Pathways of Transition

Climate Resilience & Energy Efficiency in Agriculture

Learnings from District Level Consultative Inter-Departmental Workshops, Kerala

emc KERALA

EQUINOCT
CoSMoS
COMMUNITY SOURCED MODELLING SOLUTIONS

asar

Pathways of Transition

Climate Resilience & Energy Efficiency in Agriculture

Learnings from District-Level Consultative Interdepartmental Workshops, Kerala

CLIMATE RESILIENCE AND ENERGY EFFICIENCY IN AGRICULTURE
CREEA

Supported by

Energy Management Centre, Kerala

Department of Agriculture Development and Farmers' Welfare

Organised by

Asar Social Impact Advisors Pvt. Ltd.

EQUINOCT Community Sourced Modelling Solutions LLP

Pathways of Transition: Climate Resilience and Energy Efficiency in Agriculture – Learnings from District-Level Consultative Interdepartmental Workshops, Kerala

ISBN (print edition): 978-81-988012-5-8

978-81-988012-5-8

First Edition: June 2025

Layout and Book Design: Deepak Sasikumar
Email: deepaksasikumar08@gmail.com

Cover Photography: Uma Sannasi

Published by
Asar Social Impact Advisors Pvt. Ltd.
No.16, 7th Temple Road, 15th Cross Road,
Malleshwaram, Bangalore - 560 003
https://www.asar.co.in

EQUINOCT Community Sourced Modelling Solutions LLP
Encore, Jawahar Road, Vyttila PO, Ernakulam, Kerala – 682019
https://www.equinoct.com/

Contributors
Usha Kumari S, Sreeja K.G, C.G. Madhusoodanan, Sridhar Radhakrishnan, Priya Pillai, Rajesh Krishnan, Jayaraman Chillayil, Manjula K, Hari Subbish Kumar, Indu Periodi, Amjad Anwar, Abhay Vishnu

Infographics: Indu Periodi

Printed in India

Citation: Asar Social Impact Advisors & EQUINOCT Community Sourced Modelling Solutions. (2025). *Pathways of Transition: Climate Resilience and Energy Efficiency in Agriculture – Learnings from District-Level Consultative Interdepartmental Workshops, Kerala* [Report].

The Preface

Dr. R. Harikumar
Director, Energy Management Centre-Kerala,
Department of Power, Government of Kerala

Energy Management Centre - Kerala, Thiruvananthapuram, Kerala Kerala's agriculture sector accounts for less than 4% of the state's total energy consumption, with the domestic sector being the largest consumer. However, the Energy Management Centre-Kerala (EMC) has consistently prioritised energy efficiency in agriculture—recognising that, despite its lower energy footprint, the sector is on the frontlines of the climate crisis.

In recent years, the impacts of climate change, water scarcity, prolonged dry spells, unseasonal rains have increasingly disrupted agricultural livelihoods. Addressing these challenges demands an integrated approach that links energy efficiency with climate resilience, both for mitigation and adaptation.

To explore this intersection more deeply, EMC—along with Equinoct Community Sourced Modelling Solutions and Asar Social Impact Advisors—initiated the Climate Resilience & Energy Efficiency in Agriculture (CREEA) consultation process. This process brought together key stakeholders from across Kerala's agricultural ecosystem, including representatives from the Departments of Agriculture, Fisheries, Soil Conservation, Irrigation, Animal Husbandry, NABARD, Kudumbashree, MGNREGS, LSGIs, the Agricultural and Veterinary Universities, and Krishi Vigyan Kendras (KVKs).

Between July 2023 and January 2024, inter-departmental workshops were held in 14 districts across the state, engaging more than 1,800 participants. These district-level discussions served as platforms for cross-sector dialogue, the sharing of ground-level experiences, and the identification of opportunities for integrated action. This report brings together key insights and learnings from those workshops. It highlights local innovations, implementation challenges, and emerging ideas that can inform future strategies to make Kerala's agriculture both climate-resilient and energy-efficient.

We extend our sincere gratitude to all those who contributed to the consultations, and to every participant who enriched the discussions with their experience and commitment. We hope this report serves as a foundation for deeper collaboration and action across departments and institutions working toward a sustainable and energy efficient agricultural future for Kerala.

Foreword

P. Prasad
Minister for Agriculture, Government of Kerala

Agriculture is more than just a way to earn a living—it is the foundation of human civilisation and essential for life. From ancient times, farming has helped shape how people live, how societies grow, and how economies and the environment develop.

Today, as we face the challenges of the 21st century, agriculture continues to play a key role. It is deeply connected to our efforts to ensure enough food for all, protect public health, and fight climate change. The climate crisis is no longer something that may happen in the future—it is already happening now. In Kerala, like in many other parts of the world, we are seeing its effects clearly. Weather has become more unpredictable. Heavy rains, floods, landslides, long dry periods, and rising temperatures have made farming more difficult. These changes threaten our crop production, the livelihoods of our farmers, and the food security of our state.

Because agriculture depends so much on weather and climate, it is one of the first sectors to be affected. When food production is affected, many other problems follow—poor nutrition, loss of income for farmers, and risks to the overall well-being of society. Since food is essential for life, agriculture must be a central part of our plans to deal with climate change. Making farming more resilient to climate change is not a choice—it is a necessity.

The Government of Kerala has taken many steps to face these challenges. Through the Department of Agriculture, we are promoting climate friendly farming by planning according to different local conditions and introducing crops that can survive in changing weather. A major step forward is the "KERA" (Kerala Climate Resilient Agri-Value Chain Modernization) project, supported by the World Bank. This Rs.2,365.5 crore project, running over five years, aims to make Kerala's agriculture stronger and better able to deal with climate change. It is the first agriculture focused World Bank project in Kerala in 40 years, showing how important it is. The project will use local agro-ecological zones and agro-ecological units to guide climate smart practices. It also aims to increase rice yields while reducing carbon emissions, in partnership with the International Rice Research Institute.

We also realise that modern farming often uses a lot of energy—for machines, water pumps, and processing—leading to greenhouse gas emissions. That's why we are encouraging renewable energy solutions, like solar-powered irrigation and energy-saving technologies. These help reduce emissions and improve productivity, income, and sustainability.

Our efforts don't stop at adapting to climate change. We are also working to reduce farming's impact on the environment. In December 2021, we started promoting carbon neutral farming through a national workshop held in Thiruvananthapuram. Since then, we have made the State Seed Farm in Aluva India's first carbon neutral farm. By 2026, we plan to make 13 more government farms carbon neutral.

However, true change cannot happen through policies and technology alone. We need the knowledge and support of all people involved in farming. Our farmers hold generations of experience and wisdom about nature. When this is combined with scientific research and support from institutions, we can find solutions that truly work for our people and environment. We are working closely with Kerala Agricultural University to promote climate ready, short-duration crops and eco-friendly farming practices.

This foreword accompanies the report "Pathways of Transition: Climate Resilience and Energy Efficiency in Agriculture", a joint effort by the Energy Management Centre (EMC) and the Department of Agriculture. Through district-level workshops, this initiative brought together stakeholders to share insights and identify local, practical solutions.

The CREEA framework showcased here offers a path forward for sustainable, climate-resilient farming in Kerala. I thank the EMC and all contributors for their valuable work. As we move forward in facing climate challenges, let this work inspire continued partnerships, policy innovation, and community action. The future of our food systems—and the well-being of future generations—depends on the steps we take today.

Foreword

Shri K. Krishnankutty
Minister for Electricity, Government of Kerala

Kerala's agriculture stands at a pivotal moment. Rich in biodiversity and steeped in traditional wisdom, it now faces growing challenges—climate variability, rising input costs, soil degradation, and increasing distress among farmers. Ensuring food sovereignty and securing sustainable livelihoods demands a transition to a model that integrates climate resilience, energy efficiency, and decentralised planning.

Energy is central to this transformation. Every stage of the agricultural value chain—from irrigation to storage—is energy-intensive. Adopting solar power, decentralised renewables, and efficient technologies such as micro-irrigation can reduce costs, enhance energy security, and open up new income opportunities for farmers.

CREEA – Pathways of Transition is the outcome of a collaborative effort led by the Energy Management Centre (EMC), Kerala, under the Department of Power and the Department of Agriculture Development & Farmers' Welfare, in partnership with Asar Social Impact Advisors and EQUINOCT. This report is grounded in the voices of over 1,900 stakeholders who participated in district-level workshops across Kerala during 2023-24.

It offers a practical, multi-sectoral roadmap across 12 thematic areas—ranging from risk-informed planning to digital innovation—enriched by real-world examples such as the carbon-neutral State Seed Farm in Aluva, integrated planning in Alathur, and the TAPCo cooperative in Wayanad. These examples demonstrate that energy-efficient and climate-smart agriculture is not only an ecological necessity but also an economically sound and socially just path forward.

A recurring theme across these interventions is the pivotal role of farmer agency, local innovation, and the convergence of efforts by departments and local bodies. Our shared vision must build on this foundation—designing regionally rooted, long-term solutions that blend scientific knowledge with sustainability, and energy transition with equitable growth.

As Minister for Electricity, I reaffirm our commitment to supporting Kerala's farmers—not just through reliable power supply, but by advancing decentralised energy systems and resilient agricultural solutions.

This report represents an important step forward. I hope it provides a solid foundation as we move into the next phase of CREEA, focused on translating key recommendations into practical, coordinated action. Our collective mission is to ensure that Kerala's agriculture remains resilient to climate challenges and continues to secure the livelihoods of our farmers for generations to come.

Abbreviations

ANERT	Agency for New and Renewable Energy Research and Technology
ATMA	Agriculture Technology Management Agency
CBOs	Community-Based Organisations
CRA	Climate Resilient Agriculture
CREEA	Climate Resilience and Energy Efficiency in Agriculture
CSO	Civil Society Organisations
CSR	Corporate Social Responsibility
DoECC	Directorate of Environment and Climate Change
EE	Energy Efficiency
EMC	Energy Management Centre
FAO	Food and Agriculture Organisation
FIG	Farmer Interest Group
FPC	Farmer Producer Company
FPO	Farmers Producer Organisation
GIS	Geographic Information System
IPCC	Intergovernmental Panel on Climate Change
KAU	Kerala Agricultural University
KFRI	Kerala Forest Research Institute
KKS	Karshika Karma Sena
KLDC	Kerala Land Development Corporation
KSEBL	Kerala State Electricity Board Ltd.
KSLUB	Kerala State Land Use Board
KVK	Krishi Vigyan Kendra
LSGD	Local Self Government Department
LSGI	Local Self Government Institution
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MSP	Minimum Support Price
NABARD	National Bank For Agriculture And Rural Development
NGO	Non-Governmental Organisation
PACS	Primary Agriculture Credit Societies
PAO	Principal Agriculture Officer
PM KUSUM	Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyan
RE	Renewable Energy
RIDF	Rural Infrastructure Development Fund
RKVY	Rashtriya Krishi Vikas Yojana
SHG	Self-Help Groups

Acknowledgments

We extend our deepest gratitude to the Energy Management Centre (EMC) Kerala for providing the platform for a series of consultations on energy transition in the agriculture sector. These consultations inspired the idea of conducting district-level consultations and workshops on Climate Resilience and Energy Efficiency in Agriculture (CREEA) with officers in the agriculture and allied sectors. We also acknowledge EMC's financial support in executing these workshops. Special thanks to Dr. Harikumar, Director of EMC Kerala, for his unwavering support throughout this workshop series.

We are grateful to the Department of Agriculture Development and Farmers' Welfare, Kerala for becoming a key partner in this initiative, joining us through this journey, and ensuring the active participation of agriculture officers in each of the 14 districts. We offer a heartfelt appreciation to Dr. George Sebastian, then Deputy Director of Agriculture, for his constant support, guidance, and commitment in ensuring the participation of all the relevant stakeholders. We also extend our special thanks to all the Principal Agriculture Officers (PAOs) for their efforts in facilitating the day-long consultations and workshops and ensuring engagement of agriculture officers at the district-level.

The CREEA workshop series was launched at EMC, Thiruvananthapuram on 25 July 2023. We would like to acknowledge the contributions of K. Krishnankutty, Minister for Electricity, Government of Kerala, who presided over the inaugural workshop; P. Prasad, Minister for Agriculture, Government of Kerala, who inaugurated the series; and K. R. Jyothilal, IAS, Principal Secretary, Government of Kerala, who delivered the special address.

We express our sincere gratitude to the Local Self Government Department (LSGD) and the respective District Panchayat Presidents who graciously inaugurated the district workshops. Each workshop was conducted in close consultation with the District Panchayat President and PAO of each district, whose collaboration has been instrumental in the programme's success. We would also like to acknowledge the contributions of the 19 departments, missions and institutions that participated in the workshops, including Fisheries, Animal Husbandry, Soil Survey and Conservation, Irrigation, Groundwater, NABARD, Kudumbashree, MGNREGS and KVK. Their collective

support facilitated diverse participation, fostering dialogue and collaboration among departments integral to the farming and food system.

A special note of appreciation to the resource persons - Usha Kumari S, K. G. Sreeja, C. G. Madhusoodanan, Rajesh Krishnan, Sridhar Radhakrishnan, Priya Pillai and Jayaraman Chillayil - who contributed from the ideation phase through to conducting the workshops and beyond. We also extend our gratitude to Johnson Daniel, Head of NMEEE and DSM, and Tomson Sebastian, Energy Technologist, who were consistently involved in the consultations and served as resource persons during the workshops.

