

Impact of Covid-19 Lockdown on Agricultural Production

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ABSTRACT

This study aims to assess the impact of the Covid-19 lockdown on the agricultural crop production in India and identify the factors affecting the agricultural crop production in India during the lockdown period. Due to the pandemic, production of Rabi crops such as Jowar and coarse cereals have declined, and the growth rate of Kharif crops such as Bajra and coarse cereals production have also been dropped. Among the horticulture crops, the growth rate of fruit production has been adversely affected by the restrictions imposed during the lockdown. The fertilizer consumption, annual rainfall, pesticides consumption and storage capacity are identified as major determinants affecting the agricultural crop production in the country during the lockdown period.

SARI PATI

Penelitian ini bertujuan untuk mengevaluasi dampak penguncian wilayah Covid-19 terhadap produksi tanaman pertanian di India dan mengidentifikasi faktor-faktor yang mempengaruhi produksi tanaman pertanian di India selama periode tersebut. Produksi tanaman Rabi seperti Jowar dan sereal kasar telah menurun dan tingkat pertumbuhan tanaman Kharif seperti Bajra dan produksi sereal kasar juga telah turun. Di antara tanaman hortikultura, tingkat pertumbuhan produksi buah-buahan telah terpengaruh karena pembatasan yang diberlakukan selama masa penguncian. Konsumsi pupuk, curah hujan tahunan, konsumsi pestisida dan kapasitas penyimpanan diidentifikasi sebagai determinan utama yang mempengaruhi produksi tanaman pertanian di negara tersebut selama penguncian.

INTRODUCTION

The outbreak of Corona virus disease 2019 (Covid-19) was first identified in Wuhan, China. The WHO declared Covid-19 as a pandemic in January 2020. After a hundred years, Covid-19 is one of the most challenging pandemic situations entirely affecting the world population. The virus, in its first wave, spread into more than 190 countries. The global economy will shrink by 5.2 percent in 2020 and 2021, according to World Bank predictions. This would be the worst recession since World War II, with the greatest proportion of economies witnessing a loss in per capita output since 1870. According to official reports, the most significant number of Covid-19 cases was confirmed in the USA, Italy, Spain, France, Brazil, and India during the Covid-19 first wave. 'Most countries imposed an initial lockdown aimed at slowing the spread of the virus. According to WHO, the Covid-19 pandemic crumbled away 11.4 trillion rupees of shareholder wealth. The Indian economy has already been suffering from a slowdown in recent years. After the pandemic, India's GDP shrank by 7 percent in the financial year 2020-21. At 2011-12 prices, the GVA growth rates of the agriculture, industrial, and service sectors were 3.63 percent, -6.96 percent, and -8.36 percent, respectively, in the financial year 2020-21. After the first wave, many countries relaxed containment and physical distance control measures. As a result of relaxing these safety measures, the second wave began in March 2021 in India. The second wave was much more devastating and deadly, with shortages of vaccines, hospital beds, oxygen cylinders, and other medical supplies. According to a monthly report by the Finance Ministry, the impact of the second wave on the Indian economy is likely to remain muted as compared to the first wave. The second wave has posed a downside risk to economic activity in the first quarter of FY 2021-22. In financial year 2021, our agriculture economy grew by 3.4 percent whereas the entire economy shrank by 7.7 percent.

The importance of the agriculture sector in the Indian economy can be seen in the fact that it

plays a significant role in poverty alleviation, meeting the food requirements of the existing population and providing raw materials to various industries. As per the First Advance Estimates of National Income, 2021-22 released by National Statistical Office, Ministry of Statistics & Programme Implementation, the Indian agriculture sector contributed approximately 18.8 percent of India's GVA at current prices during 2021-22. The agricultural sector is a prominent sector. 54.6 percent of the total workforce is engaged in agriculture and allied sector activities (Census 2011). The agriculture sector also contributes significantly to international trade. India is the largest producer of pulses, okra, mango, banana, lemon, and the second largest of rice, wheat, potato, tomato, and onion. The Indian agriculture sector contributes more than 20 percent of the global production of many horticultural crops like bananas, mangos, and papaya. India has three major agricultural seasons: Kharif, Rabi and Zaid. Prior to the lockdown, the Rabi season was in full swing, and crop harvesting was completed throughout the lockdown period. The lockdown had ended by the time Kharif sowing began. Rice, jowar, bajra, coarse cereals, maize, cotton, soyabean, and other oilseeds are the most important crops farmed during the Kharif season. Wheat, barley, linseed, rapeseed, mustard, and gram are major crops during the Rabi season. During the Zaid season, crops such as pulses, sugarcane, groundnuts, and horticulture crops are primarily grown. A low level of income in the agriculture sector was already a critical situation in India, whereas lockdown has disproportionately affected daily wage workers.

