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The Pandemic COVID-19 and Its Impact on Indian Agricultural Sectors:
An Assessment of Farmers

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ABSTRACT

The outbreak of COVID-19 has created a major panic among the agricultural sectors as well as the farmers in India owing to its transmissions, severity, and a lack of proper treatment methodology. From the cross-sectional study, with the help of designed questionnaire relating to the demographic-information; knowledge, attitudes, and practices of Indian farmers; and DASS-21 variables, the data from 143 farmers were collected and analyzed. Further, by using the interpretive structural modeling (ISM) approach, an ISM model was developed followed by MICMAC analysis for possible mitigation measures during this pandemic outbreak. The findings provided the interrelationships among the possible mitigation measures for the farmers as well as for the benefits in Indian agricultures, which can be suitably used in appropriate psychological intervention preparation for improving the mental health among the farmers during this pandemic period.

KEYWORDS

Agriculture, Coronavirus, COVID-19, DASS-21, Farmers, India, Interpretive Structural Modeling, ISM, Questionnaires

1. INTRODUCTION

The "coronavirus-disease in 2019 (COVID-19)" that is an epidemic in China has been turned into a serious health-threat globally (Wang, 2020), and is the prime-outbreak of a typical 'pneumonia' since the "severe acute respiratory syndrome (SARS)" outbreak in 2003. However, the initial-outbreak of the total number of cases in addition to the deaths have exceeded than that of SARS within few weeks (Hawryluck, 2004). In the late December 2019, the outbreak was revealed initially when a number of unknown etiology related pneumonia cases were recognized in the city of Wuhan of Hubei region (Nishiura, 2020). Moreover, by 30 January 2020, the number of cases has been escalated exponentially with spreading to more 34 regions of China. In the earlier time period, India had to deal with diseases such as the plagues, small-pox, and polio, etc. However, the Covid-19 which is

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rapidly spread to most of the countries in the world over the next few months can result to a biggest potential health-crisis in the history.

The first disease-case in India has been recorded on January 30, 2020, and since there have been a steady and significant increase in the number of cases. The declaration of the COVID-19 outbreak as a 'public health-emergency of international-concern' was made by the "World Health Organization (WHO)" (Mahase, 2020). Moreover, because of this pandemic situation, not only the general public, but also the farming communities from the agricultural sectors all over the world have been under psychological-stresses. Therefore, this study aimed at exploring the psychological-impacts in addition to the mental-health of the farmers in India during the COVID-19 outbreak.

Similar to SARS, the COVID-19 is a 'beta-coronavirus' capable of spreading to human-beings through intermediate congregations (Paules et al., 2020). The COVID-19 transmissibility has been estimated to be 4.08 as indicated by its' reproductive-number (Cao, 2020), which suggest that the creation of up to four new cases may occur by every COVID-19 case on an average. With significant variations, the average incubation-period has been estimated as 5.2 days among the patients (Li, 2020), that may cause in a symptomatic spreading (Rothe, 2020; Ryu and Chun, 2020). The infection symptoms include chills, fever, cough, sore-throat, coryza, breathing-difficulties, nausea, myalgia, diarrhea and vomiting (Chen, 2020), with severe-cases leading to cardiac-injuries, respiratory-failures, acute-respiratory distress-syndromes in addition to deaths (Holshue, 2020). The older men having medical co-morbidities are more prone of getting infected resulting in worst consequences (Chen, 2020). Shortages of masks as well as health-related equipment have also been accounted in the due course of time. Moreover, the ongoing COVID-19 epidemic was reported of inducing fears among people, and thus, it is an urgent requirement to understand the mental-health status in-time for the society (Xiang, 2020). It has been revealed in previous researches about deeper as well as wider ranges of psychosocial-impacts on peoples during the outbreak of infection at individual, community in addition to the international levels. Peoples are more likely in experiencing fears at individual levels regarding fall of sick, stigma and helplessness feelings (Hall and Chapman, 2008). About 10-30% of general-public were fairly or very much worried regarding the possible contract of the virus, during the outbreak of inñuenza (Rubin et al., 2010). The negative emotions that the individuals experienced were reported to be compounded with the closures of businesses as well as schools (Van Bortel, 2016). It has been revealed through many studies of significant psychiatric-morbidities during the SARS outbreak, which investigated the psychological-impact on the non-infected community, that were found to be associated with younger age-groups (Sim, 2010). At present there is a lack of information on the psychological-impacts as well as mental-health of the general-public during the peak-period of the COVID-19 epidemic, and most of the related researches on this outbreak have focused in the identification of the epidemiology as well as clinical-characteristics of the infected-patients (Chen, 2020; Huang, 2020), genomic-characterization of the virus in association with COVID-19 (Lu, 2020), the "small-manufacturing enterprises (SMEs)" (García-Vidal et al., 2020), and the worldwide health-governance challenges (Rubin and Wessely, 2020). However, there has been a lack of research that examined the psychological-impacts of COVID-19 on agriculture in addition to the associated farmers' in the Indian agricultural sectors, in particular. Thus, this study mainly focussed on two major objectives that represented the novelty of this research, such as: a) to find the prevalence of psychiatric-symptoms among the Indian farmers; and b) to identify the risk-factors that contributed to the psychological stresses among these farming communities.

To achieve the research goal, this work was organized as follows: Section 1 summarized the literatures related to the impact of the pandemic COVID-19 on the global including the Indian agricultural sectors, and the usefulness of the "Interpretive structural modeling (ISM)" approach in identifying the relationships among different factors that describe a complex-problem; Section 2 summarized the detailed steps followed for this research; Section 3 summarized the results obtained, such as the demographic-information of farmers; the knowledge, attitudes as well as practices of farmers on COVID-19 in Odisha (India); the association among demographic-information as well

as knowledge, attitudes and practices of farmers; the farmers' depression, anxieties and stresses levels that were measured by the use of DASS-21 variables-scale; the association among farmers' practices as precautionary-measures against COVID-19 infections and "depression, anxieties as well as stresses" based on DASS-21 scale; the present problems associated with the agricultural sectors of India and their possible mitigation measures in view of the pandemic COVID-19 consequences on the basis of experts' analysis; the interrelations in order to generate the ISM model for the possible mitigation measures in Indian agricultural sectors. Further, Section 4 focussed about the findings with global-perspectives of information systems in agriculture for the benefits of farmers in addition to its' associated problems; and finally, this work was concluded in Section 5.