We extend our appreciation to the media representatives who, in each district, provided coverage of the workshops, disseminated information, and highlighted unique insights emerging from the district-level discussion. Lastly, but by no means the least, our heartfelt thanks to all the volunteers from Kerala Agricultural University and other institutions who stood by us throughout all the workshops, assisting with registration and note-taking and ensuring the seamless functioning of each of the workshops.

Executive Summary

Climate Resilience and Energy Efficiency in Agriculture (CREEA) initiative in Kerala is aimed at enhancing both resilience and energy efficiency in agriculture through state-level consultations, district-level workshops, and the establishment of community-driven solutions. CREEA emphasises the profound impacts of climate change on the food system. It highlights the intricate relationship between agricultural practices and climate dynamics, the detrimental effects of climate change on food security, agricultural productivity, and socio-economic conditions. It also addresses the food system's contribution to climate change. The CREEA initiative is a call for action for transformative approaches to mitigate these challenges and foster resilience within the food production system in the state of Kerala.

Climate Resilient Agriculture (CRA) has emerged as a key framework, emphasising localised, inclusive, and participatory strategies to foster resilience at the agro-ecosystem level. The CREEA framework integrates energy efficiency into CRA's principles, highlighting the importance of inter-departmental convergence and multi-sectoral collaboration.

Climate Change, Agriculture & Need for CREEA

This report presents a comprehensive analysis of the impacts of climate change on the food system, particularly focusing on agriculture, livestock, and fisheries that were brought out during a series of state and district-level workshops on CREEA held during 2023-24 in the state of Kerala as a joint initiative of the Department of Agriculture and Farmers' Welfare, the Energy Management Centre, Asar Social Impact Advisors and EQUINOCT Community Sourced Modelling Solutions. It highlights the urgent need for climate-resilient and energy-efficient agricultural practices to mitigate the adverse effects of climate change. It also provides a range of integrated solutions, field practices, models and flagship ideas that can lead to transformative change.

Climate change is causing significant disruptions in agricultural systems and farming communities due to direct and indirect impacts of changes in precipitation patterns, temperature fluctuations, and increased frequency of extreme weather events. The global food production system supports over one billion livelihoods, many of which are

at risk due to climate-related disruptions. At the same time, the modern agricultural system is a major contributor to climate change, generating greenhouse gas emissions through farming practices, land-use changes, and downstream activities like food processing and transport. As climate change impacts intensify, they can further amplify agricultural emissions. For example, rising temperatures and shifting pest dynamics may reduce agrochemical effectiveness, leading to higher usage; prolonged dry spells may increase reliance on energy-intensive irrigation. This could make food production increasingly resource intensive if urgent, transformative plans are not implemented.

CREEA is introduced as a framework to build resilience in agricultural systems while at the same time promoting energy efficiency and institutional convergence. It emphasises localised, participatory strategies that integrate agroecological practices and local knowledge ensuring that climate mitigation, adaptation and resilience interventions are context-sensitive and inclusive.

The report also provides an overview of the food production system in Kerala, highlighting the state's diverse agricultural landscape and the significant role of agriculture in the state's economy. It discusses the hyper-local challenges posed by climate change in Kerala, which threaten food security, agricultural productivity and the very survival of farmers and farming communities.

The Process of CREEA Consultations

Building on state-level consultation insights, 14 district-level consultations were conducted across Kerala from July 2023 to January 2024 to identify local challenges and co-create solutions for climate resilient and energy efficient agriculture. The initiative involved multiple departments and stakeholders, with materials prepared over six months, including two booklets - one on CRA and the other on energy efficiency schemes. Each workshop involved pre-engagement with local stakeholders, presentations on CRA and departmental schemes, and breakout sessions to discuss localised challenges and solutions. Participants included officials, students, and local representatives, fostering a multi-stakeholder approach.

Overall, the CREEA initiative underscores the importance of grassroots involvement, multi-departmental collaboration, and localised solutions to achieve energy efficiency and climate resilience in Kerala's agriculture sector.

Outcomes & Proposed Solutions

The CREEA consultative process identified significant climate change impacts on agriculture and allied sectors, and proposed solutions that have been integrated across four key areas: Ecosystem Health Management, Extreme Event Management, Energy and Resource Management, and Institutional Management.

Ecosystem Health Management involves a comprehensive solution and management plan for soil health, water management, biodiversity conservation and waste management. **Extreme Event Management** focuses on the highly uncertain and urgent nature of climate impacts through pest & diseases, wildlife conflicts and weather extremes. **Energy and Resource Management** looks at ways in which agricultural resource use from seeds to machines to labour can be made efficient and resilient. **Institutional Management** caters to post-harvest and marketing facilitation to research, capacity building, policy and convergence and also discusses institutional mechanisms for disaster preparedness and redressal.

The CREEA process highlighted the need for localised solutions, interdepartmental collaboration, and grassroots involvement to address climate challenges emphasising sustainable practices, technology adoption, and policy reforms to build climate resilience in Kerala's agriculture and allied sectors.

Three unique experimental models of a state-owned seed farm that is implementing organic farming practices to achieve carbon neutrality, a Panchayat-level initiative led by the Krishi Bhavan, which emphasises a collaborative approach with farmer collectives to enhance the resilience of the local food system and a Farmer Producer Organisation (FPO) that illustrates how farmers' collective efforts can improve resilience across the entire value chain, from production to market access, are also presented through a CREEA lens. These case studies demonstrate innovative methods of climate-resilient agriculture in various regions of Kerala and a range of strategies at different scales in enhancing food system resilience to climate change.

Recommendations for Flagship Action

We outline several flagship project ideas and policy recommendations aimed at transitioning towards climate-resilient and energy-efficient agriculture. The overall aim of these suggested flagship initiatives is to foster collaboration among various departments and stakeholders, use technology for informed decision-making, ensure sustainable agricultural practices, and enhance community resilience to climate change across all levels of operational and governance structures in Kerala.

Under five focal theme areas of (i) Integration and Convergence Planning, (ii) Risk & Emergency Planning, (iii) Climate Resilient Farming Systems, (iv) Net Zero Agriculture and Energy Efficiency and (v) Capacity Building - Knowledge and Skills, twelve flagship project ideas are presented that can be taken up for implementation by the Department of Agriculture through multi-departmental collaboration or as community collaboratory initiatives after rigorous consultative processes, hyper-local fine-tuning and convergences with existing schemes and systems.

Contents

1. Background & Context 01

1.1. Impacts of Climate Change on Food System..... 02

1.2. Food System Contribution to Climate Change 06

2. CREEA: The Concept 10

2.1. Climate Resilient Agriculture (CRA) 14

2.2. Climate Resilience & Energy Efficiency in Agriculture (CREEA) 15

2.3. Principles & Components of CREEA 16

3. Relevance of CREEA - Kerala 18

3.1. Overview of the Food Production System in Kerala 20

3.2. The Climate Crisis in Kerala & Impact on the Food System..... 28

3.3. Building Institutional resilience: Inception of CREEA 36

4. CREEA: The Process & the Programme 38

4.1. State-Level Consultations on Energy Transition..... 40

4.2. District-Level Consultations & Workshops: CREEA Initiative 43

4.3. Process & Workshop 50

4.4. Feedback & Evaluation of the Workshop 62

5. Outcomes from the CREEA Consultative Process 64

5.1. Climate Change & the Food System: Stakeholder Insights 66

5.2. CREEA Approach to Addressing the Concerns 67

6. CRA Experimental Models in Kerala..... 82

6.1. Aluva State Seed Farm, Ernakulam..... 84

6.2. CRA in Alathur Panchayat by Krishi Bhavan, Palakkad..... 88

6.3. CRA in Thirunelly Panchayat by TAPCo, Wayanad..... 95

7. Flagship Ideas for Transition towards CREEA in Kerala 102

Concluding Remarks..... 131

References 132

Annexure *136*

List of Figures

Figure 1. Impacts of Climate Change on the Food System 04

Figure 2. Food System Contribution to GHG Emissions 09

Figure 3. Mitigation, Adaptation & Resilience 13

Figure 4. Principles & Components of CREEA 17

Figure 5. Agro-Ecological Map of Kerala 21

Figure 6. Shrinking Paddy Cultivation in Kerala 25

Figure 7. Climate Impacts on Kerala's Food System: News Clippings 30

Figure 8. District-Wise Crop Losses in Kerala, 2023–24 34

Figure 9. Importance of Building Institutional Resilience 37

Figure 10. CREEA: Timeline & Participation 45

Figure 11. CREEA Inaugural Speech by P. Prasad, Minister for Agriculture.....46

Figure 12. CREEA Inaugural Speech by K. Krishnankutty, Minister for Power 48

Figure 13. Department-Wise Participant Representation 53

Figure 14. CRA Context Setting Presentation by Usha Kumari S 54

Figure 15. Breakout Group Discussion, Thiruvananthapuram: Key Points 60

Figure 16. Feedback Form Analysis 63

Figure 17. CREEA Management Approach 67

Figure 18. Key Ideas from Breakout Group Discussion 81

Figure 19. CREEA Management Approach 85

Figure 20. Aluva Seed Farm: Components of Resilience 87

Figure 21. Alathur Panchayat Krishibhavan: Components of Resilience 92

Figure 22. TAPCo Farmer Producer Organisation: Components of Resilience 99

Figure 23. Pathways for a Transition Towards CREEA 105

List of Tables

Table 1. Mapping of Emissions across Agri-Food Systems 08

Table 2: Overview of Food Production System in Kerala 22

Table 3. Agro-Machinery Registered in 2022–23 27

Table 4. Registered Fisheries Vessels in 2022 27

Table 5. Damaged Crops in Kerala, 2023–24 35

Table 6. Challenges Identified by Stakeholders 68

Table 7. Description of Challenges Identified by Stakeholders 69

1. Background & Context

1.1 Impacts of Climate Change on Food System

1.2 Food System Contribution to Climate Change

1.1 Impacts of Climate Change on Food System

Climate Change (CC) is having unprecedented and detrimental impacts on the food system, which is highly dependent on weather patterns. Changes in precipitation, temperature, sea-level rise and extreme weather events all threaten agricultural stability. These impacts can be a direct reduction in yield through extensive crop loss during extreme weather events, or indirect, as shifts in temperature and rainfall alter water availability, disrupt cropping cycles, introduce new pests and diseases, and affect pollination services. Climate change affects many other interconnected aspects of agriculture, posing complex challenges that threaten both food yields and nutrient quality (see Figure 1).

Studies indicate a growing link between observed climate variables and crop yields, suggesting that projected climate change impacts will further strain crop production. On a global scale, research comparing recent climate data to a pre-industrial baseline found that there was 10% yield reduction in four major crops between 1850 and 2010, even after accounting for CO_2 fertilisation and agronomic adaptations (IPCC, 2022).

Climate change is having profound impacts on fisheries, aquaculture and livestock and the dependent communities and ecosystems, especially in tropical regions (Brander et al., 2018). In the fisheries sector, climate change drivers are causing potentially significant shifts in primary production, changes in species interactions, shifts in species distribution and abundance, and changes in growth and mortality rates (Doney et al., 2012; Kirtman et al., 2013). Animal production, welfare and life expectancy are negatively impacted through decreased feed availability and quality, heat stress, diseases outbreaks, weakened immune system and mortality from extreme climate events. These impacts emphasise the widespread challenges climate change poses to the entire food system.

As climate change intensifies, it poses severe threats to food security, exacerbating existing challenges. Currently, more than half of the world's population is either underweight or overweight, and over 800 million people are undernourished. Climate change impacts will likely worsen this situation by decreasing the availability and access to diets with sufficient nutritional quality and by exacerbating existing disparities in food distribution. Moreover, the global food production system supports the livelihoods of over one billion people, whose jobs are increasingly at risk from climate-related

disruptions. These impacts extend beyond farmers and fishers, endangering the livelihoods of people across the entire food supply chain, including those in processing, distribution, and retail.

Climate change impacts differ significantly based on geographic location and socio-economic conditions. In the tropics and subtropics, where agriculture relies heavily on monsoons and weather patterns, the impacts of climate change are particularly severe. A recent study highlights the severe impacts of climate change on low latitude regions (Heikonen et al., 2025). The study analysed the geographical shifts in the climatic niches of 30 major food crops under 1.5°C–4°C global warming. Low-latitude regions such as South Asia, the Middle East, and Africa could see 20–48% of their current crop production shift outside of suitable climatic conditions under 3°C of global warming. Food crop diversity in these regions could also decline by up to 56% .

These biophysical impacts are compounded by socio-economic vulnerabilities. Rural areas in low-income and middle-income countries, especially smallholder farming systems, are highly vulnerable as they rely on agriculture and livestock for their primary livelihood and subsistence. These geographically and socio-economically uneven impacts of climate change & declining food productivity act as a powerful multiplier, exacerbating existing inequalities and placing additional strain on already marginalized groups. An extensive FAO study, drawing on data from 24 low- and middle-income countries, found that floods widen the income gap between poor and non-poor rural households by approximately USD 21 billion in a year, while heat stress by more than USD 20 billion a year (FAO, 2024). These challenges underscore the difficulty climate change poses to global efforts in reducing poverty and inequality.

