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Quantifying the effect of COVID-19 pandemic lockdown among the summer crop growers of Uttar Pradesh

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ABSTRACT

Telephonic survey was done with randomly sampled 570 farmers spread across 57 districts representing eastern (16 districts), western (17 districts), central (16 districts) and Bundelkhand (7 districts) zones of Uttar Pradesh during the period of 20 April–25 June, 2020 to ascertain the effect of COVID-19 lockdown on the investment and profitability of the summer crops grown by them. Farmers' responses were compared with their observations on the same variable during the same period of previous year, i.e. 2019. Suitable descriptive and inferential statistical treatments were given to collected data. Results established that there was maximum increase in all cost components for summer maize (8.74–16.21%) followed by okra (7.40–16.24%) and bottle gourd (7–16%). Summer greengram also had similar trends of cost increase (8–17%). Summer groundnut (3.55–5.54%) witnessed a relatively lesser increase for all costs except the plant protection cost (20.19%). Thus, compared to last year (2019), the cost components significantly increased for all the cultivated crops in summer. However, the government facilitation coupled with favourable climatic conditions helped the summer crop growers to harvest better yield advantage (4–10%) and accordingly the enhanced market price (5.02–8.52% more) increased profitability index (1.02–14.44%). The parameters like per unit production and plant protection cost emerged as the most prominent determinants of the net return of most of the summer crops during COVID-19 lockdown.

Keywords: COVID-19 lockdown, Investment, Profitability, Quantity relative index, Summer crops

Coronavirus outbreak was declared to be a public health emergency of international concern during January 2020 (Sohrabi *et al.* 2020, World Health Organization 2020) and a month later its official name was COVID-19. India witnessed 77.8 lakh confirmed cases on 23 October 2020 with death cases of 117474 (1.51%) and recovery of 69.66 lakh (89.51%) (Anon 2020) implying, thereby that COVID-19 spread widely in India with relatively lesser impact on human lives as compared to many developed nations like USA, France and Australia (Mahendra Dev S 2020). Due to lockdown as imposed owing to COVID-19, the economic shock was much more severe for India mainly because of two reasons, i) the economy was already slowing down, compounding existing problems of unemployment, low incomes, rural distress, malnutrition, and widespread inequality and ii) India's large informal sector is particularly vulnerable (Rawal and Kumar 2020). There are multiple implications of COVID lockdown in the Indian agricultural sector also. However, the reported production of *rabi* (2019–20) was not less than a record of 134 million tonnes (4.5% higher of last year) as also estimated same by ICRISAT (2020) and Carberry and Kumar (2020). The Government of India took special measure for economic backstopping of farmers by financial supports and other measures like free of cost food supply. As a result, not only the good performance of *rabi* crops, the net area sown for summer crop was 34% higher than the area sown last year (Vishwa Mohan *et al.* 2020). Further, it was estimated by Pinto *et al.* (2020) that there was about 14% increase in sowing area under *kharif* cultivation that year, compared to last year (2019). Farmers of the state of Uttar Pradesh were also better insulated from lockdown shocks (Anon 2020a). Thus, it is essential to have an objective analysis as to how the different indicators of investment and profitability of summer crops have been impacted owing to COVID-19 lockdown through a systematic field based study. The study therefore was an attempt to quantify the effect for important summer crops (cereal, pulse, oilseed and vegetable crops) in one of the

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major agriculturally important states of Uttar Pradesh.

