Essays on Climate Risk, Farmers' Adaptive Capacity to Climate Risk, and Information and Communication Technologies (ICTs)

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INDIAN INSTITUTE OF TECHNOLOGY DELHI

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Essays on Climate Risk, Farmers' Adaptive Capacity to Climate Risk, and Information and Communication Technologies (ICTs)

by

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School of Public Policy

Submitted

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I dedicate this work to my revered Guru, Shri Ashutosh Maharaj Ji, whose divine guidance and enlightenment have been the true source of strength, clarity, and purpose throughout my journey.

THESIS CERTIFICATE

This is to certify that the thesis titled **Essays on Climate Risk, Farmers' Adaptive Capacity to Climate Risk, and Information and Communication Technologies (ICTs)**, submitted by **Priya Chetri**, to the Indian Institute of Technology, Delhi, for the award of the degree of **Doctor of Philosophy**, is a bona fide record of the research work done by her under our supervision and guidance. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

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I am deeply grateful to my advisors, Dr. Upasna Sharma and Dr. P. Vigneswara Ilavarasan, for their unstinting support during this long journey. I cannot express how they have inspired me as a human being and as a researcher. My guides have been my academic parents, and I am so thankful to them for patiently guiding me through the early steps of my academic journey. On multiple occasions, when I kept myself in their shoes and was convinced I would have scolded myself, my guides left me surprised (on all those occasions!). Their kindness has left an imprint on me, which I will carry forward as a legacy in academia and life in general. My guides believed in me when I did not, and I will always be indebted to them.

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My fiancé, Saumitr Chaturvedi, has always been there in good and bad times. We met when the world was so uncertain, and the COVID-19 waves were surging. In those difficult times, Saumitr has provided me with love, comfort, care, and encouragement, and above all, he has been a true friend. His kindness and patience have been boundless, always listening to my endless gibber-jabber about academia. I want to thank him and his family for their patience and unconditional support.

My friends have been a source of motivation and the reason I could enjoy my otherwise alone academic journey. I am so grateful to my friend Yuganshi. She was one of those rare people who are very difficult to find and are a blessing to be around. In a very short period of time, I have learned a lot from my dearest friend. Because of her, I have a second family. I am grateful to Vikky aunty, Rajesh uncle, and my brother Parth, who have been there in all the ups and downs and provided me with their love, care, and encouragement.

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Abstract

Agriculture sector is both a contributor and a victim of increased climate variability. Increased climate variability amplifies the vulnerability of farming communities. There is strong correlation between variations in crop yield and climatic variables such as temperature and precipitation (Ray et al., 2015). Adaptation to climate risk helps in limiting exposure to climate hazards and provides a cushion against the adverse effects of climate impacts (Leiter, 2022). The uptake of adaptation measures has been low among farmers, particularly in India (Bahinipati and Patnaik, 2022). Even if adaptation is autonomous, it cannot be expected to occur naturally (Tripathi and Mishra, 2017). Adaptation to enhanced risk would be more likely if the farmer's capacity to adapt is higher. Adaptive capacity is frequently tied to entitlements and resources where greater entitlements are attached to greater adaptive capacity while information as an enabler of farmers' adaptive capacity is often less explored. This thesis aims to analyze the link between information and the uptake of farm-level adaptation activities by farmers in India. The thesis draws attention to the non-linearity in the information-adaptation link by delving into three inter-related empirical studies. Each of these studies analyze a different facet of farmers' access to information and weave it into the discourse of farm-level adaptation.

The first empirical study takes a broader conceptualization of farmers' access to information and ICTs to highlight potential sources of inequality in access (to information and ICTs). It examines how such differential accesses influence the uptake of farm-level adaptation. The first study contributes to the literature on information-adaptation link and addresses the contradictory findings on the role of information and ICTs in facilitating farmers' adaptation.

In line with the findings of the first study, the second empirical study examines a specific case wherein access to a specific information service, viz. Agromet Advisories Service, through a specific channel, i.e., SMS, is provided to all the sample farmers to examine how farmers respond to the information and what farmer-specific factors influence those responses. We used the structural equation modelling technique in both of these quantitative studies. In the first study, it allowed modelling the interlinkages between different determinants of farmers' adaptive capacity to provide a more detailed analysis of the direct as well as indirect associations between different determinants of adaptive capacity and their link with farm-level adaptation. In the second study, it helped us understand the interlinked nature of farmers' responses to information and how relevant farmer-specific factors influence these responses.