From 2005 to 2019, agricultural production continuously rose, but the initial lockdown affected livestock products, agriculture products, horticulture products, or tradable products. The situation caused by Covid-19 and the extension of the lockdown period had several effects on the supply chain of agriculture and horticulture production. The lockdown created a tough situation for farmers because they couldn't sell products on time, had no financial backup for the next crop, and faced a

shortage of agri-inputs like seeds and labour. Most horticultural products are perishable commodities, and Indian farmers were not financially able to store them. The present paper is an attempt to assess the impact of the Covid-19 lockdown on the agricultural crop production in India and identify the factors affecting the agricultural crop production in India during the lockdown period.

Literature Review

Cariappa et al. (2021) discussed the impact of Covid-19 on the agriculture sector and suggested for post-pandemic recovery. The Conclusion of the study was that restriction on movement, transportation shortage and reverse migrant labour during initial lockdown adversely affected the domestic supply-chain. The study suggested for family farming, collective farming, buffer stocks, reform of agricultural finance and stockholders' partnerships to boost up the agricultural production.

Chetan & Yogish (2020) highlighted on disruptions in agriculture sector caused due to Covid-19 pandemic. The study concluded that agriculture sector faced disruptions because most of the farmers could not prepare land on scheduled time due to Covid-19. The study suggested that government need to take action at the right time so that the agriculture production could not affect in future.

Hassan et al. (2021) analyzed the production of horticultural crops in Jammu & Kashmir and Covid-19 impact on the supply-chain of the horticulture sector. The study highlighted the impact of Covid-19 on the pre-harvesting, harvesting and post harvesting stage of apple crops. The study revealed that horticulture production, especially apple production, was adversely affected due to fertilizer cost, labour cost and its shortage, credit crunch and market distances.

Jaacks et al. (2021) discussed the impact of the Covid-19 pandemic on agriculture production and food security in India. The study revealed that 79 percent of household wage worker witnessed

wage decline as compare to the year 2018-19. The study concluded that landless, small and marginal farmers faced the lockdown related disruption of food insecurity and agriculture. The study suggested that the schemes like NREGS, PM-GKY, PDS, and PM-KISAN can play an important role in fighting against the effects of this for avoiding similar trouble during future lockdown.

Joshi et al. (2020) identified the Covid-19 pandemic impact on fruits and vegetable exports from India. The study highlighted that India is the largest producer and exporter of banana, mango, papaya, orange, onion, cauliflower, cabbage. The study found that due to less market functioning, shortage of labour, price fluctuations, horticulture products were not able to trade on time. Conclusion of the study was that government should focus on ground level problems and provide loans, subsidies and offer income supporting schemes.

Kumar et al. (2021) highlighted that the initial lockdown affected the agricultural sector by creating unwanted implications for farmers and the supply chain of agriculture products. The results of the study revealed that lack of migrants in some areas and surplus in others, decline in agriculture wages, insufficient supply of agri-inputs adversely affected agriculture production. The study suggested for adopting sustainable Argo-policies that will make agriculture system profitable in India.

Report of FICCI (2020) assessed impact of the lockdown on India's agricultural value chain. The report showed that several activities across the agricultural value chain have been the worst hit. Stakeholders, flower farmer, poultry sector have been affected the most. The report suggested through provoking recommendations for stakeholders within the agricultural value chain to consider evaluate and adopt.

Report of NABARD (2020) analyzed Covid-19 impact on the agricultural sector and the factors that adversely affected it during the lockdown.

The results of the study revealed that production of poultry, dairy, fisheries, and horticulture crops production fall during 2020-21 and 54 percent of districts have reported a decline in overall prices of agriculture and allied sector commodities. The study concluded that farmers should have additional sources of income for continuing production. The report suggested that the government should increase and cover more benefitschemes under PM-KISAN and encourage export of the agricultural output. Varshney et al. (2021) studied the impact of government relief packages on the agriculture sector. The results of the study showed that farmers getting benefits under government schemes and relief package spent more on the procurement of seeds, fertilizer, and pesticides than other farmers. The study suggested for direct benefit transfer because of lower cost, minimal leakage, and immediate delivery of the benefits.

