# Impact of COVID-19 on Agricultural Sector Transformation

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*Abstract* - **The COVID-19 pandemic, as one of the biggest health crises in the last decades, has disruptive impacts in all spheres of human life, including social, environmental, psychological, and political ones. Nevertheless, the most severely affected was and still is the economic sector of countries across the world. One of the major pillars of global economies is the agricultural sector due to its significance in ensuring continuity in food supply and at the same time developing operating business models oriented on sustainability. For achieving these purposes, operating business models had to undergo serious reinventions often supported by digital technologies. In this paper, the impact of COVID-19 on the operating dimensions in agriculture is investigated to gather insights on digital technology implementations, as reported in scientific publications regarding agriculture and its sub-sectors. This research aims to create a conceptual and theoretical framework for investigating the influence of COVID-19 pandemic and technology-related changes that had to be done in the agricultural sector due to its impact.**

***Keywords – COVID-19, agricultural sector, digital technologies, business model transformation***

## I. INTRODUCTION

The current COVID-19 pandemic caused disruptions on a global scale that impacted all levels of business. Reactions to this disruption vary based on the disruption potential within the industry, on the scope of business processes and on the business's readiness to respond. Therefore, this paper focuses on the disruptions that have occurred within some industry sectors due to the COVID-19 pandemic, specifically within the agricultural sector that is, as reported, one of the most affected [1]. More precisely, the paper analyzes the agricultural sector and its sub-sectors to gain insights into changes that have occurred within them due to the COVID-19 pandemic. A special focus of the analysis is put on the processes which contribute to delivering value to the customers and allow business model realization. This focus is set due to the value chain consideration and awareness to adopt new and innovative technologies so that all of the involved stakeholders can achieve and sustain a competitive advantage during this health crisis.

The well-known context of Porter's value chain and its activities for creating value for customers is selected as the framing context for the literature analysis since Porter [2] describes the way an organization can choose and implement its strategy to achieve and sustain competitive advantage. According to Porter, it is very important to enhance a firm's value chain and its activities while designing, producing, marketing, and distributing its products to customers [2]. Porter's value chain is used as a reference of the scope of changes caused by COVID-19 i.e. as the scope of impact on primary and supporting activities. Primary activities include inbound logistics, operations, outbound logistics, marketing and sales, and service, all of which have a more significant influence on mission achievement and are therefore more significant in measuring the impact of COVID1-9 on these activities. Supporting activities include firm infrastructure, human resource management, technology development, and procurement, and they have a less significant influence on the margin but are relevant as support to the primary activities in a way that they help achieve maximal efficiency.

Implementing digital technologies for automation, digitalization, improvement, or even enabling the execution of primary activities seems to have been a more frequent tool for responding to the COVID-19 disruptions than in times before COVID-19, making it a most effective driver of transformation. For that reason, this paper aims to gather and analyze recent scientific publications on this matter, in order to gain insights into which business activities have been affected by the change and which technologies seemed to be promising for transforming business models in the agricultural sector.

## II. AGRICULTURAL SECTOR AND COVID-19 PANDEMIC

The COVID-19 pandemic and the lockdown which followed have not only caused enormous distress, unseen problems, and challenges that affected the value chain, but they also caused disruptions in the agricultural sector and affected its performance [3] [4] [5]. That is evident in food access restrictions, disruptions of planting, cattle breeding, fishing, harvest, and other farming operations [6] [7], all of which can lead to a large amount of food waste [8] [9] [10] [11] [12]. These disruptions and changes that followed them affected millions of poor and marginal farmers around the world, especially in developing countries, in terms of saving their crops and/or livestock and thereby assuring their livelihoods, but the aforementioned changes also impacted the overall production systems and associated value chain, nutrition and health care of consumers/customers of agricultural products and services, and also labor availability which is every government's concern. All mentioned issues influence stakeholders associated with this sector directly or indirectly [3]. Because the COVID-19 pandemic is also adversely impacting food and nutrition safety and requires urgent attention from policymakers, the concept of organic agriculture and sustainability can help farmers to survive in this situation of a global health crisis which posed new challenges [4] [5] [13] [14] [15].