MATERIALS AND METHODS

The present study was carried out in the state of Uttar Pradesh by covering all the 75 districts during the period of 20 April–25 June, 2020. From the list of FLD beneficiary farmers of KVK during the previous year of the study (usually 50–60 per KVK), the sampling frame was designed. Thus from each of 75 districts, 10 farmers were approached telephonically. However, owing to the limitations of telephonic survey in terms of non-willingness of the subject to join interview, giving inadequate information in the interview and leaving the interview in between, we could get the complete desirable data from 57 districts (76%) out of 75. Therefore, those who actually participated in interview constituted the sample (out of total population of 3420) for the investigation. Thus the randomly sampled 570 farmers were interviewed telephonically and personally also (by engaging the related Krishi Vigyan Kendras (KVKs) of the district) during the period of 20 April–25 June 2020 giving the situation of lockdown and partial unlock period. The sampled districts represented eastern (16 districts), western (17 districts), central (16 districts) and Bundelkhand (7 districts) zones of the state to have realistic representations of the crop cultivators of the state. Thus a total of 570 farmers were interviewed telephonically using the structured interview schedule. The post-stratification of the collected data showed that there were 330 data points for green gram cultivators, 230 for summer maize farmers, 250 for summer groundnut farmers, 270 for bottle gourd farmers and 250 for okra farmers. Thus, cereal (summer maize), pulse (summer greengram), oilseed (summer groundnut) and vegetable crops (bottle gourd and okra) of summer season were taken for analysis. The respondents were asked to furnish the response on the summer crops for the year 2019 (April–June) as well as 2020 (April–June) to assess the effect of COVID-19 lockdown on the investment and profitability parameters of these crops. Thus, the before-after research design (Kerlinger and Print 1986) was utilized for the present study. As it was a matter of fact that for ensuring the robustness of before-after research design, it is imperative that the untreated group also may be included to arrive at the exact effect by offsetting the space bias. However, in this particular case of investigation, as the lockdown was spread across all the districts of Uttar Pradesh state, the scope of recording data from without a lockdown environment did not exist. Hence, whatever effect of lockdown (2020) could be estimated that was with reference to the same period of the last year (2019) and hence, it was the net effect of lockdown. Thus, the robustness of the research design of the study was ensured. The major research variables were the investment and the profitability parameters of summer crops affected due to COVID-19 lockdown. The indicators taken underinvestment variables were the area allotted (ha) for selected summer crops, seed cost (₹/q), cost of land preparation and irrigation (₹/ha), cost of plant protection (₹/kg) and overall cost of production (₹/ha). Likewise, for profitability variables, the indicators included were yield obtained (q/ha), market rate (₹/q), gross return and net return (₹/ha) and profitability index (B:C ratio). The collected data were adequately curetted for eliminating the outliers. It has been hypothesized (null hypothesis) that if at all there is any significant effect of COVID lockdown on these indicators of the selected crops, the observations shall remain comparable (H_o) between the selected years and the crops. For assessing the difference in performance of years (2019 and 2020) objectively, Quantity Relative Index (QRI) for each research variable for all selected five summer crops was calculated using following formula:

$$QRI = \sum_{i=1}^{n} [(Q_{2i} - Q_{1i})/Q_1] \times 100$$

Where, Q_{2i}, Value of the indicator for second year (2020) for i^{th} respondent of given crop; Q_{1i}, Value of the indicator for previous year (2019) for the same respondent and; n, Number of observations.

The QRI values were used for estimating the average change in the selected parameters between the years and also for employing regression analysis to assess the effect of all the investment and return related indicators on the dependent variable, i.e. net return (₹/ha). Besides, the data were also collected from 110 scientists of the selected 57 KVKs to capture their perception of the effect of lockdown on the different summer crop growers even during partial unlock period in their district to cross-validate the results. The data collected on the above parameters were subjected for descriptive analysis namely average, percentage, rank, standard deviation (SD) and coefficient of variation (CV) and also the inferential statistics of paired t-test (two-tailed) to see the difference of mean between the years, i.e. 2020 and 2019 as well as the Duncan Multiple Range Test (DMRT) (Duncan 1955) to see the significance of difference of means between the crops for all parameters if any during 2020.

RESULTS AND DISCUSSION

Investment pattern affected owing to COVID 19 lockdown: As the effect of lockdown (2020), the area allocated for various summer crops remained comparable to the year 2019 which is evidently shown to vary non-significantly in Table 1 for all crops except for okra ($P<0.01$). However, the relative stability in area allocation under various summer crops seems to be lesser (CV: 21) in the year 2020 as illustrated from Graph 1. At the same time, the inter-crop area allocation was observed to vary minimally between summer groundnut (0.94 ha) and bottle gourd (0.98 ha) versus rest of the other crops (1.59–1.79 ha) which may be due to the farmers' relative and differential preference of these crops. The results of non-significant variation in area allocation of all the summer crops (except okra) over the last years implied that there was no perceptible effect of COVID-19 lockdown during 2020 and it remained exclusively the farmers' personal choice of allocating the area for different crops. Average per cent

Table 1 Effect of lockdown on average investment made by the farmers for summer crops