METHODS

The study of assessing impact of Covid-19 lockdown on agricultural crop production is based on data ranging from 2011-20 which represents the agricultural crop production of India before and during the Covid-19 lockdown. The data on Agricultural crop production is extracted from Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare. The average annual growth rate and average annual compound growth rate is calculated from the formula:

For given two consecutive years, $t=1$ and 0
 Annual rate of change: $\Delta A/A_0 = (A_1 - A_0)/A_0$

Given t years, average annual growth rate

$$\frac{(A_t - A_0) / A_0}{t}$$

Average annual compound growth rate

$$r = \exp \left[\frac{\ln(A_t / A_0)}{t} \right] - 1$$

For evaluating the major factors which affected agricultural crop production in India during the lockdown, the Multiple Linear Regression Model have been used. The effects of annual rainfall, fertilizer consumption, pesticide consumption and storage capacity on crop production is evaluated using dataset of twenty-nine states of India for the year 2019-20 depending on the data availability.

RESULTS AND DISCUSSIONS

1. Growth and Trends of Agricultural Crop Production in India

India has witnessed a continuous rise in agricultural crop production from past few years. The total agricultural production of Rabi and Kharif season crops comprises variety of items- Rice, Wheat, Jowar, Maize, Bajra, Coarse Cereals, Total Pulses, Total Nine Oilseeds and Total Foodgrains. Agricultural crop production is discussed under three sections- agricultural crop production in Rabi Season, agricultural crop production in Kharif Season and horticulture crop production.

Table 1 shows agricultural production of Rabi season crops for time period between 2011 and 2020. India's total food grain production has increased to 136.38 million tonnes in the financial year 2013-2014 from 128.01 million tonnes in 2011-12. India's total Foodgrains production has declined at 123.97 million tonnes in 2014-15. After 2014-15, India's total Foodgrain production increased throughout the study period till 2020-21 except for the year 2018-19. The production of total nine oilseeds has increased to 10.15 million tonnes in 2012-13 from 9.108 million tonnes in 2011-12. It has registered a meagre decline in 2013-14. After the year 2014-15, total nine oilseeds production shows a continuous rise till 2020-21. Among the Foodgrains, the production of Jowar and Coarse cereals has declined in 2020-21 as compared to the previous year. A meagre increase has been recorded in the production of Rice, Wheat and Maize in 2020-21 as compared to the previous year. Total Pulses production has increased by 1.99 million tonnes in 2020-21 as compared to the previous year.

Table 1.1 shows annual growth rate of Rabi production between the year 2011 and 2020. The results obtained shows that the production of total nine oilseeds have shown negative growth in the financial year 2013-14, 2014-15. It has maintained positive growth for rest of the years marking the highest annual growth rate (13.99 percent) in 2016-17. In the year 2020-21, nine oilseeds production has increased with a high annual growth rate (9.48 percent) than that of the 1.16 percent growth rate in 2019-20. Total Foodgrains production has shown negative growth -9.10 percent in 2014-15 and -0.59 percent in 2018-19. For rest of the years, the production of Foodgrains has increased with a positive growth rate marking the highest (8.17percent) in the year 2016-17. In the year

2020-21, it has increased with a low growth rate (2.21percent) than that of the 6.95percent growth rate in 2019-20. The production of Jowar and Coarse cereals have registered negative growth (-3.24 percent and -0.28 percent respectively) in 2020-21 as compared to the previous year. In the year 2020-21, the production of major food crops such as Rice, Wheat, Maize and Cereals have increased but at a low growth rate than that of in 2019-20.