In conclusion, climate change presents a complex and multifaceted threat to the farming and food systems. It threatens the socio-economic stability of agriculture, fisheries, aquaculture, and livestock sectors, leading to poverty and food insecurity in dependent communities. It also disrupts the governance and management of these vital food systems. Furthermore, climate change intensifies existing environmental impacts of agriculture by increasing crop loss, soil erosion, and declining soil fertility, which in turn drive more land clearing, deforestation, and heavier agrochemical use. This creates a destructive feedback loop, making food production increasingly resource-intensive and ecologically unsustainable.

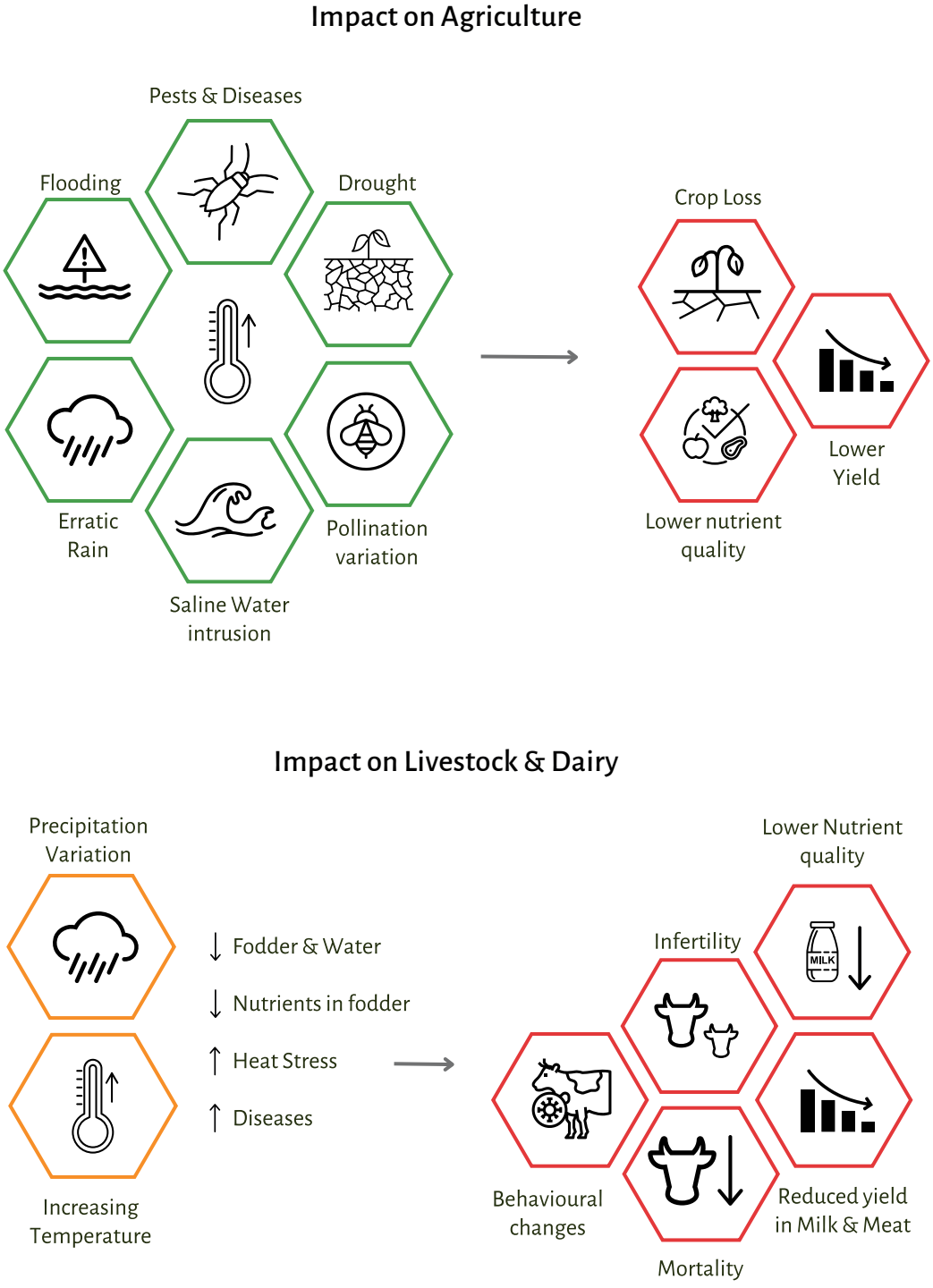
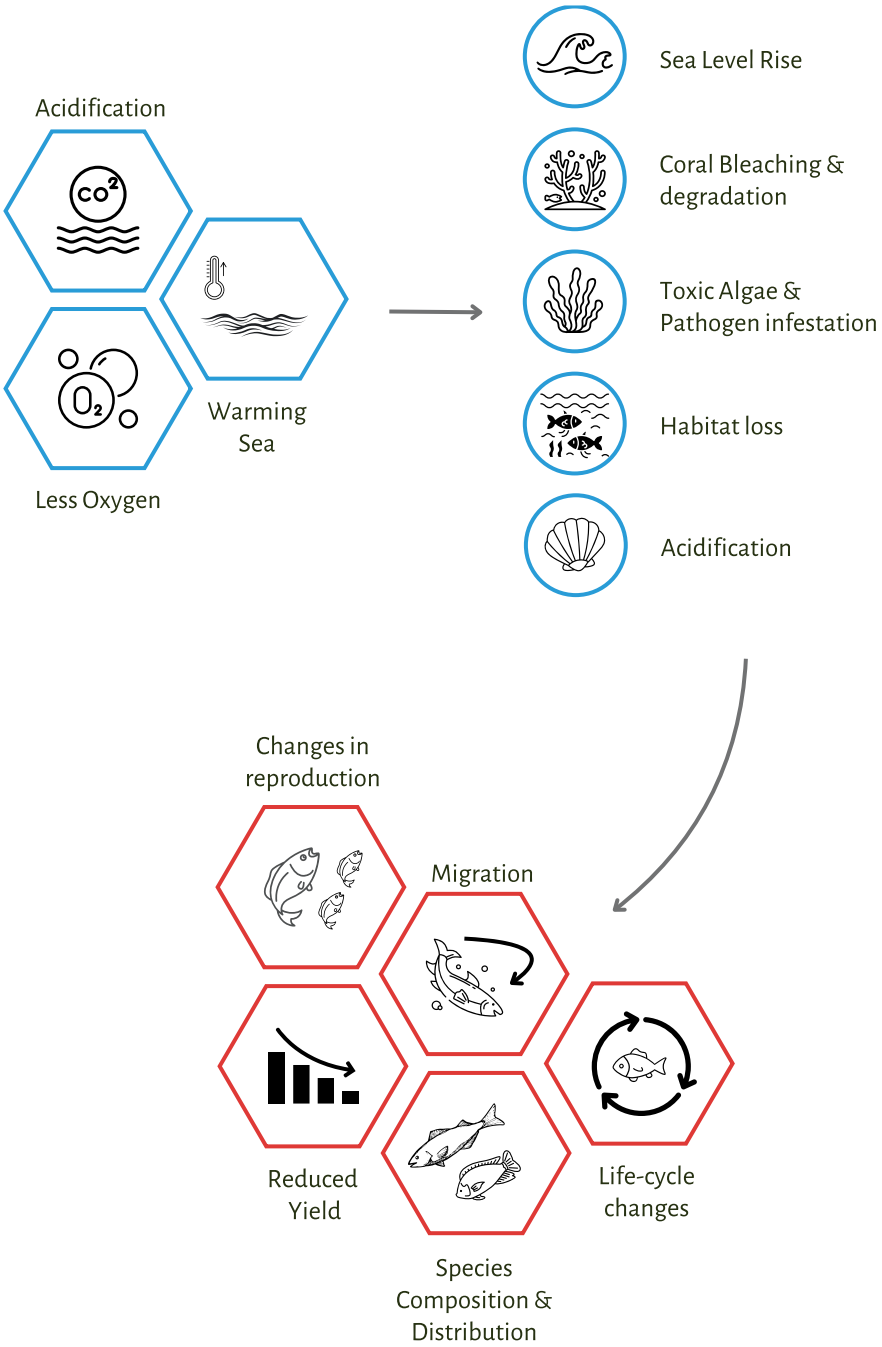


Figure 1: Impacts of climate change on the agriculture, livestock and fisheries sector

Impact on Marine Fisheries



1.2 Food System Contribution to Climate Change

The modern agricultural system has severe global environmental impacts including runoff of excess nutrients, degradation of soil and water resources, biodiversity loss, and greenhouse gas emissions. While the global food system is increasingly vulnerable to climate change impacts, it is also a major driver of climate change. The current food production system is energy- and resource-intensive, leading to substantial GHG emissions. Food system emissions primarily consist of carbon dioxide and other greenhouse gases generated from three key sources: (i) activities within the farm gate, (ii) land use and land-use change dynamics associated with agriculture, and (iii) activities beyond the farm gate (see Table 1). **Within the farm gate**, emissions arise from enteric fermentation in livestock[1], fertiliser application, and energy use for various crop and livestock management practices. Notably, the application of primarily synthetic fertilisers releases nitrous oxide, a greenhouse gas approximately 300 times more potent than carbon dioxide. Nitrous oxide emissions from the agriculture sector account for roughly three-quarters of total agricultural emissions.

Land use changes, particularly large-scale deforestation for agricultural development, also contribute significantly to global agricultural emissions. This deforestation is largely driven by the expansion of industrial plantations for crops such as soy, sugar cane, oil palm, and maize. For example, between 2001 and 2015, around 8.2 million hectares of forest were cleared for soy cultivation globally (Global Forest Watch, 2021). Oil palm plantations have expanded rapidly, with the area increasing by over 350%—from around 6 million hectares in 1990 to about 28 million hectares in 2018 (Leijten et al., 2023).

The majority of deforestation is occurring in tropical regions, with countries like Brazil and Indonesia accounting for nearly half of the total forest loss. In fact, between 2001 and 2015, just seven agricultural commodities—cattle, oil palm, soy, cocoa, rubber, coffee, and plantation wood fibre—were responsible for replacing 71.9 million hectares of forest, accounting for 26% of the global tree cover loss (WRI, 2015). In addition to this, the conversion and re-purposing of agricultural land and its surrounding ecosystems also result in increased emissions. Recently, in the context of increasing the share

[1] Emissions from livestock are part of the larger atmospheric carbon cycle, as methane from enteric fermentation eventually breaks down into CO_2, which can be reabsorbed by plants. In contrast, fossil fuel combustion releases carbon that has been locked away for millions of years.

of renewable energy in the energy mix, large areas of agricultural land have been re-purposed for solar and wind farms, as well as for the cultivation of biofuels such as corn, sugar cane, and soy beans. This re-purposing of agricultural land not only raises critical concerns over food security and ecosystem health, but also makes agriculture a significant contributor to release of greenhouse gases. Overall, agricultural activities within the farm gate and associated land-use dynamics account for about 20% of total anthropogenic emissions (IPCC, 2019).

Food system emissions extend **beyond the farm gate** to include upstream activities such as fertiliser and pesticide manufacturing, and downstream processes like food storage, processing, transportation, retail, distribution, and consumption. Emissions from activities within the farm gate and land use change are reported by countries as part of the AFOLU (Agriculture, Forestry, and Other Land Use) sector in national greenhouse gas (GHG) inventories, whereas beyond-farm-gate emissions primarily arise from energy use and industrial processes. Food production consumes around 30% of the world's available energy, with approximately 70% of this energy used beyond the farm gate (FAO, 2011). However, estimating emissions from these activities remains challenging due to limited data and insufficient studies. Although precise estimates are unavailable, Poore and Nemecek (2018) estimate that the global food system accounts for approximately 26% of all anthropogenic emissions (see Figure 2).

Thus, agriculture currently contributes roughly a quarter of global greenhouse gas emissions. As climate change impacts intensify, they can further amplify agricultural emissions, creating a reinforcing feedback loop. For instance, more agrochemicals maybe needed as their efficacy decreases, drier conditions may increase reliance on energy and carbon-intensive irrigation, and greater nutrient losses from fields can elevate biogenic GHG emissions in aquatic systems. This climate-agriculture feedback loop further warrants increased attention to the food system.

The challenges posed by climate change underscore the urgent need for a transformative shift in our food production system, one that carefully integrates agroecological, social, and cultural contexts throughout the value chain. In the following chapter, we will explore Climate Resilience and Energy Efficiency in Agriculture (CREEA) as a comprehensive framework for achieving this transformation.

Mapping of Emissions across Agri-Food Systems

IPCC		Food Systems Activity	GHG			FAO		
			(CH_4)	(N_2O)	(CO_2)			
AFOLU	LULUCF	Net Forest Conversion	x	x	x	LAND USE CHANGE	AGRICULTURAL LAND	FOOD SYSTEMS
		Tropical Forest Fires	x	x	x			
		Peat Fires	x		x			
		Drained Organic Soils	x		x	FARM GATE		
	AGRICULTURE	Burning - Crop residues	x	x				
		Burning - Savanna	x	x				
		Crop Residues		x				
		Drained Organic Soils		x				
		Enteric Fermentation	x					
		Manure Management	x	x				
		Manure Applied to Soils		x				
		Manure Left on Pasture		x				
		Rice Cultivation	x					
		Synthetic Fertilizers		x				
ENERGY		On-Farm Energy Use	x	x	x			
		Transport	x	x	x	PRE & POST PRODUCTION		
		Processing	x	x	x			
		Packaging	x	x	x			
		Fertilizer manufacturing	x	x	x			
		Household consumption	x	x	x			
		Retail –Energy Use	x	x	x			
Industry		Retail –Refrigeration	x	x	x			
WASTE		Solid Food Waste	x					
		Incineration			x			
		Industrial Wastewater	x	x				
		Domestic Wastewater	x	x				

Table 1: Mapping of Emissions across agri-food systems. Left: IPCC sectors and processes used in national GHG emissions inventories. Right: Food and agriculture sectors and categories aligned with FAO definitions.

