in the processes of the business and training. based on the wide experience of specialized consultants in these areas.

Source:
https://rocketreach.co/avenzza-profile_b4211b99fee47db4

Stages in the process

1992-2000 Economic and Field Focus: Increase production using chemical synthesis products while controlling costs.

- Design and leveling of the farm
- Drainage implementation
- Window irrigation
- Biological control of diatraea (pest of the area)
- Liquid fertilization with vinasse and diluted N
- Documentation of work, inputs, consumption, use and maintenance of machinery and labor, among others.

2001-2009 Environmental Awareness + Global Vision: To carry out sustainable practices in the field and learn about global certifications and their requirements.

- Use of crop residues for soil improvement
- Use of inoculating and decomposing microorganisms to reincorporate residues into the soil.
- Elimination of sugarcane burning
- Elimination of the use of ripening agents
- Use of green manures
- Use of alternative crops (soybeans, beans, corn).
- Use of the first computer
- Reduction of chemical synthesis products.

2010-2016 People + Business Vision: Transform the administrative part (culture, processes, training) seeking a business operation. Comply with sustainability indicators and initiate the use of the cloud.

- Creation of the logo with the work team
- Process development and documentation
- Development of a training plan
- Improving employee infrastructure
- Development of indicators
- Consulting advisory with **Avenzza SAS**
- Initiation of the use of the cloud communicating farm and office
- Elimination of chemically synthesized herbicides.
- Increased employment generation.

2017-2022 Organic and Digital Transformation: Make the necessary changes to become organic-sustainable, focus on digital aids and open to the public for visits.

- Moisture sensors (matric potential)
- Drones for management and fertilization.
- Digital equipment on tractors for control and monitoring.
- Applications for area measurement, disease control, and management.
- Compliance with Bonsucro production standards.
- Creation of biological corridors
- Composting
- Reduction in decompaction depth
- Incorporation of weeds as a source of organic matter.

Achieved results

From conventional to Organic/Sustainable: Cost of production↑12% | Profitable > 35%

Climate Change	Irrigation & Contamination	Land Degradation	Deforestation	Employment Generation
• 18% TSH* higher than market (135 vs 110) • 25cm vs 40cm Depth of decompaction • 100 T GHG captured h/ year • 0.93 T GHG emitted h/ year • 70+ T O2 emitted h/year Tones of sugarcane per hectare	• 60% Water reduction/ irrigation (3200 mt3 to 1300 mt3 /ha) • 34% Reduction of irrigation events (6 to 4 per cycle)	• 76.5% Increased in organic matter (1.7% to 3.3%) - 12years • 9 vs 5.2 # cuts vs Sector • Use Residues, microorganisms, compost, green manurea	• Ecological Restoration Plan and study of beneficial arborescences	• Annual Training Plan • 12.3yr Rotation • 100%↑ Employment Generation

And 100%:

- Elimination of Synthetic Fertilizers - Organic Use
- Herbicide Removal - Manual and Mechanical
- Biological and Natural Control
- Burn Elimination - Green Cutting

A healthy soil is our true legacy and the future of humanity!

Figure 5: A successful long-term digital transformation journey

4.2
GENERAL DIGITAL TRANSFORMATION JOURNEY RECOMMENDATIONS

Although Digital Transformation is a different process for each organization, it is possible and valuable to offer some recommendations to better achieve successful results. The following are suggested:

- Constant inspiration
- Culture and growth mindset
- Sponsorship and vision
- Ownership and prioritization
- Sweet Spot identification
- Learning and ways of working

Constant inspiration

A proper Digital Transformation is based on pursuing the "art of the possible." It is important to recognize the current capabilities of the organization and identify how they differ from what is needed. Seeking the right inspiration and constantly updating the essentials are key to reach the desired accomplishments. Here are some points to consider:

- Implement a cyclic process of searching for national and international solutions, technologies, and best practices.

- Attend events and innovation spaces for the agribusiness sector, to identify solutions adaptable to the needs of the organization and seek inspiration from organizations that may have gone through similar challenges.

Here is a relevant platform to review:

- Thrive[81]: A community of over 5,000 startups from 100 countries that creates access for organizations to solve the biggest challenges facing the food and agricultural industry.

Culture and growth mindset

A successful Digital Transformation is not only based on the proper implementation of innovative technologies. A determining factor is to achieve the right mindset in the organization, one that prepares the collaborators for incoming changes, but also promotes innovation and ensures they are the ones recommending and designing these changes. Creating processes, implementing new digital solutions, and identifying the right ways of working can be the easiest thing to do, however, achieving a growth mindset in the organization is a necessary enabler that usually represents a major challenge. To achieve this, organizations can consider:

- Focusing on the reason for the transformation and being able to communicate it effectively.
- Involve all levels of the organization in the process and make them part of the transformation from the planning stage.
- Bring together business vision and technical knowledge, as part of the same discussions.
- Introduce a sense of urgency and spotlight the benefits for all stakeholders.
- Promote change adoption recognition and reward innovation.

This is a relevant resource to consider that exposes the impact a growing mindset can have in organizations:

- How Companies Can Profit from a "Growth Mindset"[82]

Sponsorship and Vision

Although Digital Transformation is conducted by all employees of the organization, Digital Transformation initiatives must be born and remain with adequate support from leaders, allowing continuity in the pursuit of results. It is a constant process of learning and iteration. A sharp vision and integrally aligned objectives can help maintain the efforts of defining, investing, and progressing the transformation.

[81] https://thriveagrifood.com/latam-challenge/

[82] https://hbr.org/2014/11/how-companies-can-profit-from-a-growth-mindset

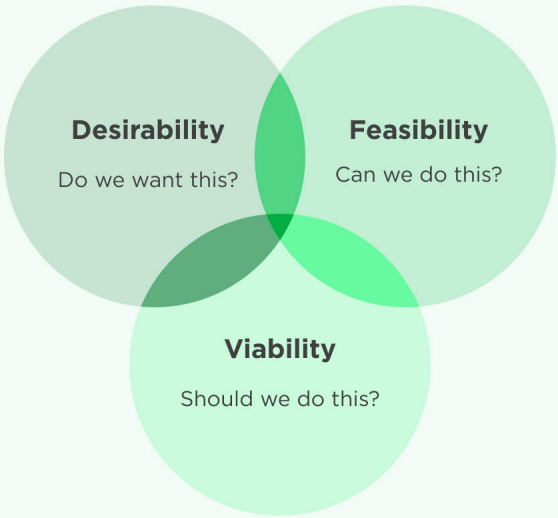
Ownership and Focus

Digital Transformation must be central to the organization, it cannot be a second-level plan of importance, as it involves planning, execution, and an adequate evaluation of constant results to achieve success. Those who are in charge and are part of the areas involved in the leadership of Digital Transformation see it as a priority. This approach must be recognized as a central part of their roles. This generates true ownership and a focus on achieving results. True success may not be possible if Digital Transformation is seen and recognized only as a second-order effort of importance and priority.

Sweet spot identification

Given the countless possibilities and solutions Digital Transformation can provide for many agribusinesses, it is essential to focus efforts on those initiatives that represent tangible value, according to priority needs, implementation and investment capabilities, and the organization's goals. Initiatives that can be found inside the intersection of Desirability, Viability and Feasibility, are in the 'Sweet spot for innovation' and are those that should be addressed first.

Desirability has to do with the question "do we want to do this?" considering the vision and objectives of the organization and making sure the solution is addressing the right problem. On the other hand, Feasibility answers "can we do this?", with which it is important to make sure the organization has the appropriate capabilities, those being technical or financial to achieve the implementation. Finally, Viability responds to the question "should we do this?" where it is key to consider both the internal and external context of the organization to understand the full potential benefits and investments of the initiative´s implementation. If the three factors are carefully considered to prioritize the digital initiatives efforts will be properly leveraged and benefits maximized.



Learning & new ways of working

Digital Transformation is a process of constant learning and iteration. Every time an initiative is adopted, the lessons learned should be capitalized. Considering Digital Transformation as a learning and iterative approach, can improve the innovation and implementation process for the future. It is important to critically evaluate the entire process comprehensively, from planning to execution, including evaluating the performance of the established governance and leadership model, and recognizing the capabilities and strengths of the organization and its collaborators. It is wise to consider agile or lean methodologies, in which the intention is to "fail fast", take the learnings and pivot. These ways of working can increase the value of activities by improving quality, adaptability and reducing risk, as well as better communication between team members.

Here is a relevant resource for reference, which demonstrates the relevance of an Agile approach for transformation:

- Digital Transformation Success Depends on Agile Approach to Change[83]

[83] https://www.forbes.com/sites/peterbendorsamuel/2019/08/26/digital-`transformation-success-depends-on-agile-approach-to-change?sh=16c5b003751e

4.3
RECOMMENDATIONS BASED ON RESEARCH STUDY FINDINGS

With an analysis of the challenges agribusiness of the LAC region is currently facing, different areas of opportunity were identified. There are some areas of opportunity that can be seized by the agribusinesses themselves through six practical recommendations:

- Look for alternative and flexible financing methods
- Develop a long-term budget mindset
- Strengthen the employer brand and industry attractiveness
- Identify industry leaders and work together to promote the digital agenda
- Join your peers and leverage the power in numbers
- Use sustainability practices as encouragement to implement Digital Transformation

The first three can help organizations strengthen enablers, while the last three can help accelerate the Digital Transformation process. These recommendations can help start the journey and leverage opportunities that may have previously gone unnoticed. Furthermore, other opportunities could be pursued by other relevant players that populate the ecosystem around agribusinesses, which are exposed farther down.

To begin agribusiness should consider the following recommendations.

Look for alternative and flexible financing methods

To help start and advance a digital transformation agenda, alternative and flexible financing methods are key. For example, organizations may use methods that do not require big upfront investments or generate revenue to finance digital transformation.

First, organizations can consider different procurement models available that do not require a huge initial investment. One alternative procurement model could be called "As a Service", where companies can opt to rent digital solutions, tools, and platforms without investing to acquire them. For this, organizations can look for companies that lend platforms, machinery, servers, and digital tools for a monthly or yearly fee.

Also, agribusinesses can consider partnering with third-party providers that offer a "success fee" or a "results-based" model. In this way, external organizations come in and perform the digital transformation with their own resources. Once the implementation is complete and if it is successful, the external organizations get some of the benefits, but later leave the original organization to execute the rest.

Businesses can rely on other revenue sources to help cover costs. For example, looking into offsetting markets, which pay companies with negative greenhouse emissions, can help digitally transformed organizations profit from their sustainability investments. Similarly, organizations can consider entering the byproduct industry where they can take full advantage and realize the complete value of their product. Further, businesses can consider selling in-house developments to others in the industry when they have a powerful solution for organizations with similar needs or development, or they can even partner with open-innovation initiatives or startups that have digital solutions that can be developed jointly.

Develop a long-term budget mindset

To enable a constant advancement of the digital transformation agenda, consider changing from a short-term to a long-term budget mindset. It is advisable to consider the Digital Transformation process as a journey and not as a specific objective with a finish line. For this, a multi-year budget incorporating constant investments is important given it is an evolving process, with new, powerful solutions emerging every day. Considering digital transformation financing as part of the operating budget is vital for the organization´s day-to-day operations and can help to make it a priority.

Additionally, to keep budgets at a sustainable level, which responds to changes in business results, organizations can set financial ranges, which keep a minimum amount allowing for the digital

[83] https://www.forbes.com/sites/peterbendorsamuel/2019/08/26/digital-`transformation-success-depends-on-agile-approach-to-change?sh=16c5b003751e

agenda to continue without interruption – and a maximum level that prevents unnecessary investments. To establish the minimum amount, it is relevant to consider the real implications that a large budget cut can have on the agenda.

Introducing the digital transformation agenda as part of the organization's strategic agenda and working together with those in charge of the digital transformation process can help to define which activities cannot stop, as well as quantify the cost of stopping and postponing the process when the budget is restricted. This quantification of potential losses can help leaders understand the importance of prioritizing the Digital Transformation budget, so that there is agreement on a minimum amount that should and will be respected.

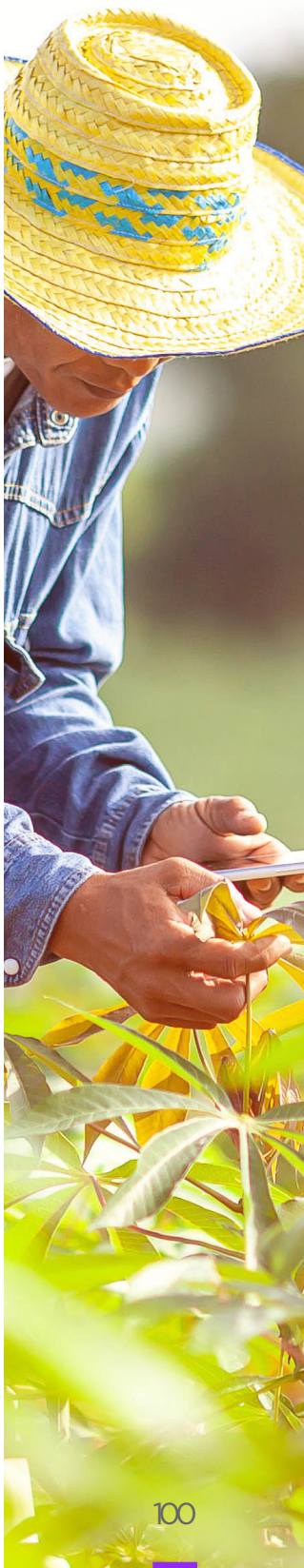
Strengthen employer brand and industry attractiveness

Organizations can strengthen their brand and increase the industry´s attractiveness to attract the best talent for enabling and accelerating their digital evolution. This may require different approaches for both individual and collaborative efforts.