Table 2 shows agricultural production of Kharif season crops for the time period between 2011 and 2020. The total Foodgrains overall has shown a rise in its production throughout the study period except for the year between 2012 and 2016 where a meagre fall in production has been recorded. Rice

Table 1. Agricultural Production of Rabi Season Crops (Values in Million Tonnes)

Crops	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21*
Rice	12.52	12.87	15.15	14.09	13	13.4	15.62	14.44	16.59	17.16
Wheat	94.88	93.51	95.85	86.53	92.29	98.51	99.87	103.6	107.86	108.75
Jowar	2.69	2.44	3.15	3.15	2.42	2.6	2.53	1.74	3.08	2.98
Maize	5.27	6.05	7.11	7.16	6.51	6.98	8.63	8.3	9.14	9.29
CoarseCereals	9.58	10.24	12.09	11.92	10.37	11.33	12.94	11.67	14.13	14.09
Cereals	116.98	116.63	123.09	112.53	115.66	123.24	128.44	129.71	138.59	140
Total Pulses	11.03	12.43	13.26	11.42	10.79	13.55	16.11	13.98	15.1	17.09
Total	9.108	10.15	10.126	8.29	8.553	9.75	10.453	10.846	10.972	12.013
NineOilseeds										
Total	128.01	129.05	136.38	123.97	126.45	136.78	144.55	143.7	153.69	157.08
Foodgrains										

Sources: Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare
*3rd advance estimate

Table 1.1. Annual Growth Rate (%) of Rabi Production

Crops	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21*
Rice	-	2.8	17.71	-6.99	-7.73	3.08	16.56	-7.55	14.88	3.4
Wheat	-	-1.44	2.5	-9.72	6.68	6.73	1.38	3.70	4.11	0.82
Jowar	-	-9.29	29.09	0	-23.17	7.43	-2.69	-31.22	77.01	-3.24
Maize	-	14.80	17.52	0.7	-9.07	7.21	23.63	-3.82	10.84	1.64
CoarseCereals	-	6.88	18.06	-1.4	-13.00	9.21	14.21	-9.81	21.07	-0.28
Cereals	-	-0.29	5.53	-8.57	2.80	6.55	4.21	0.98	6.84	1.01
Total Pulses	-	12.69	6.67	13.87	-5.5	25.57	18.89	-13.22	8.01	13.17
Total	-	11.44	-0.23	18.13	3.17	13.99	7.21	3.75	1.16	9.48
NineOilseeds										
Total	-	0.81	5.68	-9.10	2.0	8.17	5.68	-0.59	6.95	2.21
Foodgrains										

Table 2. Agricultural Production of Kharif Season Crops (Values in Million Tonnes)

Crops	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21*
Rice	92.78	92.36	91.5	91.39	91.41	96.3	97.14	102.04	102.28	104.3
Jowar	3.29	2.84	2.39	2.30	1.82	1.96	2.27	1.74	1.70	1.82
Bajra	10.28	8.74	9.25	9.18	8.07	9.73	9.21	8.66	10.36	10.48
Maize	16.49	16.20	17.15	17.01	16.05	18.92	20.12	19.41	19.43	20.95
CoarseCereals	32.44	29.79	31.20	30.94	28.15	32.44	34.03	31.33	33.61	35.57
Cereals	125.22	122.15	122.7	122.34	119.56	128.74	131.16	133.42	135.89	139.87
Total Pulses	6.06	5.92	6	5.73	5.53	9.58	9.31	8.09	7.92	8.49
Total	20.69	20.791	22.64	19.221	16.698	21.526	21.006	20.676	22.247	24.552
NineOilseeds										
Total	131.27	128.07	128.69	128.07	125.09	138.33	140.47	141.52	143.81	148.36
Foodgrains										

Sources: Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare

*3rd advance estimate

Table 2.1. Annual growth rate (%) of kharif production

Crops	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21*
Rice	-	-0.45	-0.93	-0.12	0.02	5.34	0.8	5.04	0.23	1.98
Jowar	-	-13.67	-15.84	-3.76	-20.86	7.69	15.81	-23.34	-2.29	7.05
Bajra	-	-14.98	5.83	-0.75	-12.9	20.57	-5.34	-5.97	19.63	1.15
Maize	-	-1.75	5.86	-0.81	-5.64	17.88	6.34	-3.52	0.1	7.82
CoarseCereals	-	-8.16	4.73	-0.83	-9.01	15.23	-1.26	-7.93	7.27	5.83
Cereals	-	-2.45	0.45	-0.29	-2.27	7.67	1.87	1.72	1.85	2.92
Total Pulses	-	-2.31	1.35	-4.5	-3.49	73.32	-2.81	-13.10	-2.1	7.19
Total	-	0.48	8.81	15.04	-13.13	28.91	2.41	-1.57	7.59	10.36
NineOilseeds										
Total	-	-2.43	0.48	-0.48	-2.32	10.58	1.54	0.74	1.61	3.16
Foodgrains										

has shown a rise in its production except from the year between 2013 and 2016 where some downfall in production has been recorded but overall, it has a consistent growth. Total production of kharif Rice during 2020-21 is estimated at 104.3 million tonnes. It is higher by 6.47 million tonnes than the previous five years' average production of 97.83 million tonnes. The total nine oilseeds have shown a downfall in its production in 2014-15, 2015-16 and 2018-19. The total production of nine oilseeds in the country is estimated to be 24.552 million tonnes in 2020-21, which is 2.31 million tonnes higher than the production in 2019-20.