1.1 Agricultural Impacts of COVID-19

The contagious-disease such as COVID-19 has been threatening as well as disturbing humanity. Past experiences on pandemics have shown the quarantines & panic having impacts on human-activities and economic-growth (Arndt and Lewis, 2001; Bermejo, 2004; Hanashima and Tomobe, 2012), but, these also effect the agricultural-activities. With an outbreak of infectious-diseases, there also occur augmented hungers and starvations (Burgui, 2020; Sar et al., 2010). With the progress of the disease, the situation worsens that make more stringent restrictions in movement resulting in labor-shortages during harvesting periods, also make difficulties for farmers in bringing the agricultural-products to markets. The food-security is mainly related to agriculture which is regarded as one of the most important human-development sector (Abdelhedi and Zouari, 2020; Kogo et al., 2020; Lopez-Ridaura et al., 2019). In case of livestock-sectors, enormous losses have been reported in India because of diseases like cystic-echinococcosis and brucellosis (Singh et al., 2014; 2015). Significant health as well as economic burdens was reported in developing countries due to zoonotic diseases (Halliday et al., 2015). Several zoonotic-pathogens have been a serious public and animal health-concerns in India, such as, rabies related deaths were about 20,000 (Knobel et al., 2005). The zoonotic-diseases are also taken to be occupational health-hazards (Battelli, 2008). Klous et al. (2016) have revealed that the livestock-owners are subjected to various type & intensity of 'human-livestock contacts' that may result in transmitting of microorganisms in addition to the associated zoonoses. In India, the higher risk potential for the occurrence of zoonotic-diseases in the livestock's in addition to its' keepers are because of inadequate knowledge regarding the disease-transmissions, preventions and control-measures (Singh et al., 2019).

According to the statement of "FAO (2020a)", the agriculture is affected by the COVID-2019 in two significant aspects such as food supplies and demands that are directly related to food-security, and thus, making food-security to be at higher risk. Siche (2020) has revealed of significant effect of the pandemic COVID-19 disease on agricultures as well as the food supply-chains. It was reported of affecting the food-demand and the food-security with greater impacts for the most part of vulnerable population. Moreover, the food supply-chain is a network connecting agricultural systems to the consumers, which include the processes, for example, manufacturing, packaging, distributions, and storages (Chen et al., 2020). At the initial stages, the individuals were required to go to the providing centres generating shortages of some products due to the announcements of social-isolation, but despite of this, stabilization in the food delivery has been established with the view to ensure a balanced food-security. An uninterrupted and continuity in operation of 'food value chains' have been a key role of "Food and Agriculture Organization (FAO)" (FAO, 2020b). Therefore, even though there have been imposed restrictions by governments on the labor-mobility in agricultural systems, providing the basic necessities are normally assured even with the occurrence of some problems. For imported or exported goods, the situation is somewhat different owing to the border-closers, and interrupted international-trade. Zhang (2020) has revealed of a greater impact by COVID-19 pandemic on the livestock-sectors because of accessing difficulties in animal-feeds and shortages of labor.

1.2 Interpretive Structural Modeling (ISM)

Moreover, in order to identify the relationships among different items that help in describing a problem, the "Interpretive structural modeling (ISM)" has been found to be a well-established methodology. With the view of analyzing complex 'socio-economic systems', the ISM was initiated and developed by J. Warfield in 1973 (Warfield, 1974). The key objective of ISM outlines the classification as well as evaluation the relationships between different variables, which defines a problem or issue with the utilization as well as help of the experts' knowledge and skills for recognizing and identifying the nature of relationships between system-elements (Sage, 1977; Warfield, 1974). Individual application of the ISM approach can also be done, though it has been regarded mainly as a group-learning process (Elhiraika, 1996). An interactive-learning process can be achieved through ISM, and for certain issues, the combinational results of both the ISM method as well as the MICMAC analysis can help in providing a clear summary of the interactive-relationships among concerned elements (Attri et al., 2013).

The ISM approach has already been applied in different significant areas such as in automobile-industry (Ravi and Shankar, 2005); in manufacturing-industry (Dubey et al., 2017); in carbon-emission trading-systems (Shen et al., 2016); in analyzing the interactions between different barriers in energy-saving (Wang et al., 2008); in analyzing the drivers and barriers that influenced the green supply-chain-management implementations (Diabat and Govindan, 2011); in analyzing the interactions between different barriers in 'smart grid technology' (Luthra et al., 2014); and others. Moreover, Cai and Xia (2018) have identified seventeen elements having impacts on the "Characteristic Agriculture-Development project" implemented in area of Chinese-poverty, and examined the interrelationships between them based on ISM approach. Latifi et al. (2020) have used ISM as well as MICMAC method for representation of a comprehensive-model for "Conservation agriculture development" in Iran by the identification and determination the relationships between the institutional-drivers that influenced its promotion. Similarly, Bian et al. (2020) have used ISM and MICMAC method for the development of a hierarchical-structure by considering thirteen social as well as natural risk-factors affecting adversely to the fresh agricultural products' supply for analyzing the correlation among them. In this study, the ISM was used to find interrelations among the possible mitigation measures for the associated problems in the agricultural sectors of India in context with the adverse impacts of the pandemic COVID-19.

2. METHODOLOGY

To obtain the psychological-impacts of the pandemic COVID-19 on agriculture and the associated farmers in the Indian agricultural sectors, the present study was made in a step-by-step manner as illustrated in Figure 1.

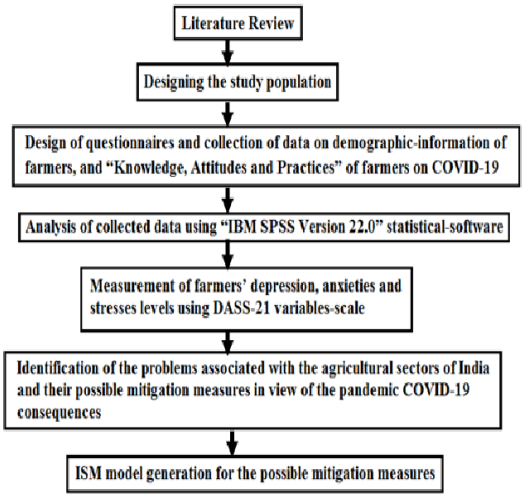
2.1 Study Population

The targeted population in this study included the farmers from the rural-areas of Odisha (India). Because of the movement restrictions, a total of 20 adjacent villages were selected from Khorda district in the state of Odisha. Out of 20 numbers of villages, a total of 150 farmers were selected randomly with the help and guidance of respective village heads for the subsequent studies.

2.2 Design of Questionnaires and Collection of Data

The questionnaire was designed and developed for collecting the detailed demographic-information and related knowledge, attitudes as well as practices of farmers about the pandemic COVID-19. The demographic-information included the age, sex, family-sizes, educational-levels, primary as well as secondary occupations, experiences in farming, and type of ownership of farming-lands. While, the questionnaire related to knowledge, attitudes as well as practices of farmers included the present issues in association with the COVID-19. Moreover, the mental-health status of the farmers was measured

Figure 1. Step-by-step procedures followed in this research



by the use of the "Depression, Anxiety and Stress Scale (DASS-21)" as shown in Appendix (Table 15), and the subsequent scores-calculations were based on the earlier-studies (Le, 2019; Vidyadhara et al., 2020). The questions 1 to 7 formed the depression sub-scale that was divided into "normal (0-9), mild-depression (10-13), moderate-depression (14-20), severe-depression (21-27), and extremely-severe depression (28+)". The questions 8 to 14 formed the anxiety sub-scale that was divided into "normal (0-7), mild-anxiety (8-9), moderate-anxiety (10-14), severe-anxiety (15-19), and extremely-severe anxiety (20+)". Similarly, the questions 15 to 21 formed the stress sub-scale that was divided into "normal (0-14), mild stress (15-18), moderate stress (19-25), severe stress (26-33), and extremely severe stress (34+)". Moreover, the DASS has been an established, reliable and valid-measure in order to assess the mental-health (Ho, 2019; Quek, 2018), which has also been used previously in SARS related research (McAlonan, 2007).