To be sustainable and resilient, the agricultural sector must balance the ability to be efficient in the current crisis with the ability to re-organize and to adapt in response to unforeseen (and unforeseeable) changes. The focus should be on shifting of relations within the agricultural sector (e.g. a production activity, a farm, a region) as well as the relations between the focal system and its context (e.g. other production activities on the farm, the farm's natural environment, the regional cultural norms, supply and processing networks, preferences of citizen-consumers). Considering that the agricultural sector is not only driven by biophysical and technological processes, but also by social ones, it is the perception of what is feasible and desirable that shapes a sector, at individual production activities level, and also at farm-level, and at a larger regional or national level [16].

In recent years all stakeholders associated with the agriculture sector have been using technological improvements and innovation to maintain and sustain its competitiveness. Those innovations can be chemical (pesticides and fertilizers), biological (new seed variety), animal rearing (feeding and breeding), or mechanical advancements innovations (machinery) [5].

## III. Methodology

The literature review for this paper was conducted in January 2021 as a continuation of previous studies on the matter of implementation of digital technologies for changing business models. In previous research [1], the agricultural sector was identified as one of the most affected sectors during the COVID-19 pandemic which indicates the need for investigating this matter in more detail. Therefore, the literature review was conducted following similar steps as described in the aforementioned research: performing a search of relevant research databases and platforms followed by constructing a research framework for qualitative analysis, applying the qualitative analysis framework. Selected databases for this study were: Web of Science, Scopus, ScienceDirect, and Taylor and Francis Online. The search strategy was based on keyword combinations: "COVID-19", "pandemic", "agriculture", "case study", "business model", and "digital technology" and it resulted in a total of 58 hits. After merging all 58 papers, duplicated papers were excluded, whereby 46 different papers remained for further qualitative analysis.