Source: Tubiello et al., 2022

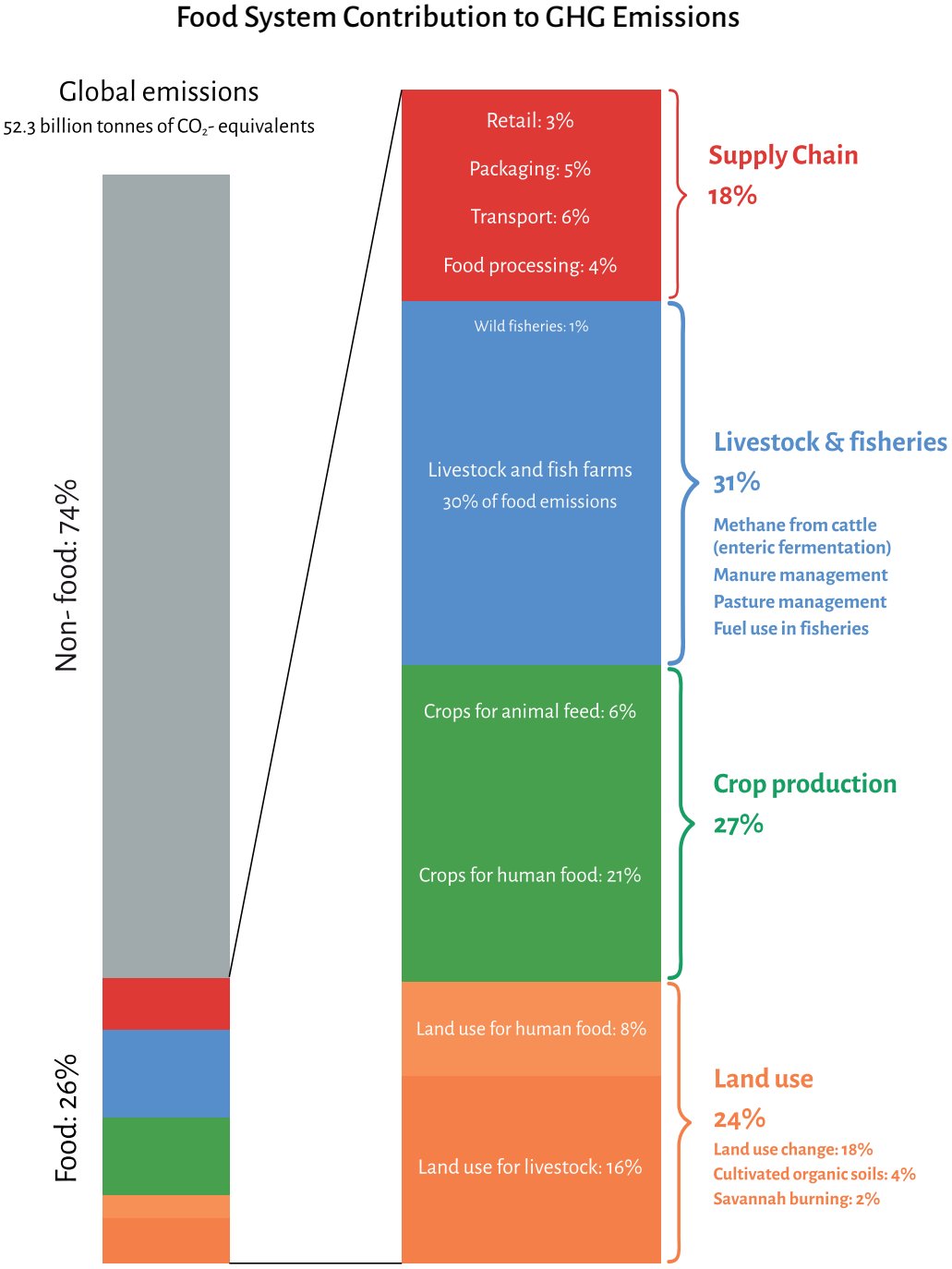


Figure 2: Food system contribution to GHG emissions

Source: Joseph Poore & Thomas Nemecek (2018), Reducing food's environmental impact through producers and consumers.

2. CREEA: The Concept

2.1. Climate Resilient Agriculture (CRA)

2.2. Climate Resilience & Energy Efficiency in Agriculture (CREEA)

2.3. Principles & Components of CREEA

CREEA: The Concept

To effectively tackle climate change, it is crucial for the food production system to **adapt** and build **resilience** to its impacts while simultaneously contributing to **mitigation** efforts (see Figure 3). Over the years, several approaches have been developed to tackle these challenges, with Climate-Resilient Agriculture (CRA) emerging as a key framework. CRA emphasises localised, inclusive, and participatory strategies to foster resilience at the agro-ecosystem level. The Climate-Resilient and Energy-Efficient Agriculture (CREEA) framework integrates energy efficiency into CRA's principles, emphasising the importance of inter-departmental convergence and multi-sectoral collaboration. These principles are explored further in the discussion below.

Mitigation, Adaptation & Resilience

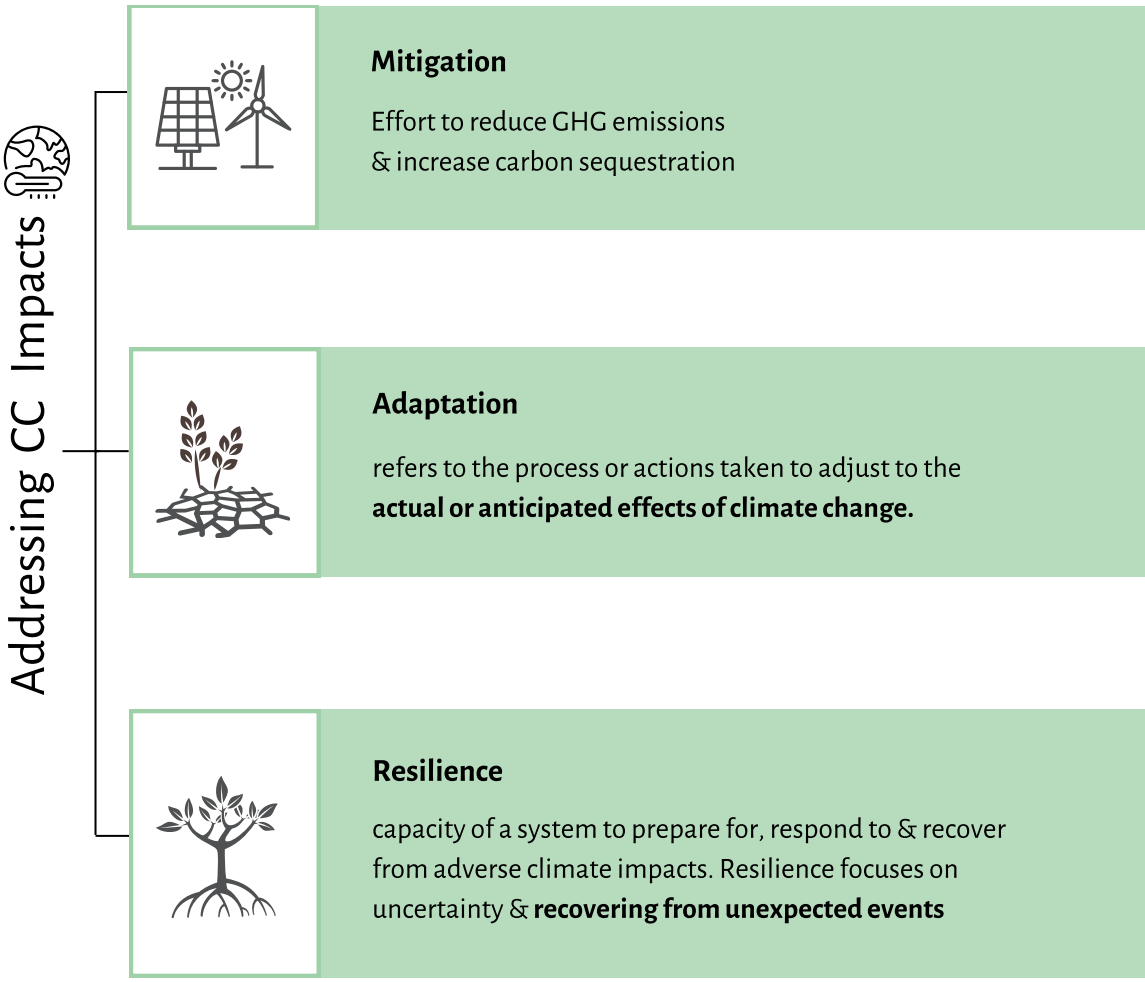


Figure 3: Mitigation, Adaptation & Resilience

2.1 Climate Resilient Agriculture (CRA)

Climate Resilient Agriculture (CRA) refers to "the ability of an agriculture system to prepare for, absorb, respond to, and recover from climate-related changes and extreme weather events" (FAO, 2021). This approach aims to reduce vulnerability in production systems and practices, addressing not only immediate responses to climate-related shocks but also developing long-term strategies that enhance the overall resilience of the agriculture system and the communities (social systems) that depend on them. In response to the urgent need for agricultural systems to withstand and recover from climate change impacts, the CRA approach was developed to safeguard food security and livelihoods.

CRA focuses on addressing climate change impacts at the **local level**, recognizing that these impacts are highly site-specific and depend on the unique agro-ecological, socio-economic and political landscapes of each region. CRA prioritises locally rooted strategies and practices rather than relying on generalized solutions. This ensures that interventions are relevant and context-sensitive. CRA adopts a **systems-based perspective**, focusing on building social-ecological resilience across multiple levels—farms, communities, and landscapes. The systemic approach goes beyond simply offering technical fixes and recognises the need for multidimensional interventions that engage with the socio-economic, political, and cultural dimensions of the food system.

Furthermore, CRA recognises the critical role of farmer **agency and local knowledge** in developing adaptive strategies. Historically, many smallholder farming communities, particularly in regions like South Asia and Africa, have employed diverse social and technological innovations—such as irrigation systems, terracing, mulching, and soil conservation practices—to effectively manage ecological resources. These practices, often referred to as "cultural resilience," reflect generations of accumulated knowledge and adaptive strategies. These livelihood strategies reflect the community's ability to adapt and persist through socio-environmental changes over time and space. By valuing these local practices and insights, CRA challenges deterministic views that portray rural communities as only passive victims of climate change.

Recognising the importance of local knowledge and agency, a central feature of CRA is its participatory approach. Innovations are **co-created** by involving farmers and other

stakeholders in the design, testing, and implementation of locally-based solutions. This ensures that the innovations are demand-driven and responsive. Beyond transforming agricultural practices, co-created strategies can reshape social dynamics and address structural inequalities that heighten vulnerability and limit adaptive capacity. Given the structural inequalities in access to resources, CRA prioritises solutions that are inclusive and accessible to all social groups including women farmers, smallholder and marginal farmers, forest/mountain farming communities etc.

2.2 Climate Resilience & Energy Efficiency in Agriculture (CREEA)

As a systems-based approach, the CRA framework underscores the pivotal role of governmental involvement and robust **institutional mechanisms**. Integration with government initiatives is crucial to generate the political will necessary for the sustainability and institutionalisation of CRA. A strong overarching institutional framework is essential for leveraging funding, facilitating effective implementation, ensuring comprehensive monitoring, and providing policy support. Sustained funding can be achieved through channeling resources from various state and central government schemes and funds, thereby ensuring the long-term sustainability of CRA.

Given that modern food system agriculture is energy-intensive—accounting for approximately 30% of total energy consumption—Climate Resilience and Energy Efficiency in Agriculture (CREEA) was conceptualised to integrate energy efficiency into the CRA framework. CREEA embeds energy efficiency into climate-resilient strategies, making the convergence of agriculture and energy sectors central to its inception. Furthermore, the interconnected nature of food systems necessitates a multi-sectoral approach, involving not only agriculture and energy but also collaboration across various other sectors and departments integral to the food system. CREEA builds on the CRA framework by integrating energy efficiency and placing greater emphasis on the entire food system value chain, from production to marketing and distribution. Effective implementation requires strong institutional mechanisms, inter-departmental convergence, and collaboration among stakeholders across sectors. These elements are foundational to the CREEA approach (see Figure 4).

2.3 Principles & Components of CREEA

The principles and components of Climate Resilience and Energy Efficiency in Agriculture (CREEA) emphasise systemic, co-created, inclusive solutions with institutional convergence. These principles are embedded across all key components of CREEA, which include:

1. ***Research & Knowledge:*** Rigorous research on climate-resilient and energy-efficient agriculture integrating scientific and local/indigenous knowledge. Emphasises education and capacity building for stakeholders in agriculture and allied sectors regarding climate-resilient strategies.
2. ***Climate Information Services***: Hyper-localised weather forecasts, agro-advisory services, and pest bulletins, ensuring that farmers have timely and accurate climate information to make informed decisions.
3. ***Planning & Climate Action:*** Conducting agricultural vulnerability assessments, developing climate action plans for the agriculture sector, and robust monitoring and evaluation mechanisms to track progress and adapt strategies as needed.
4. ***Energy Efficiency & Renewable Energy***: Promotes energy efficiency and the transition to decentralised renewable energy across all stages of the production cycle. Focuses on DRE-driven, community-led, women-centric approaches to advance climate justice.
5. ***Ecosystem Health:*** Enhancing interconnected soil and water health to improve water retention and drainage, thus reducing CC impacts of drought, flooding, and erosion. Emphasises biodiversity at all levels (genes, species, ecosystems) through agroforestry, mixed and multi-cropping systems, and conservation of indigenous germplasm.
6. ***Livelihood:*** Generate and enhance local livelihoods while ensuring sustainable livelihood security throughout the food value chain.