After distributing the questionnaires personally as well as through farmer-to-farmer to all the 150 selected individuals during the period of "March 15th 2020 to May 15th 2020", only 143 responses were collected. The collected responses were further considered for analysis.

2.3 Analysis of Collected Data

The questionnaires' analysis was conducted by the use of "IBM SPSS Version 22.0" statistical-software (2013, Armonk, NY: IBM Corp). As the first two questionnaires were based on "yes or no" type responses such as questionnaire for demographic-information and questionnaire for knowledge, attitudes as well as practices of farmers about the pandemic COVID-19, so for the statistical-analysis purpose, the response of "yes" was regarded as "1" and "no" was regarded as "0". Similarly, for the questionnaire of DASS-21, by summing the obtained scores from the respondents for the relevant-variables, the scores for all the three-subsets of depression, anxieties and stresses were calculated.

2.4 ISM Model Generation

With experts' analysis, the present problems associated with the agricultural sectors of India and their possible mitigation measures in terms of solution-parameters were identified in view of the pandemic COVID-19 consequences. Further, the ISM method was applied in this analysis for establishing a hierarchal-structure between the possible solution-parameters. Then, the MICMAC

analysis was employed for classifying the solution-parameters based upon their driving-power as well as dependencies.

The various steps of ISM approach (Kannan and Noorul Haqa, 2007; Kumar et al., 2009; Malone, 1975; Mishra and Satapathy, 2020; Satapathy, 2014; Sohani et al., 2012; Ravi and Shankar, 2005; Sushil, 2012), for this study included the following: (1) recognizing and identifying the relevant variables of the study, (2) establishing a "structural self-interaction matrix (SSIM)" by careful examination of pair-relationships among the identified variables with the help of experts' opinions, (3) constructing of the "SSIM reachability-matrix", (4) careful examination of the reachability-matrix for any contextual transitivity-relationships and constructing of the "final reachability-matrix", (5) performing of different levels partitioning of the final reachability-matrix obtained in the previous step (Dubey et al., 2017), (6) designing of a directed-graph followed by an ISM model with a subsequent check for conceptual inconsistency as well as necessary adjustments in the model.

For the development of SSIM, the following symbols (Mishra and Satapathy, 2020) were taken into consideration:

- Symbol V indicated of parameter 'i' in helping to accomplish parameter 'j'.
- Symbol A indicated of parameter 'j' in helping to accomplish parameter 'i'.
- Symbol X indicated of parameter 'i' as well as parameter 'j' in helping each other to be accomplished.
- Symbol O indicated of no-relation between both parameter 'i' and parameter 'j'.

Subsequently, the entry of (i, j) in the reachability matrix was placed with '1' for V as the (i, j) entry in the SSIM, and the entry of (j, i) was set to '0'; the entry of (i, j) in the reachability matrix was placed with '0' for A as the (i, j) entry in the SSIM, and the entry of (j, i) was set to '1'; the entry of (i, j) in the reachability matrix was placed with '1' for X as the (i, j) entry in the SSIM, and the entry of (j, i) was also set to '1'; and the entry of (i, j) in the reachability matrix was placed with '0' for O as the (i, j) entry in the SSIM, and the entry of (j, i) was also set to '0', respectively (Mishra and Satapathy, 2020).

Moreover, for identifying the key drivers that drive the system, a "Matrice d'Impacts Croisés Multiplication Appliquée á un Classement (MICMAC)" analysis was done that was developed by Duperrin and Godet in 1973 (Wang et al., 2008). To analyze the dependency as well as driving-power of concerned variables, the MICMAC analysis was used (Mandal and Deshmukh, 1994). The grouping of the drivers was made into four-clusters in accordance with the driving-powers as well as dependencies. In the grouping, the first-cluster (I) was composed of "autonomous-parameters" with poor driving-ability and heavy-dependency, which were fairly-disconnected from the network that can even be powerful having only a fewer relationships. The second-cluster (II) was composed of "dependent-parameters" with lesser driving-capacity, but with stronger dependencies. The third-cluster (III) was composed of "linkage-parameters" with stronger driving-power in addition to higher dependencies. The fourth-cluster (IV) was composed of "driving-parameters" with stronger driving-power, but with lesser dependencies (Mishra and Satapathy, 2020; Ravi and Shankar, 2005).

3. RESULTS

3.1 The Demographic-Information of Farmers

The demographic-information of the Indian farmers considered in this study was illustrated in Table 1. It was observed from a total of 143 numbers of farmers that, majority of respondents were aged between 36 to 45 years (32.17%), males (60.84%), education-levels of £10th (60.14%), crop-farming as primary-occupation (100%), dairy-farming as secondary-occupation (60.84%), number of household

Table 1. Demographic-information of farmers (n= 143)

Variables	Category	n (%)
Age in Years	11-25	05 (3.49)
	26-35	37 (23.77)
	36-45	46 (32.17)
	46-55	34 (23.77)
	56-65	13 (9.09)
	65+	08 (5.59)
Gender	Male	87 (60.84)
	Female	56 (39.16)
Education-level	Illiterate	33 (23.07)
	£10th	86 (60.14)
	£12th	21 (14.68)
	£Graduation	03 (2.09)
	£Post-graduation	00 (00)
	Doctorate or more	00 (00)
Primary-occupation	Crop-farming	143 (100)
	Dairy-farming	00 (00)
	Others	00 (00)
Secondary-occupation	Crop-farming	20 (13.98)
	Dairy-farming	87 (60.84)
	Others	22 (15.38)
	None	14 (9.79)
Number of household members	1 to 5	91 (63.63)
	6 to 10	51 (35.66)
	11 to 15	01 (0.69)
	16 to 20	00 (00)
	20+	00 (00)
Farming years	0 to 5	03 (2.09)
	6 to 10	09 (6.29)
	11 to 15	33 (23.07)
	16 to 20	76 (53.14)
	20+	22 (15.38)
Farmers' ownership of land	Yes	123 (86.01)
	No	20 (13.98)

*n= Total number of respondents

members of 1 to 5 (63.63%), expertise in farming of 16 to 20 years (53.14%), and with farmers' ownership of land of 86.01%, respectively.