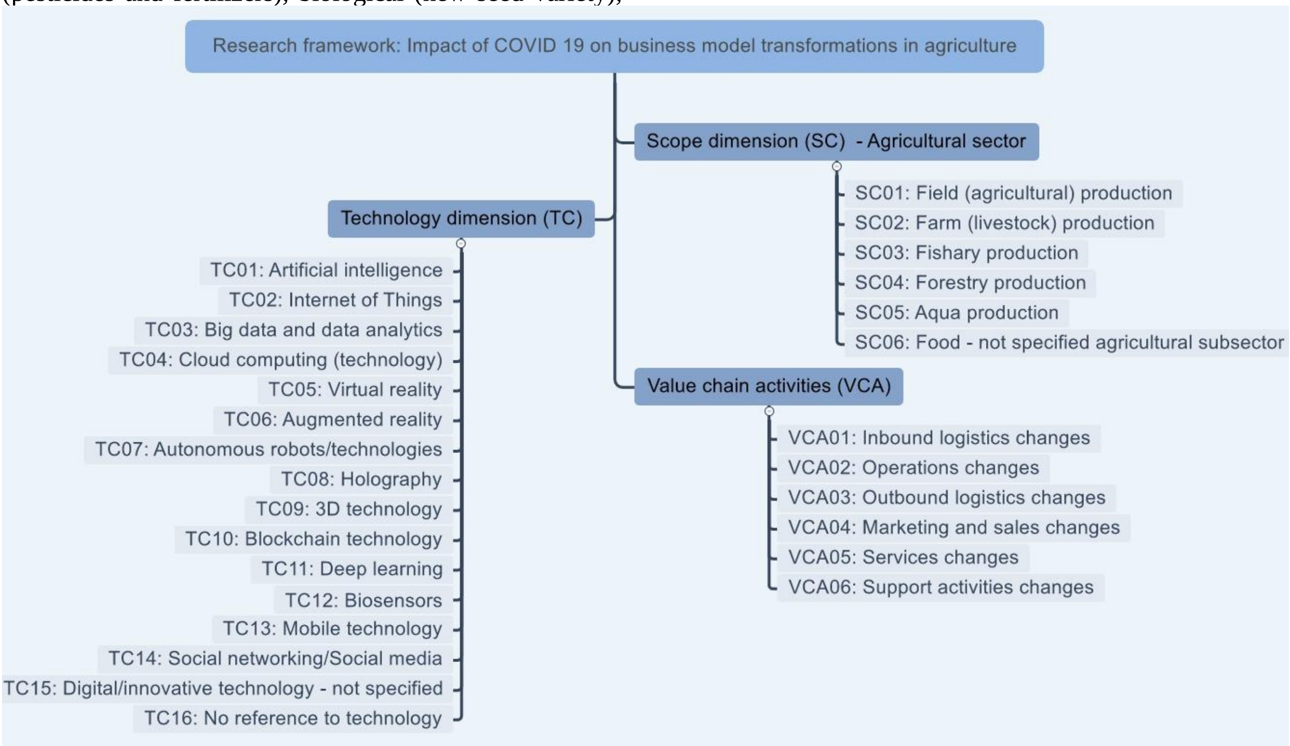


Figure 1: Research framework

Parallel to the search of papers and their detailed analysis, the dimensions of the research framework for the study were constructed (Figure 1). The basis for those dimensions is the investigation of how agricultural subsectors (according to NAICS classification [17]) are coping with the challenges caused by the COVID-19 pandemic: which value chain activities they needed to change and which technology they applied to incorporate transformation into their business model.

The three-dimensional research framework was designed to enable the goal of this research, and it consists of the following dimensions: (1) Scope dimension related to the agricultural subsectors, (2) Changes in value chain activities, and (3) Technology dimension related to selected technology for responding to disruptions in the business models. Publications matching the investigated dimensions and the subconcepts are listed in the right column of table 1.

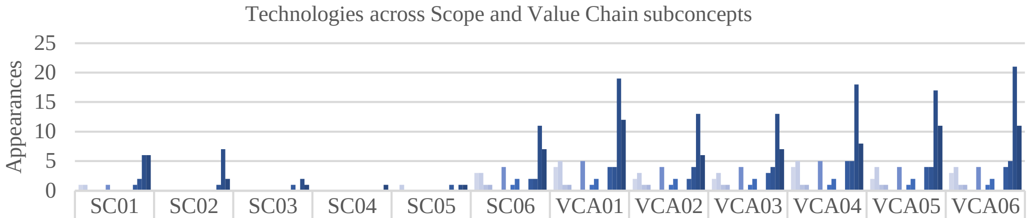
TABLE I: RESEARCH DATA ON INVESTIGATING THE USAGE OF DIGITAL TECHNOLOGIES IN THE AGRICULTURAL SECTOR