Together, these principles and components form a comprehensive framework for enhancing resilience and energy efficiency in agriculture. The following chapter examines Kerala's agricultural landscape, the challenges within its food system, and the relevance of the CREEA framework for the state.

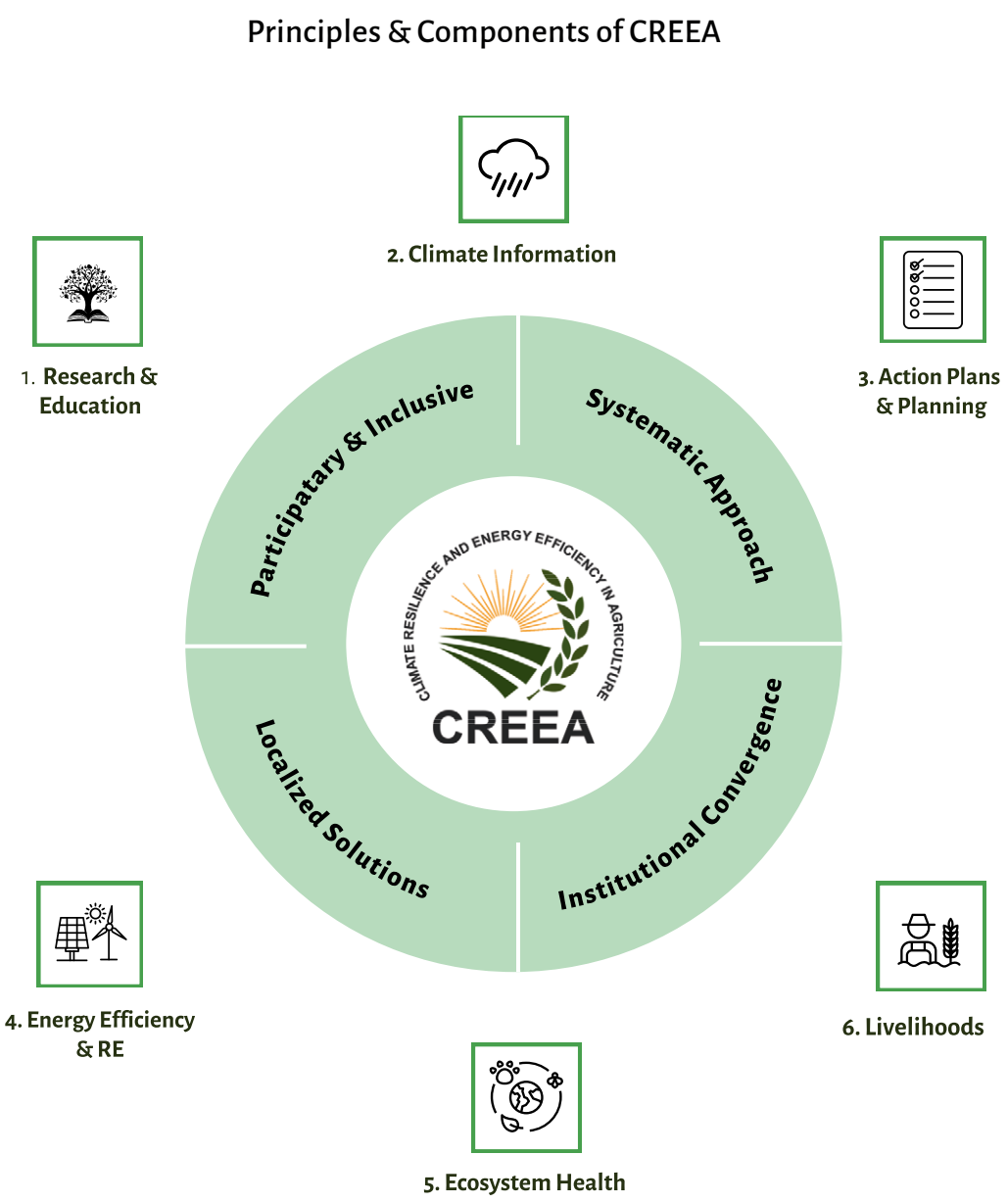


Figure 4: Principles and components of CREEA

3. Relevance of CREEA - Kerala

3.1. Overview of the Food Production System in Kerala

3.2. The Climate Crisis in Kerala & Impact on the Food System

3.3 Building Institutional Resilience: Inception of CREEA

3.1. Overview of the Food Production System in Kerala

Kerala, a tropical state in southwestern India, is enriched by the Arabian Sea in its West and Western Ghats on its East, yielding a diverse agricultural landscape (see Figure 5). Agriculture occupies 52% of the state's land area, employing 21.3 lakh people in agriculture and allied sectors, which contributes to 17% of the state's livelihoods (Government of Kerala, 2022; Economic Review, 2023). Agriculture and allied sectors contribute to nine percent of the Gross State Value Added (Economic Review, 2023)[2]. The diverse agro-climatic conditions prevailing in the state favour the cultivation of a variety of crops. Coastal plains have wetland paddy fields and coconut groves, while inland valleys yield spices, fruits, and vegetables. Due to colonial intervention from the late 19th to early 20th century, the hilly terrain is now dominated by tea, coffee, and rubber plantations. Depending on the agroecological landscapes, farmers also grow pepper, cashew, cardamom, turmeric, ginger, bananas, pineapple, and recently, indigenous and exotic fruits as well (see Table 2).

The livestock sector plays a crucial role in the agricultural economy, serving as an asset in rural areas after land and irrigation. It promotes an inclusive agricultural system, provides essential inputs for farming, and creates an additional source of income, particularly for landless, small, and marginal farmers, and marginalised communities. In the state, the contribution of the livestock sector is significant, accounting for around 26% of the agricultural GSVA, with approximately 25 lakh households engaged in animal husbandry activities. The state has a livestock population of 38 lakh, comprising 15 types of livestock and poultry (Economic Review, 2023). Milk, meat, and eggs are the primary livestock products in the state, providing essential protein and nutritional security for households while also serving as an additional source of income for livestock farmers.

The fisheries and aquaculture is a prime sector in the state. The state has a long coastline of 590 kilometers and a continental shelf of 39,139 square kilometres. The coastal areas of Kerala are the most productive part of the Arabian Sea. Kerala also has an extensive inland water system, including 41 west-flowing rivers and three east-flowing rivers totalling 85,000 hectares, along with 9 freshwater lakes covering 1,620 hectares and 51 backwaters spanning 46,128.9 hectares. The long coastline and inland water systems support extensive

[2] This figure includes only the primary farm produce and does not account for the processing of raw materials or value-added products.

marine and inland fishing, while also providing significant opportunities for aquaculture. The sector contributes 12 percent of the agricultural GSVA and employs around 2.40 lakhs people (Economic Review, 2023). Fisheries and aquaculture play a vital role in the state's food security by providing an affordable source of protein with higher retention rates compared to animal protein sources.

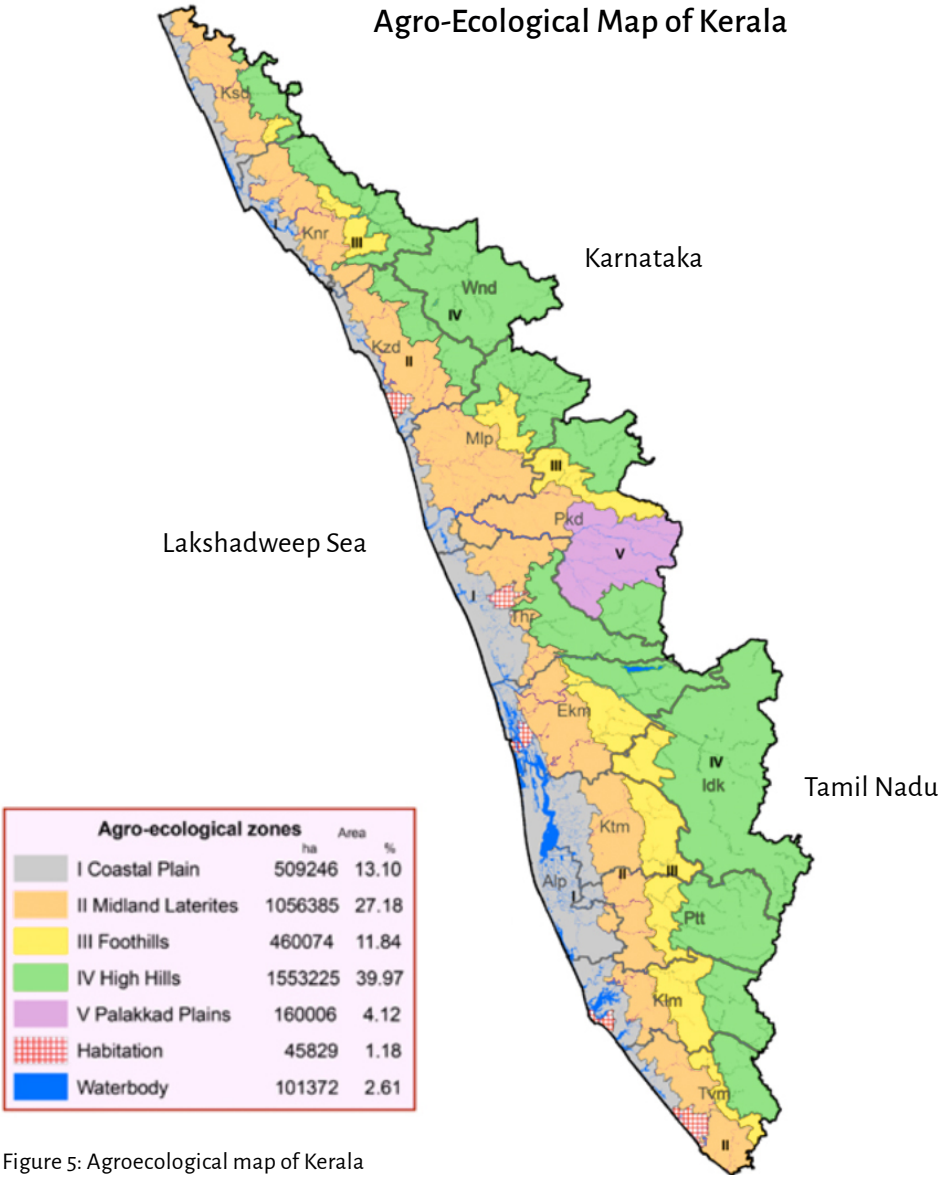


Figure 5: Agroecological map of Kerala

Overview of Food Production System in Kerala

District	Total area	Land Physiology (%)	Coastline	Land Use (%)	Major Crops
Codes	lakh hectares	Lowland (Blue) Midland (Yellow) Highland (Green)	Kilometers	Agriculture (Yellow) Forest (Green) Others (blue)	Each icon represents 10% of the total agricultural area
TV	2.2		78		
KL	2.5		37		
PT	2.7		0		
AL	1.4		82		
KT	2.2		0		
ID	4.4		0		
ER	3.1		46		
TS	3.0		54		
PL	4.5		0		
MA	3.6		70		
KZ	2.3		71		
WA	2.1		0		
KN	3.0		82		
KS	2.0		70		
Kerala	39.0		590		

Table 2: Overview of food production system in Kerala

Sources: Census data, 2011; Fisheries Statistics, 2021; Agriculture Statistics, 2022; Livestock Census, 2019; Natural Resource Data Bank; Fisheries Handbook, 2020

Livestock (in thousands)			Dairy Production		Fish Production	
Big Ruminant	Small Ruminant	Poultry	Milk (kilotonnes)	Meat (kilotonnes)	Marine (kilotonnes)	Inland (kilotonnes)
205	169	2523	254	34	414	28
123	113	1522	198	33	967	64
88	52	799	114	21	0	66
97	56	1779	168	26	170	501
100	103	2212	183	28	0	503
106	113	746	171	17	0	19
115	133	4034	217	43	1524	338
133	141	3399	196	44	356	204
1,081	122	2029	285	36	0	26
115	141	6137	158	79	217	52
119	55	1760	185	39	876	21
318	44	889	138	12	0	13
100	69	1325	167	31	107	20
124	38	615	113	15	126	200
2,824	**1,350**	**29,772**	**2,547**	**458**	**4,757**	**2,055**

3.1.1. Changes in Land & Waterscapes

Kerala's agricultural landscape has undergone significant transformation over the last 50 years. The highlands of Kerala harbour a fragile and diverse eco-region recognised as one of the world's eight biodiversity hotspots. However, this region has experienced significant changes in forest cover. Kerala lost 50% of its forest area between 1973 and 2016, equivalent to ~9 lakh hectares (Ramabhadran and Ramachandra, 2016). This substantial loss of forest cover has adversely affected the soil health and agro-biodiversity of agricultural systems in the region. In the coastal and lowland regions of Kerala, there has been extensive conversion of wetland paddy fields (see Figure 6).