Table 2.1 shows annual growth rate of Kharif production between the year 2011 and 2020. Due to the pandemic, when India's GDP contracted by 23.9 percent in the first quarter (April to June 2020), agriculture emerged as the incredible

winner, expanding at 3.4 percent. This rise in the agriculture sector was based on Rabi/winter crops rather than kharif season crops because production was mostly reported until the Rabi season ended. The Kharif season crops have not shown a good contribution throughout the whole study period. The production of oilseeds has increased with highest annual growth rate (28.91percent) in 2016-17. Similarly, the total Foodgrains has also shown a highest annual growth rate (10.58 percent) in the year 2016-17. The production of total Food grains and total Nine oilseeds have increased marking an annual growth of 3.16 percent and 10.36 percent respectively in the year 2020-21. Among the Food grains, the production of Bajra and Coarse cereals have increased with low growth rate 1.15percent and 5.83percent respectively in the year 2020-21 due to the impact of Covid 19 lockdown.

The table 3 shows compound annual growth rate (CAGR) for Rabi crops and Kharif crops for the time period between 2011 and 2020. Among all the Rabi season crops, Maize and Pulses have shown the highest CAGR (6.50 percent and 4.99 percent respectively) whereas Pulses have shown the highest CAGR (3.82percent) in the Kharif season crops throughout the study period. Among the Kharif crops, Jowar has shown the negative CAGR (-6.37 percent) and Bajra the lowest CAGR (0.21 percent) due to the economic fluctuations, some seasonal impacts and uncertainty of rain.

2. Growth of Horticulture Production in India

Table 4 and graph 1 shows horticulture crop production in India for the time period between 2011 and 2020. Horticulture is the agricultural branch dealing with highly produced plants that are directly used by man for food, medicine, and aesthetic delight. It is the cultivation, production, and sale of vegetables, fruits, flowers, herbs, ornamental, or exotic plants. Because it is more profitable than agriculture, the horticulture sector has emerged as a major engine of growth (food grains mainly). The production under total horticulture crops has increased to 311.7 million tonnes in 2017-18 from 257.3 million tones in 2011-12.

Total horticulture crops production has faced a toness fall of 0.96 million tones in 2018-19 as compared to the previous year. It has again increased and recorded 320.47 million tonnes in 2019-20. The production of fruits and vegetables has shown a rising trend throughout the study period. Fruits production have increased to 102.08 million tones in 2019-20 from 76.4 million tones in 2011-12 whereas the vegetables production has increased to 188.28 million tones in 2019-20 from 146.6 million tones in 2011-12. For the year 2020-21, the total horticulture crops production is estimated to be 331.05 million tones which is 10.58 million tones higher as compared to the previous year. Among the horticulture crops, fruits and vegetables production is estimated to be 103.03 million tones and 197.23 million tones.

Table 4.1 shows annual growth rate of horticulture production from time period between 2011 and 2020. The annual growth rate of total horticulture crop production has been the highest in 2016-17 at 5.03 percent. Total horticulture crops have shown negative growth (-0.31 percent) in 2018-19. Among the total horticulture crops, fruits have shown the highest annual growth rate of 9.47 percent in 2013-14 whereas vegetables have high annual growth 6.62 percent in 2012-13. In 2014-15 both fruits and vegetables have shown lowest annual growth rate of 0.56 percent and 0.43 percent respectively. In the year 2020-21, the total horticulture crops have increased marking an annual growth of 3.30 percent. Vegetables' production increased at an annual growth of 4.75 percent and fruits production has also increased but at a comparatively low growth rate (0.93 percent) than the previous year due to the lockdown.

3. Factors affecting Agricultural Production in India during the Lockdown

(i) Demand Chain for Agricultural Production

A significant part of the demand for primary goods depends on the service sector (hotels, restaurants, tourism) and the industrial sector. In between complete lockdown, all these services and industrial demand for agriculture commodities were completely near to zero.

