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REVIEW

A Review on What Consequence Did COVID-19 Leave on Agriculture and Its Associated Sectors?

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Abstract

Throughout history, humanity has grappled with the widespread repercussions of pandemics, both economically and socially. The contemporary landscape contending with multifaceted challenges posed by the COVID-19 pandemic brings to the forefront a need for a thorough examination of its pervasive impact on agriculture and its interconnected sectors. Governments across the globe have responded with a spectrum of non-pharmaceutical interventions, encompassing measures such as social distancing, self-quarantine, and travel restrictions. While these interventions aim to mitigate the spread of the virus, their consequences also extend to vital sectors such as agriculture, that have received limited attention thus far. The disruption of supply chains, coupled with reduced production and distribution, has engendered a cascade of challenges. Notably affected are sectors integral to agriculture, including floriculture, information collection, pisciculture, irrigation facilities, agro-processing units, animal husbandry, labor availability, etc. The current study aims to disentangle the intricacies of challenges faced by agriculture and its allied sectors in the wake of the COVID-19 pandemic. By unravelling the complexities of this global crisis, it aims to contribute to the academic discourse, fostering a deeper understanding of the implications for sustainable development, economic resilience, and policy information.

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Statement of Sustainability: The effects of COVID-19 on agriculture and its related sectors have been thoroughly examined; however, our research presents a fresh viewpoint by incorporating a multidimensional evaluation of disruptions in agriculture, including floriculture, information collection, pisciculture, irrigation facilities, agro-processing units, animal husbandry, labor availability, etc. In contrast to earlier studies that typically concentrate on singular impacts, this research offers a holistic analysis of how the pandemic has advanced digital transformation within agribusiness, altered policy responses, and affected long-term resilience strategies. By linking sector-specific disruptions with policy responses and sustainability issues, this research contributes a novel perspective on resilience-building and economic recovery strategies in the post-pandemic context.

1. Introduction

Most of the entire world is facing the problem of a dreadful disease, i.e., Covid-19. The main culprit for the spread of the disease is severe acute respiratory syndrome coronavirus 2 (SARS–CoV–2), also named the COVID-19 virus. It was observed in Wuhan city of China, so it is more appropriate to say that China is the epicenter of the coronavirus outburst. This virus has the zoonotic property, i.e., animal (bat), the primary host. It gets transmitted to humans through bats, and human-to-human spreading starts (Meshram et al., 2020). Coronavirus SS-positive sense RNA makes proteins for their cell and genome without interference cellular genome. Preliminary studies said that this virus has come from the bat, but some studies state that the origin of SARS-CoV-19 comes from the pangolin (Abdel-Moneim and Abdelwhab, 2020). Humans suffering from COVID-19 who ate seafood and infected meat from the SARS-CoV-19 virus. Most probably,

COVID-19 spread in humans from bats because bats, directly and indirectly, contact mankind communities (Figure 1). Some studies also said that the SARS-CoV-19) virus was coming from the pangolin.

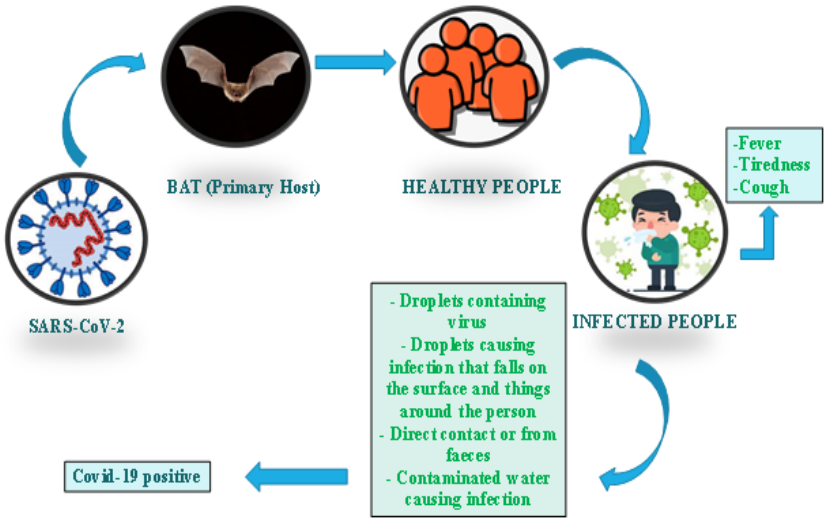

Figure 1. Pathways of spreading COVID-19.