Paddy cultivation in Kerala has significantly declined, with the area under cultivation decreasing from approximately 8.02 lakh hectares in 1980 to 1.91 lakh hectares in 2020 (Economic Review, 2020). Two primary reasons contribute to this shift: first, farmers have shifted to cultivating non-rice seasonal crops such as bananas, tapioca, and various vegetables, along with perennial tree crops like coconut, nutmeg, and rubber. Second, the main driver of this conversion is the transition to non-agricultural livelihoods for both cultivators and labourers. Vast stretches of previously cultivated paddy land have been left fallow and are now being converted for various non-agricultural activities, large-scale investments, and infrastructure development projects. The paddy wetlands that spread across the floodplains of Kerala's 44 rivers play a crucial role in moderating floods. The conversion of these floodplains has diminished the resilience of Kerala's agricultural landscape.

Changes in land use and waterscapes have significantly impacted the fisheries and dairy sectors in Kerala. Deforestation, urbanisation, encroachment on wetlands have transformed the waterscapes of the state, diminishing the land's capacity to absorb rainfall and manage water flow. This has led to increased flooding during monsoon seasons and reduced water availability during dry periods. Additionally, pollution from agricultural runoff, industrial waste, and plastic debris has contaminated water systems. All these challenges—flooding, reduced water supply, and pollution—have adversely affected fish health and production. In the dairy sector, land use changes and the expansion of built-up areas have encroached on essential fallow land, grazing lands, and wetlands, reducing land and water availability for livestock while also altering and limiting the diversity of grass and fodder that they can consume.

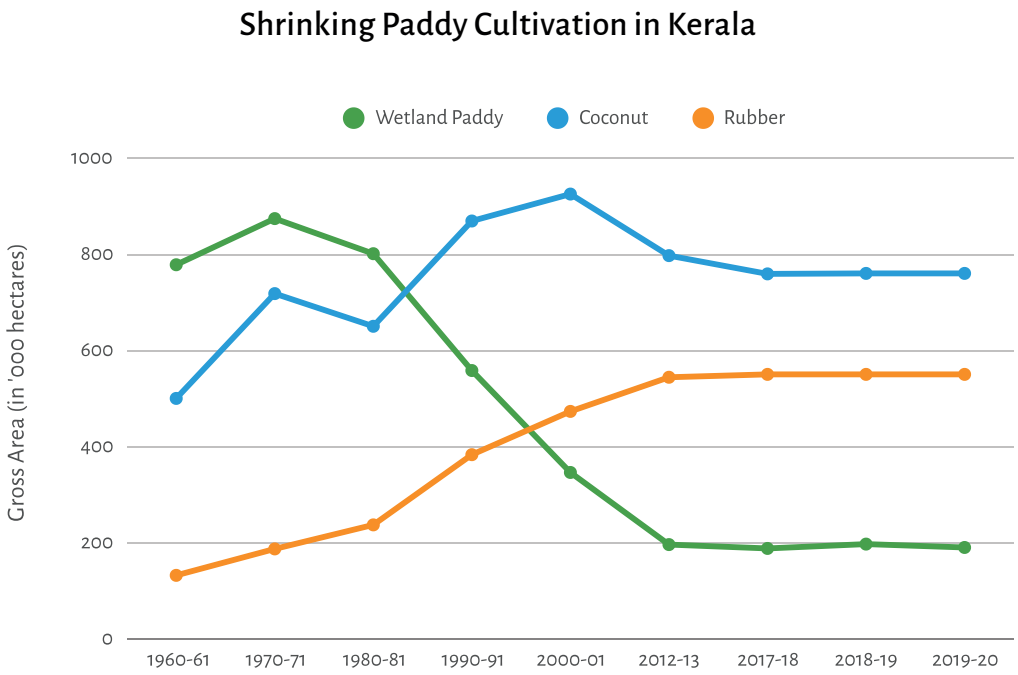


Figure 6: Trends in Land Use: Decline of paddy cultivation in Kerala

Source: Economic Review, 2020

3.1.2. Food Security

Transformations in Kerala's land and waterscapes pose a significant threat to the food production system and the state's food security. As a major consumer state, Kerala relies heavily on food imports from other states and abroad. Kerala imports a substantial portion of its essential food commodities, including rice, wheat, pulses, and cooking oil, from states like Tamil Nadu, Andhra Pradesh, Telangana, Karnataka, Maharashtra, Madhya Pradesh, Gujarat, and Bihar. The state produces only 15% of its total food grain requirements, while over 57.6% of its vegetable supplies are sourced from other states (Government of Kerala, 2012). Milk and meat products are also imported. In 2022, 3.15 lakh metric tonnes of milk was imported (Economic Review, 2022). While inter-state trade ensures a steady food supply, it also exposes Kerala to vulnerabilities such as transportation disruptions, price fluctuations, and supply chain challenges. For over a decade, the state government has focused on boosting local food production to reduce external food dependency. Several initiatives have been launched, including the Vegetable Development Programme (VDP) in 2012 and the Organic Farming Policy in 2008, all aimed at enhancing food security within the state. (Pinheiro, 2017).

3.1.3. Resource Use in Agriculture & Allied Sectors

The food system in the state is characterized by high resource intensity, requiring substantial inputs of labour, water, fertilisers, and pesticides during production, as well as energy throughout the food value chain. While the system still relies on **labour**, there has been a notable shift toward mechanisation in response to persistent labour shortages and rising wage rates. The state faces a persistent shortage of agricultural labour, driven by urbanisation and a growing shift from agriculture to service-sector livelihoods (Economic Review, 2020). To address these challenges, the Kerala state government has initiated several programmes to promote and support mechanised farming. The Agricultural Mechanisation Mission, established in 2018, aims to streamline and coordinate the efforts of various machinery service providers, including Agro Service Centres (ASC), Karshika Karma Senas (KKS), Kerala Agromachinery Corporation (KAMCO). According to the survey conducted by the mission in 2023, 11,505 agro-machines have been distributed to various farmer groups (see Table 3). This trend is also evident in the fisheries sector, where most of the fishing activities have become highly mechanised (see Table 4). As a result, the food system has experienced a significant shift from human labour to mechanised energy inputs.

Water requirements in the agriculture sector are immense, with over 60% of surface water and 44% of groundwater being used for irrigation (Shaji & Pradeepkumar, 2019; Economic Review, 2022).

The use of **chemical inputs**, such as fertilisers, pesticides & herbicides, is substantial, particularly for cash crops like rubber and tea. Fertiliser manufacturing is an energy-intensive industrial process which also contributes to greenhouse gas emissions. In 2022, fertiliser consumption in Kerala was reported at 166,100 tons (CEIC Data, n.d). Estimates suggest that producing and distributing a single ton of synthetic fertiliser can result in roughly 2.6 tonnes of carbon dioxide equivalent (CO_2e) emissions, with variations depending on the specific fertiliser type and production methods (Menegat, 2022). In aquaculture, production of fish feed—primarily from corn, soy, wheat, and animal by-products—demands considerable indirect energy inputs.

Energy requirements throughout the food value chain are considerable, encompassing production, storage, post-harvest processing and distribution. As mentioned above, at the production level, most on-farm activities require machinery, including tilling, ploughing, soil preparation, irrigation, sowing, and harvesting, all of which require substantial energy inputs.

Agro-Machinery Registered in 2022 - 23

Combine Harvester	81
Tractor/Mini Tractor	530
Transplanter	367
Power Tillers	2401
Mini Tiller	188
Thresher/Winnower	1616
Reaper	544
Pumpset	1217
Sprayers	2767
Brush Cutter	959
Climber	290
Others	545

Table 3: Number of Agro-machinery registered in 2023–24

Source: Kerala State Agricultural Mechanisation Mission 2023

Registered Fisheries Vessels in 2022

Motorized Non-mechanical	33,949
Motorized Mechanical	6,421
Non-motorized	2,971
Deep sea fishing vessels	11
Total	43,298

Table 4: Number of registered fisheries vessels in 2022

Source: Fisheries Statistics, 2022

As of 2021-22, the agriculture sector consumed 1,018.02 MW of electricity, accounting for 3% of the total electricity consumption in the state (KSEBL Power System Statistics, 2020-21). This figure includes electricity used for on-farm activities, such as machinery operation and

irrigation. However, energy consumption extends beyond the farm activities, with substantial amounts also required for post-harvest management and value addition processes. Comprehensive data on this remains limited.

The fisheries sector reflects these trends, with extensive mechanisation and heavy reliance on diesel-powered fishing vessels, trawlers, and aquaculture equipment. Post-harvest energy needs are also significant, as cold storage, processing, and transportation of seafood require high energy inputs due to its perishable nature. Fishing is often seasonal and demands intense resource use over short periods, creating challenges in managing production and inputs. In the dairy sector, energy use is also rising. Modern cow sheds increasingly use cooling systems, fans, and sprinklers to protect livestock from heat stress.

3.2. The Climate Crisis in Kerala & Impact on the Food System

Introduction

The climate crisis is significantly impacting Kerala's food production systems, exacerbated by the state's geographical vulnerabilities, including its extensive coastline and the ecologically sensitive Western Ghats. These factors heighten Kerala's susceptibility to climate-related challenges (see Figure 7). Additionally, the existing vulnerabilities within the food production system—such as land use changes and food insecurity—further compound the effects of the climate crisis. Addressing these interconnected issues is key to strengthening resilience in Kerala's agriculture.

Image 1: Heavy rains and winds cause Rs.4.5 crore loss in Wayanad, June 2018
Source: The Hindu

Drought & heatwaves in Idukki caused crop loss of cardamom in 29,560 hectares, affecting 22,311 farmers.
Source: Hindu, 2024

Image 3: Rs.8,829 crore loss in agriculture due to heavy rains and landslides in Kerala, October 2021
Source: Manorama

Image 4: 34% decline in South-West monsoon rainfall impacts farmer yields, October 2016
Source: The Week

Climate Impacts on Kerala's Food System: News Clippings

THE NEW INDIAN EXPRESS

NATION WORLD STATES OPINION

Kerala

Kerala suffers Rs 260-crore loss as drought destroys crops

Crops in 46,587 hectares of land lost, devastating lives of 56,947 farmers | Additional loss of I250 crore estimated in secondary sector, including dairy & fisheries

Situation in Idukki district is particularly alarming as cardamom farmers have been devastated by the wilting of plants. Photo | Express

Kerala sanctions Rs 1.98 cr as compensation for livestock died in heatwave

Onmanorama Staff

Published: July 19, 2024 05:14 PM IST

DownToEarth Subscribe

Health Agriculture Water Waste Clima

Climate Change

Insured against heat

States and private firms are implementing insurance schemes to protect livestock rearers against milk production losses caused by heat stress

KERALA 3 Mins Read

Saline intrusion kills Kole fields that provide 40% of Kerala's rice requirement

Published / Updated – July 23, 2023 18:27 IST

KERALA

Seawater intrusion threatens paddy cultivation in Kuttanad

Published / Updated – December 03, 2022 20:21 IST

THE HINDU BUREAU

Listen to article

Outer bunds of at least four paddy polders were breached in the last three days.

The rising water level in Kuttanad caused by the ingress of seawater due to high tide is threatening paddy cultivation in the region.

Figure 7: Newspaper clippings highlighting climate change impacts on agriculture, dairy, and fisheries in Kerala

MONGABAY

Features Videos Podcasts Specials Articles Subscribe

How climate change is taking a toll on livelihoods of small-scale fishers in Kerala

KVA KHADAR
16 AUG 2021 INDIA CONSERVING AGRO-BIODIVERSITY

Comments Share article

After snails, farmers in Idukki battling spotted locust infestation; experts say change in climate pattern could be a cause

Published / Updated – October 18, 2024 20:05 IST

THE HINDU BUREAU

Spotted locust in a farm at Konnathay panchayat in Idukki. | Photo Credit: SPECIAL ARRANGEMENT

Paddy Cultivation in Kerala Increasingly Dependent on Irrigation Due to Erratic Climate

By IANS · 22 July, 2022 · TWC India

Representational image
(IANS)

3.2.1. The Agriculture Sector

The state's agriculture heavily relies on the southwest monsoon, and fluctuations in monsoon patterns have resulted in significant variations in crop yields and agricultural incomes. In 2023, Kerala experienced its lowest rainfall during the southwest monsoon, which typically accounts for 70-80% of the state's total annual precipitation. That year's monsoon was the worst in the past 50 years, recording a deficit of 34% (see Figure 8 & Table 5). Consequently, there were substantial crop losses in both area and monetary value, particularly affecting the highlands of Kerala. The decline in rainfall has long-term implications, as seen in the decrease in black pepper production from 87,000 metric tons in 2004-05 to 34,000 metric tons in 2019-20, accompanied by a proportional decline in cultivated area (Malhotra et al., 2021). Black pepper is culturally and economically vital to Kerala, making these losses particularly concerning.

Heavy and intense spells of rainfall during monsoon seasons have increased the risk of floods, landslides and soil erosion, affecting agricultural land quality and productivity. In 2018, Kerala experienced one of the most severe floods, which devastated the state's food production system, damaging crops and causing significant losses. The agricultural sector suffered significant damage, with approximately 2.37 lakh hectares of crop loss, valued at around Rs.18,500 crore. Additionally, the floods severely impacted vital fishing assets, such as boats and fishing nets, resulting in an aggregate loss of approximately Rs. 1,030 crore in aquaculture and inland capture fisheries. Livestock and poultry also experienced substantial losses, totalling around Rs. 465 crore (NIDM, 2018).

