Impediments and Plausible Suggestions to Farmers in Cyclone Affected Region of Odisha: Kendall's Coefficient of Concordance Approach

BISWAJIT MALLICK, SUDHANAND PRASAD LAL* and ALONGBER BASUMATARY

PG Department of Extension Education, Dr. Rajendra Prasad Central Agricultural University Pusa, Samastipur, Bihar, India.

Abstract

Taking into account the farmer's perception of impediments, this study examined the impediments encountered in cyclone ravaged regions as well as their plausible suggestions. Odisha is one of the top 10 ranked climatic vulnerable state of India. 480 km of coastal boundary is exposed to Bay of Bengal and 06 coastal districts are highly vulnerable towards climatic events. As Odisha has an agrarian economy, farmers are severely affected by cyclones. So, the state was purposively selected for the study. Total of 160 respondent farmers were chosen randomly from 8 villages of 2 districts. 20 specific impediments (constraints) were further categorized into 4 broad dimensions of impediments viz., social, economic, environmental, and miscellaneous impediments. Impediments were ranked using Garrett's ranking method, while Kendall's coefficient of concordance approach was executed to rank 4 broad dimensions of impediments. Among 20 impediments, "rain and storms lead to flooding after cyclone" with Garrett's mean value 64.53 was perceived as the most important one. Kendall's coefficient of concordance was significant at 1% significance level (p=.000, <0.01) with the commendable agreement value of 0.588, as it ranges from 0 to 1. Where, Zero denotes nonexistent of agreement among judges, and one denotes perfect agreement with the $\chi 2$ value of 282.192 with 3 degrees of freedom. Kendall's coefficient of concordance values for 4 broad impediments were environmental impediment (3.53) was ranked first as constraint followed by economic impediment (2.85), social impediment (2.40) and miscellaneous impediment (1.22). The following suggestions were extracted from the grassroots level investigations viz., attending timely

training and awareness programs regarding cyclones, constructions of pucca houses to protect from heavy wind and rain, cultivation of early verities of paddy crops and vegetables, constructing permanent drainage systems, reforestation and afforestation of salt-tolerant mangrove trees, chlorination of drinking water after the cyclone and use of battery operated gadgets to save life post cyclones.

Introduction

Global population is exposed to frequent and intensive hazards, *viz*., cyclones, drought, floods, heat waves, melting glaciers, and increasing sea levels due to climate change and human interventions. Among all the hazards, cyclone is one of the most frequent and leading natural hazards worldwide that causes massive causalities. The unique geographical setting of the country, along with climate, topography, and populace add to its risk and vulnerability to disasters like cyclones and floods, which can't be entirely prevented.[1] According to IMD,[2] 5-6 tropical cyclones formed per year across the North Indian Ocean (the Bay of Bengal {BoB} & the Arabian Sea) which accounts for merely 7 percent of the global tropical cyclones, but the severity of cyclones are most destructive while crossing over the mainland. Most of the tropical cyclones (TCs) formed over BoB struck the Odisha-West Bengal coast, Andhra Pradesh coast in the month of November. According to the report of Council on Energy, Environment and Water,[3] Odisha secured 10th position in relation to Climate vulnerable states in India with overall vulnerable index score 0.368. Around 76% of the total population of the state is engaged in agricultural activities as their primary as well as secondary occupation.[4] According to agricultural Census, 2015-16, the state has total cropped area of 87.46 lakh hectares out of which 46.19 lakh ha is total operated area. 5 6.51 lakh ha crop was lost during cyclone Phailin in 2013 followed by 3.04 lakh ha in cyclone Titli during 2018, 1.69 lakh ha in cyclone Bulbul and 1.46 lakh ha in cyclone Fani during 2019.[6] Almost every year state economy accounts for huge loss due to cyclones in agriculture and allied sectors. Among several reasons, natural calamities were also recorded for the distressed hotspots where farmers commit suicide or want to quit farming due to crop failure.[7] In the present study, numerous constraints were identified i.e., perceived by farmers to cope with cyclonic vagaries in coastal Odisha.