Table 2. Knowledge, attitudes and practices of farmers on COVID-19 in Odisha (India)

Variables	Responses (n= 143)	
	Yes [n (%)]	No [n (%)]
Knowledge		
Do you have any idea of infectious diseases?	140 (97.90)	03 (2.09)
Have you heard about the COVID-19?	99 (69.23)	44 (30.77)
Do you know the transmission routes of COVID-19?	121 (84.61)	22 (15.38)
Do you know that COVID-19 has spread in India?	131 (91.60)	12 (8.39)
Do you know the primary causes of COVID-19?	98 (68.53)	45 (31.46)
Have you heard that the COVID-19 infected individuals number has increased in India?	113 (79.02)	30 (20.97)
Have you heard that the number of deaths of COVID-19 infected individuals has increased in India?	136 (95.10)	07 (4.89)
Have you heard that the recovery rate of COVID-19 infected individuals' number has also increased in India?	111 (77.62)	32 (22.37)
Attitudes		
Do you think the transmission of COVID-19 infections can be prevented through proper measures?	120 (83.91)	23 (16.08)
Do you think COVID-19 is curable?	56 (39.16)	87 (60.84)
Practices		
Do you cover mouth when cough and sneeze occurs?	84 (58.74)	59 (41.25)
Do you wash hands with the use of detergent or soap and water?	87 (60.84)	56 (39.16)
Do you avoid in utensils' sharing during meals?	78 (54.54)	65 (45.45)
Do you wash hands after in-contact or touching of contaminated-objects?	112 (78.32)	31 (21.67)
Do you immediately wash hands after the occurrence of coughs, sneezes or rubbing of nose?	56 (39.16)	87 (60.84)
Do you stay at home for maximum time in order to avoid COVID-19 transmission?	130 (90.90)	13 (9.09)

*n= Total number of respondents

3.2 Knowledge, Attitudes and Practices of Farmers on COVID-19

The knowledge, attitudes as well as practices of farmers on COVID-19 in Odisha (India) were illustrated in Table 2. So far the knowledge of farmers were concerned, their idea of infectious diseases was found to be 97.90%, followed by if they have heard about the number of deaths of COVID-19 infected individuals to be increased in India as 95.10%, their knowledge of spreading of COVID-19 in India as 91.60%, and so on. Based on the responses on their attitudes, 83.91% of the farmers thought that the transmission of COVID-19 infections can be prevented through proper measures, and 39.16% of farmers thought that COVID-19 is curable. Moreover, as far as the practices of farmers were concerned,130 (90.90%) farmers reported of staying at home for maximum time in order to avoid COVID-19 transmission, while only 56 (39.16%) farmers reported of washing hands immediately after the occurrence of coughs, sneezes or rubbing of nose.

3.3 Statistical-analysis

The independent variables such as "age, and gender" were found to be negatively associated as well as significant (P-value of <0.001) with "knowledge-score (dependent variable)" of farmers (Table 3). Whereas, the independent variable such as "farming years" was found to be positively associated as well as significant (P-value of <0.001) with the knowledge-score of farmers as dependent variable. Similarly, by considering the "practices-score as dependent variable", the independent variables such as "knowledge-score" was found to be negatively associated and non-significant, while the "attitude-score" to be positively associated as well as significant (P-value of <0.001). The adjusted R^2 values revealed a well-outcome of the data for all the relevant variables under consideration as illustrated in Table 3.

Table 3. Association among demographic-information as well as knowledge, attitudes and practices of farmers

Variables		b	P-value	Adjusted R^2
Dependent variable	**Independent variables**			
: Knowledge-score	Age in Years	−0.024	<0.001	0.057
	Gender	−0.221	<0.001	0.074
	Education-level	−0.061	0.058	0.013
	Primary-occupation	0.018	0.355	0.024
	Secondary-occupation	0.011	0.214	0.019
	Number of household members	-0.045	0.061	0.024
	Farming years	0.068	<0.001	0.011
	Farmers' ownership of land	0.077	0.013	0.003
Practices-score	Knowledge-score	−0.016	0.176	0.011
	Attitude-score	0.211	<0.001	0.018

3.4 DASS-21 Survey Analysis

The farmers depression, anxieties and stresses levels that were measured by the use of DASS-21 variables-scale (Appendix) revealed that for the depression sub-scale, the normal-depression was found among 76 (53.14%) farmers with scores of 0 to 9, the mild-depression with scores between 10 to 13 among 21 (14.68%) farmers, the moderate-depression with scores between 14 to 20 among 04

(2.79%) farmers, the severe-depression with scores between 21 to 27 among 05 (3.49%) farmers, and extremely-severe depression was observed with scores ≥28 among 37 (25.87%) farmers (Table 4). For the anxiety sub-scale, the normal-anxiety was found among 78 (54.54%) farmers with scores of 0 to 7, the mild-anxiety with scores between 8 to 9 among 09 (6.29%) farmers, the moderate-anxiety with scores between 10 to 14 among 18 (12.58%) farmers, the severe-anxiety with scores between 15 to 19 among 03 (2.09%) farmers, and extremely-severe anxiety was observed with scores ≥20 among 35 (24.47%) farmers. Similarly, for the stress sub-scale, the normal-stress was found among 67 (46.85%) farmers with scores of 0 to 14, the mild-stress with scores between 15 to 18 among 05 (3.49%) farmers, the moderate-stress with scores between 19 to 25 among 22 (15.38%) farmers, the severe-stress with scores between 26 to 33 among 07 (4.89%) farmers, and extremely-severe stress was observed with scores ≥34 among 42 (29.37%) farmers, respectively.

Table 4. Scores of the DASS-21 scale (n= 143)

Mental-health	Normal	Mild	Moderate	Severe	Extremely-severe
Depression	0-9	10-13	14-20	21-27	≥28
Respondents' number (%)	76 (53.14)	21 (14.68)	04 (2.79)	05 (3.49)	37 (25.87)
Anxiety	0-7	8-9	10-14	15-19	≥20
Respondents' number (%)	78 (54.54)	09 (6.29)	18 (12.58)	03 (2.09)	35 (24.47)
Stress	0-14	15-18	19-25	26-33	≥34
Respondents' number (%)	67 (46.85)	05 (3.49)	22 (15.38)	07 (4.89)	42 (29.37)

*n= Total number of respondents

The association among farmers' practices that were considered as precautionary-measures against COVID-19 infections, and "depression, anxieties as well as stresses" based on DASS-21 scale was obtained as illustrated in Table 5. All the six practices of farmers' (precautionary-measures) were taken as independent variables such as "Coverage of mouths when cough and sneeze occurs, Hands washing with the use of detergent or soap and water, Avoidance in utensils' sharing during meals, Hands washing after in-contact or touching of contaminated-objects, Immediate wash of hands after the occurrence of coughs, sneezes or rubbing of nose, and Staying at home for maximum time in order to avoid COVID-19 transmission. Further, the depression, anxieties and stresses were taken individually as dependent variables. All the precautionary-measures were found to be significant (P = <0.001) and negatively associated with stresses of farmers except the variable "Staying at home for maximum time in order to avoid COVID-19 transmission" to be significant (P = <0.001) and positively associated. Moreover, the variables such as "Coverage of mouths when cough and sneeze occurs, Avoidance in utensils' sharing during meals, Hands washing after in-contact or touching of contaminated-objects, Immediate wash of hands after the occurrence of coughs, sneezes or rubbing of nose" were found to be significant (P = <0.001) and negatively associated with depression of farmers. While, the variable such as "Hands washing after in-contact or touching of contaminated-objects" was found to be significant (P = <0.001) and negatively associated with anxieties of farmers. Similar to the statistical-analysis for the association among demographic-information as well as knowledge, attitudes and practices of farmers, in this case also, the adjusted R^2 values revealed a well-outcome of the data for all the relevant variables under consideration as summarized in Table 5.