(ii) Marketing of Agricultural Products

There were frequent price variations in agricultural product market committee or mandis because of pandemic. Mandis was working at lower capacity due to the social distancing norms. For the safety purposes, government made warehouses to buy the produce directly from these government selling points that reduced the demand at mandis, and private sellers forced farmers to sell their product even at prices below the MSP.

(iii) Management of Perishable Goods

It was very difficult to manage or store perishable food items such as fruits, vegetables, dairy products, fisheries and poultry and affected severely due to

Covid-19 lockdown. It was difficult to deal with exotic vegetables with the shortage of food storage facilities that caused to wastage of food.

Farmers were unable to pay to the labour engaged in poultry Industry. Lockdown also affected the production of fisheries and poultry because demand for its drastically reduced.

(iv) Transportation Availability and Logistics

The transportation industry got affected due to the ban on manufacturing and logistics of non-essential items during lockdown. The supply of transportation has affected due to lack of truck drivers because of the fear of corona virus which refrained them to travel inter-state. Increase in the rates of transportation services which leads to the increase in the prices of agricultural commodities because of high transportation and storage costs.

(v) Weather

Unusual weather patterns, such as droughts and extended rainy seasons destroy crops and reduce

productivity. Unseasonal rains and thunderstorms in several parts of north harmed agricultural produce in India during the pandemic, resulting in a surge in farm claims and delays in substantial payouts.

(vi) Reverse Migration

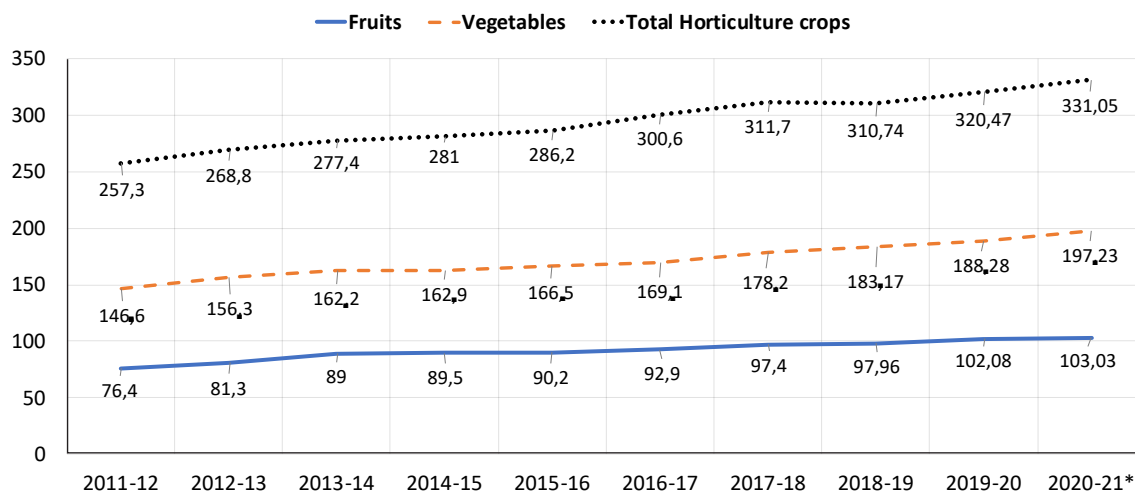
Government initially imposed restrictions on the movement of labour from one place to another mainly affected the Rabi harvesting and procurement process. Lockdown led to surplus labour in Jharkhand, Chhattisgarh, Bihar and UP due to reverse migration. Most of the states in northern India like Punjab and Haryana depend mainly on migrant labours to harvest food grains that had been affected due to the reverse migration during lockdown.

(vii) Agricultural Inputs

Agricultural inputs such as seeds, fertilizers, agro-chemicals, farm equipments also got affected due to lockdown. Lockdown also impacted the movement of seeds from production fields to factories. Farmers were unable to access to the factor market during

Tabel 3. Compound Annual Growth Rate (CAGR) of Rabi and Kharif crops Production

Crops	Rice	Wheat	Jowar	Bajra	Maize	Coarse Cereals	Cereals	Pulses	Nine Oilseeds	Total Food grains
Rabi 2011-20	3.56	1.53	1.14	-	6.50	4.38	2.02	4.99	3.12	2.30
Kharif 2011-20	1.31	-	-6.37	0.21	2.70	1.03	1.24	3.82	1.92	1.37