As a result of climate change impacts, the state has seen shifts in the incidence and distribution of pests and diseases, along with the emergence of new threats. For example, the gall midge, typically found in plains, has recently been reported in Wayanad, leaving farmers unprepared for this unexpected pest infestation, which resulted in severe crop losses (Mongabay, 2023). Farmers in Idukki were severely affected by a locust infestation, an outbreak linked to climate change impacts, that caused significant damage to coconut trees, pepper, and banana plants (The Hindu, 2024). The fisheries and dairy sectors in the state have also experienced a rise in both emerging and existing infestations and diseases.

Coastal areas in Kerala are increasingly impacted by rising sea levels and saltwater intrusion, contaminating freshwater sources and threatening paddy cultivation in

low-lying regions such as Kuttanad and the Kole fields. Improper management of regulators has failed to prevent saltwater intrusion in these regions. In Kuttanad region, rising water levels have caused frequent bund breaches, leading to crop losses and disrupting field preparations. The Kole fields span 13,612 hectares in Thrissur and Malappuram and supply about 40% of Kerala's rice. Farmers and fishers have reported substantial financial losses due to saline intrusion. For instance, 3,104 farmers from Vengidangu and Mullassery panchayats alone suffered losses amounting to Rs.12 crore (~4,424 tonnes of paddy) over the past two years (The Hindu, 2023).

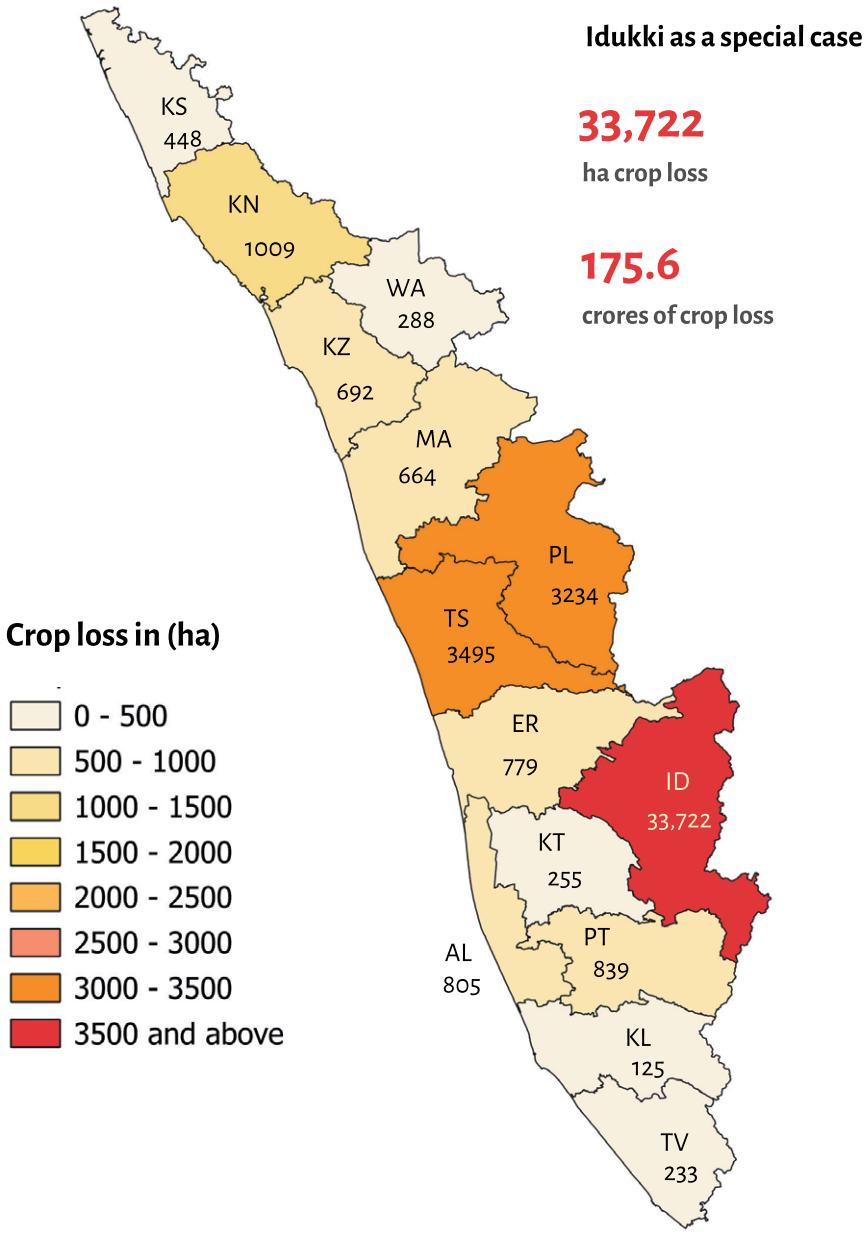
3.2.2. Marine Ecosystem & Dairy Sector

Warming of the sea and associated impacts, including cyclonic storms and erratic monsoon patterns have reduced the number of fishing days as well as fishing stock along the coast of Kerala. Following Cyclone Ockhi in 2017, the state experienced a 46% reduction in fishing days in 2017 compared to the previous year (CMFRI, 2017). Changes in ocean ecosystems have particularly affected small pelagic fish, like oil sardines, which are economically significant in Kerala. Since 2012, sardine catches have sharply declined from 4 lakh tonnes to just 0.44 lakh tonnes in 2019, with yields falling to one-third of this in the subsequent year (CMFRI, 2019). This decline in sardine catch has gravely impacted the livelihoods of Kerala's 137,248 active fishermen, especially small-scale fishers who rely on daily catches to support their families.

The dairy sector is facing significant challenges due to rising temperatures and heat stress, which have led to increased mortality rates and decreased fertility among dairy cattle. In response, the state government has allocated Rs.1.98 crore to the Animal Husbandry Department. In 2024 alone, extreme heat conditions resulted in the deaths of 742 animals, including cattle and poultry (Manorama, 2024). Additionally, intense heat, coupled with fodder and water shortages, has significantly reduced milk production in Kerala. The usual summer decline has intensified, with farmers reporting drops of up to 45% in 2023, compared to the typical 15%. In response, Kerala became the first state to introduce a livestock insurance scheme in 2023 (Down to Earth, 2024).

Numerous other climate change impacts are faced daily by farmers and fishers and many others dependent on the food system, many of which go unreported and remain absent from climate change discussions. In response to the detrimental impacts of the climate crisis and as part of national and international commitments, the Kerala State

District-Wise Crop Losses in Kerala, 2023-24



South-West Monsoon:

Rainfall: 1326.1 mm | **LPA:** 2018.6 | **Deficiency:** 34%

Figure 8: District-wise crop losses in Kerala, 2023–24 due to a 34% deficiency in the southwest monsoon.

Source: Mathrubhumi, 2024

Damaged Crops in Kerala, 2023-24

	Crops	Total loss (ha)
	Cardamom	30,536
	Rice	6,369
	Pepper	3,182
	Banana	2,884
	Areca Nut	1,577
	Vegetable	603
	Coconut	521
	Rubber	336
	Nutmeg	303
	Coffee	261
	Fruits	100
	Cocoa	61

Table 5: Crop losses in Kerala, 2023–24 due to a 34% deficiency in the southwest monsoon.

Source: Mathrubhumi, 2024

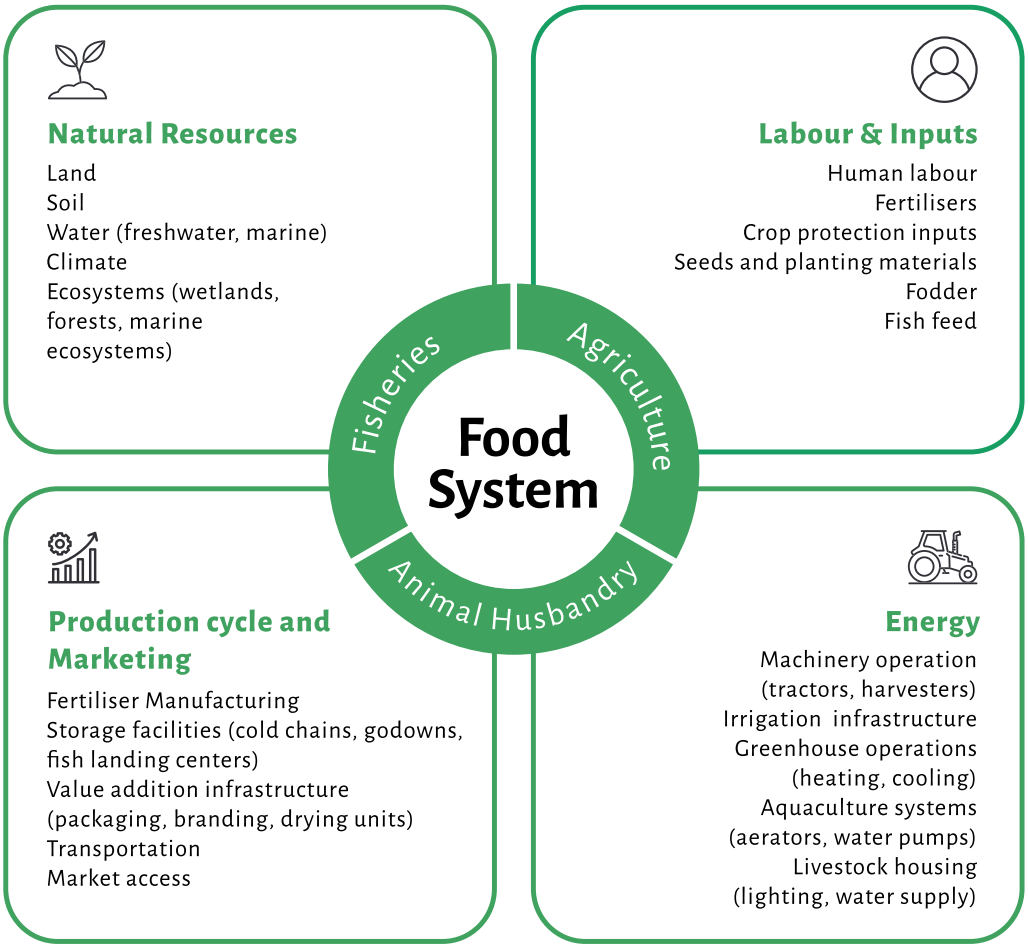
Government has introduced several initiatives aimed at achieving carbon neutrality by 2050. Among these initiatives are the Carbon Neutral Panchayats, part of the flagship Haritha Kerala Mission, Carbon Neutral Agriculture and the recent Kerala Agroecology-based Regenerative Agriculture (KERA) initiative. While these are commendable initiatives that address greenhouse gas emissions and contribute to climate change mitigation, they remain limited in scope, as they do not adequately respond to the immediate challenges and vulnerabilities faced by farmers on the ground, particularly those arising from extreme weather events and climate-induced disasters. CREEA is an attempt to address this crisis and build grassroots and localised resilience in the agriculture and allied sectors. The CREEA initiative aims to ensure farmers can adapt to changing conditions and reduce energy consumption, ensuring nutritional security and livelihood security amidst climate uncertainty.

3.3. Building Institutional Resilience: Inception of CREEA

To address the climate crisis and the various challenges posed by land use change and urbanisation, it is crucial to enhance resilience and energy efficiency within the food production system. However, it is not an isolated system; rather, it is interconnected with and reliant on labour, water resources, irrigation, energy inputs and market access. Therefore, fostering resilience across the food system requires a coordinated effort that brings together all relevant departments, actors and stakeholders within the productive sectors (see Figure 9). This multi-sector and integrated approach is essential for developing a holistic response to the various challenges faced by agriculture. In response to these needs, CREEA was conceptualised as an integrated initiative to address the vulnerabilities across Kerala's agriculture and allied sectors, encompassing agro-ecologically diverse crop systems, fisheries, animal husbandry, dairy, soil health and conservation, groundwater, irrigation, farming collectives like FPOs, SHGs and all related social systems. This initiative not only seeks to identify challenges but also identify opportunities and potential to co-create innovative approaches in resilience building. As already discussed in Section 2.2, building this institutional resilience and inter-departmental convergence is central to the CREEA approach.

The following chapter provides a detailed exploration of the inception of the CREEA district-level consultative workshops, the sequence of events that led to their initiation, the agenda, and the feedback received from participants.

Importance of Institutional Engagement & Collaboration



All components require research, training and capacity building processes

Importance of Institutional Engagement & Collaboration

- Operates within an interconnected food system reliant on other sectors
- Enables streamlined state and central funding
- Builds on extensive and established extension programmes
- Ensures alignment of inter-departmental schemes with CRA goals

Figure 9: Importance of institutional engagement and collaboration for building climate resilience

4. CREEA: The Process & the Programme

4.1. State-Level Consultations on Energy Transition

4.2. District-Level Consultations & Workshops: CREEA Initiative

4.3. Process & Workshop

4.4 Feedback & Evaluation of the Workshop

4.1. State-Level Consultations on Energy Transition

There is a growing concern over the impact of the climate crisis and the role of the energy sector in contributing to climate change. Kerala depends heavily on fossil fuel imports, with over 60% of its electricity supplied by coal power generated outside the state (Fernandes & Sharma, 2023). To understand Kerala's energy landscape and explore pathways for the state's energy transition, a consultation was held at the Energy Management Centre (EMC) in Thiruvananthapuram on 20 June 2022. The consultation highlighted Kerala's significant dependence on non-renewable energy, emphasised the need for greater energy efficiency, explored diverse pathways for sector-wise energy transition, and promoted Decentralised Renewable Energy (DRE) solutions as a means to create sustainable livelihood opportunities. The event brought together key stakeholders and experts, including representatives from relevant government departments. The consultation was organized by Asar, a Bangalore-based social impact advisory group, and EQUINOCT, a Kochi-based start-up focused on climate-resilient action, in collaboration with EMC.