Table 5. Association among farmers' practices as precautionary-measures against COVID-19 infections and "depression, anxieties as well as stresses" based on DASS-21 scale (n= 143)

Independent variables	Dependent variable								
	Depression			Anxieties			Stresses		
	b	P-value	Adjusted R^2	b	P-value	Adjusted R^2	b	P-value	Adjusted R^2
Coverage of mouths when cough and sneeze occurs	0.061	<0 001	0.053	0.085	0.011	0.022	0.144	<0.001	0.011
Hands washing with the use of detergent or soap and water	0.088	0.009	0.014	0.076	0.027	0.014	0.148	<0.001	0.008
Avoidance in utensils' sharing during meals	0.088	<0.001	0.023	0.076	0.013	0.013	0.148	<0.001	0.018
Hands washing after in-contact or touching of contaminated-objects	0.087	<0.001	0.073	0.075	0.032	0.032	0.234	<0.001	0.013
Immediate wash of hands after the occurrence of coughs, sneezes or rubbing of nose	0.061	<0.001	0.053	0.085	0.022	0.022	0.144	<0.001	0.011
Staying at home for maximum time in order to avoid COVID-19 transmission	0.081	0.007	0.057	0.087	0.014	0.014	0.099	<0.001	0.019

*n= Total number of respondents

3.5 Problems and Possible-Solutions In Agricultural Sectors of India

On the basis of experts' analysis, the present problems associated with the agricultural sectors of India and their possible mitigation measures in view of the pandemic COVID-19 consequences were identified as illustrated in Table 6 and Table 7, respectively. Further, the identified 9 numbers of solution-parameters (Table 7) were considered to find their interrelations in order to generate the ISM model for the possible mitigations of the impacts of COVID-19 on Indian agricultural sectors.

3.6 Development of ISM Model

3.6.1. Reachability-Matrix

The experts' opinions were translated into a SSIM (Table 8) followed by a binary-digit matrix called initial reachability-matrix in accordance with the contextual-relationships between the identified solution-parameters (Shen et al., 2016). The construction of SSIM was based on the responses of experts on the direct impact of "parameter i on parameter j and parameter j on parameter i" by conducting a pair-wise comparison of the parameters.

The result of contextual-relationships between the nine solution-parameters was translated into initial reachability-matrix as shown in Table 9. Further, based on transitivity-principle, the initial reachability-matrix was converted into a final reachability-matrix (Attri et al., 2013), with the purpose

Table 6. The problems associa0.080ted with the agricultural sectors of India in view of the pandemic COVID-19 consequences

Sl. No.	Parameters
1	Uncertainty of future and risk-attitude of farmers as well as consumers.
2	Isolation as well as quarantine fears and miscommunications.
3	Lacking in motivation regarding "what and how much" to be produced because of uncertainty.
4	Because of inadequate cash-economy as well as market-disruptions, there has been reduction in farmers' input purchasing-powers.
5	There has been reduced adoption of improved production-technologies by the farmers.
6	The effectiveness of farmers has been adversely affected due to the restrictions in movement to other countries and other rural-areas.
7	Loosing of adequate linkages among the governmental bodies and the relevant stake-holders.
8	Diversion of resources by providing more attention to COVID-19 than the agricultural sectors.
9	Shortages of input resources to farmers.
10	Lack of proper access to markets for the farmers' products.
11	There have been disruptions in the movement of wage-workers owing to the restrictions in movements.

Table 7. The possible-solutions for the agricultural sectors of India in view of the pandemic COVID-19 consequences

Sl. No.	Solution-parameters
1	Creation of awareness among farmers and consumers
2	Motivation of farmers as well as their community through proper guidance and counselling
3	Establishment of well organized as well as functional communicative-channels like mobile apps to reach the small-scale farmers and through extension-leaflets
4	Family as well as farmer-to-farmer extension methods
5	Tax-waivers or cost-sharing by agricultural co-operatives for the agricultural-inputs
6	Increasing the number of input-distribution access-points for farmers
7	Strengthening the linkages among various governmental-bodies by properly defining the tasks as well as decision-making roles to each actor
8	Enhancing communications through existing information technologies
9	Creating of market-linkages having demands for agricultural-products

of revealing the indirect-relationships among these nine solution-parameters concerned to this study. As a result, the obtained final reachability-matrix was as illustrated in Table 10.

3.6.2. Partitioning of Levels

The solution-parameter's reachability set as well as antecedent set were derived from the 'ðnal reachability-matrix'. The reachability set of a solution-parameter was composed of the parameter itself along with the other parameters that helped it directly or indirectly in achieving, and the antecedent set was composed of the parameter itself along with the other parameters that helped them directly or indirectly in achieving (Attri et al., 2013). The solution-parameters that appeared in both the reachability set as well as the antecedent set in the same period of partitioning were included in the intersection set.

Table 8. Structural Self-Interaction Matrix (SSIM)

Solution-parameters	9	8	7	6	5	4	3	2	1
1	X	X	O	X	O	X	X	X	
2	X	X	O	O	A	X	X		
3	X	X	O	X	O	V			
4	X	X	O	X	X				
5	O	O	O	A					
6	X	X	A						
7	V	V							
8	X								
9									

Table 9. Initial reachability-matrix

Solution-parameters	1	2	3	4	5	6	7	8	9
1	1	1	1	1	0	1	0	1	1
2	1	1	1	1	0	0	0	1	1
3	1	1	1	1	0	1	0	1	1
4	1	1	0	1	1	1	0	1	1
5	0	1	0	1	1	0	0	0	0
6	1	0	1	1	1	1	0	1	1
7	0	0	0	0	0	1	1	1	1
8	1	1	1	1	0	1	0	1	1
9	1	1	1	1	0	1	0	1	1

Table 10. Final reachability-matrix with transitivity-relationships

Solution-parameters	1	2	3	4	5	6	7	8	9	Drive-power
1	1	1	1	1	0	1	0	1*	1*	7
2	1	1	1*	1*	0	0	0	1*	1*	6
3	1	1	1	1	0	1	0	1*	1*	7
4	1	1	0	1	1	1	0	1*	1*	7
5	0	1	0	1	1	0	0	0	0	3
6	1	0	1	1	1	1	0	1	1	7
7	0	0	0	0	0	1	1	1	1	4
8	1	1	1	1	0	1*	0	1	1	7
9	1	1	1	1	0	1*	0	1	1	7
Dependence	7	7	6	8	3	7	1	8	8	