Crop	Area allotted (ha)		Seed cost (00' ₹/kg)		Land preparation cost (thousand ₹/ha)		Irrigation cost (thousand ₹/ha)		Plant protection cost (thousand ₹/ha)		Cost of production (thousand ₹/ha)	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Greengram	1.80	1.78[a]	1.25	1.32[a]	6.47	7.20[a]	5.49	5.86[a]	2.32	4.90[a]	18.42	19.60[a]
	(0.880) [117.85)		(0.059)[108.79]		(0.00079*) [111.17]		(0.015**) [111.59]		(0.0007*) [117.85]		(0.009*)[108.21]	
Summer maize	1.60	1.79[a]	2.47	2.78[a]	8.83	9.54[b]	7.74	8.42[b]	3.22	3.73[b]	29.11	33.39[b]
	(0.052) [101.73]		(0.0002**) [112.69]		(0.0001**)[109.20]		(0.0271*)[108.26]		(0.0005**)[116.21]		(0.0003**) [108.74]	
Summer groundnut	0.93	0.94[b]	1.14	1.18[a]	7.84	8.31[c]	8.87	9.13[c]	1.90	2.37[c]	46.86	49.46[c]
	(2.361)[101.28]		(0.099)[103.55]		(0.005*)[108.77]		(0.589)[104.40]		(0.008*)[120.19]		(0.0393*)[105.54]	
Bottle gourd	0.86	0.98[b]	3.14	3.64[c]	8.40	9.39[b]	8.66	9.65[c]	3.89	4.57[a]	42.72	46.54[c]
	(0.077)[111.33]		(0.0599)[116.22]		(0.000**)[113.21]		(0.000**)[111.72]		(0.0012**)[118.56]		(0.0029**) [106.83]	
Okra	1.26	1.59[c]	2.02	2.22[b]	4.12	4.57[d]	3.93	4.24[a]	2.92	3.27[b]	54.69	58.28[d]
	(0.0051**) [116.24]		(0.0027**) [111.22]		(0.360)[108.22]		(0.0007**) [108.08]		(0.0049**)[114.10]		(0.00049*) [107.40]	

2019–20, Lockdown period (March–May, 2020); 2018–19, No Lockdown period (March–May, 2019). Figures in ( ) indicate t-value (two-tailed); figures in [ ] indicate quantity relative index. * P<0.05; ** P<0.01; Values in every column bearing similar superscripts do not vary significantly (P<0.01 and P<0.05) for each indicator during lockdown period.

area, albeit increased and it ranged from 1.28% (summer groundnut) to 26.73% (okra) during 2020 over the year 2019. Vishwa Mohan *et al.* (2020) however, had reported to have net sown area increase for summer crops during 2020 as compared to 2019.

Likewise, the average seed cost was highest for bottle gourd (₹3.64 hundred/kg) and lowest for summer mungbean (₹1.32 hundred/kg) during the year 2020 (Table 1). Compared to last year, the seed cost was significantly higher (P<0.01) for summer maize (₹2.78 hundred/kg) and okra (₹2.22 hundred/ha) with their respective QRI of 112.69 and 111.22. The results imply that over the year 2019, there was considerable increase in seed price of summer maize and okra during COVID-19 lockdown period. Though the QRI was highest for bottle gourd (116.22) but this increase was not significant when compared with previous year (2019). In general, the average increase of seed price for all crops ranged from 3–16% during 2020.This may be because of the fact that the sowing of summer vegetable crops mostly depends on seed procured from the private or government seed agencies every year rather than using the home saved seed as the case may be for summer greengram and groundnut. Jump in the cost of seeds in Jharkhand and Bihar by as much as 15–25% was also reported (Anon 2020a),

In the similar manner, the average land preparation cost of all crops ranged from ₹9.54 thousand/ha (summer maize) to ₹4.57 thousand/ha (okra) during the lockdown period. As compared to previous year (2019), the cost was significantly more (P<0.01) for summer maize (₹9.54 thousand/ha), bottle gourd (₹9.39 thousand/ha), summer groundnut (P<0.05; ₹8.31 thousand/ha) and greengram (P<0.05; ₹7.20 thousand/ha) during 2020 with their respective QRIs of 109.20, 113.21, 108.77 and 111.17 over the year 2019. It helped to infer that the increase in land preparation cost during lockdown was observed because of the restricted movement of village labour and as a result, their supply was reduced which enhanced their cost. The relative variation in the land preparation is indicated in Fig 1. Kumar *et al.* (2021) had also observed the similar trends on cost components which increased but did not become much unbearable may be because of the cushioning effect of government initiatives at least in Uttar Pradesh state.