The genome of the SARS-CoV-19 is single-stranded positive-sense RNA which means it makes all necessary proteins for viral progression, integration, and replication. From 2019 to till date, numerous coronavirus variants have been found all due to a mutation in their genome. The viral genome is susceptible to mutation. The new mutation creates a new variant of Coronavirus. Here a table shows the coronavirus variants and their origin, date, and country (Table 1).

Table 1. Representing various variants of coronavirus, their origin, date and country

Variants	Pango Lineage	Reported Country	Timeline
Alpha	B.1.1.7	UK	Dec. 2020
Beta	B.1.351	South Africa	Dec. 2020
Gamma	P.1	Brazil	Jun. 2021
Epsilon	B.1.427, B.1.429	USA	Mar. 2021
Zeta	P.2	Brazil	Mar. 2021
Eta	B.1.525	Multiple countries	Mar. 2021
Theta	P.3	Phililippines	Mae. 2021
Iota	B.1.526	USA	Mar. 2021
Kappa	B.1.617.1	India	April. 2021
Delta	B.1.617.2	India	May. 2021
Lambda	C.37	Peru	Jun. 2021
Mu	B.1.621	Colombia	Aug. 2021
Omicron	B.1.1.529	South Africa	24 Nov. 2021
Sub-variants	BA.4	South Africa	Jan. 2022
	BA. 5	South Africa	Jan. 2022
	BA.2.12.1	USA	Dec. 2021
	BA.2.9. 1	Multiple countries	Feb. 2022
	BA. 2.11	Multiple countries	Mar. 2022
	BA.2.13	Multiple countries	Feb. 2022

Source: https://www.ecdc.europa.eu/en/covid-19/variants-concern

The COVID-19 viral attaches to the ACE-2 receptors of the mammalian cells and is integrated into the cell. In the cell, viruses make proteins for their proliferation; first, viral RNA, through reverse transcription mechanisms, makes cDNA using RdDp (RNA Dependent DNA Polymerase), and then. DNA makes proteins by common molecular phenomenon central dogma (DNA RNA Proteins). Then proteins are transported to the endoplasmic reticulum and Golgi bodies for proper modification. After modification proteins make a viral coat and genome of COVID-19. Viral particles break the

cell, and then they leave from there. Viral attacks on the lung epithelium stop the gaseous exchange between the lung and mouth by making a slimy layer on the lungs (Figure 2). In the past, the world has faced many such outbreaks that have severely affected the whole planet, as depicted in Table 2.