On an individual level, organizations can actively offer better incentives that provide value-added to workers by upskilling and reskilling of their capabilities. This can encompass economic incentives and other actions that recognize their additional efforts. The approach can help guarantee the availability of qualified talent for tasks specific to productive activities, such as heavy machinery operation for harvesting or other technical jobs, like drone fertilizer application, which requires more specialized training.

Also, companies may consider offering work benefits to their office workers, who do not need to be in the field every day. For example, they may appreciate work-from-home flexibility allowing those who qualify to live in the city without the need for a long commute. These kinds of benefits can attract professional talent who drive innovation in organizations. Overall, these actions can help strengthen the employer's brand and make it more desirable for top talent.

On a collaborative level, organizations can come together to improve the industry´s attractiveness. Companies can advertise the countryside, no longer as a traditional and old-school industry, but as an evolving endeavor that incorporates innovative technologies each day and requires new and creative minds looking for a challenge. This way, the agribusiness prestige can come back and – with new talent – help innovate and advance the field. Further, by inspiring future potential for agricultural workers, young people can grow up developing adequate career possibilities working in the sector. Organizations can work together with the government or different entities to design technical curriculums to be taught in regions where there is a high potential for agricultural workers. As a result, young people can grow up developing adequate capabilities, as well as considering these careers as a desirable future they may have not considered otherwise.



Identify industry leaders and work together to promote the digital agenda

To ensure coordination between digital solutions across different players throughout the value chain, organizations should identify industry leaders and work together to determine the appropriate path forward. This can prevent incompatibilities with other players in the value chain by establishing a clear way forward with synchronized advancement. Also, industry leaders can provide knowledge on best practices to follower[84] organizations, so they can catch up quickly and can reap digital transformation benefits faster. Additionally, companies can use success stories from organizations that are more advanced in the digital transformation journey for benchmarking of conclusive benefits. This can help companies better understand the advantages they realize from digital solutions. Overall, a more collaborative approach among industry organizations can accelerate the progression of digital transformation in the agricultural business.

Organizations across the value chain should have open communication channels that prevent confusion and ensure proper digital transformation value is fully recognized. Currently, some organizations, at the beginning of the value chain – mainly producers – are not being properly compensated for their efforts, even though players at the end of the value chain, such as consumer packaged goods (CPG) companies, are starting to require certain practices in the production process. There might be a problem with communication, which is why an open exchange between all players in the value chain is crucial. Essentially, if producers explain the cost of implementing solutions that help meet the CPGs requirements, this can encourage formal agreements that properly compensate all players, and digital transformation is no longer hindered by uncompensated costs.

Join your peers and leverage the power in numbers

Organizations can join forces with other industry members to increase their negotiating power and achieve economies of scale. This can help companies make necessary changes, receive better prices, as well as realize savings on different operating costs.

First, organizations can use the power of numbers to come together and demand necessary changes. Specifically, organizations can work together to demand that governments and other private providers implement policies for better connectivity services. It can go as far as organizing a public-private partnership to promote new infrastructure in rural areas with agribusinesses. Joining forces can bring to light the challenges companies are facing that require external help and in turn place pressure on governments or big private companies to overcome them.

[84] Follower organizations can be considered smaller organizations in the industry that are not trend setters and usually look toward bigger players to identify best practices.

Secondly, organizations can look to associate with other similar, industry organizations to gain the power of negotiation when dealing with financial institutions and agritech providers. With banks, for example, organizations can bargain for better interest rates, given a diversified risk, when taking out a collective loan. Similarly, with agritechs they can negotiate deals by offering to sell their solutions to different organizations, but at a reduced rate, given the guaranteed large number of clients. Also, as a group, they can approach agritechs and explain their specific industry solution requirements making sure it is viable for them to develop personalized solutions and invest in R&D to enter new markets. All of the above, translates into a benefit for both agribusinesses and agritech providers as organizations can acquire solutions adapted to their needs and agribusinesses can address more clients and therefore grow their revenue and market share. This collaboration can further speed up the digital solution adoption process and have their needs met more easily.

Collaborating can also help agribusiness achieve economies of scale. One possibility is cutting out some costs related to the day-to-day operations that can also be shared between organizations (for a small cost like renting out). For example, companies that do not fill out their shipping containers that have all the pertinent technologies for produce conservation, can rent out the remaining space to smaller companies that would have difficulty making the large investments needed to achieve those solutions on their own. This collaboration and cost-sharing can help organizations catch up faster in their digital transformation journey by being able to gain benefits from digital technologies.

CASE STUDY

Innovahub: Logistics, Traceability & BI for the sugar Industry

Agribusiness organization

Location: Guatemala

Crop: Sugarcane

About

The Association of Sugar Producers of Guatemala -ASAZGUA- was created in 1957 and became a cornerstone of the development and growth of the Sugar Agroindustry in this country.
Thr organization of 11 sugar mills and 3 research organizations helped Guatemala become the fifth largest exporter of sugar globally, the secons in Latin America and the third with the highest productivity in the world. It generates 56,000 direct jobs and 270,000 indirect jobs, is the second most exported product in the country and generates foreign exchange that has exceeded one billion dollars annually.

Solution provider

About

INNOVAHUB, innovation hub Association of Sugar Producers of Guatemala aims to contribute to the development of Sugar in Guatemala and other sectors of the country, through new ideas, generating business models in new and transformative areas, promoting the development of skills, technologies and infrastructures, as well as promoting a Guatemalan innovation ecosystem.

Problem to solve

It is extremely important for the competitiveness of agribusiness, to guarantee the quality and traceability of the product in all it phases, to be able to monitor and optimize the processes involved in the transformation of the product and detect in time changes in the quality of the same along the entire value chain.

Additionally, the use of innovative solutions for the agriculture require a business intelligence solution to impove decision making.

Solution implemented

INNOVAHUB developed a platform solution for monitoring the logistics of agricultural products. Integrating “Digital Twins” sensors, GPS positioning systems, connectivity, analytical models and integrated logistics softwarw for decision making.

Additionally, a it developed a dashboard with tools, graphs and templates that allow comparative analysis and trends to anticipate events that may affect harvests. This decision-making solution integrates and analyzes data form different sources to measures productivity and its relationship with climate.

Archive results

The main results from the **logistic platform** were:

- Optimized routes form the field to the customer’s warehouse
- Improved efficiency in fue consumption
- Reduced delivery times of final products and raw materials
- Guaranteeing traceability throughout the chain
- Reduction of water consumption
- Reduction in the use of fertilizers without affecting yields
- Optimization of the overall cost of production

Figure 6: An example of powerful collaboration between peers

Use sustainability practices as encouragement to implement Digital Transformation

Organization's collaborators can use the emergence of sustainable practices to convince stakeholders in the adoption of a digital agenda, given many practices can be effectively achieved in this manner. First, it is relevant to point out that sustainable practices encompass more than just environmental aspects including social ones such as inclusion, gender equality and diversity. Digital Transformation can be a mighty tool to work toward accomplishing both environmental and social aspects of the sustainability agenda. It is important for companies understand that the implementation of sustainable practices is not an altruistic action, but a powerful practice that can also bring economic benefits to the organization.

Regarding the social aspect there are several ways Digital Transformation can be leveraged in the agricultural industry. For example, technology can help the inclusion of women in agribusiness by removing the necessity for inordinate strength with more sophisticated tools. According to IDB estimates, out of 58 million women who work in agriculture in LAC only 17 million are formally recognized, which reduces access to state programs, credits, and technical field assistance[85]. Moreover, the transition to digital solutions can help with inclusive growth if companies choose to invest in training and educational programs to learn and acquire digital capabilities specifically targeted at women, which can allow women to participate in the industry. Additionally, digitization in agriculture can increase access to financial services which aids the development of the field and increase productivity85. The commitment to social aspects is important to improve overall employee satisfaction and retain the best talent, which translates into better productivity. Consequently, as it has already been mentioned, consumers and investors expect companies they buy from or invest in agribusiness that have fair working conditions for their workers, which turns it into a competitive advantage over other companies in the sector.

Besides the social aspects, targeting sustainable environmental practices can usually translate into huge savings for organizations by improving efficiency and reducing the use of many costly agricultural inputs such as water, fertilizers, and pesticides. Further, it is important to have the tools and processes to properly document and make public the sustainability results, such as carbon offset, water consumption, and contamination. Although this documentation can be done without digital means, it would require a lot of effort by collaborators which could create considerable inefficiencies. Therefore, digital tools to measure sustainability commitment and results are vital for organizations to seize the external opportunities that sustainable practices bring.

One external opportunity that sustainable practices leverage with Digital Transformation, is access to inexpensive

[85] (Azevedo & Valencia, 2021)

capital. Many investors and other financing methods such as sustainable or green bonds, which usually offer low interest rates, can only be accessed when certain requirements are met. Even though some countries in Latin America are a long way from establishing a policy that requires sustainable practices, CPGs, and retailers, which are agribusinesses' biggest clients, are already starting to be pressured to include them in their products. Because of this, these big players will soon start asking their suppliers for sustainable practices, which will turn into a competitive advantage needed to compete in international markets. As a result, using the pressure of incoming sustainable practices to push the digital agenda can be beneficial.

Areas of opportunity for other players in the ecosystem

As was previously mentioned there were opportunities identified where other relevant players, that work around the agriculture industry ecosystem, can intervene to promote necessary changes. The identified areas of opportunity are:

- **Connectivity issues:** Multilateral entities and other relevant actors in the ecosystem can work together with governments and private telecommunication companies to develop projects that provide a better connectivity in rural areas that are currently being underserved.

- **Education:** There are a couple of initiatives that can be pursued by multilateral entities and other actors to address the education challenge in agribusiness. First, there can be coordination with governmental training or educating institutions where specialized agricultural technical curriculums, which connect with the digital necessities of the industry, are meticulously designed and promoted. Secondly, there can be a joint effort with agribusinesses to design and replicate upskilling and reskilling training for workers that focus on digital capabilities.

- **Narrative change:** Currently, there is an outdated perception of the agricultural industry mainly associated with poverty and hard labor. To address this, different campaigns can be implemented that can bring back the industry´s prestige and encourage different players to invest in it, stakeholders ranging from young individuals that can invest their careers and future to private companies that can invest their resources. For these campaigns, new and attractive methodologies, as well as new ways of working that are enabled by technology (importance of business intelligence, work from home, etc.) can be promoted.

- **Ecosystem coordination:** In line with what has been said throughout the report, multilateral entities can work as ecosystem coordinators. Entities can get into contact and create relevant partnerships between currently disconnected organizations to encourage an integrated approach to digital transformation. Similarly, this type of organization can sponsor digital solution providers, in a way that agribusinesses can identify which providers they can trust to help them with their digital journey, and even collaborate with them and finance pilot programs for digital solutions that can encourage agribusinesses to implement and scale them. Additionally, ecosystem coordination can be done by organizing networking events where best practices and lessons learned are shared by organizations throughout the entire value chain and across different agricultural industries.

- **Policy and regulatory advocacy:** Multilateral entities can be sponsors of how Digital Transformation can be a powerful tool to address sustainable practices. They can promote the importance of sustainable practices and work with governments and important private companies to implement integral and comprehensive policies that consider the realities of the agricultural industry.

4.4 CONCLUSIONS

Today, agribusiness organizations are facing overwhelming pressures that need to be promptly addressed. There is an increased demand for productivity to cope with the growing world population[86]; a globalized economy, which increases competition and puts price pressure on agricultural inputs; as well as sustainability requirements that relate to how goods are produced, such as food safety, health, environmental protection, and adequate working conditions[87]. All of these, are under the threat of climate change, where agribusinesses must manage the trade-offs related to maintaining a stable food supply, which includes additional carbon emissions, resource depletion and biodiversity loss[88].

Through this study, it was found that the agricultural industry has identified Digital Transformation as a powerful tool to challenge these daunting pressures. **Nevertheless, Digital Transformation in the Latin American and Caribbean region is still in its early stages, with most organizations closer to a lower level, between those with no Digital Transformation agenda in sight, and those that recognize its crucial importance and already have a running start.**

[86] (Loukos & Arathoon, 2021)

[87] (Interamerican Development Bank, Interamerican Development Bank - Invest, 2022)

[88] (Morris, Ashwini, & Perego, 2020)

Not pursuing a Digital Transformation agenda can prevent agribusinesses from proactively transforming to obtain benefits that will help keep them relevant within the industry. Specifically, digital solutions can be used to achieve greater operational efficiency -including risk mitigation- by eliminating waste, reducing losses, and preserving produce value. They can increase productivity, extracting maximum value from available resources, including land, water, labor, and capital; and can help with the alignment of growing sustainable practices, then, complying with increasing requirements and providing access to new markets and inexpensive capital. **Thus, defining a clear trajectory can give agribusinesses the strong competitive advantage they have been seeking.**

It has been found there are various barriers agribusinesses are facing to achieving Digital Transformation adoption. The most important ones have to do with the lack of strategic vision, inappropriate financing, and lack of driven and qualified talent within agribusiness organizations. The first two mainly happen because the **top management of agribusiness organizations does not properly recognize the significance of the potential of Digital Transformation.** Only if they understand it and take action to pursue it with proper leadership and financing can evolution and advancement happen.