Graph 1: Trend of Horticulture Crop Production in India (Values in Million Tonnes)

Tabel 4. Horticulture Crop Production in India (Values in Million Tonnes)

Crops	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21*
Fruits	76.4	81.3	89	89.5	90.2	92.9	97.4	97.96	102.08	103.03
Vegetables	146.6	156.3	162.2	162.9	166.5	169.1	178.2	183.17	188.28	197.23
Total	257.3	268.8	277.4	281	286.2	300.6	311.7	310.74	320.47	331.05

**Horticulture
Crops**

Sources: Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare
*3rd advance estimate

Table 4.1. Annual Growth rate (%) of Horticulture Crop Production

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21*
Fruits	-	6.41	9.47	0.56	0.78	2.99	4.84	0.57	4.21	0.93
Vegetables	-	6.62	3.77	0.43	2.21	1.56	5.38	2.79	2.79	4.75
Total	-	4.47	3.20	1.30	1.85	5.03	3.69	-0.31	3.13	3.30

**Horticulture
Crops**

the lockdown due to the restrictions on the supply of factors or inputs like production fertilizers, seeds etc. And prices of agricultural inputs got much rise as compared to the previous year.

Specification of the Model

An attempt was made to assess the effect of these factors on crop production by using Multiple Linear Regression Model. Econometric specification of agricultural crop production function is specified as follows:

$$P_i = \beta_0 + \beta_1 FC_i + \beta_2 Ar_i + \beta_3 PC_i + \beta_4 SC_i + \epsilon_i \quad \dots (1)$$

Where,

P_i = Crop production as measured by sum of total cereals, total pulses and nine oilseeds in lakh tonnes

FC_i = Fertiliser consumption (in terms of nutrients N, P & K) in lakh tonnes

Ar_i = Annual rainfall in mm

PC_i = Chemical Pesticides consumption in lakh tonnes technical grade

SC_i = Storage capacity in lakh metric tonnes

Given the equation 1; β_1 , β_2 , β_3 and β_4 are the regression coefficients of fertilizer consumption,

annual rainfall, pesticides consumption and storage capacity respectively.

Table 5 shows major predictors (fertilizer consumption, annual rainfall, pesticides consumption and storage capacity) of crop production for the year 2019-20. Multiple Linear Regression Model has been applied to test whether the overall fit of the model is good or not. The results obtained show that there is high degree of positive correlation between crop production and fertilizer consumption; moderate degree of positive correlation between crop production and pesticides consumption and the same for crop production and storage capacity. On the other side, there is moderate degree of negative relationship has been reported between crop production and annual rainfall. The reason may be attributed to the actual annual rainfall exceeding over the normal rainfall in many states, viz. Sikkim, Odisha, Bihar, Punjab, Jammu & Kashmir, Rajasthan, Madhya Pradesh, Gujarat, Goa, Maharashtra, Chattisgarh, Telangana, Karnataka and Kerala in the year 2019. Value of R (.959) indicates a good level of prediction of crop production. The coefficient of determination or R^2 value shows that 92.1% variation in crop production is explained by fertilizer consumption,

Tabel 5. Regression Results

Regression Statistics					
	Mean	Standard Deviation			
Crop Production	113.96	137.344			
Fertilizer Consumption	10.12	12.113			
Annual Rainfall	1637.34	951.870			
Pesticides Consumption	21262.41	32225.105			
Storage Capacity	25.89	49.686			
R Square		.921			
Adjusted R Square		.907			
Standard Error		41.813			
Durbin-Watson		2.142			
No. of Observations		29			

Correlations				
	Fertilizer Consumption	Annual Rainfall	Pesticides Consumption	Storage Capacity
Crop Production	.931	-.498	.657	.559

ANOVA					
	df*	Sum of Squares	Mean Square	F	Sig.
Regression	4	486213.972	121553.493	69.526	.000
Residual	24	41959.321	1748.305		
Total	28	528173.293			

	Coefficients	Standard Error	t Stats.	Sig.	Collinearity Statistics	
					Tolerance	VIF
Intercept	7.607	22.481	.338	.738		
Fertilizer Consumption	11.560	1.158	9.981	.000	.317	3.152
Annual Rainfall	-.003	.010	-.271	.789	.727	1.375
Pesticides Consumption	-.001	.000	-2.404	.024	.367	2.725
Storage Capacity	.556	.181	3.071	.005	.772	1.295

annual rainfall, pesticides consumption and storage capacity. The obtained F value ($F=69.526$) is significant at 5% level of significance. It indicates that all the regression coefficients are significantly different from zero or the regression model is a good fit of the data.