| CODE | FREQUENCY | REFERENCES |
|---|---|---|
| SC01: Field (agricultural) production | 15 | [4]; [5]; [18]; [19]; [13]; [20]; [21]; [14]; [6]; [16]; [22]; [23]; [24]; [15]; [25] |
| SC02: Farm (livestock) production | 9 | [3]; [20]; [21]; [14]; [10]; [26]; [27]; [28]; [29] |
| SC03: Fishary production | 4 | [20]; [30]; [21]; [7] |
| SC04: Forestry production | 1 | [14] |
| SC05: Aqua production | 3 | [13]; [31]; [32] |
| SC06: Food - not specified agricultural subsector | 21 | [8]; [9]; [33]; [34]; [35]; [36]; [37]; [11]; [38]; [39]; [12]; [40]; [41]; [42]; [43]; [44]; [45]; [46]; [47]; [48]; [49] |
| VCA01: Inbound logistics changes | 38 | [3]; [4]; [18]; [19]; [13]; [20]; [30]; [21]; [14]; [31]; [6]; [16]; [22]; [23]; [24]; [7]; [33]; [34]; [36]; [26]; [11]; [29]; [32]; [25]; [39]; [12]; [40]; [27]; [28]; [41]; [42]; [43]; [44]; [45]; [46]; [47]; [48]; [49] |
| VCA02: Operations changes | 23 | [3]; [4]; [19]; [20]; [21]; [16]; [23]; [24]; [7]; [33]; [34]; [36]; [11]; [12]; [40]; [27]; [28]; [43]; [44]; [46]; [47]; [48]; [49] |
| VCA03: Outbound logistics changes | 25 | [3]; [4]; [19]; [20]; [30]; [21]; [14]; [16]; [23]; [24]; [7]; [33]; [34]; [36]; [11]; [12]; [40]; [27]; [28]; [43]; [44]; [46]; [47]; [48]; [49] |
| VCA04: Marketing and sales changes | 34 | [3]; [4]; [5]; [19]; [20]; [30]; [21]; [16]; [22]; [23]; [24]; [15]; [7]; [9]; [33]; [34];[36]; [10]; [26]; [37]; [25]; [11]; [39]; [40]; [27]; [28]; [41]; [43]; [44]; [46]; [47]; [48]; [49] |
| VCA05: Services changes | 34 | [3]; [4]; [5]; [19]; [20]; [30]; [21]; [14]; [31]; [6]; [16]; [23]; [24]; [7]; [9]; [33]; [34]; [36]; [10]; [11]; [38]; [32]; [25]; [39]; [40]; [27]; [28]; [43]; [44]; [45]; [46]; [47]; [48]; [49] |
| VCA06: Support activities changes | 39 | [3]; [4]; [19]; [13]; [20]; [30]; [21]; [14]; [6]; [8]; [16]; [22]; [23]; [24]; [15]; [7]; [33]; [34]; [35]; [36]; [29]; [32]; [10]; [25]; [26]; [37]; [11]; [38]; [40]; [27]; [28]; [42]; [43]; [44]; [45]; [46]; [47]; [48]; [49] |
| TC01: Artificial intelligence | 4 | [22]; [41];[44]; [48] |
| TC02: Internet of Things | 5 | [31]; [22]; [34]; [36]; [44] |
| TC03: Big data and data analytics | 1 | [36] |
| TC04: Cloud computing (technology) | 1 | [36] |
| TC05: Virtual reality | 0 | 0 |
| TC06: Augmented reality | 0 | 0 |
| TC07: Autonomous robots/technologies | 5 | [24]; [36]; [41]; [44]; [48] |
| TC08: Holography | 0 | 0 |
| TC09: 3D technology | 1 | [44] |
| TC10: Blockchain technology | 2 | [36]; [44] |
| TC11: Deep learning | 0 | 0 |
| TC12: Biosensors | 0 | 0 |
| TC13: Mobile technology | 5 | [30]; [31]; [15]; [44]; [48] |
| TC14: Social networking/Social media | 5 | [24]; [15]; [28]; [44]; [48] |
| TC15: Digital/innovative technology in general | 23 | [5]; [19]; [20]; [21]; [6]; [16]; [33]; [34]; [35]; [10]; [26]; [37]; [40]; [27]; [28]; [41]; [29]; [32]; [42]; [43]; [46]; [47]; [49] |
| TC16: No reference to technology | 15 | [3]; [4]; [18]; [13]; [14]; [8]; [23]; [7]; [9]; [11]; [38]; [39]; [12]; [45]; [25] |

Relevant meta-data (e.g., author(s), title, year of publication, database source, type of article, source of the article, and the topic that it covers) and content analysis data across the three dimensions from the research framework on gathered 46 papers were extracted. Based on the research framework, all papers have been analyzed and their content was matched across the dimension subconcepts. According to the meta-data of 46 analyzed papers, all of them are journal articles published in journals related to the agricultural sector; 12 of the analyzed papers are conceptual articles, 7 of them are review articles, and 27 articles are empirical ones. The leading topic of 30 analyzed papers is agricultural sustainability, 7 were focused on safety-related to agricultural products, and 9 papers are covering both leading topics.