Constraints analysis is ubiquitous in the research discipline. Constraint is the restriction or limitation that doesn't allow the event to accomplish hassle-free. It is also termed as hindrance or obstruction that limits a system from reaching its goal.[8] Different methodologies were used by researchers to rank the most critical constraints. Goyal *et al.*[9] explored five broad constraints, *viz*., Social constraints, Communicational Constraints, Managerial constraints, Technical Constraints and Infrastructural Constraints perceived by veterinary surgeons in Haryana ranked by using Garrett ranking method. Lal *et al.*[10] used Friedman ranking analysis 11 to distinguish the most important impediments among dairy farmers who have been affected by national calamity in Bihar. Lal *et al.*[12] used exploratory factor analysis (EFA) and identified 4 types of broad impediments *viz*., environmental constraints, pecuniary constraints, policy constraints and miscellaneous impediments and ranked by using Garrett ranking technique. Similar in-depth study had been carried out by Sinha *et al.*,[13] Popoola *et al.*,[14] Bandhavya *et al.*,[8] Lal *et al.*[15] Reviewing the above studies, this paper uncovers various impediments perceived by farmers in the cyclone affected region of Odisha.

Materials and Methods
Background of the Study Locale

Odisha has a long history of climatic events like cyclones and floods. But the official database was prepared after the establishment of India Meteorological Department (IMD) in 1975. However earlier, the descriptive database was provided by the British East India Company for the period of 1804 to 1875. An insight into the database revealed that during the 19th and 20th centuries Odisha experienced 128 flooding events associated with tropical cyclones (TCs) and monsoon depressions (MD) with maximum impact in the Balasore district followed by Puri and Ganjam districts.[16] Examination of IMD data unraveled that with 295 cyclones, 262

landfalls across the East coast in 20th century, while 8 cyclones landfall in first two decades of 21st century.[17] The severity of cyclones and surges is increasing as population and coastal infrastructure increase.

Selection of the Study Locale and Sampling Plan
The study was carried out in the state Odisha during 2021-22. The state has 30 districts, out of that 6 districts lie next to Bay of Bengal. Among the coastal districts, Puri and Gnajam were selected purposively as these districts witnessed the maximum number of cyclones. Further 2 affected blocks from each district and 2 villages from each block were chosen randomly by applying computer-based research randomizer technique to avoid the biasness. Lastly, 160 respondents were finalized for the study after taking 20 respondents from 8 villages. "Ex-post-facto research design" was employed to determine the broad impediments *viz.*, social, economic, environmental, and miscellaneous impediments (Figure 1).
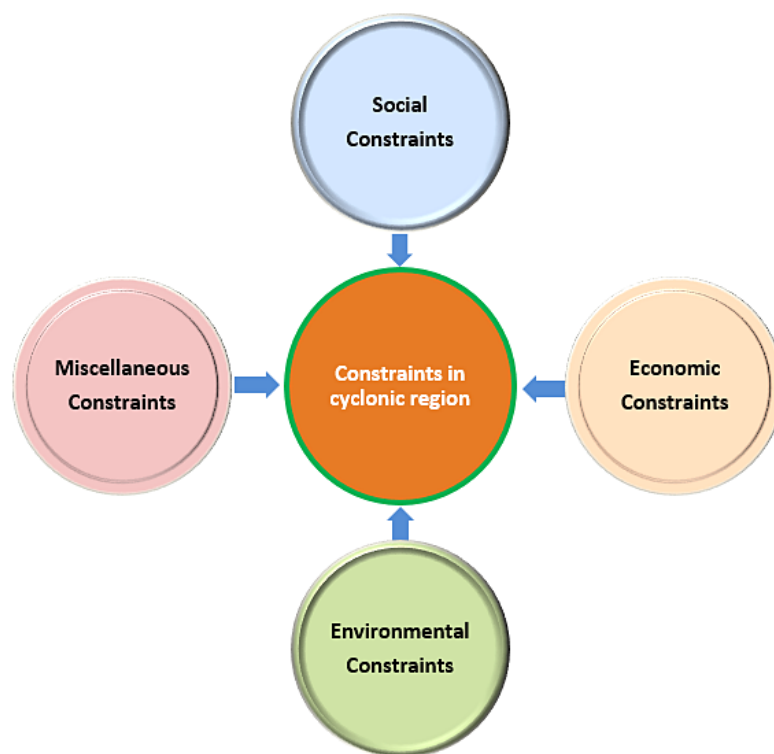

Fig. 1: Broad constraints perceived by the farmers

Statistical Tools used for the Analysis of the Data
To obtain accurate findings from collected data, statistical tools like Garrett's ranking method and Kendall's coefficient of concordance approach was employed through MS Excel (version 2007) and IBM SPSS software (version 26).