Although there are several actions agribusinesses themselves can take to overcome further obstacles, an ecosystem effort can be the turning point to solve the most challenging problems to drive forward the agricultural industry's development and transformation. Therefore, there is an important role that other actors who work around the agricultural industry play, where active participation of the private sector, along with governments and other multilateral entities, can guide and coordinate agribusinesses to a clear path forward, as well as promote key Digital Transformation enablers like education, a narrative change, and appropriate policy and regulatory advocacy. The IDB Invest is one of these key players, that can drive Digital Transformation in the agricultural industry forward by providing access to financing products as well as comprehensive advisory services.

Hopefully, the contents of this report will inspire those organizations that have yet to begin their Digital Transformation journey to look both outside and inside, to recognize a path that suits them and will push them forward by securing all potential benets. And for those that already have a running start, this report can help to solve problems they may be facing with their current implementations, or as inspiration to take their Digital Transformation journey and, by extension, their organizations to the next level. Furthermore, it is expected this report can encourage a deeper level of collaboration among all players in the industry so they can equally reap the benets that a synchronized Digital Transformation effort can bring. All of this will allow the agricultural industry in Latin America to reach a level of innovation and productiveness that will drive the development of the entire region.

5

APPENDIX

5.1
SHORTFALLS IN DATA COLLECTION AND ANALYSIS

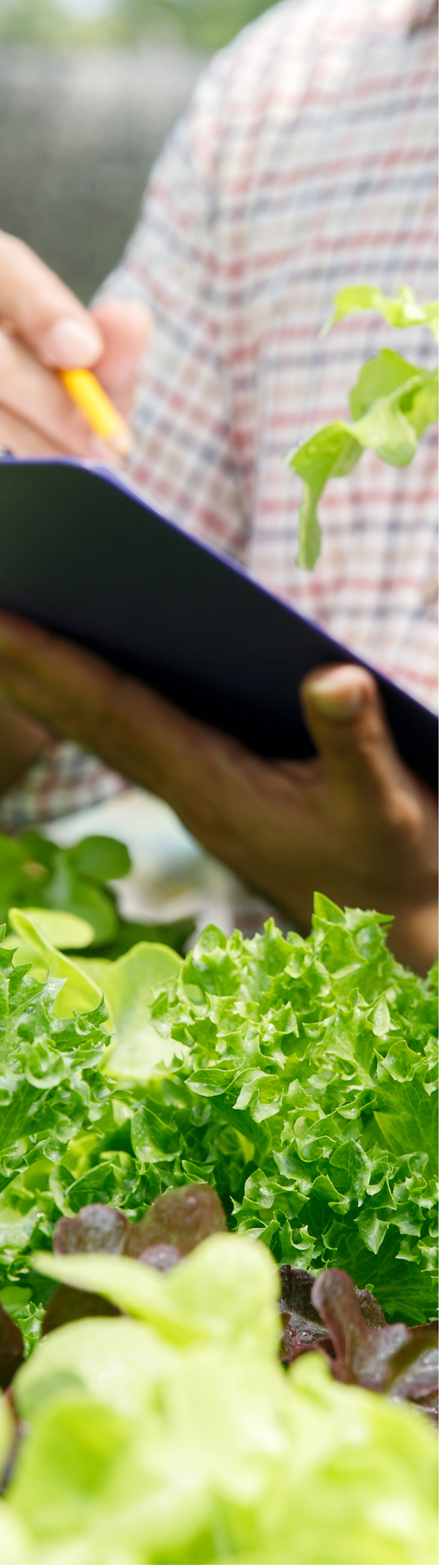
It is important to communicate the potential shortcomings of the data collection and analysis method utilized for this project. This endeavor relied heavily upon primary source data collection. Bias, in various forms, is present in any survey or interview. The team has mitigated these biases to the best of its ability, but this should still be conveyed in this report. Additionally, both primary and secondary research is subject to the availability of data and, in this case, access to willing participants to be interviewed. As a result, it is possible that proprietary technologies and processes were not discovered by the research or that important challenges were not identified.

1. **Self-selection bias.** The primary research conducted was limited to willing, uncompensated participants. However, those companies that participated were given a free assessment of their digital maturity and will have access to the materials produced by this report.

2. **Sample bias.** The sample of companies surveyed was limited to those who volunteered (as stated above) and those accessible through the network of the research team. These limitations reduced the possible sample size, and though the sample is meant to be representative of a larger population, some stakeholders like small producers, associations, cooperatives and extremely large international corporations have been missed. Additionally, all the companies contacted have some level of digital maturity due to their scale and prominence. It is reasonable to assume that there are smaller companies that fall below the baseline of digital maturity that this project established.

3. **Self-assessment.** The DMA was an important part of the data collection process for this project. Company leaders are most qualified and best positioned to understand their digital maturity. However, to quantify the data as objectively as possible, a scale of 1-to-5 was used, and guidance was provided to each respondent. In most cases, one was used to express a non-existent capacity, tool, model, or strategy, three was used to describe some level of development with the opportunity for improvement, and five was used to express confidence in the capacity, tool, model or strategy the company possess.

Because of the variety of profiles that can respond to the DMA, the answer for each question could vary. In this case, the perspective of the CFO at one company may vary from that of the CTO at another.



5.2
FURTHER DESCRIPTION OF VARIABLES ANALYZED IN THE DIGITAL MATURITY ASSESSMENT

To define a suitable model to assess the digital maturity of any agribusiness, seven key variables were identified. These were mainly intended to frame the digital capabilities and facilitate the analysis, thanks to the logical connection between them.

The seven chosen categories are:

1. **Strategy and Governance**
2. **Organization and Collaboration**
3. **Customer Experience and Interaction**
4. **Technology and Platforms**
5. **Information and Insights**
6. **Growth and Innovation**
7. **Security and Privacy**

As it was designed, the seven variables are correlated. Strategy and governance create, empower, and oversee a plan for the organization to develop initiatives in the form of technologies and platforms. These initiatives leverage operational business capabilities such as information creation for decision-making and customer experience. All this is in a framework of cybersecurity that allows securely scaling of the Digital Transformation. The constant iteration of this flow leads the organization to grow and innovate.

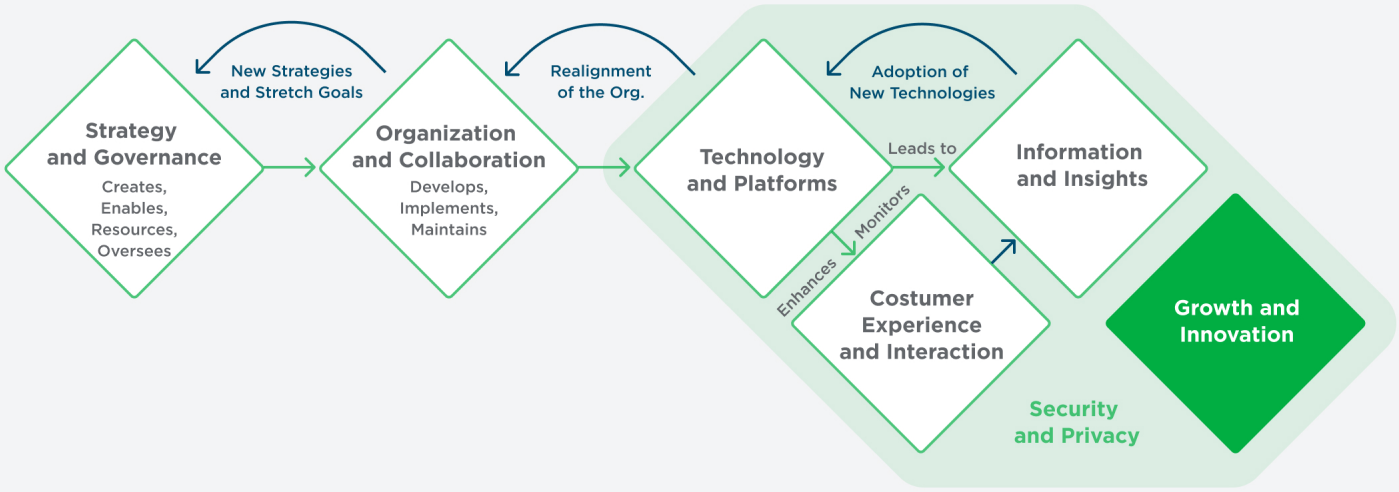


Figure 7: Map of correlation between digital capabilities

1. Strategy and Governance.

How have new digital technologies influenced strategy and business plans at your company?

This first category defines the path and the way to achieve the objectives. An inspired strategy and an appropriately thought-out governance model ensure that a company has aligned its business objectives with its goals of digital development – and holds the organization accountable. Maturity in this category demonstrates a company is committed to and understands the importance of prioritizing as critical. A crucial step is to polish and frequently reassess the digital strategy.

Some identified characteristics in successful companies are the following:

- Have a clear strategy that perpetuates a culture of innovation
- Develop an optimal and efficient digital governance model
- Constant review of its digital strategy with the ability to adapt its plan according to its new needs and those of the market
- Encourage managers throughout the organization to take calculatedrisks to improve operations
- Identify innovative technology trends as they emerge, enabling the organization to put itself at the digital forefront

For example, some companies have embedded technology and innovation with young and digitally savvy leadership profiles, provide financial incentives for ESG (sustainability) objectives and facilitate access to technology fairs and ecosystems. These companies in the region use digital solutions like precision agriculture and fiber optics on the farm.

2. Organization and Collaboration.

To what extent is the staff adapted to future qualification needs?

The second category intends to measure the current status and willingness of the organization and its empl`oyees to be part of and leverage the Digital Transformation of the company. This willingness comes from leadership applied to the right talent and facilitated by a well-organized company that promotes innovation from entry levels through various channels. We have seen that most innovation comes from the operative teams, but leadership is essential in shaping the company's culture and not overlooking any reasonable idea.

Some identified characteristics in successful companies are the following:

- Leverage human capital to keep up in an ever-changing digital landscape
- Have flat organization that is more agile and superior in adopting new technologies as they come to market
- Apply thoughtfully organized and delineate clear lines of communication and an atmosphere of camaraderie that cultivates creative thinking, innovation, and ownership of work
- Explore ideas spawned by the lowest-ranking members of the organization and have a channel to communicate these ideas to decision makers

For example, digitally mature companies have a technology and innovation leader who constantly interacts with operational teams to identify pain points and potential digital solutions. The person in this role looks for solutions for the lower link in the organization (e.g., PDA's and training for farm operators), but finds synergies with the rest of the company (e.g., agnostic connectivity solutions and analytics platforms).

3. Technology and Platforms.

How mature is your digital or mobile operating model and to what extent does it integrate with your existing IT operating model?

The Technology and platforms' capability seek to evaluate the current state of the digital capacity, as well as digital platforms and tools. Digital technology has a place in every part of the agricultural value chain. From data collection via ground sensors and drones in the field, to software that optimizes pricing at the retailer. However, solutions must be communicated with each other, and organizations must collaborate with the same information. That is why this category of the DMA focuses primarily on how advanced the infrastructure is to generate and integrate data from across the organization (including third-party applications).

Some identified characteristics in successful companies include the following:

- Implementation of information sharing, integrating different hardware and software solutions
- Encompass the important level of resources and proficiency in analyzing collected data
- Rely on different types of technologies and measure incremental value realization

For example, many companies have proficiency in collecting data from different sources across their operation (drones, satellite images, soil sensors, PDAs from operators, machinery, supply chain and commodities prices) but most struggle with a platform that connects all this information and allow for better decision making.

4. Customer Experience and Interaction.

To what extent does the technology back-end support a consistent customer experience?

This category evaluates how customers interact with the product, the company, and how feedback is captured. The customer depends upon where a company is positioned within the value chain. For retail, the customer may be interacting

with a product directly online or via physical stores all over the world. In most cases, the companies interviewed for this project are somewhere up to mid-stream with B2B operations. Therefore, this category can be considered basic and, in some cases, non-existent, because of the small number of high-volume customers managed, who prefer to have a relationship manager model.

For example, many companies follow up on a weekly or monthly basis using personal visits, telephone or in some small cases by means of their applications or instant messaging to encourage trust and proximity. This type of follow-up allows a close and trusting relationship between the parties involved and the different technologies can be used as a high-value lever in the experience and service.

5. Information and Insights.

Does the organization integrate data from internal and external sources to generate insights?

This category speaks to the capacity of the organization's ability to use, process, and generate relevant information for business decision-making. Insight generation is one of the most important parts of Digital Transformation because the data an organization collects is only as good as its ability to then process and generate value-enhancing insights. Therefore, this category says a lot about the sophistication of an organization and its proficiency in applying the proper enablers.

Some identified characteristics in successful companies are the following:

- All the right people have ready access to information they require
- Insights are gained and used to enhance the company's strategies
- Employees are trained to manage and use data
- Someone is accountable for data quality
- Repetitive tasks like data gathering and analysis are automated to allow people to focus on decision making

For example, a high-value crops producer automated all the taxes and payroll activities to the workload accountants to focus on tax efficiencies, workers' productivity, and financial strategies.

6. Security and Privacy.

Is there a solid framework in place to ensure the protection of information?

This category seeks to evaluate the company's ability and status to generate security mechanisms related to IT infrastructure. Security, preventive, and reactive strategies must be integrated and leveraged with technologies to ensure adequate protection of digital assets. In today´s environment, security is key to Digital Transformation. With massive amounts of data collected by modern software solutions, safeguarding corporate secrets and customer information is critical.