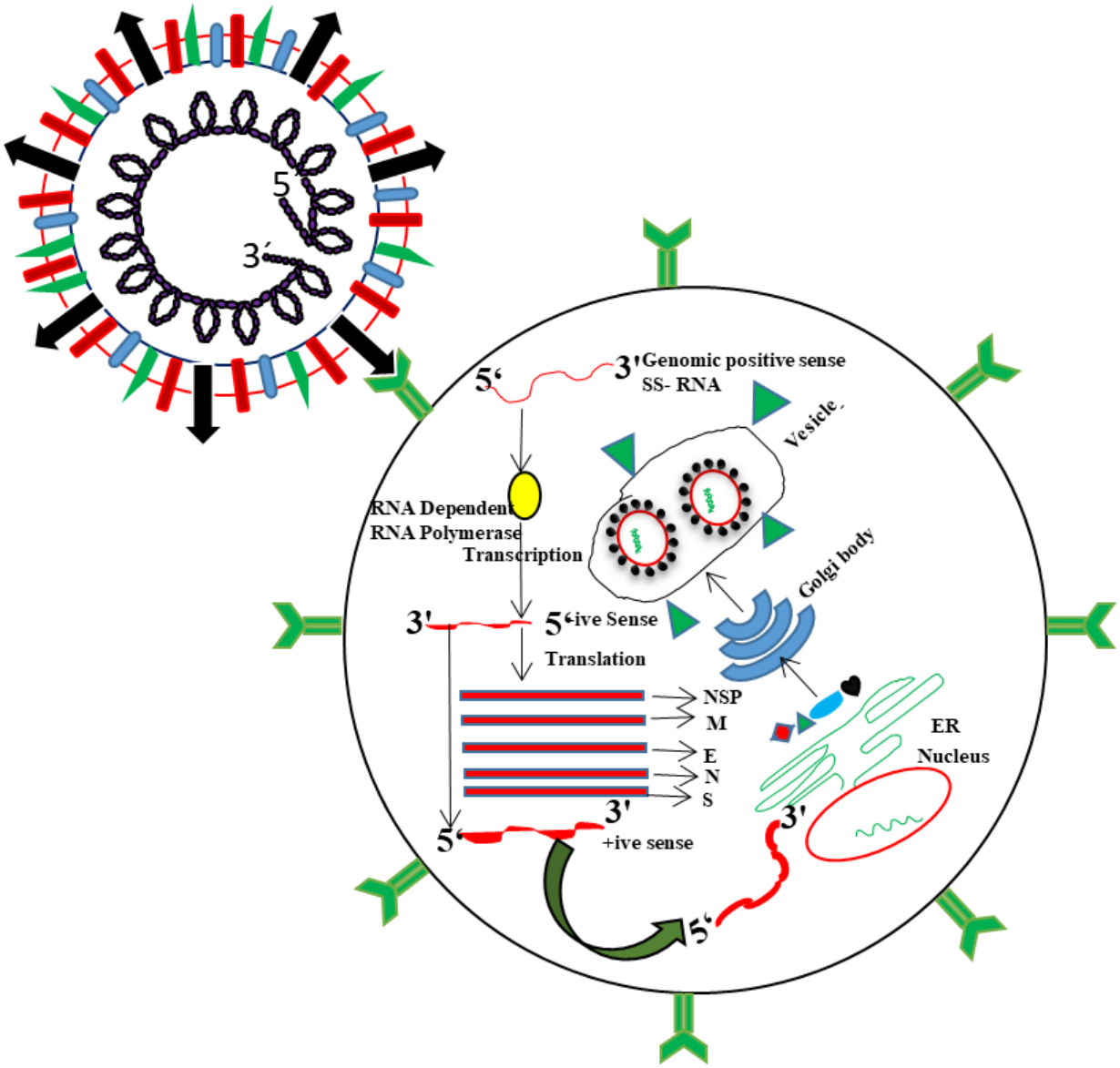

Figure 2. Interaction of SARS-CoV-2 ligands with the mammalian Angiotensin Converting Enzyme- 2 and the production of new Viruses through the transcription and Translation by this mechanism within the host cell (Source: Harrison et al., 2020).

The pandemics mentioned above in the table affect the lives of people and the economic, social, agricultural, physiological, and other such sections of the environment. Total emphasis on agriculture and its allied sectors is affected by the ongoing terror of the COVID-19 virus spread. Agriculture is one of the major sectors affected by the COVID-19 pandemic. Transportation, marketing closing, and the outing of the people from the village to town were restricted (Figure 3). Agriculture is a critical industry that plays an essential role in the Indian Economy. It is one of the chief sectors that employ the rural population, thus circulating the budget's entire circle. Most of the population throughout the world is limited to this sector. With the progressing pandemic, the employment of a considerable number of planters and individuals enjoying this division are at high risk. In certain countries, covid-19 has vanished, while in some, it is returning. Only a limited capacity to focus on the pandemic will leave an everlasting impact on the agriculture division. However, the pandemic will disappear; however, we don't have the foggiest idea when it will come to an end. It is also not clear the quantum of the negative effect it will have on the Economy. Leading researchers and analysts have said there may be a food emergency if measures are taken quickly to keep the most helpless food supply chains alive (Marwah, 2020).

Table 2. Representing the pandemics that occurred in last decades.