Data Analysis
Garrett's ranking method was employed to prioritize the impediments. Respondents were asked open-ended questions developed before identifying the constraints. Statements were categorized based on social, economic, environmental and miscellaneous impediments in the interview schedule. Respondents ranked the impediments accordingly as per importance to their livelihood. As the responses were not the same for each statement by all respondents, the method of integrating of incomplete order of merit ratings was given by Garrett.

• Primarily constraints were ranked by the respondents according to their importance.

- The rank assigned by the respondents was converted into percent position using the following formula.

%position=(100(R_{ij}-0.50))/Nj

R_{ij} = The rank given for the ith constraint by the jth individual.

N_j = The total number of impediments ranked by the jth individual.

- Rank obtained through % position was changed into scores followed by the table proposed by Garrett.[18]
- Appropriate rank was assigned after calculating the mean score for each constraint.

In addition, Comparison of various broad constraints used in the specific study was done by using the formula of Kendall's coefficient of concordance approach (Kendall and Smith,[19] Kendall,[20] Legendre[21]).

w=12S/(m^2 n(n^2-1))

As ranks was tied between judges in the present study below formula is appropriate to measure correction factors between tied ranks

$$w = \frac{12\sum_{i=1}^{n}(R_i^2) - 3m^2n(n+1)^2}{m^2n(n^2-1) - mT}$$

Where,
n= the total number of objects
m= the total number of individuals
$R\_i = \sum_{i=1}^{m} r_{ij}$ is the sum of the rank position for i^{th} item
T= correction factors for tied ranks
Kendall's coefficient of concordance (Kendall's W) is accustomed to evaluating agreement or consistency between different judges or respondents to certain objects, ranging from 0 to 1. Where, Zero denotes nonexistence of agreement at all between judges, and 1 denotes perfect agreement.

Results and Discussion
Social Constraints as Perceived by the Farmers
It is evident from the analysis presented in Table 1 that "Damage to residential as well as other infrastructures" was most important among social constraints, with mean value (62.38). It could be concluded that people with kutcha and semi-pucca houses were more vulnerable to weather events. Damage to residential house and livestock shed during a cyclone may cause the death of human and animal assets. "Lack of training and knowledge to cope with cyclone" was perceived as the second most important constraint, with mean value (56.63). Respondents were not skilled in operating motor boats, climbing buildings, using lifejackets, safety belts, rappelling ropes, and emergency lights used during or post cyclone. In the following order of constraints "unavailability of timely information regarding cyclone" mean score (50.53) was important. Respondents were unaware of the timely and correct information regarding cyclones. Some respondents ignored the emergency alert even after the message was broadcasted in the community. The fourth serious constraint, "insufficient relief materials provided by the government," holds a mean score (42.97). After enormous damage and flooding, respondents urged for quick external support by govt. or private organizations for cooked food, clean drinking water, temporary shelter, first aid, and medical services.

Last but not least, "less community cohesiveness to fight with such situation" was perceived as the fifth social constraint with mean value (36.69). Community participation and cohesiveness were important to help each other in difficulties. Lack of it creates an isolated environment in the community.

Suggested solutions to overcome social constraints include using pucca and semi-pucca houses like shelter houses, school buildings during heavy rainfall and wind in cyclones. Mass media and officials help disseminate timely and correct information regarding cyclones, so regular contact is necessary. UNICEF[22] started children centric disaster-risk reduction programme to strengthen the education, health, nutrition, water & sanitation sectors to foster resilience in India for 2018-22. Sufficient relief materials for all the affected population and community participation after cyclone are also helpful in overcoming the constraints.

Economic Constraints
Economic constraints were affecting the livelihood of the respondents. "Huge loss to cultivated crops" ranked first with mean score (62.72). Post-monsoon cyclones damaged standing crops with high wind velocity and continuous rain, followed by floods.