Some identified characteristics in successful companies are the following:

- Provide the right people with access to information they need to complete their jobs effectively
- Implement flexible and secure, innovative cloud-based solutions for open collaboration and the addition of hundreds of new inputs from remote sensors
- Share data up and down the value-chain with strong protocols and standards for data access
- Continuously evolve security strategy

For example, failure to secure data related to growing techniques and technological implementation could cost a company its competitive advantage. Further, ineffective security could open the door for malicious parties to hold a company's data for ransom.

7. Growth and Innovation.

How are innovation ideas identified, prioritized, and developed?

This category measures the output of the previous categories because if a company excels in all identified areas, it is positioned to develop digitization initiatives from the strategy to the production process, passing through the human talent. However, this is not always the case and companies miss the opportunity to thrive.

Some identified characteristics in successful companies are the following:

- Have processes to identify solutions on the market
- Implement tools, processes, and responsible parties for publishing insights and developing solutions
- Incentivize knowledge sharing between employees and other agrobusinesses or ecosystem partners
- Look for opportunities to monetize knowledge generated by selling knowhow and digital solutions to other industry players (even competitors)

For example, industry leaders have a track record of developing solutions from a conscious process and insights that generate value for the company and can improve any of the other six categories. One company created a spin-off business to sell technologies and digital applications generated in-house.

5.3
DETAILED ACCOUNT OF THE COUNTRY AND VALUE CHAIN PRIORITIZATION

To define the crops and countries focus of the study, crops were sorted out based on the five variables stated below, as well as additional qualitative input from BID Invest Agriculture Team.

- **Value:** Value of production[89]
- **Land:** Land dedicated to primary production[90]
- **Volume:** Volume produced in metric tons[91]
- **Exports:** Value of exports[89]
- **GDP:** GDP of the agriculture sector[92]

For Land, Volume, and Exports variables, relevance was defined as:

- **High:** Top ten crops
- **Medium:** Crop between 11 and 20
- **Low:** Crops in place 21 and above

On the other hand, for the Value variable, relevance was defined as:

- **High:** Values greater than $5B
- **Medium:** Values between $5B and $2B
- **Low:** Values below $2B

[89] All value or monetary indicators in constant 2015 USD

[90] In ha.

[91] Tons

[92] Idem

The values that were considered for the segmentation are in the table below.

Crop	Value	Land	Volume	Exports	Volume LAC / World
Soy	39.3	57.3	184.4	145.5	52%
Sugar cane	24.9	13.4	975.5	22.5	48%
Corn	22.9	36.3	171.7	49.9	18%
Coffee	10.4	5.3	6.0	3.8	55%
Banana	8.4	1.3	31.6	15.5	27%
Grape	7.2	0.6	8.3	1.3	11%
Rice	6.7	4.9	28.8	1.7	4%
Potato	6.3	1.0	20.2	0.3	6%
Tomato	5.9	0.3	13.1	2.1	7%
Vegetables	4.8	6.6	6.7	0.7	11%
Avocado	3.8	0.5	4.8	1.7	72%
Pome & Stone fruit	3.7	0.4	7.4	2.2	5%
Wheat	3.1	9.6	30.0	0.4	4%
Leaf & stem vegetables	3.1	0.8	11.2	1.7	2%
Citrus	4.9	1.2	25.9	3.2	11%
Spices	2.5	0.4	0.4	1.3	4%
Mandioca	2.4	2.1	26.5	0.2	9%
Berries	2.4	0.1	1.7	0.6	12%
Nuts	2.1	1.6	2.7	1.1	5%

Table 3: Value summary of variables considered for segmentation
Source: FAOSTAT

Then, crops were segmented using the following criteria:

Score	Criteria	Result
1	High relevance in value and exports	Selected
2	High relevance in at least one variable, and at least Medium in any other variable	Selected
3	Medium or Low relevance in all variables	Not selected

Table 4: Crops segmentation criteria
Source:

As a result of the analysis, crops with scores of 1 or 2 were selected, while crops with a score of 3 were discarded. Therefore, the list of selected crops considered in the scope of the study were soybeans, sugar cane, corn, coffee, banana, grape, rice, potato, tomato, legumes, avocado, and citrus.

The results from the evaluation are summarized in the table below:

Crop	Value	Land ranking	Volume ranking	Exports ranking	% Volume LAC / World	Score
Soy	39.3	1	2	4	52%	1
Sugar cane	24.9	3	1	8	48%	1
Corn	22.9	4	3	6	18%	1
Coffee	10.4	6	25	7	55%	1
Banana	8.4	15	6	9	27%	1
Grape	7.2	22	14	10	11%	1
Rice	6.7	7	5	24	4%	2
Potato	6.3	17	10	38	6%	2
Tomato	5.9	35	12	20	7%	2
Vegetables	4.8	5	22	30	11%	2
Avocado	3.8	26	27	13	72%	2
Pome & stone fruits	3.7	30	18	14	5%	3
Wheat	3.1	4	7	15	4%	2
Leaf & stem vegetables	3.1	19	13	22	2%	3
Citrus	2.6	16	9	18	34%	2
Spices	2.5	37	30	23	4%	3
Cassava	2.4	11	8	44	9%	2
Berries	2.4	49	36	21	12%	2
Nuts	2.1	14	32	17	5%	3

Table 5: Ranking of relevant variables for each crop
Source: Own analysis of FAOSTAT[93] data

Once crops were prioritized, the focus shifted to selecting countries where each of the prioritized crops was relevant. With the goal to have a significant representation of countries, two variables were analyzed:

[93] (FAOSTAT, Various years)

1. **Regional relevance:** Proportion of the crop produced in the country over the total produced in Latin America and the Caribbean.

$$Regional\ relevance = \frac{Volume_{country}}{Volume_{LAC}}$$

2. **National relevance:** Contribution of the crop to the total production of crops in the country, normalized by GDP of the agricultural sector.

$$National\ relevance = \frac{Value_{crop,\ country}}{\Sigma Value_{crops,\ country}} \times \%GDP\ Agriculture_{country}$$

The following criteria was used to define the focus of the study:

Considering Regional relevance:

- **High:** top two countries overall
- **Medium:** countries ranking was between 3 and 10
- **Low:** countries ranking eleven or more

Considering National relevance variable had only two categories:

- **High:** values over 2%l
- **Low:** values below 3% (≥2%)

The final evaluation used the following criteria:

Regional relevance	National relevance High	National relevance Low
High	Selected	Selected
Medium	Selected	Not selected
Low	Not selected	Not selected

The relevance of the crop for the country and the relevance of the country for the region are shown in the following table.

Crop	Country	Regional relevance	National relevance
Cereals and oilseeds	Brazil	58,81%	1,98%
Cereals and oilseeds	Argentina	25,42%	3,03%
Cereals and oilseeds	Mexico	6,05%	0,58%
Cereals and oilseeds	Paraguay	5,07%	7,91%
Sugar cane	Brazil	77,53%	0,99%
Sugar cane	Mexico	5,53%	0,21%
Avocado	Mexico	45,48%	0,26%
Avocado	Dominican Republic	13,42%	0,95%
Avocado	Peru	10,51%	0,34%
Banana	Brazil	21,07%	0,09%
Banana	Ecuador	19,12%	4,35%
Banana	Guatemala	14,21%	2,54%
Coffee	Brazil	60,78%	4,35%
Coffee	Colombia	13,69%	1,08%
Citrus	Mexico	29,85%	0,10%
Citrus	Brazil	22,72%	0,03%
Citrus	Argentina	22,01%	0,09%
Grape	Chile	35,99%	1,13%
Grape	Argentina	26,69%	0,41%
Grape	Brazil	18.64%	0,07%
Tomato	Mexico	34,69%	0,30%
Tomato	Brazil	31,40%	0,10%

Table 6: Prioritized countries by crop
Source: Own elaboration based on data from FAOSTAT and World Bank Open Data, 2020.

5.4

DESCRIPTION OF THE AGRIBUSINESS VALUE CHAINS

The definition of "Agribusiness value chain" as used in this report is similar to the definition used by Harvard Business School, where it is defined as "the various business activities and processes involved in creating a product or providing a service"[94]. The process of producing and delivering any product to the supermarket must encompass the entire value chain. Depending on the product, some actions may vary within the process, but all agribusiness chains begin with the procurement of agricultural inputs and end with the final distribution ready for consumption. Some organizations have a presence in almost the entire chain, while others prefer to specialize in specific activities. It is important to clarify that some stages of the chain for some crops were prioritized in the study, given their relevance and weight in the industry.

Agro-industrial value chains are composed of five main activities: Agro-industrial inputs such as seeds and fertilizers; Machinery such as tractors, irrigation systems and packing machines; Farming and Harvest; Trading and Processing; CPG and Manufacturer. Each activity may vary in a number of microprocessors and actions depending on the crop.

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[94] (Harvard Business School Online, 2020)

Figure 8: Agribusiness Value Chain

Agro-industrial inputs (Seeds, agro-chemicals, and equipment)

In recent years, Latin American companies have started developing their agricultural inputs, a market previously dominated by foreign companies. They have opened a space for their products in several countries in the region and have taken advantage of the characteristics of the region's crops to market products specialized in crops such as soybeans, tomatoes, and coffee, among others. Similarly, for fertilizers, organizations have partnerships with large companies such as Bayer.

Farming and Harvest

The next stage of the value chain encompasses those who are responsible for using the previously described inputs and the land for planting and harvesting. In Latin America and the Caribbean, a wide variety of farming systems and levels of technology can be found depending on the area and kind of crop. Within a wide variety of farm types operating as agribusinesses, there are some large, well-capitalized and technologically sophisticated companies with the mission of supplying the local and international market, such as the large soybean producers in Argentina and coffee producers in Brazil. However, it is common to find many small producers with a low technical level and capitalization that are grouped in commercial associations such as coffee producers in Colombia and cocoa producers in Guatemala. It is also normal to see this category of associations for all kinds of crops, such as "Asocaña" in Colombia and "Acsoja" in Argentina.

Trading and processing

This third stage mainly involves the transformation of raw materials and/or the sale and distribution of the product. At this stage, the producers can vertically integrate and expand their operational capacity to go one step further and transform the product for subsequent sale. Nevertheless, it is still common in Latin America and the Caribbean for some small producers to sell their products to cooperatives and be transformed into a final product under a generic brand. On the other hand, methods of commercialization and transformation into byproducts vary according to the kind of crop.

CPG Manufacturer & Retail

In this final stage of the process, large clients such as supermarkets and food industry manufacturers acquire products for final sale through large distributors or direct contact with producers or cooperatives and associations. In this case, CPGs and retail stores play a fundamental role in setting conditions for sustainability or standardized processes, as they are the dominant party in the negotiations.

5.5
DESCRIPTION OF PRIORITIZED VALUE CHAINS

Cereals and Oilseeds

This chain is differentiated from the others by having a trader involved in the commercial process with robust processing procedures. The path in this micro process splits into two paths depending on the type of by-product: the production of oil or, raw material for more complex foods such as flour. The transformation of different cereals such as soybeans or wheat needs a central mill or several mills to transform the product into e.g., flour, soybeans or corn, which is then sent for industrial production, CPG or animal feed.

