**Index Development for Building Institutional Capacity to Climate Risk Management in Rainfed Farming**

 **Abstract:**

 In the past decade the cost made by the act of God has increased significantly in the world including India. Climate risk reduction measures are gradually mushroomed and executed through governance, where the rapport and decision-making among actors lead to seeding and reinforcement of institutions. In this respect, Institutions are the regulations that shape the rapport of actors in different phases of risk management. Based on the review of literature and discussions with experts, 7 dimensions along with indicators and sub-indicators through indicator approach method for institutional capacity. Total 33 indicators and 94 sub-indicators were identified and experts were given the relevancy rating score from relevant fields. The score 0.80 or above we finally considered for inclusion of 33 indicators and 74 sub-indicators in institutional capacity index.

**Keywords**: Institutional capacity, Climate risk management, Dimensions, Indicators,

 Sub-indicators.

**`Introduction**

 Action against climate change is currently more important than ever. However, despite initial achievements on an international and national level towards the Agenda 2030, the widespread implementation on a local scale and specific measures are yet to be enforced (Espinosa, 2019). This phenomenon of lacking action in spite of existing knowledge is also referred to as research implementation gap (Knight *et al*. 2008), which often originates from limited access to information or collaboration between researchers and practitioners and can be perpetuated by institutional barriers as will be discussed. Alongside the difficulty to combine a multitude of stakeholder interests, this results in limited implementation of innovative measures to combat climate change in specific regional or local contexts (Campbell *et al.* 2016). Acting on climate change would require fostering the nexus of research and implementation and facilitating technical information to decision-makers (Toomey *et al.* 2017).

 The additional stress on land posed by climate change aggravates existing risks to livelihoods, biodiversity, human and ecosystem health, infrastructure and food systems (IPCC *et al*. 2019). This stress is exacerbated by mismanagement of soil and land-use (IPBES, et al., 2018), by investment that does not consider climate risk (Bowen *et al.* 2011) or investment into traditional productive capital (Millner and Dietz, 2014), thus threatening future development (Reyer, *et al*. 2017). The patterns of human activities, technological development and land management are therefore directly linked to the level of climate change risk (IPCC *et al.* 2019). IIED believes that effective climate risk management (CRM) and institutional responses to climate change will help countries achieve climate resilient development and maintain the trajectories despite the effects of climate change. The role of innovations and adoption technologies are plays major path to mitigating the climate risk at the local level, with this the role of institutions to be sliver-line to farmers in the rainfed areas.

**Importance of Institutions Rainfed Agriculture:**

 In drought-prone areas the purpose-built institutions are to address risks faced by the farmers and manage them.

**Mitigating Climate Risks and Variability**:

 knowledge dissemination- climate smart practices, Develop and implement climate adaptation strategies, including drought-tolerant crop varieties and water harvesting techniques, Provide early warning systems to help farmer from extreme weather events, Facilitate access to weather-indexed insurance to mitigate financial risks from crop failures.

**Governance and Policy Implementation:**

Institutions establish and enforce policies, guidelines and strategies for sustainable rainfed agriculture. They help in developing frameworks for climate risk management, water usage rights, and soil conservation.

**Access to Resources and Support:**

Facilitate access to financial resources like credit, subsidies, and insurance tailored for rainfed farmers who face unpredictable yields. Provide inputs such as improved seeds, fertilizers, and appropriate technology to enhance productivity.

**Knowledge Dissemination and Capacity Building:**

Institutions support research and extension services to promote knowledge of climate-resilient practices such as crop diversification, agroforestry and conservation agriculture.

**Infrastructure Development:**

 Develop and maintain critical infrastructure, including water harvesting systems (e.g., check dams, tanks), rural roads, post-harvest technology storage facilities, **Weather Stations and forecasting Systems** which are crucial for rainfed areas. Promote irrigation innovations and efficient water management to complement rainfall-dependent systems.

**Social Capital and Community Organization:**

Support the formation of farmer cooperatives and self-help groups to improve collective bargaining, reduce transaction costs and enhance market access.Strengthen local governance structures to improve community participation in decision-making.

**Objectives**:

To develop index to measure the capacity of institutions for climate risk management in rainfed agriculture.

**Methodology:**

 Institutions referred as ‘rules of the game’ (North, 1990). Institutional capacity, defined as the ‘ability to perform functions, solve problems and set and achieve objectives’ (Willems, 2003). Institutions are the treatments that mankind use to arrange all forms of cyclical and systematic exchanges including those within households, wards, consumer bases, entities, athletic associations, parishes, non-public links, and administration at all scales” (ostrom,2005). The following steps for index preparation.