Paddy was in the ripening stage during November; due to cyclone, it could not collect paddy from the field. Secondly, "less market value of agricultural products due to damage during cyclone" (57.69) is important because the market value for damaged, diseased, rotten, premature agricultural products was very less and respondents accepted low selling prices and massive financial loss. "Non-availability of farm inputs like seeds, fertilizers" with mean value (50.94) was ranked as the third severe constraint. It was due to the loss of previously stored seeds and immediate demand for new seeds and chemical fertilizers in the market that were reasons for non-availability. The result was contrary to Lal *et al.*[12] who reported that "duplicity of agricultural input *viz*., seed, fertilizer etc" ranked 3rd with mean score (58.97). Respondents ranked "reduce quality

and quantity of coconut production" (46.65) as the fourth constraint. In coastal regions, coconut was an additional source of income for agriculture, but frequent cyclones damaged most coconut orchards, and sooty mould disease devastated the quality of fruits in terms of size and taste. "Damage to livestock sector leads to food insecurities" (43.09) was the fifth important constraint. Respondents dependent on livestock for their primary source of income were vulnerable to cyclones every year. Damage to their sheds, farms and mortality of livestock units caused huge economic loss. "Lack of knowledge about crop insurance and its recovery after loss" (39.33) ranked sixth as perceived by respondents. Cooperative societies were not working properly in the study area. So, the respondents were unaware of the crop insurance schemes and their benefits.

Table 1: Ranking of Impediments perceived by the farmers through Garrett mean values

Sl. No.	Constraints	Garrett Score ($\bar{X}$)	Rank
1.	Social constraints (Range: 25-75)		
i.	Damage to residential as well as other infrastructures	62.38	I
ii.	Lack of training and knowledge to cope up with cyclone	56.63	II
iii.	Unavailability of timely information regarding cyclone	50.53	III
iv.	Insufficient relief materials provided by government	42.97	IV
v.	Less community cohesiveness to fight with such situation	36.69	V
2.	Economic constraints (Range: 23-77)		
i.	Huge loss to cultivated crops	62.72	I
ii.	Less market value of agricultural products due to damage during cyclone	57.69	II
iii.	Non-availability of farm inputs like seeds, fertilizers	50.94	III
iv.	Reduce quality and quantity of coconut production	46.65	IV
v.	Damage to livestock sector leads to food insecurities	43.09	V
vi.	Lack of knowledge about crop insurance and its recovery after loss	39.33	VI
3.	Environmental constraints (Range: 23-77)		
i.	Rain and storms lead to flooding after cyclone	64.53	I
ii.	Erosion of sand dunes that protects as a safety wall	56.37	II
iii.	Land become unfertile due to saline intrusions	53.44	III
iv.	Loss of forest cover by heavy wind	47.13	IV
v.	Sand casting of agricultural land	42.06	V
vi.	Risk of landslides and marine erosion	35.95	VI
4.	Miscellaneous constraints (Range: 31-69)		
i.	Unavailability of food and clean drinking water	61.52	I
ii.	Outbreak of disease among the humans and livestock	50.24	II
iii.	Interruption in electricity for long days	38.36	III

To lessen economic constraints, seeds of early variety crops and vegetables, storage for agricultural produce and agricultural input demand must be fulfilled in the affected area. Agricultural and horticultural scientists from KVK should conduct training and demonstration of farmers. New Cooperative society should form and the old society should take care of easy disbursement of crop insurance to crop loss farmers. Farmer should form Farmer producer organization (FPO) and 'Mandis' to sell their agricultural products.

Environmental Constraints
Regarding environmental constraints, respondents perceived "rain and storms lead to flooding after cyclone" (64.53) as the most severe among all. During the landfall of cyclones, wind velocity varies from 62 km/h to 220 km/h even it crosses the limit sometimes. Infrastructure, forest, agriculture, and transportation mostly affected during the catastrophe. Heavy to very heavy rainfall caused inland flooding, damaging agriculture sectors the most. Floods sustained up to 5 to 6 days and destroyed crops, roads, and kutcha houses in affected villages. "Erosion of sand dunes that protect as a safety wall" (56.37) was the respondents' second stern constraint. Coastal sand dunes were eroded due to high wind velocity and storm surges during cyclones. "Land become unfertile due to saline intrusions" (53.44) was ranked third by the respondents. Due to high tide and flash flooding, saline water could not drain from agricultural land for a long period, leading to increased salt content in the soil. Salt concentration (Estimated Soluble Salts ie. ECe) ranged from 6.94 to 16.86 dS m^{-1} in coastal Ganjam and Chilika lake region.[23] Respondents ranked "loss of forest cover by heavy wind" (47.13) as the fourth important constraint. Wind velocity up to 168-221 km/h during extremely severe cyclonic storms devastated the forest ecosystem, which was an important component of rural livelihood. "Sand casting of agricultural land" (42.06) was the fifth important constraint. In the long term, agricultural lands became unfertile due to sand casting. "Risk of landslides and marine erosion" (35.95) was ranked the sixth constraint as they affect respondents in the long run.