Year of outbreak	Disease spread	Infected count	Rate of death	Severely affected countries	References
1918-19	Influenza (H1N1 virus), also known as Spanish flu	500 million people	50 million people throughout the world	USA (More than half a million people died)	CDC (2018)
1940s to 1950s	Polio	35000 people each year	2720 deaths in the United States	The United States and Canada	
1957s to 1958s	Asian Flu	-	1.1 million globally	East Asia	
1960s	Marburg hemorrhagic fever	31	7	Germany and Belgrade, Yugoslavia (now Serbia)	CDC (2014)
1968s	Influenza	-	1 million all over the world	United States	
1980s and 1990s	AIDS	-	7,70,000 (2018) globally	Africa	Epidemiology of HIV/AIDS (2020a)
1996	Hepatitis	Greater than 391 million (2017)	65,400 direct (2015), greater than 7,50,000 (total)	Worldwide	Hepatitis (2020b)
2002	West Nile Fever	3389 cases	704 persons	USA	CDC (2002)
2003	SARS	8096	774 worldwide	Worldwide	WHO (2004)
2009	Influenza	60.8 million cases	1,51,700-5,75,400 universally	United States	CDC (2019a,b,c)
2014 to 2016	Ebola hemorrhagic disease	28,616	11,310 worldwide	Liberia, Guinea, Sierra Leone (West Africa)	WHO (2016)
2019	COVID-19	21 million on 16 August 2020	0.77 million on 16 August 2020	USA	John Hopkins University (2002)

Source: Mishra et al. (2020).

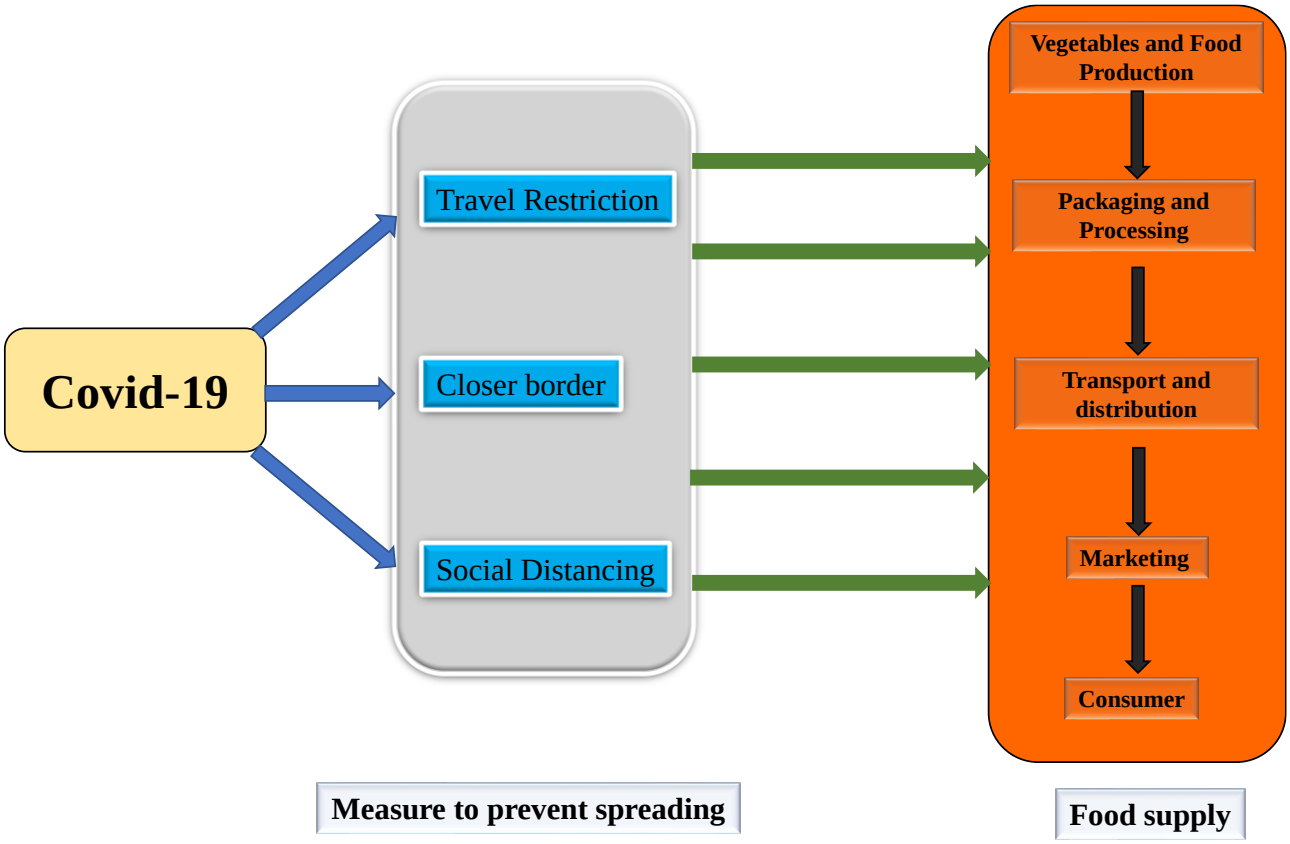

Figure 3. COVID-19 restriction to prevent spreading and its effects on agriculture marketing.