During the period of lockdown, the average expenses on irrigation were also noted to be significantly more for bottle gourd (₹9.65 thousand/ha, P<0.01) followed by summer groundnut (₹9.13 thousand/ha, P<0.05), greengram (₹5.86 thousand/ha, P<0.01) and okra (₹4.24 thousand/ha, P<0.01) as compared to their respective cost in the year 2019. The enhanced irrigation cost may also be because of increased labour cost and irrigation charges during lockdown period in the study areas. The QRIs for the above crops were 111.72, 104.40, 111.59 and 108.08. For summer groundnut, the increase in cost was non-significant may be because of relatively lesser water requirements in this crop as compared to other summer crops.

Data in Table 1 further indicate that due to the lockdown during 2020, average plant protection cost was very significantly (P<0.01) higher for summer maize with QRI value of 116.21, bottle gourd (QRI value 118.56) and okra (QRI = 114.10), and significantly (P<0.05) higher for greengram (QRI value 117.85) and summer groundnut (QRI = 120.19) over the last year (2019). It implied that for all crops, the plant protection cost increased to the extent of 14–20% during the lockdown period. This is comprehensible

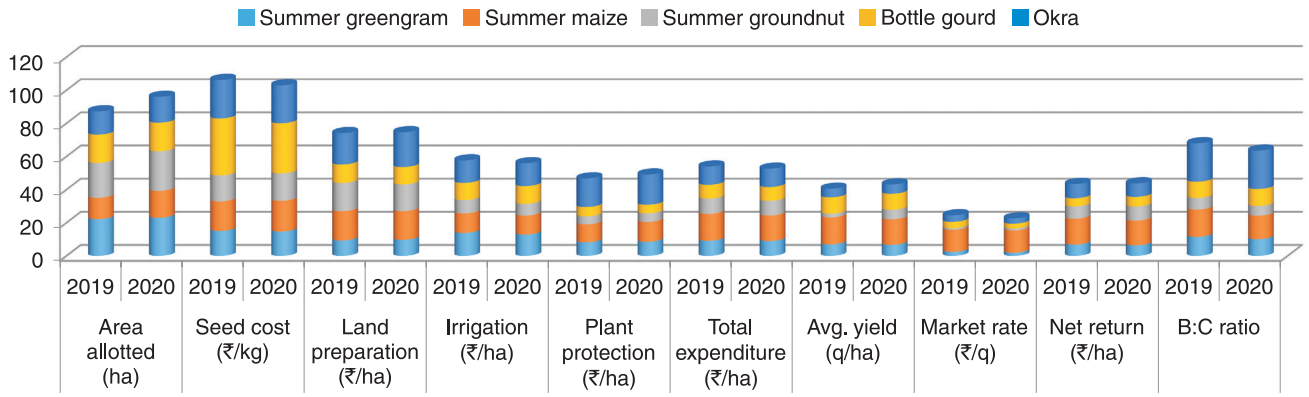

Fig 1 Indicator-wise and year-wise relative stability (CV) of various summer crops due to lockdown.

on the fact that during the lockdown most of the shops and outlets pertaining to agricultural inputs were closed despite the relief given by the Government of Uttar Pradesh for such agencies. Variation in the total expenses was more or less stable (CV: 6.1–18.2) (Fig 1).

Returns pattern affected owing to COVID-19 lockdown: The yields (q/ha) of the selected crops in the study are as per the attributes and physiological specifications of crops. Hence comparison of inter-crop yield carries little implications. However, it is interesting to see the comparative yield difference between post lockdown period (2020) and previous year (2019). The results as shown in Table 2 indicate that the yield was increased highly and significantly (P<0.01) only for the summer maize during 2020 (43.03 q/ha) as compared to last year which may be because of relatively more favourable climatic situations for the summer maize in 2020. For others, the yields in both the years were comparable. The non-significant difference in yield for other crops between the years has definitely no influence of lockdown as the yield depends on genetic and environmental interaction rather than any other abiotic event like COVID-19 lockdown. The average yield increase, however, ranged from 3.83% for bottle gourd to 10.27% for summer groundnut as indicated by their respective QRI values. The above magnitude of yield increase may be attributed only to the favourable climatic conditions and management practices followed by the farmers. The relative stability (CV) of the yields showed little variation (Fig 1).