Suggestions to overcome environmental constraints are permanent drainage systems of low land area to remove excess or flood water to the nearest river or water bodies. Reforestation and afforestation of salt tolerant trees *viz.*, *Casuarina equisetifolia* (Jhaun), *anacardium occidentale* (Cashew) plantation along with seashore works as windbreak and protect from high wind velocity. Plantation of the mangroves must be done with the help of the community and forest department to reduce soil erosion. Immediately after the flood, cleaning sand casting from agricultural land will help for next crop cultivation. Construction of non-erosive stone wall along the sea beach is also a measure to protect roads from erosion. This finding is in conformity with Chittibabu *et al.,*[16] who also suggested for build number of dykes or embankments in between the major tributaries areas that protect from floods (Fig.3 & 4).

Miscellaneous Constraints
"Unavailability of food and clean drinking water" (61.52) was ranked as the top most miscellaneous constraint perceived by respondents. Post cyclone, people lacked food and drinking water facilities in shelter houses. Due to flood bore well potable water becomes unfit for drinking puropse. "Outbreak of disease among the humans and livestock" (50.24) was second serious constraint. Spread of various diseases among humans and animals was most common post cyclones. The emergence of mosquitoes, snakes, rats and other harmful animals also caused harm to respondents. "Interruption in electricity for long days" (38.36) was the third severe constraint. Because of the unavailability of electricity, respondents faced various day to day problems. Without electricity, mobile communication service was affected for more than a month in the cyclonic region.

To ameliorate miscellaneous constraints, respondents were suggested to collect and cook food and clean drinking water. Chlorination of drinking water kills parasites, bacteria, and viruses, so it is recommended to use chlorinated water. The government should provide emergency medicines for ill people. Battery-operated torch light and radio are helpful post cyclones.

Kendall's coefficient of concordance approach was used to rank 4 broad dimensions of impediments.

Table 2: Test for Kendall's coefficient of concordance (Kendall's W)

Test Statistics			Values
N			160
Kendall's W			.588
Chi-Square			282.192
Degrees of freedom			3
Asymptotic Significance			.000
Monte Carlo Significance	Significance		.000
	99% Confidence Interval (CI)	Lower Bound	.000
		Upper Bound	.000

Based on the analysis of Table 2, it was revealed that Kendall's coefficient of concordance value was 0.588. As the value ranges between 0-1, score 0.588 indicates that respondents were closer to agreement among broad groups of impediments. A symptotic significance was 0.000 which is significant (p<0.01) and the chi-square test value was 282.192 with 3 df. Table 2 clearly indicated that Monte Carlo value was significance at 99% CI. Hence, it can be clearly stated that there was a significant difference among the 4 different broad groups of impediments faced by the farmers in coastal Odisha.
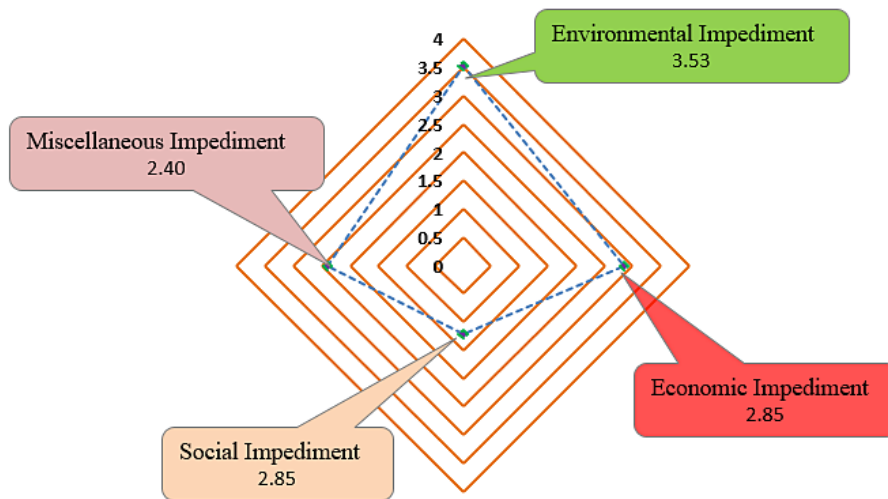