*Transitivity-relationships

The bottom level in the ISM hierarchy was occupied by the solution-parameter(s) with the same reachability as well as the intersection sets, which were further discarded from the remaining parameters in the next period of partitioning. This process was repeated until the identification of all the parameter's levels (Dubey et al., 2017). The partitioning of different levels was illustrated in Table 11, Table 12, Table 13, and Table 14, respectively. It may be observed from Table 11 that for the solution-parameters 1, 2, 4, 8 & 9, the reachability set as well as intersection set included the

Table 11. Iteration-1

Solution-parameters	Reachability-set	Antecedent-set	Intersection-set	Level
1	1, 2, 3, 4, 6, 8, 9	1, 2, 3, 4, 6, 8, 9	1, 2, 3, 4, 6, 8, 9	I
2	1, 2, 3, 4, 8, 9	1, 2, 3, 4, 5, 8, 9	1, 2, 3, 4, 8, 9	I
3	1, 2, 3, 4, 6, 8, 9	1, 2, 3, 6, 8, 9	1, 2, 3, 6, 8, 9	
4	1, 2, 4, 5, 6, 8, 9	1, 2, 3, 4, 5, 6, 8, 9	1, 2, 4, 5, 6, 8, 9	I
5	2, 4, 5	4, 5, 6	4, 5	
6	1, 3, 4, 6, 7, 8, 9	1, 3, 4, 5, 6, 8, 9	1, 3, 4, 6, 8, 9	
7	6, 7, 8, 9	7	7	
8	1, 2, 3, 4, 6, 8, 9	1, 2, 3, 4, 6, 7, 8, 9	1, 2, 3, 4, 6, 8, 9	I
9	1, 2, 3, 4, 6, 8, 9	1, 2, 3, 4, 6, 7, 8, 9	1, 2, 3, 4, 6, 8, 9	I

Table 12. Iteration-2

Solution-parameters	Reachability-set	Antecedent-set	Intersection-set	Level
3	3, 6	3, 6	3, 6	II
5	5	5, 6	5	II
6	3, 5, 6	3, 6, 7	3, 6	
7	6, 7	7	7	

Table 13. Iteration-3

Solution-parameters	Reachability-set	Antecedent-set	Intersection-set	Level
6	6	6, 7	6	III
7	6, 7	7	7	

Table 14. Iteration-4

Solution-parameters	Reachability-set	Antecedent-set	Intersection-set	Level
7	7	7	7	IV

same parameters. So, these solution-parameters were assigned in the partitioning of level-I. In this case, the concerned solution-parameters 1, 2, 4, 8 & 9 were classified as bottom-level parameters in the ISM hierarchy, and were removed from the subsequent partitioning of level-II, as shown in Table 12. The similar process was followed for other levels partitioning.

Based on the results of levels partitioning, an ISM-based hierarchy-structure was generated between the nine solution-parameters followed by the final ISM model as shown in Figure 2 and Figure 3, respectively. With this ISM approach, all the nine solution-parameters were classified into four-levels. The solution-parameters such as 1 (Creation of awareness among farmers and consumers), 2 (Motivation of farmers as well as their community through proper guidance and counselling), 4 (Family as well as farmer-to-farmer extension methods), 8 (Enhancing communications through existing information technologies), and 9 (Creating of market-linkages having demands for agricultural-products) were occupied at the bottom-level I of the ISM hierarchy. It indicated that these five-parameters were highly-dependent on other parameters (Cai and Xia, 2018). The solution-parameter 7 (Strengthening the linkages among various governmental-bodies by properly defining the tasks as well as decision-making roles to each actor) was occupied at the top-level IV of the ISM hierarchy, which indicated this parameter to be the most essential parameter that can influence the

Figure 2. ISM model for solution-parameters

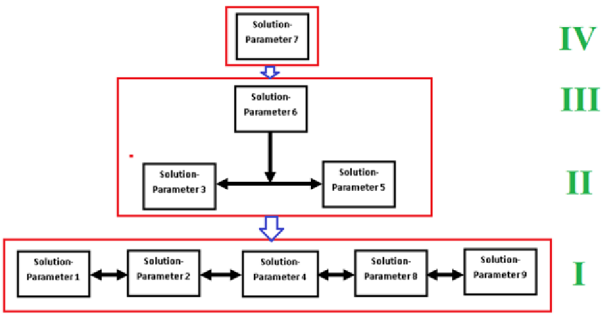
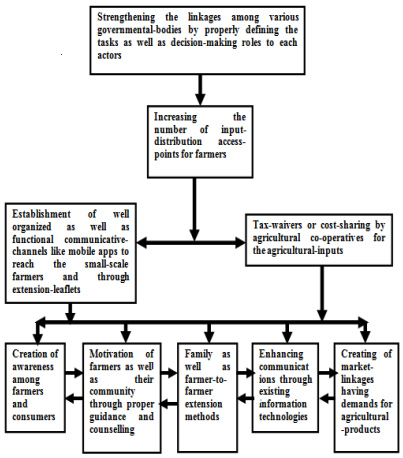


Figure 3. Final ISM model



agricultural sectors of India in view of the pandemic COVID-19 consequences. Similarly, the solution-parameters such as 3 (Establishment of well organized as well as functional communicative-channels like mobile apps to reach the small-scale farmers and through extension-leaflets), 5 (Tax-waivers or cost-sharing by agricultural co-operatives for the agricultural-inputs), and 6 (Increasing the number of input-distribution access-points for farmers) were occupied at the middle level (II-III) of the ISM hierarchy, which indicated that they will be affected by the top level-parameters and also, can put influence on the bottom level-parameters (Cai and Xia, 2018).

3.7 MICMAC Analysis

The MICMAC analysis of the solution-parameters was performed after developing the final ISM model on the basis of the drive-powers and dependencies of all the nine-parameters. All the parameters were categorized into four-clusters in accordance to their drive-powers and dependencies (Figure 4), as discussed below:

a) *Cluster-I:*

In this study, the solution-parameters no. 5 and 7 (e.g., "Tax-waivers or cost-sharing by agricultural co-operatives for the agricultural-inputs", and "Strengthening the linkages among various governmental-bodies by properly defining the tasks as well as decision-making roles to each actors") were under this category.

b) Cluster-II:

None of the solution-parameters were found under this category.

c) Cluster-III:

The solution-parameters no. 1, 2, 3, 4, 6, 8 and 9 (e.g., "Creation of awareness among farmers and consumers", "Motivation of farmers as well as their community through proper guidance and counselling", "Establishment of well organized as well as functional communicative-channels like mobile apps to reach the small-scale farmers and through extension-leaflets", "Family as well as farmer-to-farmer extension methods", "Increasing the number of input-distribution access-points for farmers", "Enhancing communications through existing information technologies", and "Creating of market-linkages having demands for agricultural-products") were found under this category.