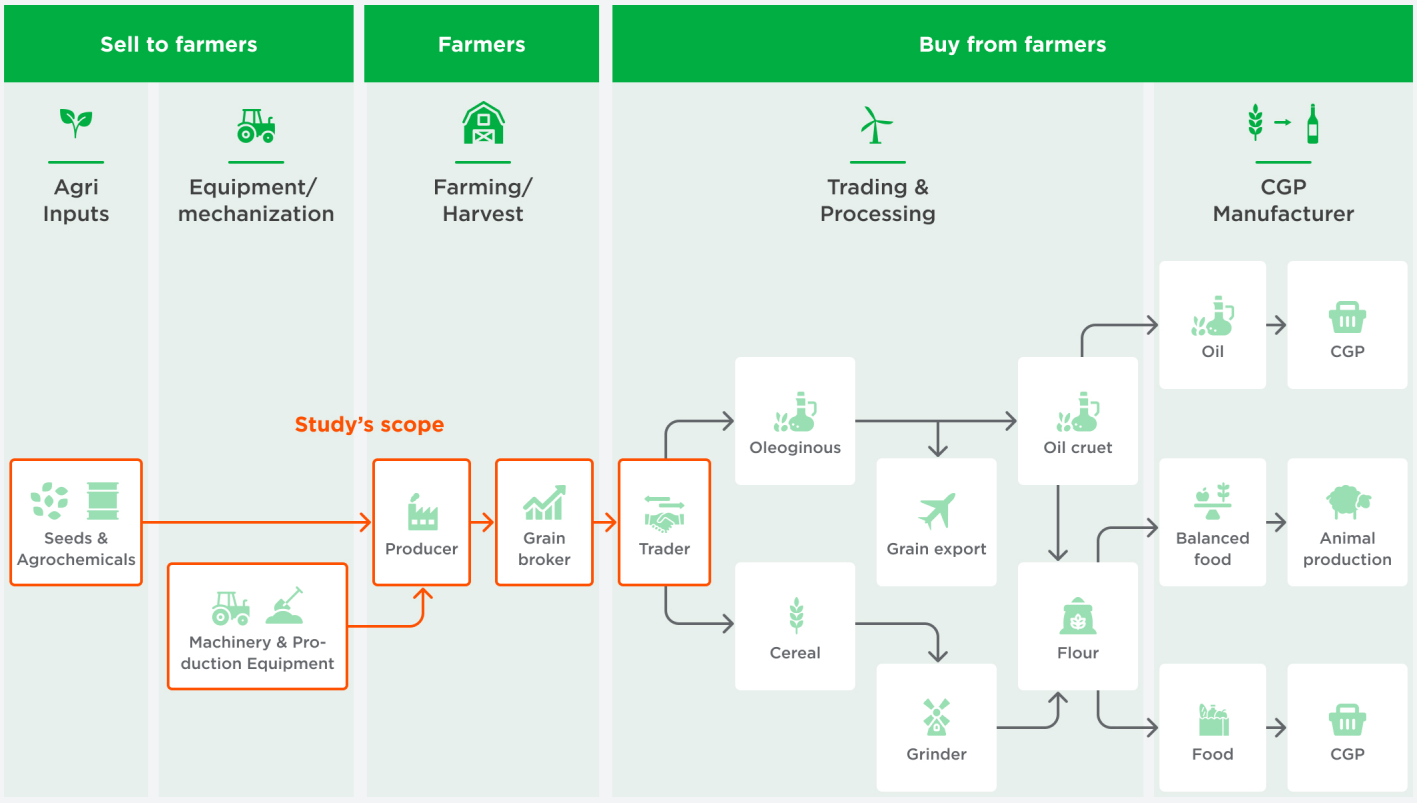


Figure 9: Cereals and Oilseeds Value Chain

Sugar Cane

This value chain is characteristically composed of large producers, who oversee of the cultivation and distribution of the products, large surface areas for crop cultivation, and many by-products and the implementation of the circular economy. As for the process, once the sugarcane is grown and cut, it goes through different processes depending on what final product is preferred. One of the processes is milling, which is the transformation of sugar cane for consumption in the form of sugar – or as an ingredient in processed foods. Another well-known process conversion of sugarcane into ethanol through fermentation and transformation into biological containers. In addition, the remains of all these transformation processes can be used for energy generation, employing the concept of the circular economy.

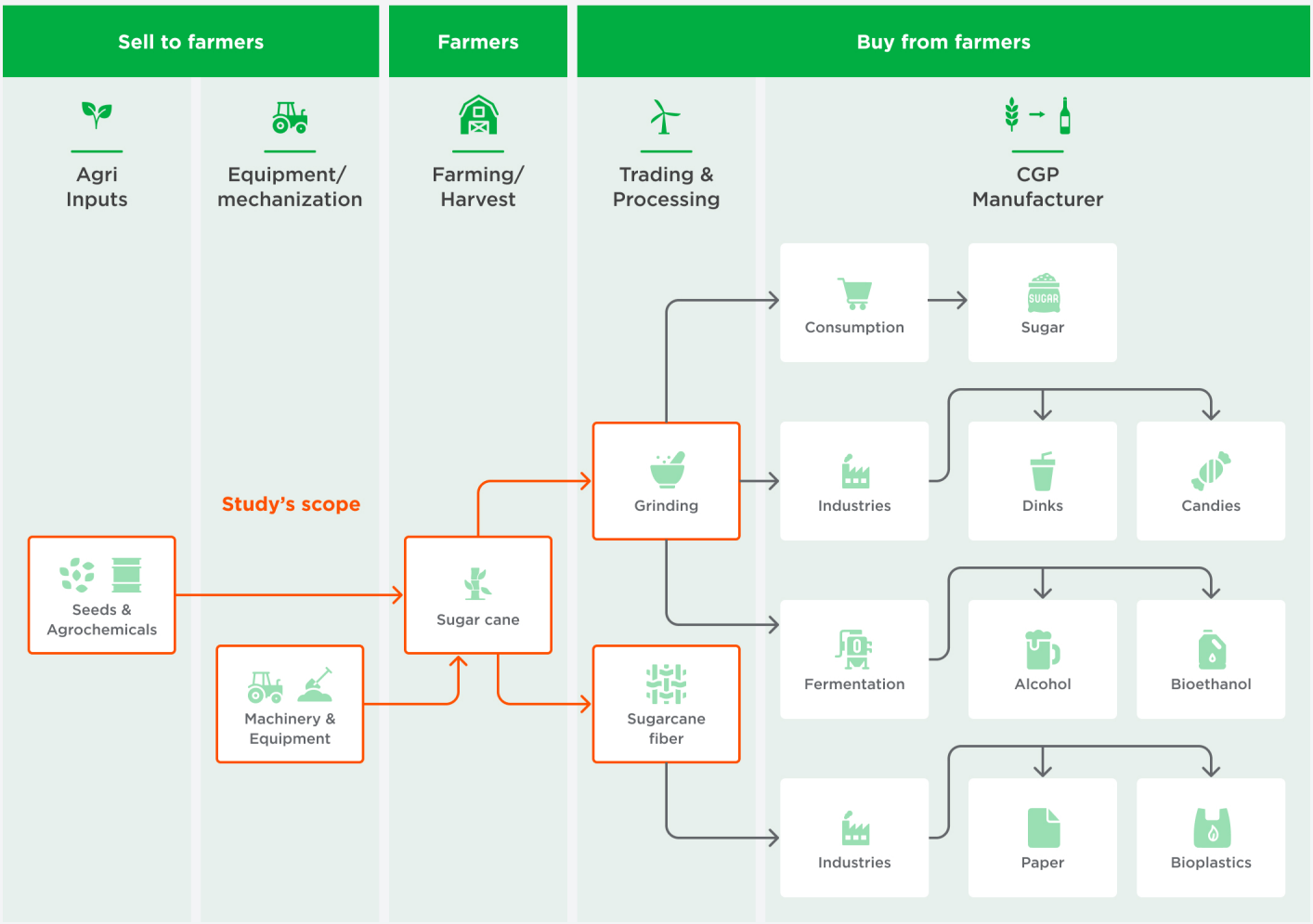


Figure 10: Sugarcane Value Chain

High Value Crops

This value chain is not recognized as extensive crops, where quality is valued over volume. These crops are products that require high standards of quality and care, so the use of manual labor at harvest time is still key. Among the products in this chain are berries, avocados, asparagus, and grapes. Crops like tomatoes and citrus fruits can also be included. This chain requires high monitoring during harvesting and packing, as well as high care requirements once outside the facilities, so investments in these stages of the process are recurrent and important. Once harvest season arrives, it is necessary to hire a large number of pickers to ensure the quality of the fruit, which goes to the sorting and packaging stage for subsequent shipment to large distributors who are responsible for commercialization it to the industry or CPGs. In many cases the large producers also direct distribution.

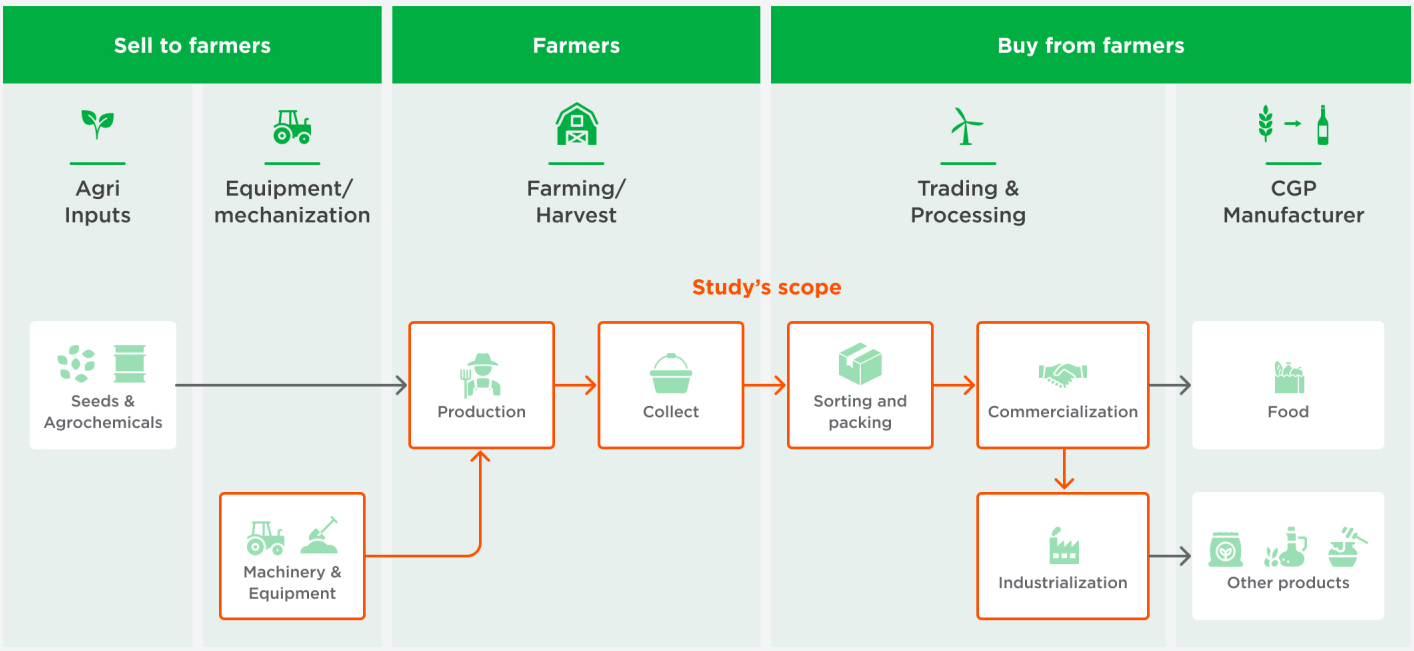


Figure 11: High Value Crops Value Chain

Coffee

This value chain operates differently depending on geography and location. The main distinction starts at the beginning of the chain, where the size of the producers varies. In countries such as Colombia and Guatemala, farms are small, in contrast to countries such as Brazil. The second difference is the focus of the cultivation, whereas in countries with small producers, the quality of the coffee is the added value that result in specialty coffees. For this reason, manual harvesting plays a particularly important role. In contrast, countries like Brazil have extensive and volume crops, and use a harvesting method by flooding the land. In countries with small producers, it is common to create associations and sell the coffee fruit to cooperatives for the transformation of the fruit and commercialization of coffee. For both kinds of producers, once harvested, the coffee bean goes through a quality-control process, and then undergoes the drying and roasting process. The origin and variety of the coffee determine whether the coffee is sold as arabica coffee or as soluble coffee.

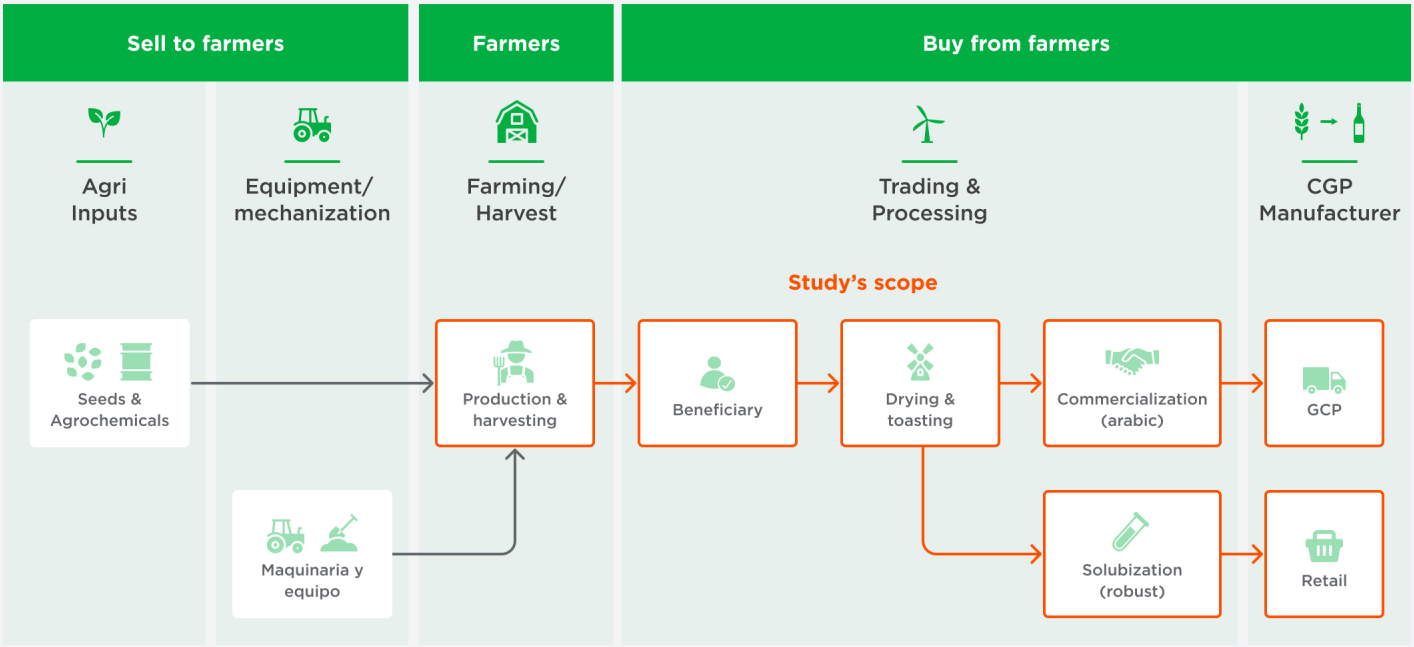


Figure 12: Coffee Value Chain

Cocoa

With this value chain, the crop is grown in tropical climates. The cultivation process is remarkably similar to that of coffee, where it varies according to geography. In countries such as Peru, Guatemala and Colombia, there are mostly small farms where small producers are associated with or sell to a large company in charge of transforming the product. It is also similar because a focus on quality and origin is highlighted. While in countries like Brazil, the harvest is more intensive. Once the cocoa is harvested, the beans are extracted and left to rest for the fermentation process naturally. Once this process is complete, the beans are dried by temperature to eliminate humidity, which can be done naturally by the sun or with drying machinery. Then, the beans are taken to roasters to be milled. The final product is a cocoa paste, which can be used as an ingredient in chocolate or converted into cocoa powder or cocoa butter