Fig. 2: Comparative ranking of various impediments through Kendall's W mean value

A lucid examination of the Figure 2 revealed that all four major impediments was calculated through Kendall's coefficient of concordance approach and mean value of environmental impediment (3.53) was the highest among all the impediments. Environment has crucial role during hydrological calamities. Thus environmental factors restrain farmers from coping with cyclones. Economic impediment scored the second rank with mean value (2.85), as economically poor farmers were unable to bounce back to their normal life easily. Social impediment ranked third with mean value (2.40), factors like lack of awareness, training, social cohesiveness are major impediments under social constraint. Last but not the least, miscellaneous impediments with mean value (1.22) scored fourth ranked among major constraints.

Fig. 3: Mangroves to lessen soil erosion

Fig. 4: Construction of non-erosive stone wall

Conclusion

Prioritizing the constraints and to suggest mitigating measures plays a pivotal role in cyclone-affected area. An effort was made to identify the impediments, for these 20 statements were finalized and grouped into four broad categories: social, economic, environmental, and miscellaneous. Respondents were asked to rate each constraint. Finally, Garrett's ranking method was employed to rank the statements and Kendall's coefficient of concordance approach was used to classify four broad impediments. Under social constraints, "Damage to residential as well as other infrastructures" was the most important constraint. "Huge loss to cultivated crops" was the most serious constraint perceived the respondents under economic constraints. Under the environmental constraints, the statement "rain and storms lead to flooding after cyclone" was the more pertinent among others. "Unavailability of food and clean drinking water" was ranked as respondents' top miscellaneous constraint. Among broad constraints, "Environmental Impediment" was the most serious one and from Monte Carlo Significance it was evident that there was significant difference among the 4 broad sets of impediments. The following suggestions were extracted from the grassroots level investigations *viz*., attending timely training and awareness programs regarding cyclones, constructions of pucca houses to protect from heavy wind and rain, cultivation of early verities of paddy crops and vegetables, constructing permanent drainage systems, reforestation and afforestation of salt-tolerant mangrove trees, chlorination of drinking water after the cyclone and use of battery operated gadgets to save life post cyclones.

Conflict of Interest

The authors declare no conflict of interest.

References

1.   Prasad B, Rao P. B, Mohanarao P. R, Sarathkumar S. Flood Hazard Vulnerability Assessment by using Geo Spatial Techniques: Krishna & Guntur Districts, Andhra Pradesh. *Curr World Environ.* 2022;17(2):498-506. doi: http://dx.doi.org/10.12944/CWE.17.2.20

2.   IMD. Cyclone Warning in India: Standard Operation Procedure, India Meteorological Department. Ministry of Earth Sciences. Government of India. 2013. URL: https://

rsmcnewdelhi.imd.gov.in/images/pdf/sop.pdf

3. Mohanty A, Wadhawan S. Mapping India's Climate Vulnerability – A District Level Assessment. New Delhi: Council on Energy, Environment and Water. 2021. URL: https://www.ceew.in/publications/mapping-climate-change-vulnerability-index-of-india-a-district-level-assessment

4. Niti Aayog. Natural Farming. Directorate of Agriculture and Food Production, Odisha. 2021. URL: https://naturalfarming.niti.gov.in/odisha/

5. Directorate of Economics and Statistics. Agriculture Census. Planning and Convergence Deartment, Govt. of Odisha. 2015. URL: http://www.desorissa.nic.in/agril_census.html

6. Special Relief Commissioner, Govt. of Odisha. Memorandum on very severe cyclonic storm 'BULBUL'. 2019. URL:https://srcodisha.nic.in/calamity/emorandum%20OF%20Bulbul.pdf

7. Lal S. P, Kadian K. S, Jha S. K, Singh S. R. K, Goyal J, Kumar R. S. A Resilience scale to Measure Farmers' Suicidal Tendencies in National Calamity Hit Region of India. *Curr World Environ.* 2014;9(3):1001-1007. doi: http://dx.doi.org/10.12944/CWE.9.3.55