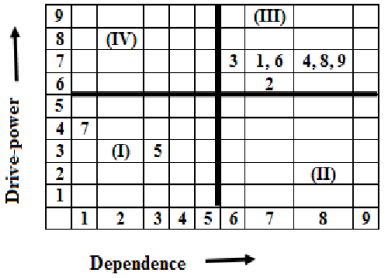
d) Cluster-IV:

These are also known to be the "entry-enablers" in the system. None of the solution-parameters were found under this category.

4. DISCUSSION

The different pandemics experienced by human-beings had greater impacts on the economy, the environment and other human-activities, such as the SARS, Swine-Flu, HIV/AIDS, and Bird-flu etc. The sectors that are affected with these pandemics include education, industry, agriculture, livestock, tourism, health, transport, mining, fishing, commerce, and so on. Currently, another pandemic is faced globally, the infection of the new coronavirus generating the COVID-19 disease. The outbreak of COVID-19 has resulted in a number of farmers in India to have an impact on their mental-health in addition to negative impacts on the complete agricultural sectors. Higher-levels of stresses, anxieties,

Figure 4. Diagraph of MICMAC analysis



I. Autonomous, II. Dependent, III. Linkage and IV. Independent (Driver)

and depression were observed among the Indian farmers. In this study the knowledge, attitudes as well as practices of agricultural farmers relating to the adverse impacts of COVID-19 in Odisha state of India was evaluated. The demographic-information of farmers revealed of majority of respondents from males in the age groups of 36-45 years with education-levels of $\leq 10^{th}$ and crop-farming as primary-occupation, which was observed to be in line with the findings by Singh et al. (2019). The results indicated that most of the farmers have good level of awareness in terms of "knowledge, attitudes and practices" of the transmissions, anticipations and control-measures of COVID-19 infections in Odisha. Nevertheless, the findings of this study showed an opposite-trend to that of earlier studies relating to one of the transmitted diseases like "zoonotic-diseases" in India, which have indicated a lower to medium knowledge of livestock-farmers (Hundal et al., 2016; Singh et al., 2019). However, during the epidemic SARS-CoV in 2003, researchers have revealed of moderate anxiety-levels which was further associated with a high awareness of preventive-measures among the respondents in their studies (Leung, 2003). Further, the farmers' age, gender and farming years of expertise as independent variables were found to be significant (P-value of <0.001) with "knowledge-score as dependent variable", which was in accordance with the findings of Singh et al. (2019). However, in this study a negative association was found between age and gender with the knowledge-scores, and a positive association between farming years of expertise with the knowledge-scores. While, Singh et al. (2019) have revealed of negative associations among age, gender and farming years of expertise with knowledge-scores in their study.

A majority of farmers In this study reported of normal-depression (53.14%), normal-anxieties (54.54%) and normal-stresses (46.85%), which were followed by extremely-severe depression (25.87%), anxieties (24.47%), and stresses (29.37%). Vidyadhara et al. (2020) have also used DASS-21 scale in their study and have found of normal depression (57.5%), anxieties (53%), and stresses (68%), followed by extremely-severe depression (18%), anxieties (27.5%), and stresses (12.5%) among the pharmacy-students in India during the pandemic Covid-19 quarantine-period.

Moreover, there has been a higher requirement for the governments as well as health-authorities to ensure about adequacy in infrastructures for producing and providing sufficient amounts of soaps, masks, alcohol-based hand-rubs, and also, other personal hygiene-products during this COVID-19 epidemic period for public well-being. As food-demands refer to the eagerness as well as capability of consumers in paying money for any particular goods or services during any particular-period (Gottheil, 2013), so owing to uncertainties, the food-demands have reduced and there may be further reduction of peoples' spending-capacities, if the pandemic continues for a longer-time with the result of decreased incomes and job-losses (FAO, 2020b). In similar situations with the probability of spreading of any virus on contacts, the delivery-services that are contactless become preferable by consumers. For instance, use drones for the delivery of products in order to satisfy the basic-necessities (Rosales and Mercado, 2020). Moreover, there may be food-crisis by not taking quick-actions that

will have a greater impact on the most vulnerable population. Thus, there must be adequate focus on the activation of global food supply chains and in mitigating the pandemic-impacts across the food-systems. An initiation of social-programs will help to minimize the effects of short-term crises. The food-security refers to the unrestricted access by everyone to foods, and if the virus keep on spreading with adverse impacts on health-systems, then the small-scale farmers may be prevented from working on agricultural lands and from accessing the markets to purchase seeds & other important inputs, and also, in selling their products. Moreover, the children from low-income families who are mainly nourished by foods provided by social-programs will face a greater problem by the suspension of these programs owing to the COVID-19 pandemic (FAO, 2020c). As a result, there is a higher requirement for each country in maintaining the farmers' grievances as well as their basic requirements in addition to the agricultural systems in order to ensure effective social food-programs by taking appropriate precautions to avoid virus-transmission. Moreover, an added potential long-term trend supposed to be emerging from the pandemic of COVID-19, is the consumers' way of food and other fruits as well as vegetables purchases. Some consumers may go for online healthier purchases with the use online automated shopping-lists (Pozzi, 2012).

4.1 Agricultural "Global Information Management (GIM)" For The benefits of Farmers

An agriculture-based information management system refers to a system where information gets generated, converted, transferred, united, and received as well as fed-back for the processes to function in a systematic-manner to explore the agricultural producers' knowledge (Dařena, 2007; Kučera and Látečková, 2006; Roling, 1988; Šilerová and Lang, 2006; Šilerová and Kučírková, 2008), and it has been considered as an essential-input for agriculture-based researches, educations, and extension services. Over the past twenty-years, there has been rapid progression and common use of agricultural information technology in the developed nations that combines agriculture with information technology improving the agricultural production based efficiency (Zhao et al., 2018), and their applications can help in changing and reshaping of the producers' ideas with considerable enhancement in environmental-awareness, and encouraging in the creation of agricultural production with equal importance in terms of both quantity and quality (Tian, 2013). However, with the acceleration in industrialization in addition to urbanization in developing nations like India, the shortage of rural labour-force has become a serious concern, and the changes in the agricultural production strategies has become more significant issue, which requires an urgent attention in the optimization the agricultural resource allocation with the help and use of appropriate information management techniques.