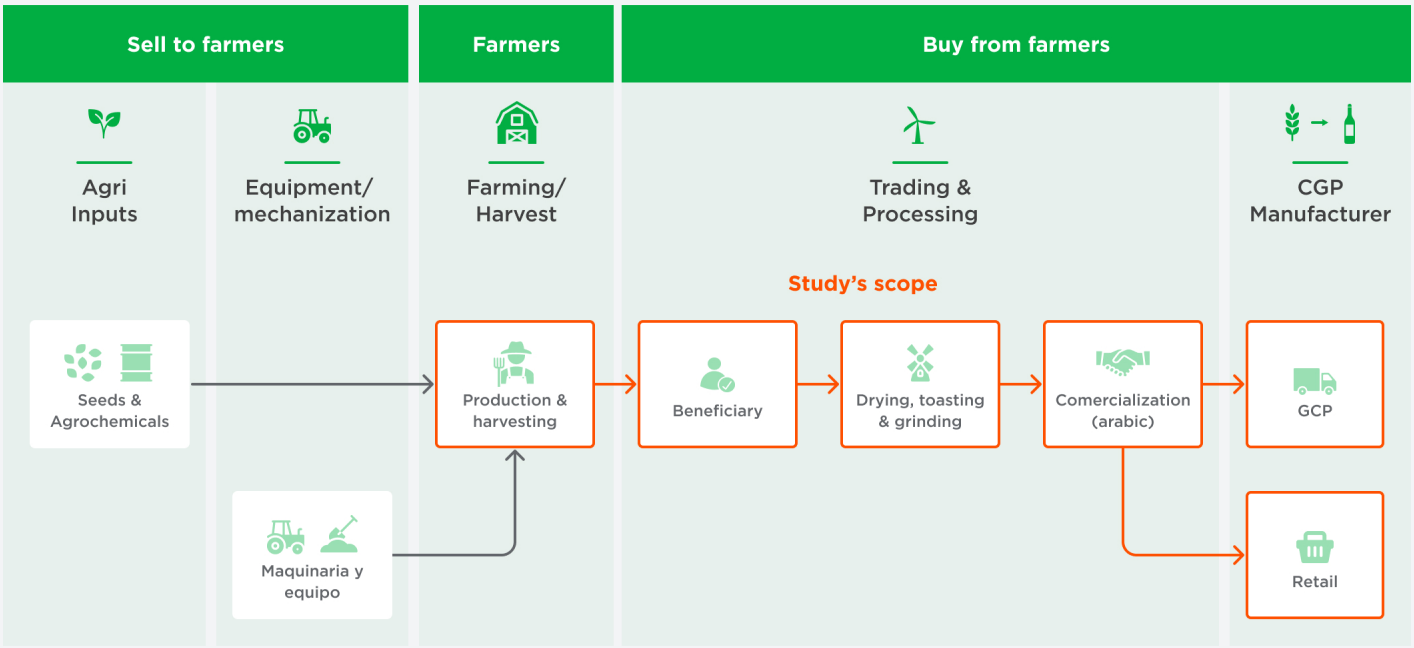


Figure 13: Cocoa Value Chain

5.6
IMPACT OF RUSSIA-UKRAINE WAR ON LAC AGRIBUSINESS

On 24 February 2022, Russia invaded Ukraine affecting global markets and threatening global food security, problems that were already in place due to the COVID-19 pandemic. Ukraine and Russia are some of the most important producers and exporters globally of crops of interest for this report: wheat, barley, corn, sunflower seed, and rapeseed.

According to the Food and Agriculture Organization (FAO), Russia and Ukraine accounted for 10% and 3% of global wheat production and 20% and 10% of global exports, respectively, making them the first and fifth largest wheat exporters, and critical suppliers to the Near East and North Africa region, where wheat is the main staple food. Ukraine and Russia are also the world's largest producers of sunflower seeds, accounting for more than half of the global production. Ukraine is the third largest exporter of corn and the largest exporter of soybeans outside the Americas.[95]

Regarding agricultural inputs, Russia is the world's top exporter of nitrogen (N) fertilizers, the second exporter of potassic (P) fertilizers and the third exporter of phosphorous (K) fertilizers, according to FAO. This accounts for over 15% of total global fertilizer exports in 2020.[96] Russia is also highly relevant in the Oil and Gas Sector (O&G) markets, which also raises production costs for agriculture,

leading natural gas exports and being the second largest oil exporter; accounting for 10% and 11% of global exports respectively in 2021.[97]

Ukraine and Russian agriculture production & exports

Ukraine continues to produce crops and livestock products, but due to direct damages from active fighting and high input costs, production of corn, soybeans, and sunflowers in 2022 is expected to be 20% lower than in 2021, while preliminary forecasts suggest a reduction in wheat production in 2022 of around 30% compared to the previous year. Regarding exports, even though Ukraine's production is going to be higher than internal

[95] All value or monetary indicators in constant 2015 USD

[96] (United Nations, 2022)

[97] (FAO, 2022)

consumption, exports have already been impacted due to export restrictionssuch as oats, by the Ukrainian government that seek to guarantee food security for their population and to logistics disruptions. The export supply chain depends on seaports at the Sea of Azov and the Black Sea that are currently not accessible due to war. Current FAO estimates suggest that current exports can only reach 20% of normal export quantities. [98]

Russia's data is less accessible, but according to the FAO, the 2021 Russian wheat harvest was below average due to adverse weather, and Russia's export restrictions on its wheat before the start of the war.[99] Trade sanctions and disruption in ports could impact Russian producers through margin pressures for producers, as well as reduced access to imported pesticides, machinery and digital solutions.

Impact on LAC agribusiness

LAC agribusiness organizations have not had relevant exports to the countries at war, so financial impacts will not come from trade disruptions on agriculture products.[100] As explained above, the Russia-Ukraine war has impacted trade flows and increased energy costs, leading to increases in international agricultural commodity prices. LAC producers rely heavily on fertilizers[101] and have an import dependency above 30% on Russian fertilizers (N, P & K), which has already increased costs across all crops in the study and will most likely continue due to a trade embargo on exports from Russia or a self-imposed export restriction. It is important to note that according to the USDA, fertilizer accounts for more than a third of a farmer's operating costs for corn and wheat.

Ukrainian corn supply disruption to China, Europe and North Africa has shifted demand and benefits among agribusinesses in Argentina and Brazil. But this has already shown inflationary pressures in Argentina, which caused a suspension in corn exports to fight food price inflation.

Corn price inflation has affected wheat prices as well, as it is a direct substitute for corn for animal feed. Argentina saw a record year for wheat production and exports during the 2021-2022 season, and its government has already seen an opportunity to capture international prices and open export records for 2022-2023 to 10 million tons of wheat.[102] On the other

[98] Idem

[99] Idem

[100] Ecuador and Costa Rica have exported small amounts of tropical fruits to Russia and Ukraine, LAC coffee produces have also small markets in those countries (less than 2% of exports). Mexican CPGs have operation in those countries, but manufacture is done in Europe with wheat and other inputs produced on that region.

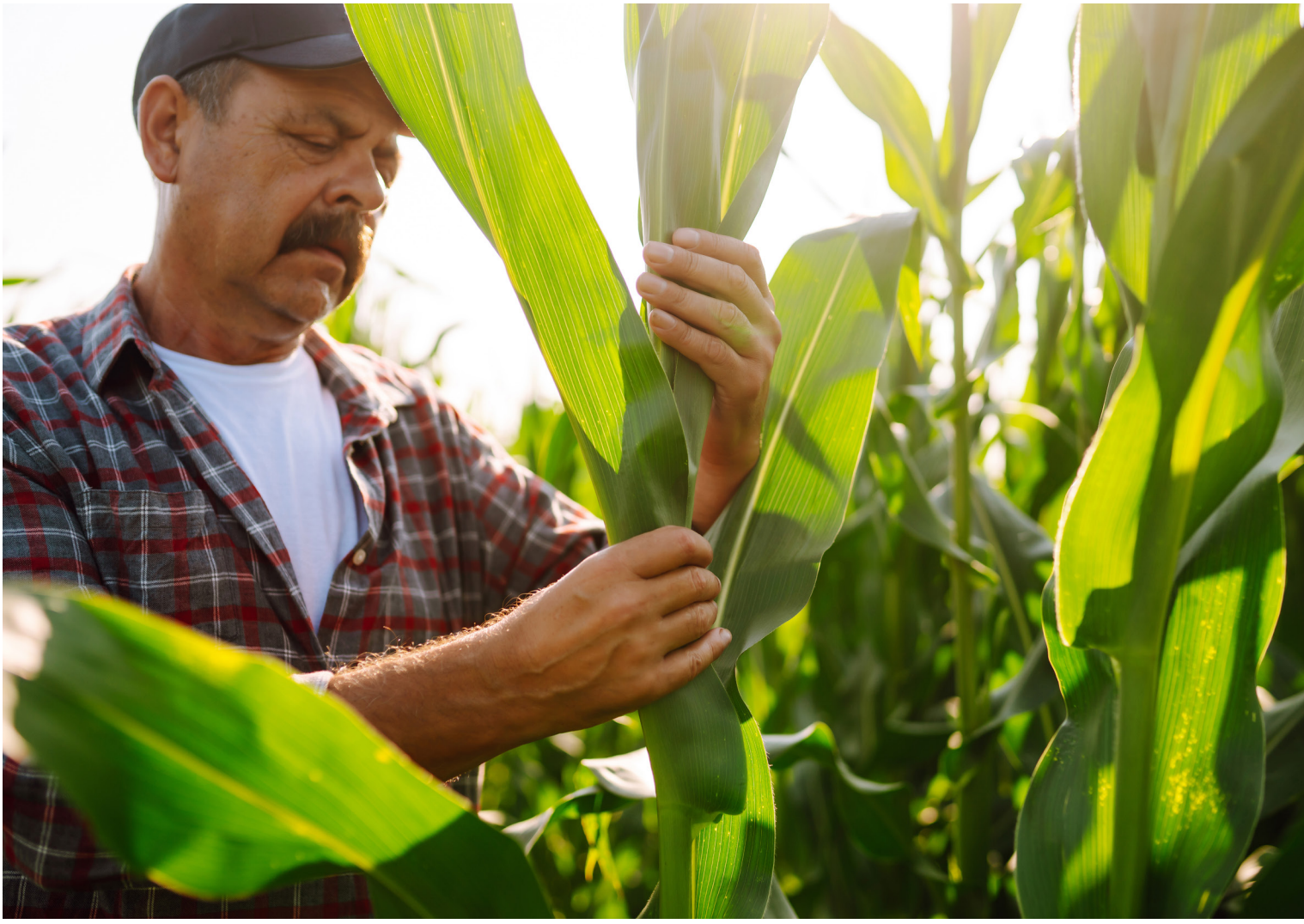
[101] According with the USDA, Brazil is the second largest user of fertilizer per hectare, consuming 246 kg per hectare. Brazil and Mexico import more than 60% of their fertilizer.

[102] According to the Buenos Aires Grain Exchange, Argentina harvested a record 21.8 million tons of wheat in marketing year 2021/2022, with exports pegged at 13.3 million tons.

hand, some LAC producers may have increased soybean production because they require less fertilizer.

Despite the high fertilizer prices, reasonable profit margins are possible given the relatively high prices of commodities (corn, wheat and soybeans). Unfortunately, for other crops like coffee and avocado,103 inflation costs cannot be fully transferred to consumers through price hikes. Producers in the region have stated they struggle to break even, just when they were just recovering production levels after the COVID-19 disruption. Peruvian avocado producers also are impacted by oversupply in Europe due to Israel channeling fruit typically shipped to Russia.

It is unclear when is the Russia-Ukraine war going to end or what the long-term impact will be on agriculture markets. In the short term, LAC agribusiness organizations should take this opportunity to become more efficient in the use of inputs through the leverage of digital solutions. LAC governments should reduce market disruption through prices and export restrictions but ensure food security through policies that facilitate Digital Transformation in the fields to increase productivity sustainably.



5.7
NEEDS TO BE ADDRESSED BY THE ORGANIZATIONS

Across the study, there were certain crop and country particularities identified. These were determined based on what some organizations expressed through the interview process and cannot be generalized to the entire region. The particularities identified are exposed in the table below.