8. Bandhavya M, Singh A. K, Lal S. P. Procedural impediments in e-NAM system faced by stakeholders in Guntur Mandi of Andhra Pradesh. *Indian Research Journal of Extension Education.* 2022; 22(4):106-111. URL: https://seea.org.in/archiveContents/25/volume-22-no-4-october-december-2022

9. Goyal J, Singh K, Tiwari M, Datt R, Lal S. P. Constraints perceived by Veterinary Surgeons of Haryana. *Interaction.* 2014; 32(3):92-96. URL: https://www.indianjournals.com/ijor.aspx?target=ijor:jcs1&volume=32&issue=3&article=020

10. Lal S. P, Kadian K. S, Kale R. B, Shruti. Friedman based analysis of perceived constraints among dairy farmers affected by national calamity in India. *Indian J. Dairy Sci.* 2016; 69(6):725-727. URL: https://krishi.icar.gov.in/jspui/bitstream/123456789/1389/1/SUDHANAND%20IJDS.pdf

11. Friedman M. A Correction: The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *J. Amer. Statist. Assoc.* 1939; 34:109. https://www.tandfonline.com/doi/abs/10.1080/01621459.1937.10503522

12. Lal S. P, Kadian K. S, Wodajo W. A, Shruti. Is that environmental factor affected the distressed farmers" most?! - An Exploratory factor analysis of constraint and amelioration strategies in national calamity hit region of India. *Curr World Environ.* 2016;11(3):859-868. doi: http://dx.doi.org/10.12944/CWE.11.3.22

13. Sinha S, Sankhala G. Lal S. P. Profile Characteristics and Analysis of the Constraints Faced by the Dairy Farmers of Urban and Peri-Urban Areas of Indian National Capital Region vis-a-vis Using Mobile Android Application "Eco-Dairy". *Int. J. Curr. Microbiol. App. Sci.* 2018;7(03):2335-2342. doi: https://doi.org/10.20546/ijcmas.2018.703.274

14. Popoola O.O, Yusuf S. F. G, Monde N. Information Sources and Constraints to Climate Change Adaptation amongst Smallholder Farmers in Amathole District Municipality, Eastern Cape Province, South Africa. *Sustainability.* 2020;12(14):5846. doi: https://doi.org/10.3390/su12145846

15. Lal S. P, Shukla G, Jha R. K. Perceived Impediments faced by farmers' vis-à-vis adoption of Zero tillage machine in Indo-Gangetic plain of India: PCA based Construct Validation. *Agricultural Mechanization in Asia.* 2022; 53(6):7909-7918. URL: https://www.shin-norinco.com/search-article?page=53

16. Chittibabu P, Dube S. K, Macnabb J. B, Murty T. S, Rao A. D, Mohanty U. C, Sinha P. C. Mitigation of Flooding and Cyclone Hazard in Orissa, India. *Natural Hazards.* 2004;31(2):455-485. doi: https://doi.org/10.1023/B:NHAZ.0000023362.26409.22

17. India Meteorological Department. Cyclone Warning in India Standard Operation Procedure. Ministry of Earth Sciences, Government of India. 2021; (Published in March).

18. Garret H. E. Statistics in psychology and education. Sixth edition, Vakils, Feffer and Simons Ltd., Mumbai, India. 1979. URL: https://psycnet.apa.org/record/1937-03956-000

19. Kendall M. G, Smith B. B. The problem of m-rankings. *Ann. Math Stat.* 1939;10(3):275–287. doi: https://doi.org/10.1214%2Faoms%2F1177732186

20. Kendall M. G. Rank correlation methods. Griffin & C, London. 1962. URL: https://psycnet.apa.org/record/1948-15040-000

21. Legendre P. Species Associations: The Kendall Coefficient of Concordance Revisited. *Journal of Agricultural, Biological and Environmental Statistics.* 2005;10(2):226–245. URL: https://pdodds.w3.uvm.edu/files/papers/others/2005/legendre2005a.pdf

22. UNICEF. Disaster risk reduction. Article published online 2022. URL: https://www.unicef.org/india/what-we-do/disaster-risk-reduction

23. Srinivasan R, Singh S. K, Nayak D. C, & Dharumarajan S. Assessment of soil and water salinity and alkalinity in Coastal Odisha–a case study. *Journal of Soil Salinity and Water Quality.* 2018;10(1):14-23.