The world has already faced the subsidiary effects of a pandemic on the agriculture sector. The massive reduction in the demand for food in hotels, restaurants, cafeterias, and other food services and the labor restrictions, processing capacity, and storage of these products has led the farmers to discard the output in a massive amount. Due to quarantine, labor availability in high time, from sowing crops to picking fruits becomes problematic. As the emergency creates, these effects are prone to be all the more generally and profoundly felt in farming parts and national economies (Stephens et al., 2020). The noteworthiness and seriousness of the pandemic and its presumable effect on farming worldwide calls for a significant short- and long-term appearance. We have to comprehend the prompt results of global farming, and food systems depend on it so intensely. We should follow unforeseen dangers, shortcomings, and fundamental movements to see transient impacts just as those that might be durable or lasting.

2. Indirect Impact on Agriculture

The tremendous effect of the virus has been noticed in different sectors of the environment. One way or the other, every sector is co-linked. So, if one gets affected, the other automatically gets transformed. Agriculture and its allied sectors face a lot in this lockdown during the spread of a pandemic. Some of the sectors that were significantly impacted are mentioned below and well depicted in Figure 4.

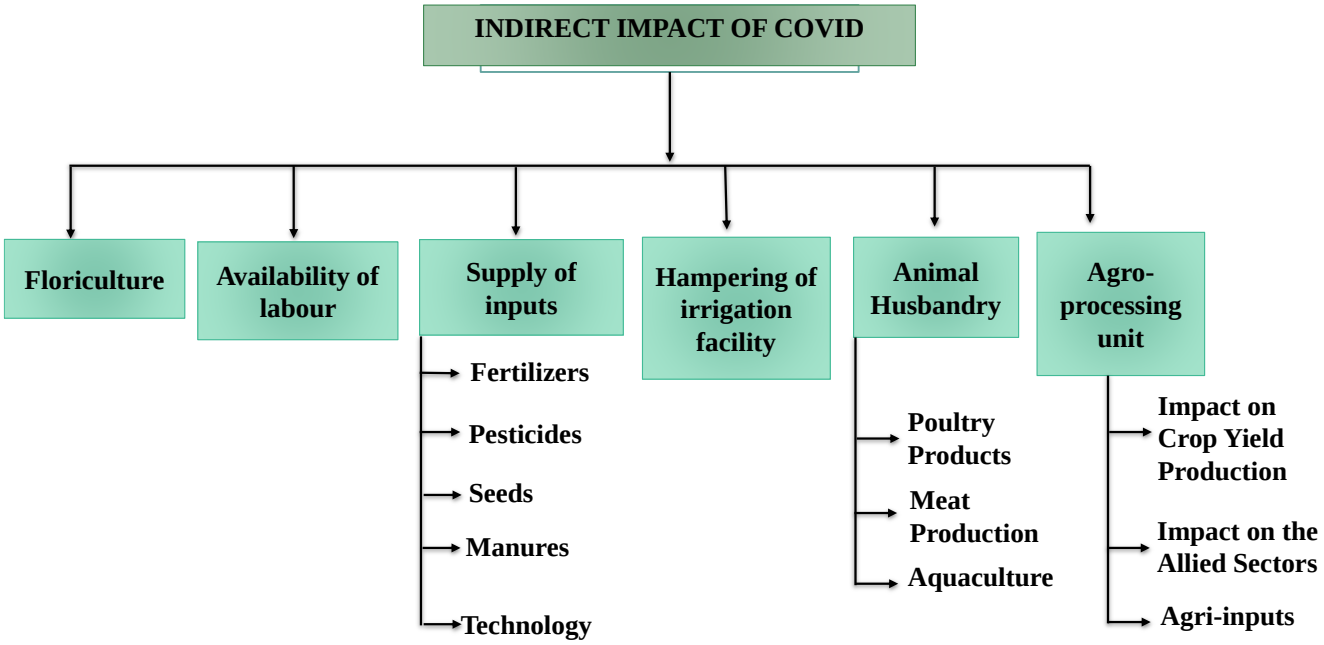

Figure 4. Indirect impact of COVID-19 on agriculture and its allied sectors.