## IV. DISCUSSION

Based on data in Table 1, which shows 313 records on content matching across the three dimensions and their subconcepts, a graphical representation of appearances is visualized in figure 2. The visualization shows Technology concepts in relation to the other two dimensions – Scope and Value chain activities. The x-axis shows Scope subconcepts (i.e. Agricultural subsectors) and Value chain activities. The y axis shows the frequency of appearances according to Table 1. The results show that the technologies are mostly reported in the SC06: Food with no explicit reference on a specific agricultural subsector. Two agricultural subsectors which have been reported about, but on a smaller scale, are SC01: Field (agricultural) production and SC02: Farm (livestock) production, although these subconcepts are often referencing technologies in general or have no reference to technologies at all. The description of Value chain activities is more illustrative. For supporting VCA01: Inbound logistics changes with specific technologies, the highest number of appearances have TC02: Internet of Things and TC07: Autonomous robots/technologies, each of them has 5 appearances. The same two technology subconcepts are used for VCA04: Marketing and Sales, but two more technologies have the same number of appearances for this Value Chain subconcepts: TC13: Mobile technology and TC14: Social networking/Social media (all with 5 content matchings). For technology subconcepts TC15: Digital/innovative technology in general and TC16: No reference to technology, the data shows that the goal of changes was the implementation of technologies for administration workload relief as in VCA06: Support activities changes, but also on VCA01: Inbound logistics changes, VCA04: Marketing and sales changes and VCA05: Services changes.




| | SC01 | SC02 | SC03 | SC04 | SC05 | SC06 | VCA01 | VCA02 | VCA03 | VCA04 | VCA05 | VCA06 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TC01 | 1 | | | | | 3 | 4 | 2 | 2 | 4 | 2 | 3 |
| TC02 | 1 | | | | 1 | 3 | 5 | 3 | 3 | 5 | 4 | 4 |
| TC03 | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| TC04 | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| TC05 | | | | | | | | | | | | |
| TC06 | | | | | | | | | | | | |
| TC07 | 1 | | | | | 4 | 5 | 4 | 4 | 5 | 4 | 4 |
| TC08 | | | | | | | | | | | | |
| TC09 | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| TC10 | | | | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| TC11 | | | | | | | | | | | | |
| TC12 | | | | | | | | | | | | |
| TC13 | 1 | | 1 | | 1 | 2 | 4 | 2 | 3 | 5 | 4 | 4 |
| TC14 | 2 | 1 | | | | 2 | 4 | 4 | 4 | 5 | 4 | 5 |
| TC15 | 6 | 7 | 2 | | 1 | 11 | 19 | 13 | 13 | 18 | 17 | 21 |
| TC16 | 6 | 2 | 1 | 1 | 1 | 7 | 12 | 6 | 7 | 8 | 11 | 11 |

Figure 2: Technologies across Scope and Value Chain subconcepts

In this research 5 subconcepts of the technology dimension are not appearing in the scientific papers reporting on changes in the agricultural sector: TC05: Virtual reality, TC06: Augmented reality TC08: Holography, TC11: Deep learning, and TC12: Biosensors. This does not mean that these technologies are not usable for this particular sector, but that the papers published in the year 2020 and gathered in this study do not report about their application. This may be a potential insight for creating a new competitive advantage if appropriate solutions based on these technologies could be developed.

## V. Conclusion

The results of the analysis of the impact of COVID-19 on the operating dimensions in agriculture in this study show that the scientific publications report mainly on implementing digital technologies in the sector related to the food industry in terms of organic food, food waste, and in the context of sustainability and food safety. According to this, there is still space for focused research in agricultural subsectors and on their specific issues. Some technology subconcepts from the initial research framework were not appearing at all in this study (Virtual reality, Augmented reality, Holography, Deep learning, and Biosensors) while several other technologies already represent a common infrastructure (Internet of Things, Autonomous robots/ technologies, Mobile technology and Social networking/ Social media). In terms of supported Value Chain activities, more technology solutions would be appropriate for core processes related to Operations, due to existing reports on solutions for other Value chain elements. This research could be valuable for identifying space for new technological solutions, in terms of following the existing paradigms or selecting an alternative approach for a specific organization.

A limitation of this research can be found in the scope of appearing agricultural subsectors, comprehension objectivity (although a neutral perspective was aimed), and the fact that the analysis was performed solely on secondary sources, i.e., the scientific publications reporting on this issue. Future research should be oriented on exploring concrete products and services in the agricultural sector, developed as business model transformation results, and in conducting regional and country-oriented research in order to identify local specificities impacting the business model transformation based on the implementation of digital technologies.

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