As indicated above, the yield of the different summer crops did not have any influence of COVID-19 lockdown, their market price, however, varied pre-COVID-19 lockdown or aftermath and partial unlock phase. Data contained in Table 2, show that there was highly significant (P<0.01) increase in the market price of summer groundnut (6.44%), bottle gourd (8.52%) and okra (5.02%) over the last year with their average market price of ₹4.60 thousand/q, ₹1.43 thousand/q and ₹1.58 thousand/q respectively. Similarly, for greengram (6.65%) and summer maize (5.80%), there was significant increase (P<0.05) in market price during 2020. The lockdown had an influence on the increase of market

Table 2 Effect of lockdown on economic indicators of summer crops

Crop	Yield (q/ha)		Market rate (thousand ₹/q)		Gross return (thousand ₹/ha)		Net return (thousand ₹/ha)		B:C ratio	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Greengram	11.22	11.63[a]	6.54	6.93[a]	45.10	55.79[a]	26.29	32.49[a]	3.46	3.65[a]
	(0.134) [106.71]		(0.00079)* [106.65]		(0.0012)*[114.14]		(0.0011)*[119.89]		(0.329)[105.69]	
Summer maize	39.11	43.03[b]	1.84	2.00[b]	55.40	59.99[b]	25.29	26.60[b]	2.31	2.32[b]
	(0.0061)**[110.26]		(0.010)*[105.80]		(0.0008**)[115.69]		(0.00061**)[114.23]		(0.894)[111.47]	
Summer groundnut	21.50	22.20[c]	4.32	4.60[c]	92.88	102.12[c]	51.13	53.00[c]	1.78	2.06[b]
	(0.1422)[110.27]		(0.009)**[106.44]		(0.0001**)[116.63]		(0.0004**)[105.61]		(0.143)[114.44]	
Bottle gourd	260.00	273.00[d]	1.33	1.43[b]	344.28	383.50[d]	301.56	336.91[d]	8.10	7.11[c]
	(0.0948)[103.83]		(0.0050**)[108.52]		(0.0024**)[110.79]		(0.0013**)[113.70]		(0.047)[101.02]	
Okra	165.50	166.20[e]	1.52	1.58[b]	97.79	101.02[e]	43.10	42.74[e]	7.67	7.21[c]
	(0.0954)[104.33]		(0.0004**)[105.02)		(0.390)[104.97]		(0.0288)[102.55]		(0.407)[[100.22]	

2019–20, Lockdown period (March–May, 2020); 2018–19, No lockdown period (March–May, 2019). Figures in ( ) indicate t-value (two tailed); figures in [ ] indicate quantity relative index. * P<0.05; ** P<0.01; Values in every column bearing similar superscripts do not vary significantly (P<0.01 and P<0.05) for each indicator during lockdown period.

price of various commodities. However, for summer crops in Uttar Pradesh, the favourable climatic condition during 2020 favoured their production which ensured the adequate availability of produce in the market. Therefore, the market price did not witness much increase in post lockdown. In many instances, the price has gone down. The variation in market price (Fig 1) was observed to be highest (CV: 15.39%) for summer maize and for others it ranged from 5.81–6.68.

The returns for different summer crops were analyzed in terms of average gross return (AGR) and average net return (ANR) for before (2019) and partial unlocking (2020) period and has been presented in Table 2. Results show that both the AGR and ANR increased very significantly (P<0.01) during the post lockdown period for summer maize (14–16%), bottle gourd (11–14%) and summer groundnut (6–17%) as indicated by their respective QRI. For green gram, the average increase (QRI) recorded was significantly more (P<0.01) and it was to the extent of 14–20%. For okra, the increase was minimal (1–3% only). The enhanced return from different crops in post lockdown period may be actually attributed to the fact that relatively more remunerative market value was realized to the produce which might be facilitated by the state Government even in the situation when there was increase in different cost components (Table 1). Between the crops also, the magnitude of return varied because of the differential level of expenditure incurred, yield obtained and market price received as depicted in Table 2. The variation (CV) in the net return was prominent for summer maize (Fig 1).

The results as shown in Table 2 again indicate that the profitability index did not change significantly due to the lockdown effect as compared to previous year (2019) for any of the crops selected. The average quantitative increase in the profitability index was maximum for summer groundnut (14%) followed by summer maize (11.47%), green gram (5.69%) and bottle gourd (1.02%) as reflected by their respective QRIs. There was the lowest gain in the profitability index of okra (0.22%). Another important observation of the result was the significantly (P<0.01) more B:C ratio of the bottle gourd (7.27) and okra (7.21) over summer green gram (3.65^a), summer maize (2.32^b) and summer groundnut (2.06^b) with intra-crop significant variation (P<0.05) as indicated by the different superscripts. The trend is expected as the vegetables being the high value and commercial crops, their relatively higher profitability index over other crops is comprehensible.