**Fig 1:** Study Protocol

**Step1: Identification of dimensions**

 Institutional capacity in rainfed agriculture was identified as a dependent variable based on thorough review of literature related to institutional capacity in rainfed farmers seven dimensions were identified viz.

* Financial resources
* Institutional factors
* Information and communication factors
* Social and policy factors
* Technical factors
* Personal factors
* Legal and regulatory framework

 For each dimension we were framed different indicators and sub-indicators through indicator-based approach and moreover sub-indicators were used to my research.

**Step 2:** Collection of indicators and sub- indicators:

In this stage based on literature of institutional capacity we specified indicators regarding to their concerned dimension and further sub-indicators were noticed under each indicator. These were refined, reformed and reorganized in Google forms.

 The Google forms were mailed to 100 experts in agricultural extension education and other related fields of ICAR institutes and SAUs to critically evaluate the relevancy of each indicator and sub-indicators in the three-point continuum viz., Relevant (R), Most Relevant (MR), Not Relevant (NR) with the score of 3,2 and 1 respectively. Some experts are suggested to add indicators that they are relevant to institutional capacity in rainfed agriculture. Out of 100 total 50 expert were answered the questionnaire. This will be processed to my further research. Whatever the data obtained from experts is used to calculate the relevancy rating score to both indicators and sub-indicators by using the formula.

 Relevancy Rating Score =(R×3 + SWR×2 + NR×1)/ (No. of judges responded ×Maximum score).

 After getting overall values of each item, which were given by the judges the relevancy rating score is equal to more than 0.80 were considered for the further analysis. The relevancy rating score of those remaining 24 sub-indicators rating score below the 0.80 have been excluded. Finally the 74 indicators and sub-indicators were chosen for studying the institutional capacity in rainfed agriculture. The indicators that have passed the criteria are presented in table1 and 2.

**Stage 3:** Validity of the Institutional capacity Index: In the present investigation, content validity method was adopted to compute the validity of the Institutional capacity Index and it was established by the expert’s judgement. Content validity is defined as the extent to which the item measures the underlying indicator selected for index. The items under each indicator were given to the experts to indicate their relevancy rating against 3 point continuum- strongly agree, agree and disagree. Only those items with relevancy rating score more than 0.80 were selected for inclusion in the index. All the possible items were identified before administering relevancy test sheets to the experts. No domain was left out to be included in the index.

**Stage 4:** Reliability of the Research Productivity Index: Internal consistency reliability method was used to test the reliability. The Cronbach Alpha coefficient obtained for the index was found to be 0.888, which indicates good internal consistency of items in the index.

**Results and discussions:**

**Selection of indicators and sub-indicators for inclusion in the index**: The responses were quantified and presented in the Table 1. And it is evident from the Table 1&2 that the relevancy scores for different indicators and sub-indicators ranged from 0.57 to 0.89.

**Table 1. Relevant rating score of Indicators**

|  |  |
| --- | --- |
| Indicator  |  RRS |
| Financial resources | 0.83 |
| Credit Availability | 0.80 |
| Insurance | 0.84 |
| Market Access and Linkages | 0.89 |
| Financial Support from External Sources | 0.80 |
| Institutional Structure | 0.84 |
| Institutional Members | 0.87 |
| Institutional Governance | 0.82 |
| Resource Availability and Management | 0.84 |
| Community Coordination | 0.85 |
| Policy and Planning Integration | 0.83 |
| Public-Private Partnerships | 0.88 |
| Capacity Building and Training Programs | 0.83 |
| Information Access and Utilization | 0.84 |
| Knowledge and Expertise of CRTs | 0.86 |
| Communication Network Effectiveness | 0.87 |
| Feedback and Engagement Mechanisms | 0.86 |
| Community Participation and Inclusion | 0.87 |
| Policy Awareness and Adherence | 0.86 |
| Social Capital and Networks | 0.83 |
| Collaboration with External Stakeholders | 0.85 |
| Technology Adoption and Utilization | 0.84 |
| Impacts vs. Adaptation | 0.82 |
| Adaptation Planning | 0.81 |
| Technical Skills and Expertise | 0.82 |
| Innovation and Adaptation of Practices | 0.85 |
| Innovation and Adaptation of Practices | 0.82 |
| Knowledge and Awareness | 0.82 |
| Working Experience | 0.84 |
| Leadership and Initiative | 0.84 |
| Problem-Solving Skills | 0.87 |
| Engagement and Participation | 0.82 |
| Compliance with Regulations | 0.88 |
| Advocacy for Policy Changes | 0.86 |