2.1. Floriculture

Floriculture is one of the boosting economic sectors of the world that comes under the horticulture branch, an allied sector of agriculture that involves the cultivation and plantation of flowering and ornamental plants in fixed areas of land such as gardens, greenhouses, nurseries, landscapes, etc. From the worldwide outlook, the top countries that are majorly involved in floral export and import (i.e., export revenue) in 2019 include the Netherlands (48.9%, i.e., 4.6 billion dollars USD), Columbia (14.9%, i.e., 1.4 billion USD), Ecuador (9.3%, i.e., 879.8 million USD), Kenya (7.5%, i.e., 709.4 million USD) and Ethiopia (2.6% i.e., 241.3 UDS). But, after the pandemic in 2020, the Floriculture industry had a contraction of around 6.2% (Petal Republic, 2020). Looking at the Indian Floriculture Industry, it was observed that even the areas where the people weren't affected by the virus had a shocking impact on the production, processing, and migration of flower products. This has been due to the nationwide lockdown and hindrance in the migration of people and carriage vehicles. The lockdown occurred in two phases: 1st (25 March to 14 April 2020) and 2nd (15 April to 3 May 2020). These two phases are the peak times in which the religious, cultural, and tourism activities are at their peak, and the demand for flowers is at its peak. However, due to the closure of temples, markets, hospitals, schools, and hotels, the demand for flowers declined to the utmost level, thus affecting the whole floriculture industry.

It reported that in 2019 the global floral market was worth INR 188.7 billion. Even though flowers are an essential part of Indian culture and are grown for different purposes that cover the social and religious sectors, the commercial floral business is a recent trend. A solid expansion in demand for cut and lose flowers has made gardening one of the significant business exchanges in Indian agribusiness. Due to India's lockdown, the flower business gets hindered as religious ceremonies and marriages get postponed. The wedding runs from the third week of January until the last week of June and the last week of November to the second week of December. The wedding business turnover is around USD 40–50 billion and is among the most significant salary sources for the floristic division. As COVID-19 prompted weddings to be deferred, flower cultivators and organizations that produce planting materials endured budgetary losses. With no social and strict get-togethers occurring, local interest in flowers halted totally. An import boycott additionally hit the fare of roses to the Gulf States.

2.2. Availability of Labor

Due to pandemics, the availability of laborers in the field has become an evolving problem. The lockdown has resulted in the restriction of labor migration in many areas of the world. In India, the availability of internal migrant labor is around 100 million, approximately 20 percent of the Indian workforce, and suffered from the unplanned lockdown on 25 March 2020 (GOI, 2016). They got stuck in the areas of their work without having any wages, money, or food. So, they started migrating to their hometown to save their lives. It is observed that most laborers working in the field belong to the scheduled caste or schedule type category, which is one of the most deficient levels of the rural hierarchy. Due to the restricted migration, this section of society faced scorching conditions during the pandemic lockdown (NSS, 2007). The Pandemic made its way when the country was already facing an economic crisis due to stagnation and a fall in demand. The consumption rate has already been significantly less in rural areas since last year, and due to covid-19 worse conditions, it shows no sign of recovery. It observed a reduction in the wages of rural workers from 14.6 percent to 1.1 percent from 2014 to 2019. Women workers are the worst sufferers as they are paid only four-fifths of the 'men's wages during harvest and post-harvest activities (Sitharaman, 2019). Under such a tragic situation, the crops grown during that agricultural season were affected as the rural workers were not getting wages, so they were not going to work. Its migration also got hindered. These migratory workers are mainly classified as manual workers who shift their work according to their position. In the season of harvesting and post-harvesting, they work in the field. The rest of the time, they got busy with non-farming work.