In the last study, we undertook a qualitative research approach to examine a very specific factor that we found influencing the link between information, ICTs, and farm-level adaptation. The factor is farmers' social ecosystem pertaining to use of ICTs at the local level. In the last empirical study, we map the farmers' ecosystem around information and

ICTs and examine how it enhances/constrains farmers' capacity to adapt and thereby influence their farm-level adaptation.

The thesis provides empirical evidence proposing the need to look beyond the "access" dimension for both the information and the technologies that facilitate access to information – the Information and Communication Technologies (ICTs). The thesis discusses broader policy implications that the findings of the thesis entail and provides some recommendations for practice.

सार

कृषि क्षेत्र योगदानकर्ता और बढ़ी हुई जलवायु परिवर्तनशीलता का शिकार दोनों है। बढ़ी हुई जलवायु परिवर्तनशीलता कृषक समुदायों की भेद्यता को बढ़ाती है। फसल की उपज और जलवायु चर जैसे तापमान और वर्षा (रे एट अल., 2015) में भिन्नता के बीच मजबूत संबंध है। जलवायु जोखिम के लिए अनुकूलन जलवायु खतरों के जोखिम को सीमित करने में मदद करता है और जलवायु प्रभावों के प्रतिकूल प्रभावों के खिलाफ एक तकिया प्रदान करता है (लेटर, 2022)। किसानों के बीच अनुकूलन उपायों का उपयोग कम रहा है, विशेष रूप से भारत में (बाहिनीपति और पटनायक, 2022)। यहां तक कि अगर अनुकूलन स्वायत्त है, तो यह स्वाभाविक रूप से होने की उम्मीद नहीं की जा सकती है (त्रिपाठी और मिश्रा, 2017)। बढ़े हुए जोखिम के अनुकूलन की संभावना अधिक होगी यदि किसान की अनुकूलन करने की क्षमता अधिक है। अनुकूली क्षमता अक्सर अधिकारों और संसाधनों से जुड़ी होती है जहां अधिक से अधिक पात्रता अधिक अनुकूली क्षमता से जुड़ी होती है जबकि किसानों की अनुकूली क्षमता के प्रवर्तक के रूप में जानकारी अक्सर कम खोजी जाती है। इस थीसिस का उद्देश्य भारत में किसानों द्वारा कृषि-स्तर अनुकूलन गतिविधियों की जानकारी और उत्थान के बीच की कड़ी का विश्लेषण करना है। थीसिस तीन अंतर-संबंधित अनुभवजन्य अध्ययनों में तल्लीन करके सूचना-अनुकूलन लिंक में गैर-रैखिकता पर ध्यान आकर्षित करती है। इनमें से प्रत्येक अध्ययन किसानों की जानकारी तक पहुंच के एक अलग पहलू का विश्लेषण करता है और इसे खेत-स्तर के अनुकूलन के प्रवचन में बुनता है।

पहला अनुभवजन्य अध्ययन पहुंच (सूचना और आईसीटी तक) में असमानता के संभावित स्रोतों को उजागर करने के लिए किसानों की सूचना और आईसीटी तक पहुंच की व्यापक अवधारणा लेता है। यह जांच करता है कि इस तरह के अंतर पहुंच खेत-स्तर के अनुकूलन के उत्थान को कैसे प्रभावित करते हैं। पहला अध्ययन सूचना-अनुकूलन लिंक पर साहित्य में योगदान देता है और किसानों के अनुकूलन को सुविधाजनक बनाने में सूचना और आईसीटी की भूमिका पर विरोधाभासी निष्कर्षों को संबोधित करता है।

पहले अध्ययन के निष्कर्षों के अनुरूप, दूसरा अनुभवजन्य अध्ययन एक विशिष्ट मामले की जांच करता है जिसमें एक विशिष्ट चैनल यानी एसएमएस के माध्यम से एक विशिष्ट सूचना सेवा, अर्थात एग्रोमेट एडवाइजरी सर्विस तक पहुंच सभी नमूना किसानों को प्रदान की जाती है ताकि यह जांच की जा सके कि किसान जानकारी पर कैसे प्रतिक्रिया देते हैं और किसान-विशिष्ट कारक उन प्रतिक्रियाओं को कैसे प्रभावित करते हैं। हमने इन दोनों मात्रात्मक अध्ययनों में संरचनात्मक समीकरण मॉडलिंग तकनीक का उपयोग किया। पहले अध्ययन में, इसने किसानों की अनुकूली क्षमता के विभिन्न निर्धारकों के बीच अंतर्संबंधों को मॉडलिंग करने की अनुमति दी ताकि अनुकूली क्षमता के विभिन्न निर्धारकों और खेत-स्तर अनुकूलन के साथ उनके लिंक के बीच प्रत्यक्ष और अप्रत्यक्ष संघों का अधिक विस्तृत विश्लेषण प्रदान किया जा सके। दूसरे अध्ययन में, इसने हमें जानकारी के लिए किसानों की प्रतिक्रियाओं की परस्पर