The relevancy rating scores were calculated by dividing the actual score obtained with maximum score obtainable from 30 experts. The indicators with relevancy rating score more than 0.80 were selected for inclusion in the index for measuring the institutional capacity. Total 33 indicators were satisfied the criteria and they were Financial resources, Credit Availability, Insurance, Market Access and Linkages, Financial Support from External Sources, Institutional Structure, Institutional Members, Institutional governance, Resource Availability and Management, Community Coordination, Policy and Planning Integration, Public-Private Partnerships, Capacity Building and Training Programs, Information Access and Utilization, Knowledge and Expertise of CRTs, Communication Network Effectiveness, Feedback and Engagement Mechanisms, Community Participation and Inclusion, Policy Awareness and Adherence, Social Capital and Networks, Collaboration with External Stakeholders, Technology Adoption and Utilization, Impacts vs. Adaptation, Adaptation Planning, Technical Skills and Expertise, Innovation and Adaptation of Practices, Innovation and Adaptation of Practices, Knowledge and Awareness, Working Experience, Leadership and Initiative, Problem-Solving Skills, Engagement and Participation, Compliance with Regulations, Advocacy for Policy Changes.

**Selection of items**: Only those items with relevancy rating score more than 0.80 were selected for inclusion in the index. The relevancy scores were calculated by diving actual score with the maximum score possible. Out of 94 items chosen, 74 items were finally selected for inclusion in the index. The responses for items of the index were quantified and given in the Table 2.

**Institutional capacity index:** The indicators and sub-indicators that passed the criteria of relevancy rating scores were selected for inclusion in the index. Consequently, the scores of all indicators and sub-indicators were normalized using the provided formula. The indicators and sub-indicators that passed the criteria of relevancy rating scores were selected for inclusion in the index. Consequently, the scores of all indicators and sub-indicators were normalized using the provided formula.