2.3. Supply of Input:

- **Fertilizer:** Due to the Covid-19 pandemic impact, fertilizer use in agriculture is less. Maybe two reasons for the lesser use of fertilizers in agriculture. Due to the Covid-19 pandemic, public savings are diminished just because of no source of income. During the pandemic, most small-scale industries, shops, fertilizer shops, and other income sources stop. That's why farmers would not be able to buy fertilizers. Less pollution in the environment due to the COVID-19 pandemic so the quality of soil and abiotic factors improved during this pandemic; this is one of the reasons for the less fertilizer use during the COVID-19 pandemic. Transport can also be another reason for the low fertilizer use in the Corona period. During this pandemic, most states seal their boundaries and prevent any transportation from another state.
- **Pesticides:** The use of pesticides in the COVID-19 situation is less than the previous year just because of suitable environmental conditions, and the impact of insects on agriculture practices is less. During this pandemic, farmers do not have enough money to buy pesticides for agriculture, and another reason is a lockdown. In a lockdown, most of the market pesticides and other shops were closed, so farmers could not buy any pesticides for agriculture practices.
- **Seeds:** for high crop production, new varieties of crop implantation, conserving plants' genomes, and many other applications, plant seeds are crucial for this purpose. The implantation of new crop varieties other than plant actual habitat seed import is necessary. Seeds are easy to transport from one place to another (McNeill, 2009). The seeds industry is well-established and genuinely globalized. Seeds, before reaching the farmers, can be preprocessed well packaged. This is to protect it from any biological and mechanical damage. Nevertheless, during the COVID-19 pandemic to prevent the spreading of the Coronavirus from one geographical area to another geographical area, most of the cries ban any arrival from other countries (Schlosser et al., 2020). The restrictions are not only for countries but also district to district, so the transport is also affected by COVID-19. COVID-19 imposed a severe impact affects the production, distribution, and cost of seeds (Nchanji et al., 2021). COVID-19 majorly affects

developing countries because developing countries mainly depend on agricultural practices for their survival, and during covid-19 pandemic most farmers are suffering from a lack of money, lack of transport facilities, and the consequences of this pandemic farmers cannot buy or sell their seeds and crop yields Jaacks et al. (2021). From March to June 2020, the Coronavirus spread at its peak and affected all sectors of society including industrial sectors, pharma sectors, agriculture sectors, transportation, etc. (Muley et al., 2020).

- **Manure:** The COVID-19 negatively impacts on the manure industries, and the manure supply chain is very much affected by the COVID-19 pandemic. For better or mass crop production fertilizers are essential; they have most of the nutrients required for proper plant growth, yield, and protection. With increasing population demands more food to sustain their life, that is why a huge crop yield is required, and this crop yield is achieved by manure. The global manure consumption during this decade was 190 million tons and the worldwide fertilizer market was 155.80 million USD in 2019. The manure has high efficiency for producing high yield within a short period, and the overall impact of the Covid- 19 on the manure/fertilizer industries is observed moderate. Around 60% of all manure production is globally shared by Asia, and in South Asia, China is the largest fertilizer consumer (Mordor Intelligence, 2020).
- **Technology:** Businesses, as well as organizations, have instructed their staff members to work from home as a preventative measure to lessen the risk of transmission in light of the COVID-19 outbreak brought on by the newly discovered coronavirus. However, because of remote work, employees have been subjected to new security risks. Additionally, the sheer amount of data produced by various sources has increased due to the quick worldwide dissemination of COVID-19. Applications for cloud computing (CC) are largely responsible for enabling employees to work from home effectively. In the COVID-19 pandemic crisis, the cloud computing environment (CCE) is an unsung hero. It consists of the quick service delivery methods that follow the development of quickly deployable data maintenance applications (Alashhab et al., 2021).

2.4. Hampering of Irrigation facility

It was recently observed that treated wastewater used for irrigation contains the strain of SARS-CoVs-2 (Wurtzer et al., 2020). The treated wastewater effluent used for irrigation of fruits and vegetables in the field is a source of indirect spreading of SARS-CoVs-2 through the management and eating of contaminated foodstuff (Adegoke et al., 2018; Dickin et al., 2016). This might be particularly important for innovations that do not have any significant bearing on the water straightforwardly to the root zone (for instance, trickle water system), for example, surface or sprinkler water system. There is no evidence of foodborne transport of SARS-CoVs-2 in documented form, but there are other similar viruses (e.g., Bovine CoV; is transmitted through the foodborne pathway, irrigated with wastewater.