प्रकृति को समझने में मदद की और कैसे प्रासंगिक किसान-विशिष्ट कारक इन प्रतिक्रियाओं को प्रभावित करते हैं।

अंतिम अध्ययन में, हमने एक बहुत ही विशिष्ट कारक की जांच करने के लिए एक गुणात्मक शोध दृष्टिकोण अपनाया, जिसे हमने सूचना, आईसीटी और खेत-स्तर के अनुकूलन के बीच की कड़ी को प्रभावित करते हुए पाया। इसका कारण स्थानीय स्तर पर आईसीटी के उपयोग से संबंधित किसानों का सामाजिक पारिस्थितिकी तंत्र है। पिछले अनुभवजन्य अध्ययन में, हमने सूचना और आईसीटी के आसपास किसानों के पारिस्थितिकी तंत्र का मानचित्रण किया और जांच की कि यह किसानों की अनुकूलन की क्षमता को कैसे बढ़ाता है/बाधित करता है और इस तरह उनके खेत-स्तर के अनुकूलन को प्रभावित करता है।

थीसिस अनुभवजन्य साक्ष्य प्रदान करता है जो सूचना और प्रौद्योगिकियों दोनों के लिए "पहुंच" आयाम से परे देखने की आवश्यकता का प्रस्ताव करता है जो सूचना और संचार प्रौद्योगिकी (आईसीटी) तक पहुंच की सुविधा प्रदान करता है। थीसिस व्यापक नीतिगत निहितार्थों पर चर्चा करती है जो थीसिस के निष्कर्ष शामिल हैं और अभ्यास के लिए कुछ सिफारिशें प्रदान करते हैं।

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List of Abbreviations

AAS	Agromet advisory services
ADO	Agriculture Development Officer
AGR	Adaptation Gap Report
AI	Artificial Intelligence
AMFU	Agrometeorological Field Unit
ATM	Assistant Technology Manager
ATMA	Agriculture Technology Management Agency
BFAC	Block Farmers Advisory Committee
BTM	Block Technology Manager
BTT	Block Technology Team
CCSAMMN	Climate Change and Sustainable Agriculture: Monitoring, Modeling and Networking
CCSHAU	Chaudhary Charan Singh Haryana Agriculture University
CI	Confidence Interval
CICR	Central Institute for Cotton Research
CRM	Crop Residue Management
CSC	Common Service Centre
C-TAM-TPB	Combined Technology Acceptance Model and the Theory of Planned Behaviour
DAP	Diammonium Phosphate
DFID	Department for International Development
DOI	Diffusion of Innovation
ELM	Elaboration Likelihood Model
e-NAM	Electronic National Agriculture Market
FAO	Food and Agriculture Organization
FFS	Farmer Field School
FTC	Farmer Training Camp
GHG	Greenhouse Gas

GKMS	Gramin Krishi Mausam Seva
GPS	Global Positioning System
HAU	Haryana Agriculture University
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICTs	Information and Communication Technologies
ICT4D	Information and Communication Technologies for Development
IIT	Indian Institute of Technology
IMD	India Meteorological Department
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IPCC AR5	IPCC Fifth Assessment Report
ITC	Indian Tobacco Company
KCC	Kisan Call Centre
KVK	Krishi Vigyan Kendra
MM	Motivational Model
MOES	Ministry of Earth Sciences
NAPCC	National Action Plan on Climate Change
NICRA	National Innovation on Climate Resilient Agriculture
NMAET	National Mission on Agricultural Extension and Technology
NMSA	National Mission on Sustainable Agriculture
PLS-SEM	Partial Least Square Structural Equation Modelling
PPP	Public-Private Partnership
PRADAN	Professional Assistance for Development Action
PNB	Punjab National Bank
QR code	Quick Response Code
R&D	Research and Development
RSETI	Rural Self-Employment Training Institutes
SAU	State Agricultural University
SBI	State Bank of India

SCT	Social Cognitive Theory
SD	Standard Deviation
SEM	Structural Equation Modelling
SIM	Subscriber Identity Module
SLF	Sustainable Livelihood Framework
SMS	Short Message Services
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UIS	UNESCO Institute for Statistics
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme
UPL	United Phosphorus Limited
UTAUT	Unified Theory of Acceptance and Use of Technology
VLE	Village Level Entrepreneur