Country	Particularity
 Argentina	• In Argentina, there is great openness to collaborate between organizations. The organizations recognize the value of joint efforts and understand how it facilitates and promotes innovation. • There seems to be a lack of alignment between supply and demand of digital solutions (´agtechs'). Even though there are many options available to Argentine organizations, many do not know which ones can truly address their needs. Therefore, there can be little perceived value of the available solutions.
 Chile	• The geographical and climate conditions of Chile have been strong drivers to implement Digital Transformation. Their restrictive availability of water, the remote location, faraway customers, and high input costs made technology a requisite to stay competitive within the industry by achieving high levels of efficiency and quality. • Similar characteristics between Chile and other countries with high advancements in agricultural technology, have provided Chile with advanced digital solutions, adaptable to their conditions. Because Chile has similar conditions to California, Israel and Australia, digital solutions providers from these locations have found a strong market in Chile. • Chile is one of the few countries in Latin America with good and reliable connectivity infrastructure. This in turn, favors Digital Transformation given they have substantial options when deploying digital solutions and can take full advantage of them.

Colombia

- Several Colombian organizations in the study, complained connectivity was a major challenge in rural areas. Although in urban areas, Colombia has good connectivity performance, in rural areas the reliability of connectivity slows down implementation of Digital Transformation.
- A common thread with Colombian organizations was the perception that new and younger generations had a declining interest to work in the agricultural industry. This is a challenge to organizations looking for fresh talent to rapidly adopt new digital ways of working.

Ecuador

- In Ecuador, there is a wariness by the government of market concentration, which is why companies do not attempt to grow too much. Therefore, there is not much encouragement for digital technologies to expand.
- High levels of unionization in Ecuador represent an additional barrier for organizations to implement digital solutions. Because there is such a high cost to severance packages, the adoption of digital technologies represents more manual labor, and this becomes too expensive for organizations there. There is a culture resistant to Digital Transformation.

Peru

- Governmental policies and controls in Peru have become important drivers for digitalization in the country. Specifically, federal requirements that affect payroll and invoicing have placed pressure on organizations to adopt digital technologies to help keep control and even automate these processes.
- There seems to be a lack of appropriate 'off the shelf' solutions available in Peru. Because of this, Peruvian organizations embrace in-house developments to get answers. Unfortunately, this creates a longer process to achieve Digital Transformation, given it is not part of their core business and capabilities. Additionally, internal developments may also cause incompatibilities with other platform.

Guatemala

- Given the nature and traditional growth, which has up until now provided results, there seems to be a conservative risk and adverse mentality towards financing of new and innovative projects.

Mexico

- Mexico has a particular challenge regarding the power and influence illegal actors have in the agricultural industry. This has created a distrustful environment for small producers who are hesitant to accept help from larger players, who incentivize Digital Transformation, this can greatly hinder the transformation process.

Crop	Particularity
Cereals and oilseeds & Sugarcane	• Cereals, oilseeds, and sugarcane are highly commoditized products where price is still the main competitive advantage. Because of this, organizations need to cover high, fixed costs with great volume. This places pressure on organizations to implement technology in operations that provide all possible efficiencies. • Given the large crop extensions these products require, there is a need for a panoramic view that can help with correct and efficient management of the fields. For example, precise fertilizer and pesticide application rely on, digital technologies as an important aid. Additionally, there is the benefit of automation, which makes processes like harvesting more agile and less costly. • Because these are capital intensive crops that demand large volume to cover fixed costs, there are high barriers to entry, with few large producers dominating the market. • CPGs are an important player within these crops' value chains. CPGs place pressure on producers by establishing sustainability requirements. This can be an important driver for transformation, given how digital solutions help to meet these emerging requests.
Sugarcane	• There is an important trend that is pushing to reduce sugar consumption. Specifically, governments are in the process of introducing policies to reduce public sugar consumption because of growing public health concerns. Now, the sugarcane industry is under pressure to innovate and develop business opportunities to stay relevant, where digital technologies can play an important role. • Sugarcane has many uses besides sugar production, such as alcohol and energy production, which provide a high level of opportunity for vertical integration. There is an opportunity to include digital tools to determine a proper business diversification based on data analysis.
High Value Crops	• Different from the previous crops, High Value Crops emphasize quality over volume. For this kind of crop, quality is determined by an array of variables that can be difficult to verify with current automation technologies. So, there may be a greater need for manual labor in the process. Nevertheless, there is an important need for technology that

helps with value conservation, such as smart sensors. For example, smart sensors can identify and warn when a refrigeration device is not working properly and there is a risk for produce loss – and that can help organizations take timely, preventative action.

- Due to the perishable nature of the products, organizations dealing with these crops need as much information as possible to make accurate decisions and carefully plan their operations from production – to final delivery. Organizations face small windows to maneuver when unforeseen situations arise, and digital tools can help predict these situations, as well as effectively manage them when they happen.

- With crops requiring intensive manual labor, tools and technologies that help with the proper and efficient distribution of personnel is critical. Additionally, using digital tools to measure how collaborators perform can help organizations retain or allocate them in specific areas to, give them a more productive operation.

Banana

- On a lower but similar level to High Value Crops, banana crops have certain characteristics important for their overall quality and value. There are certain variables like color and weight by individual unit that are important for their selling price. Because of this, technologies that help achieve these desired characteristics, can be valuable to the industry.

- With some organizations, there is a latent opportunity to take advantage of bananas' subproducts for new business lines. For example, banana waste can be used for energy production via biomass.

Cocoa

- Cocoa producers are small producers that rely on larger companies to gather and commercialize the cocoa bean or derivative products. Their small size is an important barrier for Digital Transformation, given the small volume and revenue, is not enough to justify the labor and cost. There is an opportunity for greater organization to be able to take advantage of and give a value added to their operations.

5.8
COMPLETE AGRITECH MAP FOR THE LATIN AMERICA AND CARIBBEAN REGION

AGRITECH MAP LAC

#	Solution category	Solution	Agtech company	Country of origin	Country with services	Webpage
1	*Basic*	Enterprise Resourse Planning	Eiwa	Argentina	Argentina, Brazil	https://www.eiwa.ag/
2	*Basic*	Enterprise Resourse Planning	Aegro	Brazil	Brazil	https://aegro.com.br/
3	*Basic*	Enterprise Resourse Planning	Jetbov	Brazil	Brazil, Bolivia, Paraguay, Uruguay, Peru	http://www.jetbov.com/
4	*Basic*	Enterprise Resourse Planning	Agroprime	Chile	Chile, Peru, Argentina	https://www.agroprime.com/
5	*Basic*	Enterprise Resourse Planning	AgtechApps	Guatemala	Latam	https://www.agtechapps.com/
6	*Basic*	Enterprise Resourse Planning	Tecno Agro Business	Mexico	Mexico	https://www.tecnoagrobusiness.mx/https://www.tecnoagrobusiness.mx/
7	*Basic*	Information and market platforms	Agree	Argentina	Argentina, Paraguay	https://www.agree.ag/home-en.html
8	*Basic*	Information and market platforms	Picsel	Brazil	Brazil	https://picsel.com.br/
9	*Basic*	Information and market platforms	Agromatch	Chile	Chile	https://agromatch.cl/
10	*Basic*	Information and market platforms	SiembraCo	Colombia	Colombia	https://siembraco.com/https://siembraco.com/

11	*Basic*	Information and market platforms	Ifinca	Colombia	Colombia	https://www.ifinca.co/
12	*Basic*	Information and market platforms	Cosecha Connect	Ecuador	Ecuador	https://cosecha.space/
13	*Basic*	Information and market platforms	Laser y GPS	Mexico	Mexico	https://luxelare.com/
14	*Basic*	Remote sensors	DeepAgro	Argentina	Argentina, Brazil, Uruguay	http://www.deepagro.co/
15	*Basic*	Remote sensors	Tarvos	Brazil	Brazil	https://tarvos.ag/
16	*Basic*	Remote sensors	Morphola	Chile	Chile	https://morphola.com/agricultura/
17	*Basic*	Remote sensors	Advector	Colombia	Colombia	https://www.advector.co/en/
18	*Basic*	Remote sensors	VIT Sensors	Colombia	Colombia	https://vitsensors.com/
19	*Basic*	Remote sensors	Kleffmann Digital	Germany	Brazil, Argentina, Uruguay, Paraguay	https://kleffmann.digital/
20	*Basic*	Remote sensors	Agrio Biotech	Mexico	Mexico	http://www.agribiotech.com.mx/drones-agricolas/
21	*Basic*	Remote sensors	Appgricola	Mexico	Mexico	http://appgricola.com/
22	*Basic*	Remote sensors	Metos	Mexico	Mexico	https://metos.at/es/
23	*Basic*	Remote sensors	Laser y GPS	Mexico	Mexico	https://laserygps.com/
24	*Enhancer*	Campaign planning systems	AgroPro	Argentina	Argentina	https://agropro.ag/
25	*Enhancer*	Campaign planning systems	Caburé	Argentina	Argentina	https://cabure.com.ar/
26	*Enhancer*	Campaign planning systems	Puma	Argentina	Argentina	https://plataformapuma.com/

27	*Enhancer*	Campaign planning systems	Climate-Fieldview	Canada	Argentina	https://www.climatefieldview.ca/ https://www.climatefieldview.ca/
28	*Enhancer*	Campaign planning systems	NeoAg	Chile	Chile	https://neoag.net/
29	*Enhancer*	Campaign planning systems	Reset	Chile	Chile	https://www.reset.cl/
30	*Enhancer*	Campaign planning systems	Aedrotec	Mexico	Mexico	https://aedrotec.com/agriculture.html
31	*Enhancer*	Campaign planning systems	Agroware	Mexico	Mexico	https://www.agroware.mx/
32	*Enhancer*	Campaign planning systems	Space AG	Peru	Peru	https://www.spaceag.co/
33	*Enhancer*	Campaign planning systems	Agritracer	Peru	Peru	https://agritracer.pe/
34	*Enhancer*	Campaign planning systems	AGROS	Peru	Peru	https://agros.tech/index.html
35	*Enhancer*	Precision agriculture	Auravant	Argentina	Argentina	https://www.linkedin.com/company/auravant/?originalSubdomain=mx
36	*Enhancer*	Precision agriculture	Solinftec	Brazil	Brazil, Colombia	https://www.solinftec.com/es-la/
37	*Enhancer*	Precision agriculture	Instacrops	Chile	Chile, Colombia, Mexico	https://www.instacrops.com/
38	*Enhancer*	Precision agriculture	Agroprecision	Chile	Chile	https://agroprecision.cl/
39	*Enhancer*	Precision agriculture	Sioma	Colombia	Colombia	https://www.sioma.store/palma
40	*Enhancer*	Precision agriculture	SkyFLD	Germany	Argentina, Brazil	https://www.skyfld.com/es_ar/ https://www.skyfld.com/es_ar/

41	*Enhancer*	Precision agriculture	Huvster	Mexico	Mexico	https://huvster.com/
42	*Enhancer*	Precision agriculture	Agrofacto	Mexico	Mexico	https://agrofacto.com/
43	*Enhancer*	Precision agriculture	Rising Farms	Mexico	Mexico	https://risingfarms.co/
44	*Enhancer*	Precision agriculture	Precision Agricola	Mexico	Mexico	http://www.precisionagricola.com/
45	*Enhancer*	Smart irrigation	Kilimo	Argentina	Latam	https://www.kilimoagtech.com/
46	*Enhancer*	Smart irrigation	Wiseconn	Chile	Chile	https://www.wiseconn.cl/
47	*Enhancer*	Smart irrigation	Filclair	France	Mexico	https://www.filclair.com/es/
48	*Enhancer*	Smart irrigation	Agroirrigación	Mexico	Mexico	http://agroirrigacion.com/
49	*Enhancer*	Smart irrigation	Hortau	USA	Mexico	https://hortau.com/
50	*Enhancer*	E-commerce platforms	Agrofy	Argentina	Latam	https://www.agrofy.com/
51	*Enhancer*	E-commerce platforms	Agrired	Argentina	Argentina	https://www.agrired.com/
52	*Enhancer*	E-commerce platforms	Agrarium Technologies	Mexico	Mexico	http://www.agrarium.tech/
53	*Enhancer*	E-commerce platforms	Avoexchange	Mexico	Mexico	https://www.avoprice.com/
54	*Enhancer*	Monitoring and control systems for safety and process variables	Wiagro	Argentina	Argentina	https://www.wiagro.com/

55	*Enhancer*	Smart packaging	Polynatural	Chile	Chile, Mexico	https://polynatural.com/
56	*Enhancer*	Smart packaging	SaveFruit	Mexico	Mexico	https://www.savefruitcorp.com/
57	*Next Level*	Automated Cleaning & Sorting Systems	TOMRA Food	New Zealand	Colombia, Chile, Peru, Brazil, Argentina, Uruguay	https://bbctechnologies.com/contact/
58	*Next Level*	ESG Modules integrated in ERP	Hispatec	Spain	Chile, Mexico, Peru, Colombia, Belize, Costa Rica, Guatemala, Honduras, El Salvador, Panama	https://www.hispatec.com/soluciones/
59	*Next Level*	ESG Modules integrated in ERP	SAP	Germany	Argentina, Chile, Colombia, Panama, Peru, Brazil, Costa Rica, México, Venezuela	https://www.sap.com/latinamerica/industries/agribusiness.html
60	*Next Level*	Blockchain and Asset Tokenization	Agrotoken	Argentina	Latam	https://agrotoken.io/es/
61	*Next Level*	Blockchain and Asset Tokenization	AgTrace	Argentina	Argentina, Brazil	https://agtrace.ag/es/
62	*Next Level*	Blockchain and Asset Tokenization	#GetFair	Chile	Chile	https://www.getfair.org/
63	*Next Level*	Blockchain and Asset Tokenization	Demetria	Colombia	Latam	https://demetria.ag/
64	*Next Level*	Blockchain and Asset Tokenization	Grain Chain	Mexico	Mexico	https://demetria.ag/
65	*Next Level*	Blockchain and Asset Tokenization	Ucrop.it	Paraguay	Latam	https://ucrop.it/
66	*Next Level*	Digital Twins	Accenture	Ireland	Latam	https://www.accenture.com/us-en/blogs/technology-innovation/billiard-a-moment-to-innovate-turning-data-into-action-with-intelligent-digital-twins
67	*Next Level*	Digital Twins	IBM	United States	Latam	https://www.ibm.com/co-es/topics/what-is-a-digital-twin

5.9
INTERSECTION BETWEEN DIGITAL TRANSFORMATION AND SUSTAINABILITY

Issues associated with social, economic, and environmental sustainability are becoming increasingly important for consumers, investors and policymakers in many countries around the world, where LAC countries are not an exception. Within the sample of companies considered for this study, alignment with ESG practices focus mainly on the environmental and social criteria, with most of the participants showing interest in adopting best practices that have a positive impact on productivity or product demand. Meanwhile, tracking, monitoring, and reporting of ESG or even greenhouse gas (GHG) emissions metrics is not yet a generalized interest of the sampled organizations.