MANAGERIAL IMPLICATIONS

Covid-19 pandemic affected the global supply chain and the Indian agriculture system could not remain abstained from this. The present study will help policymakers to take various measures and reforms as a response to future supply and demand shocks and apply the same to strengthen the agriculture

sector.

CONCLUSION

In conclusion, the agricultural crop production as a whole increased but the Covid-19 lockdown impacted the growth rate significantly. The growth rate of production of Rabi crops, especially, wheat, maize and cereals impacted due to the restrictions imposed on the movement of agricultural labourers and farm machinery during the lockdown. The production of Kharif crops such as Bajra and coarse cereals increased in absolute terms but the Covid-19 lockdown also hit its growth rate. Among the horticulture crops, fruits production remained stagnant and the growth rate of fruits production

crashed due to the restrictions imposed during the lockdown. The agricultural crop production was mainly affected by fertilizer consumption, annual rainfall, pesticides consumption and storage capacity during the lockdown.

Policy Recommendations

(1) Export-oriented policies and environmental conditions

The outbreak has disrupted global supply networks, and worldwide exports and imports have decreased. India might take advantage of the circumstance and establish itself as a major global agricultural commodity trader. This presents a chance for India to enhance its international market demand, which in turn helps to improve foreign capital inflows. Because India has become a more prominent exporter of agricultural products, farmers can now command higher prices for their products, increasing their real income.

(2) Farmers' Assistance Programs and Policies

The government can help farmers through numerous initiatives and policies. To safeguard and motivate producers, the government should provide financial assistance through its fiscal policy low-interest lending schemes. In May 2020, the government introduced Scheme Atmanirbhar Bharat Abhiyan, which is concerned with MSMEs, agriculture, migrant workers, non-financial firms, public health, and other issues. Tranches 2 and 3 of the Atmanirbhar Bharat Abhiyan are primarily concerned with agriculture, animal husbandry, and fisheries, among other things. However, this strategy will only succeed on the ground if the government directly involves rural local governments.

(3) Infrastructure Facilities

Physical and non-physical infrastructure enhancements that are crucial to a country's economic success are referred to as infrastructure development. Infrastructure development is a critical generator of productivity and a key driver of economic growth. Agricultural infrastructure investment has mostly concentrated on warehouses,

mandis, buffer storage, irrigation, road and transit networks, and so on. All of these services are provided by the government through social overhead capital (SOC). Agriculture's contribution of GVA must be enhanced because it draws private investment. The outbreak has made it harder to store perishable commodities (such as horticultural and dairy products). Cold storage facilities created up to the block level may benefit farmers and migrant labour.

(4) Agriculture Insurance Plans

Agriculture, in general, is a sort of risk management used to deal with poor weather, market changes, natural calamities, and so on. The government already has a programme called the PM FasalBima Yojana. This scheme covers numerous risks that impact agricultural production (for a low premium). Because a huge number of farmers are unfamiliar with this strategy, the government should make it known. After all, the literacy percentage in the primary sector is low.

(5) Agricultural Diversification and Value Addition

Agriculture diversification is an important part of economic development. It is the point at which traditional agriculture is transformed into a dynamic and commercial industry by moving the traditional agricultural product mix to high-quality commodities with the potential to increase product price. It can be accomplished in a variety of methods, including increasing structural diversity, combining cropping systems, polyculture, and agroforestry, among others. It will aid in increasing the production of small land holdings because the majority of lands in India are marginal and small. Because approximately 75 percent of farmers in India have land under 2 hectares, agriculture or cropping should be diversified with high-value crops.

(6) Institutional Infrastructure

Agricultural research, extension and education technology, information and communication services, financial services, and marketing are all

examples of institutional infrastructures. Indian agricultural research lagged behind that of the United States and other affluent countries. Dependence on farming is quite low in developed countries, yet production per farmer is very high since they benefit from research, machinery, and education. In India, farming employs the majority

of the people, and this industry is also experiencing cyclical and disguised unemployment due to a lack of research. The government should expand its investment in the study and become more involved directly by providing institutional facilities and communication services. ■

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