Determinants of the net returns for different summer crops: The QRI for all the selected indicators of both the variables were subjected for crop-wise regression analysis with QRI of the net return of the respective crops to identify the most significant variable determining the variation in the net return after the lockdown period. The results have been presented in Table 3. Data show that for summer mungbean, the yield was the most significant (P<0.01) variable which determined about two fold (b-value: 1.90) gain in the net return due to its unitary gain (R^2 value= 0.596 with highly significant F value (P<0.01). For summer maize, the economic indicators viz., plant protection cost, per unit production and total expenditure predicted very significant (P<0.01) effect in the net return and caused the magnitude of 2.16, 3.47 and -7.61 increase or decrease in the net return due to their respective unit change (R^2= 0.85 and the significant F value). For summer groundnut, two variables namely seed cost (b-value: 1.28) and per unit production (b-value: 3.21) very significantly (P<0.01) predicted the variation in itsnet return. This results is comprehensible on the ground that as this crop is high volume in nature, the

Table 3 Predictors of the QRI of the net profit of all summer crops

Crop variable	Greengram		Summer maize		Summer groundnut		Bottle gourd		Okra	
	b-value	p-value	b- value	P-value	b-value	P-value	b-value	p-value	b-value	p-value
Intercept	-11.3633	0.890156	-616.097	0.083871	-500.429	0.00096	16.239	0.7827	-138.71	0.8204
Total expenditure incurred (₹/ha)	-0.68756	0.136931	-7.60933	0.005986	-0.31285	0.64094	0.3479	0.4796	5.4548	0.2412
Land preparation cost (₹/ha)	0.031668	0.941514	3.03292	0.315546	-0.07104	0.95211	-0.059	0.7904	-7.0154	0.0023
Area allotted (ha)	-0.01386	0.908183	0.457079	0.183605	-0.01555	0.85814	0.0432	0.6834	-0.0866	0.8941
Seed cost (₹/kg)	0.185263	0.638469	3.776005	0.069988	1.278548	0.00211	0.0754	8.1E-05	-1.8861	0.1658
Irrigation cost (₹/ha)	-0.00864	0.975433	1.467671	0.480467	1.388328	0.13294	-0.236	0.329	3.88150	0.0093
Plant protection cost (₹/ha)	-0.14407	0.651678	2.163892	0.002536	0.411414	0.25880	-0.050	0.8470	-4.1191	0.1494
Per unit production (q/ha)	1.904748	3.91E-05	3.46915	0.002085	3.205583	5.8E-1	0.8498	0.0126	2.77711	0.1381
F-value	5.267 **(P<0.01)		12.397** (P<0.01)		125.97**(P<0.01)		5.721**(P<0.01)		5.6812**(P<0.01)	
R^2 value	0.596		0.852		0.979		0.678		0.642	

use of right quantity and correct quality of seed shall have definite bearing on its seed cost as well as the yield and finally the net return (R^2 value=0.97 with significant F value (P<0.01) Likewise, for bottle gourd also, the two variables namely the seed cost and per unit production emerged as the highly significant determinants (P<0.01) for its net return. The argument similar to summer groundnut holds true for bottle ground also with only contrary to this crop being the low-volume and high value. The prediction model again proved to be valid. Lastly, for okra, none of the identified variable appeared to be the significant determinants for its net return (R^2=0.44) indicated that most of the variation (0.56) in the net return remained unexplained which may be attributed to other variables which were not included in this study.

Experiences of the investigation confirmed that there was influence of lockdown on the selected summer crops on their investment (1.28–17.85% cost increase) and profitability (1.02–19.89% increase) variables. Moreover, the intercrop significant variation of all the indicators further confirmed that the bio-physical behaviour of crops having different physiological specifications was not at all affected because of the situations created by abiotic event lockdown due to COVID19 pandemic. Thus the formulated null-hypothesis (H_0) was rejected. The experiences guide the related research managers, development administrators and policy makers alike to continuously sustain their efforts for higher priority to the agriculture sector which can be the only survival option amidst any man-made crises.

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