2.5 Animal Husbandry

- **Poultry products:** Poultry is one of the essential allied sectors of agriculture concerned with the feeding and breeding of poultry animals. It contributes around 4.9 % (Rs. 758,417 crores in 2017-18) of 'India's overall gross value, which employs about 8.8% population (GOI, 2019). This sector provides a significant amount of animal proteins for vegetarian and non-vegetarian people throughout the country (approximately 851.81 million poultry) (DAHD, 2020). India is ranked the fourth-largest producer of poultry products in terms of volume, in 2019, it consumed approximately 3.8 million tons with a cost of around 85,000 crores in retail price. Consecutively, it produced around 109 billion eggs of Rs 45,000 crores. The last three years have witnessed an annual growth of 10-12 % in these products, which was expected the same in this year.
- **Meat production:** The lockdown due to the COVID-19 poses a massive impact on the poultry sector globally. It assumed that the effect continues for extended periods, bringing about a more significant threat to livelihood. More and more people were unemployed, and the world's overall economy gets disturbed. India has started facing such challenges in its current pattern of living. Looking forward to the situation, a proper understanding of the overall impact will help frame suitable policies and revived strategies.
- **Aquaculture:** Aquaculture is a significant and rapidly growing sector for providing food and employment to the people. Aquaculture provides one-third of global fish food to the world (Lehane, 2013). Over the globe, about 10% of the world population depends on seafood; due to the COVID-19 pandemic aquaculture sector is also affected. Fish production requirement globally increases by 30% with an increase in the world population (FAO, 2017; Beveridge et al., 2013). The increasing population demands high seafood for livelihood, and most countries with sea

periphery depend on aquaculture. Aquaculture food is also called local rural communities' food. Fish culture and fishing are the main business in developing countries like Africa and Asia. It is the fastest way to escape poverty in developing countries on the sea periphery (Edward, 2000). Developing and developed countries also consume a lot of seafood like shrimp, lobsters, and fish. Compared to previous years, in April 2020, fisher and fishing companies refrained from going to sea, causing a sharper decline in fish production, approximately 50% (OECD, 2020). As the impact of COVID-19, the price of seafood shrimp, lobster, and fish was reduced because of the nationwide lockdown, and the unreachability of foreign and local purchasers led to reduced costs of seafood and led to the instability of fish marketing. Due to the Covid-19 pandemic government, all nations closed restaurants and all street food corners. It led to the reduction of the local consumption of food. Some illiterate people spread the rumor; that COVID-19 spread due to seafood tilapia consumption using different social media platforms like Facebook (Rafiquzzaman, 2020). Transporting the fishing products from the sea yard to the market to supply the proper requirement of fish products is necessary, but due to the COVID-19 pandemic transport system of the nation is strongly in crisis. So, all the fisheries sector stakeholders are facing the problems of transportation of fishing to the market. Buyers cancel the shipment from the fishing site because the major fish marketing countries are located near the sea beach. In society, the rumor about COVID-19 has already spread Coronavirus spread from Hunan's seafood market in Wuhan city of China. It infects more than 50 people (Wang et al., 2020).

2.6. Agro-processing Unit

- **Impact on Crop yield production**: In India, nearly half, 47%, of the economy depends on agricultural practices. COVID-19 declined 2.7% of agriculture production and has significantly affected because most rabi crops were harvested at the end of April 2020.
- **Impact on the Allied sectors**: Allied sectors are much affected by the Covid- 19; in allied sectors, significant declines are observed to be much more affected by poultry farming (-19.5 %), followed by fisheries (-13.6 %), sheep/pigries (-8.5 %) due to the declining demand of these products and transportation facility restrictions.
- **Agri inputs**: Due to Covid- 19 pandemic, all countries applied lockdown to stop the spread of the Coronavirus and closed all shops, industries, and agriculture inputs and outputs. The consequences of the lockdown are the availability decline of agri-inputs, like fertilizers (-11.6 %), followed by fodder (-10.8 %), pesticides (-9.6 %), and seeds (-9.2 %) (Singh, 2020).

3. Conclusion

From the above information, we have come across that COVID-19 directly impacts humans but indirectly affects many components of the environment. Agriculture is one of the vital sectors of the environment that plays a crucial role in maintaining the world's economy. When the emergency was in March 2020, there was a lockdown for several days; the whole populace was disturbed. Mobility was hindered, and the people started facing starvation problems. Even the field workers could not sow seeds, and the whole crop of that season got disturbed. The output from the field also got reduced. On the other hand, allied sectors also faced many problems. Floriculture is one of the vital sectors that play a significant role in the global economy. In every ceremony, many flowers are used for decoration and other such activities. Due to COVID-19, marriage parties, birthday parties, etc., got postponed, so the flower markets faced a recession. The same is true with other sectors also.

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