The foregoing could be a result of regional governments not implementing strict regulation about ESG reporting, and pressure from investors and consumers was not perceived as high. For niche markets like palm oil, a certification about deforestation and human-rights themes is mandatory for most markets but does not require constant monitoring and reporting. Retailers from developed countries and CPGs have not yet imposed ESG conditions on LAC producers, and knowledge about the scope three emissions requirements for – and from – these important companies were low on the agribusiness organizations. Nevertheless, sustainability is a growing pillar for the Digital Transformation in LAC agribusiness, which is currently at the center of advancing sustainability across three key areas of opportunity: environmental impact, social and community impact, and value chain impact.

Environmental impact

According to the World Economic Forum, agriculture is responsible for 70% of total freshwater withdrawals, and 80% of global deforestation and uses 11% of the world's land surface. Additionally, the industry generates around one-half the region's greenhouse gas (GHG) emissions[104]. Fortunately, regional agribusiness organizations are realizing reducing their environmental footprint comes hand in hand with increasing their efficiency and productivity and product value, which increases the relevance of Digital Transformation to help reduce the environmental footprint by reconciling the need to produce more with less, optimizing resources and developing markets for sustainable products.

Precision agriculture and smart irrigation systems have been crucial to increasing productivity per hectare of land used, and reducing the use of water, agrochemicals, and fuel. Efficient use of these resources can reduce stress on natural water sources, reduce water contamination, protect biodiversity and improve GHG emissions with less fuel usage and by reducing the amount of land needed[105]. Optimizing the use of these resources, is not just an environmental consideration for agribusinesses. High prices that result from different external conditions, like natural disasters (droughts), difficult access because of remote locations, volatile markets and other political factors like war, have driven organizations to find these efficiencies to maintain margins.

On the other hand, digital tools are also a useful aid in sustainable accountability reporting. It is important for companies to not only apply but also measure their impact, which can be done efficiently with digital tools like remote sensors and ESG modules in ERP systems. This way, companies can benefit from their reduced impact on the environment by promoting their commitment to retain and even enter developing markets for sustainable products.

Social and community impact

Labor regulation in LAC countries has generated relevant pressure for agribusiness organizations to make productivity-enhancing investments, like digital solutions for the campaign and workforce planning, worker productivity measurement tools and other implementations that help comply with Occupational Health and Safety (OH&S) policies. Additionally, market forces have incentivized worker upskilling and the creation of new revenue sources. Unfortunately, support and a clear commitment to diversity, equity and inclusion were present in the agenda of few of the sampled organizations. Specifically, regarding the inclusion of women in agriculture, there still seems to be an outdated perception of gender roles and associated status in the industry that translate into reduced access to productive resources and opportunities[106]. Furthermore, although there is mention of gender issues in most national and regional policies they are not treated as an integral part of policy and programming that could place the necessary pressure on the organization to better their inclusion practices.

[104] (Morris, Ashwini, & Perego, 2020)

[105] (Armstong, Dr. Bosch Ruiz, Gujral, & Rich)

Campaign and workforce planning was observed among larger producers of high-value crops that need to coordinate 15,000+ collaborators during harvesting season. This kind of organization has implemented QR code-based solutions to verify the identity, status and qualifications of the workers on their farms, has real-time visibility of the products harvested by each worker and automatizes productivity-based payroll. The main observed benefits from these digital solutions are boosted worker productivity, reduced time and cost of the accounting team, prevention of manual errors on payroll and higher regulatory compliance. Further, the use of productivity data and enhanced planning capabilities, results not only positive in a social impact, but also less product waste and better control of product pricing.

The use of drones for spraying is widespread across value chains and countries and has positively impacted OH&S, significantly reducing worker exposure to the use of herbicides and chemicals. This technology has been adopted because of its high accessibility due to multiple suppliers with a diversity of business models (e.g., direct sale, leasing, as-a-service) and good cost-benefit relation. Nonetheless, there are opportunities to exploit more potential from this solution. Some LAC organizations have been introducing or piloting programs for soil and field analysis, water control and drainage, monitoring and health assessment, and even aerial planting.

Intelligent irrigation systems, although less present in LAC than drones, have been adopted by some high-value crops and coffee producers in Chile, Brazil, Colombia, Peru and Mexico. This technology also reduces worker exposure to herbicides and other agrochemicals.

Another identified impact of Digital Transformation on workers is the necessity for talent that has been addressed by companies with reskilling and upskilling programs for their workers. LAC agribusiness has multiple examples of how day laborers have acquired new skills by training in-house. They are switching from heavy-work-low-skill jobs to high-tech vehicle and machinery operations, earning higher salaries and enjoying better working conditions. These experiences were present primarily in the sugarcane and cereals industry across the region, with some interesting examples in the Chilean and Mexican high-value crop production.

Finally, the implementation of digital solutions at the farm has interesting implications for communities around them, beyond the workers. Sugarcane's value chains in LAC are usually vertically integrated from crop production to power generation. The cogeneration of bagasse is one of the most successful biomass energy projects in the region. The combination of heat and power from sugarcane offers renewable energy options

[106] (FAO, 2011)

that promote sustainable development, leverage domestic resources, and increases profitability and competitiveness of entire regions and multiple industries, by cost-effectively providing power and addressing climate mitigation economically.

Another identified example was the production of biodiesel in Colombia, using biomass from a palm tree and sugarcane bagasse. The project was born as a public-private partnership (PPP) between the LAC organization and European research institutions. For the development of this project the organization has implemented cloud solutions, remote collaborative systems, data platforms and advanced data analysis software. The biodiesel is compatible with existing diesel engines and distribution infrastructure which presents an opportunity to expand the biodiesel business into the sustainable aviation fuel (SAF) market. Additionally, the R&D department of this organization has plans to expand on its decarbonization efforts with other green chemistry projects such as the monetization of 50 thousand tons of biomass by producing biopolymers for packaging and phytonutrients for animal feed.

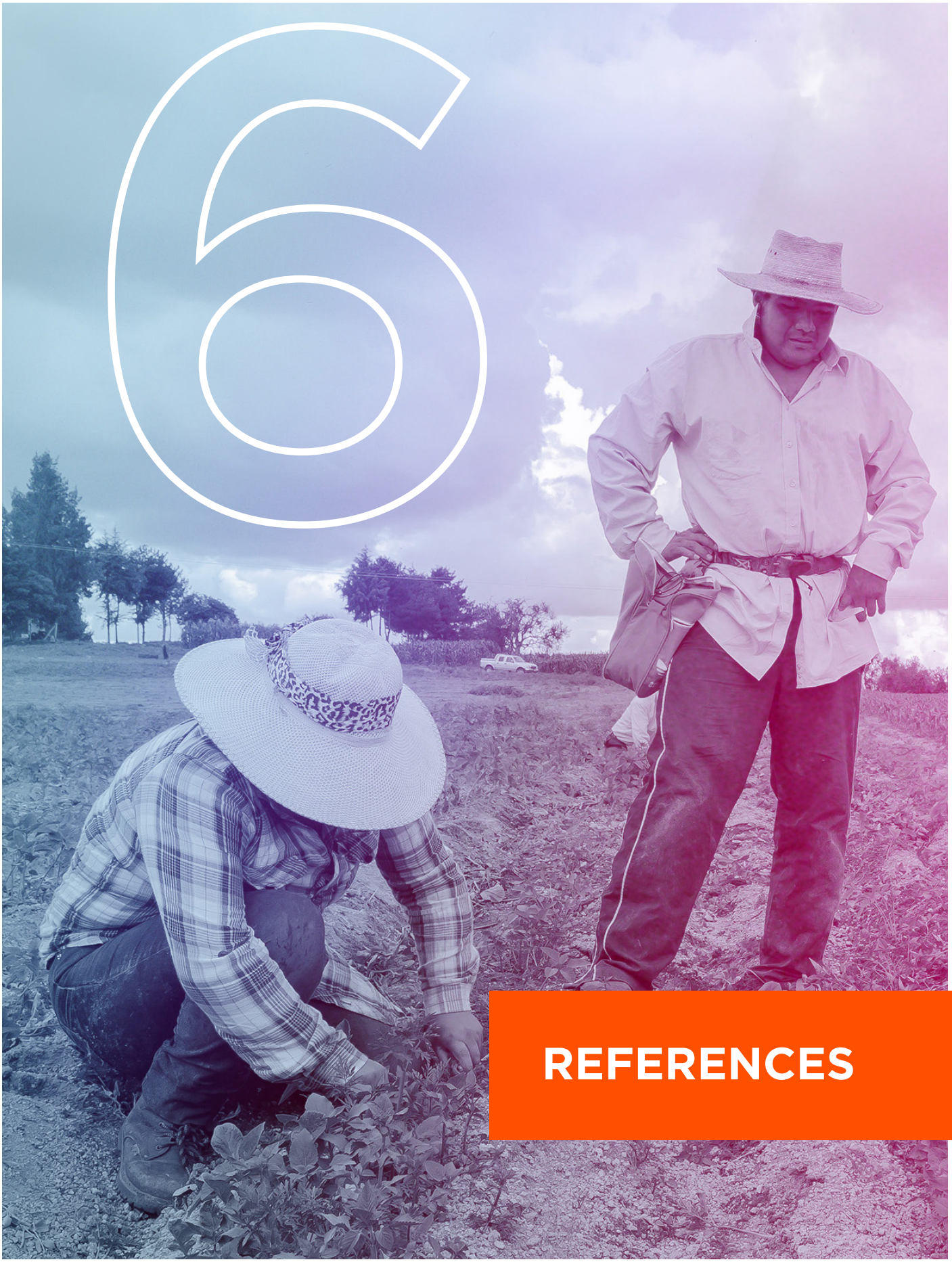
Value chain impact

Pressure from consumers and regulators to validate circularity, environmental impact and human rights claims across the value chain, which may come from agriculture importing countries, has impacted only some LAC organizations. However, most are aware that it will become more relevant shortly. One of the interesting and generalized facts was that LAC agribusinesses have not experienced a price-premium on their products linked to sustainable practices and traceability (yet they do on organic production), yet they think benefits will come from access to new markets and reduced risk of losing access to current ones. Regarding digital solutions for traceability, the region has leveraged third-party certifications and some digital solutions that facilitate data collection (e.g., personal digital assistants (PDA) and smartphones), and at best, digital platforms to integrate data. The promise of blockchain track and trace value for sustainable sourcing was not present in the conversations.

Third-party regulatory certifications required by importing countries are the key to the early traceability efforts in LAC organizations, and organic certification seems to be the most strict and efficient, assuring quality, preventing fraud and promoting commerce. High-value crops and palm tree oil producers from the region are seeking these third-party certifications to access their most relevant markets (Europe, the United States and Asia). The requirements to acquire these certifications have encouraged the adoption of Digital Transformation, although on different levels across the region. Producers from Chile and Peru have explored the use of drones, irrigation, intelligent packaging, and some levels of precision agriculture to certify that growing, storage, processing, packaging, and shipping are done without the use of synthetic chemical inputs, genetically modified seed, and without contact of non-certified products. Further, tomato producers in Mexico have adopted greenhouses with vertical farms, leveraging IoT sensors, data platforms, intelligent irrigation, intelligent packaging and even robotics for growing, processing and handling.

Data management is essential for traceability, and LAC organizations leverage strong ERP providers to keep track of processes, although prohibitive costs of advanced solutions were present in most conversations. Another innovative solution identified in Chile, Colombia and Mexico was the use of a third-party platform and technology to digitalize labeling using QR, providing information about the product source, packaging operator, and production date, among others. Alternatively, given deforestation issues around palm tree oil production, organizations require satellite and drone imaging from third-party providers to certify they are not engaging in deforestation practices, similar to a group of Argentinian cereal producers in the study, which were also involved in the forestry business.

Finally, supply chain and logistics to reach retailers is one of the most relevant links in the process given that organizations need to ensure quality, reduce waste, and maximize revenue (reducing price adjustment from retailers). Depending on company size, organizations work with third-party shipping and commercialization providers or create their own. The identified solutions go from sensors in the container to track temperature, humidity and gases to advanced AI technologies that provide a controlled atmosphere across the journey. Shipping companies provide visibility on the whereabouts of the container through a global positioning system (GPS) monitoring platform.



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