 𝑈𝑖𝑗 =$ \frac{y\_{ij}-min\_{yj}}{max\_{ij}-min\_{yj}}$

Where

Uij = Unit score of the ith respondents on the jth component

𝑌𝑖𝑗 = Value of ith respondent on the jth component

𝑀𝑎𝑥𝑖𝑗 = Maximum score on the jth component

𝑀𝑖𝑛𝑦𝑗 = Minimum score on the jth component

**Table 2. Relevant rating score of sub- indicators**

|  |  |  |
| --- | --- | --- |
| Indicator  |  Sub-indicator |  RRS |
| Financial resources | The budget allocated is adequate to take up climateRisk management interventions.  |  0.83 |
|  | The funds provided are timely to support the activities. |  0.83 |
|  | Funds can be used flexibly for different climate risk management activities. |  0.85 |
| Credit Availability | Loan repayment terms are reasonable and manageable. |  0.80 |
| Insurance | Climate risk insurance is available. |  0.88 |
| Market Access and LinkagesFinancial Support from External Sources | The insurance premium is affordable.The process of insurance claims is easy, and the coverage meets the needs.Reliable market information systems are accessibleGrants can be accessed to support climate risk management efforts. |  0.85 0.80 0.89 0.80 |
| Institutional StructureInstitution MembersInstitutional GovernanceResource Availability and ManagementCommunity CoordinationPolicy and Planning IntegrationPublic-Private PartnershipsCapacity Building and Training ProgramsInformation Access and UtilizationKnowledge and Expertise of CRTsCommunication Network EffectivenessFeedback and Engagement MechanismsCommunity Participation and InclusionPolicy Awareness and AdherenceSocial Capital and NetworksCollaboration with External StakeholdersTechnology Adoption and UtilizationImpacts vs. AdaptationAdaptation PlanningTechnical Skills and ExpertiseInnovation and Adaptation of PracticesKnowledge and AwarenessWorking ExperienceLeadership and InitiativeProblem-Solving SkillsEngagement and ParticipationCompliance with RegulationsAdvocacy for Policy Changes | There is a clear hierarchy and structure within the institution. Different departments coordinate effectively. Members have the necessary expertise and experience in managing climate risks.Diversity and inclusion among members are promoted. Leadership within the institution is effective.Roles and responsibilities of members are clear.Adequate financial and human resources are available. Technical and material resources are readily available.The institution actively engages with the community. Information about climate risks is shared effectively with the community.The institution’s activities are aligned with national or regional policies. The institution has a long-term vision for climate risk management.The institution engages with policymakers in climate risk management strategies.Stakeholders are actively involved in climate risk management efforts.Training programs cover all necessary aspects of climate risk management.Training programs positively impact the institution’s capacity to manage climate risks.Accurate and timely climate information is accessible.Climate information is effectively integrated into decision-making processes.Members have the necessary expertise in climate risk management.The technical skills of members are sufficient to manage climate risks.Members possess knowledge from multiple disciplines related to climate risk management.The institution’s messages about climate risks are clear and understandable.Modern communication technologies are used effectively.All relevant stakeholders are included in the institution’s engagement efforts.Support for technology upgrades for climate risk management is available.Support for technology upgrades for climate risk management is available.Local leadership is involved in the institution’s climate risk management activities.The institution provides capacity building for communities.The institution ensures social equity in its climate risk management efforts.Members are aware of the policies relevant to climate risk management.The institution engages in networking with peers in the field of climate risk management.The institution has the capacity to mobilize resources for climate risk management.The institution maintains a diverse range of partnerships.The institution’s partnerships are effective in achieving climate risk management goals.The institution has formal agreements and MoUs to support its activities.The institution’s technology is adaptable to changing climate risks.The institution effectively utilizes available technologies.Members are trained on how to use the technologies available.The institution supports the continuous upgrading of its technology. The institution regularly assesses the impacts of climate change.The institution balances efforts between mitigating climate impacts and adapting to them.The institution has effective strategies for adapting to climate change.The institution prioritizes the most important adaptation actions.The institution has a framework to monitor and evaluate its adaptation efforts.The institution provides or has access to technical advisory services.Members have opportunities for continuous professional development.The institution develops new practices to manage climate risks.The institution adapts traditional practices to manage climate risks.The institution collaborates with others to innovate in climate risk management.Members have knowledge of the best practices in climate risk management.Members are aware of the specific climate risks relevant to their work.The institution integrates indigenous knowledge into its climate risk management practices.Members have field experience in managing climate risks.Members are adaptable to new and emerging challenges in climate risk management.There is strong commitment from leaders to manage climate risks effectively.The institution is prepared to manage crises related to climate risks.Members have the authority to make decisions in their roles.The institution innovates in finding solutions to climate risks.The institution effectively assesses and mitigates risks.The institution participates actively in policy-making processes.The institution has the capacity to facilitate dialogue on climate risk management.The institution adheres to legal standards.The institution implements effective risk management practices.The institution engages actively in policy dialogue.The institution influences policy development. |  0.83 0.85 0.83 0.89 0.84 0.80 0.85 0.84 0.86 0.85 0.83 0.82 0.83 0.88 0.86 0.81 0.86 0.83 0.85 0.89 0.86 0.88 0.87 0.85 0.86 0.89 0.88 0.84 0.89 0.86 0.80  0.86 0.83 0.84  0.89 0.80 0.87 0.85 0.85 0.81 0.84  0.82 0.80 0.81 0.85 0.82 0.89 0.80 0.88 0.85 0.80 0.83 0.80 0.85 0.84 0.80 0.89 0.87 0.81 0.88 0.87 0.84 0.80  0.88 0.89  |

The obtained index value ranged from 0 to 1. Based on the values obtained, the agricultural scientists were categorized into 5 classes- very low, low, medium, high and very high based on the range obtained. The highest score among the respondents was 0.88 while lowest score was 0.11 (Table 3).

**Table 3. Categorization of Institutional capacity index values**

|  |  |
| --- | --- |
| Category |  Class interval |
| Very low |  0.11-0.26 |
| Low |  0.27-0.42 |
| Medium |  0.43 -0.58 |
| High |  0.59-0.74 |
| Very high |  0.75-0.90 |

**Conclusion:**

Institutions are indispensable for enhancing the **resilience, productivity, and sustainability** of rainfed agriculture. By integrating governance, resource management and innovation, they can bridge the gap between **policy and practice**, ensuring that farmers can thrive despite climatic challenges. The index developed in this study can be used to measure the institutional capacity in rainfed farming. The developed index can be used by administrators, policy makers to assess the current potential to manage the risks and to devise strategies for further empowering the farmers.

**Disclaimer (Artificial intelligence)**

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Details of the AI usage are given below:

1.

2.

3.

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