Several threats to agriculture because of COVID-19 outbreaks include slowing of supply-chains, health of farmers, agricultural-labor, personal protective-equipment and workers' safety (Syahroni, 2020); and in this context, the "Global Information Management (GIM)" systems with the use of "Big-Data Analytics" and "Internet of Things (IoT)" based applications may provide significant opportunities in these sectors (Gharajeh, 2017; 2018). In the present scenario, the governments of different developed countries have introduced a number of applications with the help of tools and machines for the agricultural processes in order to support the farmers. However, it will help the farmers to not go to their fields such that the transmission of the coronavirus between peoples can be prevented. For instance, in the United States, the "Normalized-Difference Vegetation-Index (NDVI)" has been implemented which is a method that utilizes drone-analysis and satellite-imagery for plant-health monitoring purposes (Igor, 2018). By the use of "Group Scouting" method which is like NDVI, but can be facilitated through mobile phones and tablets, the farmers are able to monitor weed-activity as well as pest-populations on the agricultural-lands (Igor, 2018). Moreover, with the help of "Telematics" which is a device involving machine-to-machine communications between sensors and hardware in automation, the farming sectors can get large benefits. For example, when weeds are identified by the camera, then it is communicated to other machines for pulling the weeds from

the ground or spraying herbicides on them (Igor, 2018). Similarly, an automated-approach such as "Precision Planting" help to optimize seed-planting, which allows for better-spacing, better planting-depth control and a better root-system (Igor, 2018). Therefore, if these technologies are utilized in the worldwide agricultural sectors including India, then it will not only help the farmers to increase the farming efficiency, but also will enable in producing foods during the COVID-19 pandemic, without going to fields and without having the fears of transmission of viruses.

4.2 Problems in "Agricultural Information Systems (AIS)" Adoption

The "Agricultural Information Systems (AIS)" in agriculture play a vital role in solving the common agriculture-based problems by integrating the researchers, farmers, agricultural-educators, and extension service-providers to help in decision-making processes and to ensure of appropriate implementation of knowledge in order to obtain the best-results in terms of sustainable-production in addition to rural-development (FAO, 2005). Vidanapathirana (2019) has discussed regarding the sources, types, usefulness and the associated problems with AIS. There occurs a lack of smoother information-flow to the end-users, due to unplanned activities involved in extension services with their improper linkages to agriculture-based researches (Ramkumar, 1995). However, in order to overcome such problems, the isolation requires to be eliminated between research and the extension services providers (Ozkaya and Olgun, 1993). Moreover, the participation of farmers need to be encouraged, as better communication between farmers and scientists can help in the augmentation of information utility as well as reliability to reach the farming community (Kloppenburg, 1991; Saver, 1990). The information systems in agriculture need to be user-friendly in their designs with computer-programs as well as portals for agricultural suitability (Mistr, 2007). Most of the disregarded interests among the farmers were reported to be occurring owing to the 'English' broadcasts as well as writing of innovations in agriculture instead of local languages (FAO, 2005). The market-related information for the small-scale farmers helps to augment the agricultural market-efficiency with significant contribution in market-participation, its' poor-access increases personal difficulties as well as unfavourable choices, and has been regarded as disappointing factor among the farmers in market-participation (Fafchamps and Hills, 2005; Shiferaw et al., 2008). The communication-based channels promoted by "Information and Communication Technologies (ICTs)" (Burt, 2004; Nzonzo and Mogambi, 2016; Sousa et al., 2016; Venkatesh et al., 2017), the social-networks (Larsen, 2011), and community-interaction related factors (Fortunati et al., 2013), have been explored as possible opportunities for the adoption-process. However, with regard to the Indian agricultural sectors, it has been suggested of market-related information and weather-updates to be of prime-interest, but cost, illiteracy, and lack of farmers' awareness to be the constraints in adoption of ICT (Patil et al., 2008). The farmers who regard farming as a business-venture usually found of using diversiðed cropping-systems with smaller farm-sizes, and are more likely to prefer the ICT based information systems (Ali, 2012), with advanced farm-management systems in agriculture (Saiz-Rubio and Rovira-Más, 2020).

5. CONCLUSION

The unparalleled lockdown due to the pandemic COVID-19 is expected to have significant adverse-effects on the Indian agricultural sectors. A number of farmers are at stake owing to halting of all the activities around the country, with no work or income generation from farming and putting them in more mental stresses as well as depressions. As possible-solutions in order to mitigate the adverse impacts of the COVID-19 epidemic, this study has made an attempt in identifying the relationship between the parameters under possible-solutions by the use of ISM approach followed by MICMAC analysis to deal with such complex issues.

Out of 150 farmers, a total of 143 farmers responded to the questionnaires designed in this study. The demographic-information of farmers revealed of majority of respondents from males in the age groups of 36-45 years with education-levels of $\leq$10th and crop-farming as primary-occupation. It was observed that most of the farmers have good level of awareness in terms of "knowledge, attitudes

and practices" of the transmissions, anticipations and control-measures of COVID-19 infections in Odisha. Further, the farmers' age, gender and farming years of expertise as independent variables were found to be significant (P-value of <0.001) with "knowledge-score as dependent variable". However, a negative association was found between age and gender with the knowledge-scores, and a positive association between farming years of expertise with the knowledge-scores. Moreover, a majority of farmers reported of normal-depression (53.14%), normal-anxieties (54.54%) and normal-stresses (46.85%), which were followed by extremely-severe depression (25.87%), anxieties (24.47%), and stresses (29.37%).

Moreover, the major limitation of this study was the sample-size for collection of data. Because of movement and other restrictions, difficulties were faced in interacting with more farmers of different locations in Odisha. Also, difficulties were found in collecting personal contact details of the present respondents because of ethical-requirements on anonymity in addition to maintaining of the confidentiality, which resulted in a non-prospective study that would have otherwise provided concrete-findings to support the farmers' requirements to health-initiatives. The outcomes of this study may assist the health-care professionals as well as the government-agencies to safe-guard the psychological well-being of the agricultural sectors and the farmers despite of expanding COVID-19 outbreak in India and other regions of the world.

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APPENDIX A – ADDITIONAL TABLES

Table 15. Sample questionnaire based on DASS-21 scale

Sl. No	Variables	Rating-scale (Please put Ö mark, Wherever applicable)			
		0 (Not-applicable to me at all)	1 (Applicable to me to some-degree)	2 (Applicable to me to a considerable-degree or a good-part of time)	3 (Applicable to me very-much or most of the time)
1	I do not have any positive-feeling				
2	I find difficulty in working-up with any initiative for doing things				
3	I feel of not anything to look-forward to				
4	I feel disappointed and azure				
5	I am not capable of becoming enthusiastic on anything				
6	I am feeling of worthless as a person				
7	I have the feeling of this life as meaningless				
8	I am aware of my mouth-dryness				
9	I am experiencing breathing difficulties like extremely rapid-breathing, a feeling of breathlessness in the absence of physical-exertions				
10	I am experiencing wavering in body-parts like the hands and others				
11	I am worried about the situations making me panic and a fool				
12	I have the feeling of getting closer to panic				
13	I am aware of my heart-actions in the absence of physical-exertions like the sense of increase in heart-rate, missing-beats of heart				
14	I have a scared feeling without any good-reason				
15	I am finding it harder to wind-down				
16	I always over-reacted to situations				
17	I have the feeling of utilizing a lot of nervous-energy				
18	I am finding me of becoming agitated				
19	I am finding difficulty to relax				
20	I have the feeling of becoming narrow-minded of anything which kept me away from my activities				
21	I have the feeling of getting sensitive				

*Note: Question numbers 1 to 7 represented “Depressions”, 8 to 14 represented “Anxieties”, 15 to 21 represented “Stresses”, respectively.

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