One of the recommendations of this workshop was to examine critical sectors separately so as to formulate transition strategies for them. Agriculture and allied productive sectors are resource and energy-intensive, relying heavily on fertilisers, pesticides, machinery, and transportation, which not only contribute to carbon emissions but also create a dependence on external energy sources. Thus, the agriculture sector was an immediate focus for discussing energy transition. As noted above, it also faces multiple challenges, including declining soil health, excessive chemical use leading to soil degradation and reduced produce quality, and increased vulnerability to climate-related impacts.

A follow-up consultation on "Energy Transitions in Agriculture in Kerala" was held in December 2022, jointly by EMC, Asar and EQUINOCT. By this time, two monsoons in Kerala had passed by, reminding the state of the urgent need to address climate impacts in this sector. The workshop saw a strong commitment and participation from both the agriculture and energy sectors. It was inaugurated by the Minister for Agriculture and Farmers' Welfare, P. Prasad and had a valedictory talk by the Minister for Electricity, K. Krishnankutty. Experts and practitioners from Kerala presented an overview of energy use in agriculture and allied sectors and highlighted concerns regarding the impacts

of climate change. Experimental models of energy efficient technologies and climate resilient approaches in agriculture were presented. Agriculture policy expert Devinder Sharma gave the keynote address to this workshop. The programme was facilitated by Usha Kumari S (Agriculture policy expert and lead organiser of the programme) and Priya Pillai (Director, State Climate Action, Asar).

While energy transition was the focus of this meeting, concerns regarding the climate change impacts on agriculture were shared by both experts and participants. Several approaches and case studies highlighted the need to build climate resilience in agriculture, alongside the State's policy for carbon-neutral agriculture, transitioning to renewable energy sources, and improving energy efficiency in farming. This broadened the scope of the workshop and laid the foundation for the CREEA programme. A key recommendation from this state-level consultation was the need to actively engage grassroots-level officers from agriculture and other productive sectors to understand specific challenges and explore potential solutions. Identifying local issues and potential interventions at the grassroots level is vital, as achieving climate resilience depends on the unique agro-physiological and social characteristics of each region.

Image 5: Dr. R.V.G. Menon addressing participants at the state-level consultation on energy transition, EMC, Thiruvananthapuram.

Image 6: Devinder Sharma addressing the participants at State-level consultation on energy transition in the agriculture sector, EMC, Thiruvananthapuram.

Image 7: Panel discussion on Agro-PV, moderated by Prof. Sultan Ismail, at the state-level consultation on energy transition, EMC, Thiruvananthapuram.

4.2. District-Level Consultations & Workshops: CREEA Initiative

Building on the momentum from the state-level consultation and recognising the need for grassroots involvement, the initiative was expanded to hold district-level consultations across all fourteen districts of Kerala. The primary objective was to bring together officials from multiple departments with a stake in the food production system to identify specific challenges at the block and district levels, examine experimental pilots of CRA in the state and co-create potential areas for intervention. This consultation was a collaborative effort and involved close coordination and multiple levels of engagement with the Agriculture Department and the 19 allied departments. Entrusted by EMC (EMC/147/2023-ETB-6 dated 13-04-2023), and in collaboration with the Department of Agriculture and Farmers' Welfare, Asar and EQUINOCT jointly organised the district-level workshops.

In accordance with the directive from the Energy Management Centre (EMC), Asar and EQUINOCT jointly scheduled the district-level workshops to take place between July

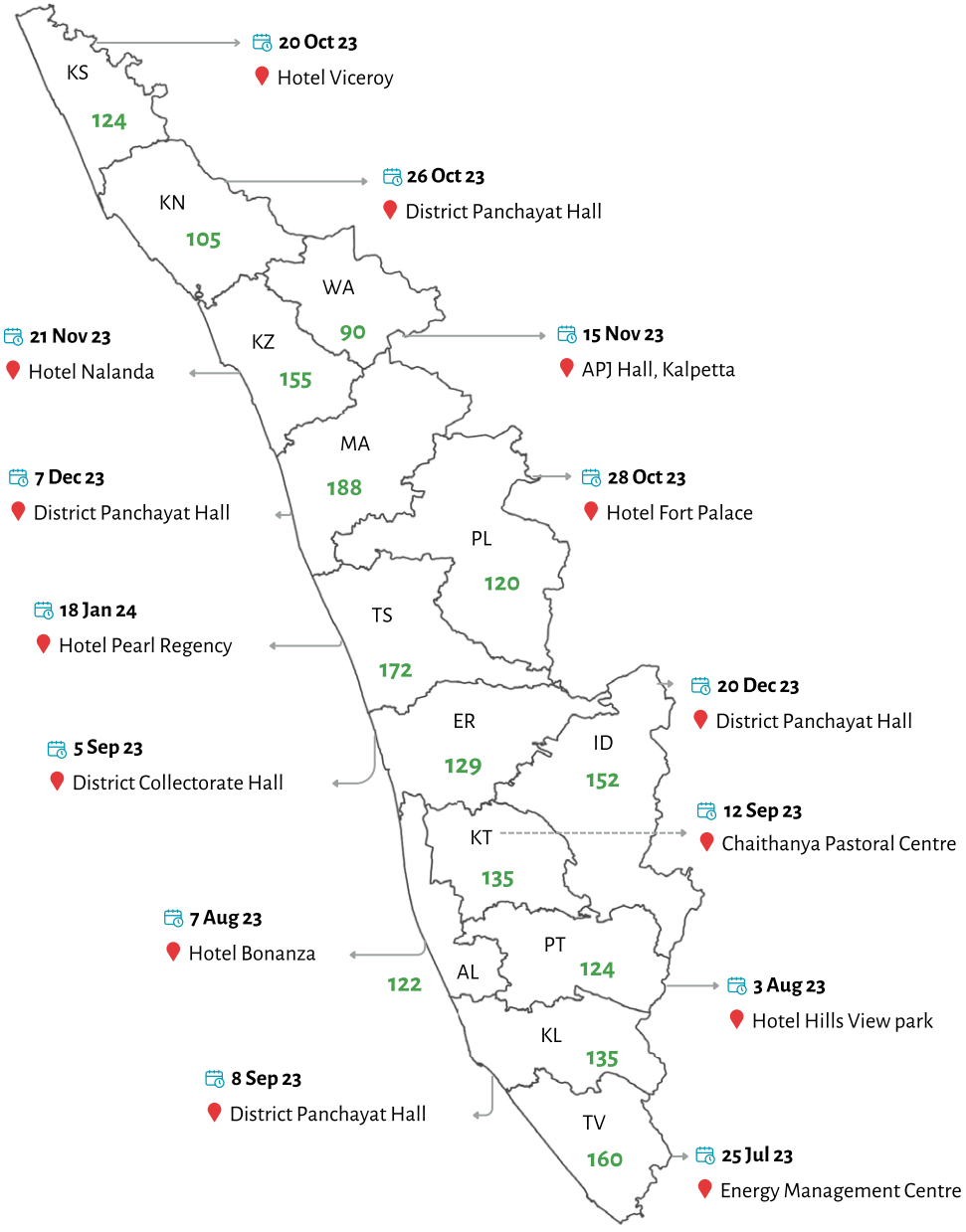
Image 8: K. Krishnankutty, Minister for Electricity; P. Prasad, Minister for Agriculture; and K. R. Jyothilal, IAS, Principal Secretary, inaugurating the CREEA workshops at EMC, Thiruvananthapuram.

2023 and January 2024. The preparatory phase spanned six months and involved the development of a comprehensive set of materials to support the workshops. These included a booklet on Climate Resilient Agriculture, TAPCo's farm calendar to support seasonal planning, and an introductory, context-setting presentation highlighting the inter-linkages between climate change and agriculture in the state. Additionally, two documentary videos were produced to showcase CRA experimental models in the state, providing practical insights from the field. EMC also contributed a booklet detailing energy efficiency schemes including those relevant the agriculture sectors. Together, these materials were developed to offer district-level stakeholders clear, coherent, and actionable insights to support informed decision-making.

The inauguration of the district-level CREEA workshops was held at EMC in Thiruvananthapuram on 25 July 2023. The event was inaugurated by P. Prasad, Minister for Agriculture and Farmers' Welfare, Government of Kerala (see Figure 11). It was presided over by K. Krishnankutty, Minister for Electricity, Government of Kerala (see Figure 12). Special addresses were delivered by K. R. Jyothilal, IAS, Principal Secretary, Government of Kerala, and Dr. George Sebastian, then Deputy Director of Agriculture. The event also saw the participation of senior officials from both the Agriculture and Power Departments. Following the inauguration, workshops were conducted across all districts over the subsequent six months, from July 2023 to January 2024 (see Figure 10).

Image 9: Release of the CRA booklet during the CREEA inauguration at EMC, Thiruvananthapuram.

CREEA: Timeline & Participation



Total Number of Participants: 1911

Number of Participants written inside the district boundary

Figure 10: Timeline & Participation of CREEA district-level workshops

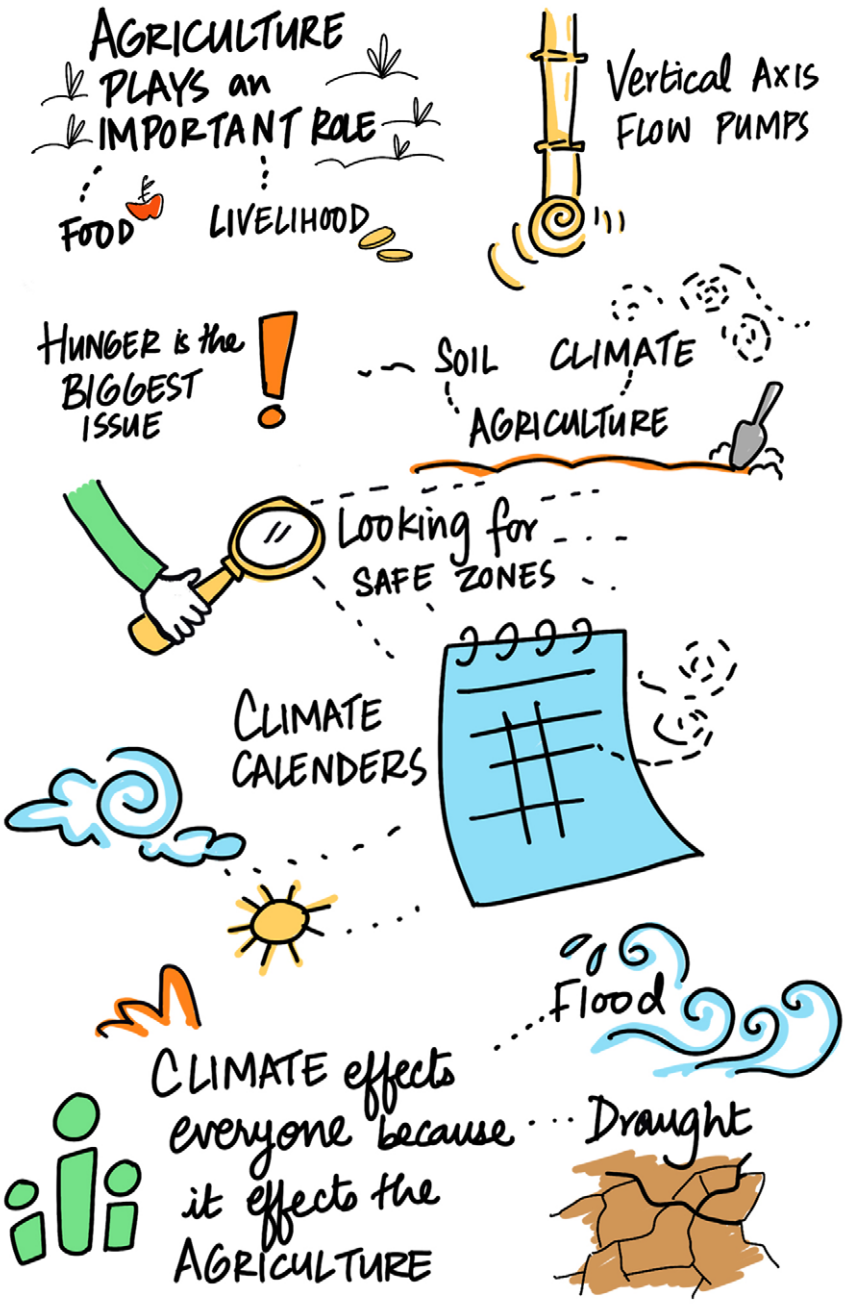


Figure 11: Representative sketch of Shri P. Prasad, Hon. Minister for Agriculture, delivering a speech at the CREEA inaugural, EMC, Thiruvananthapuram. Illustration by Nitasha Nambiar.

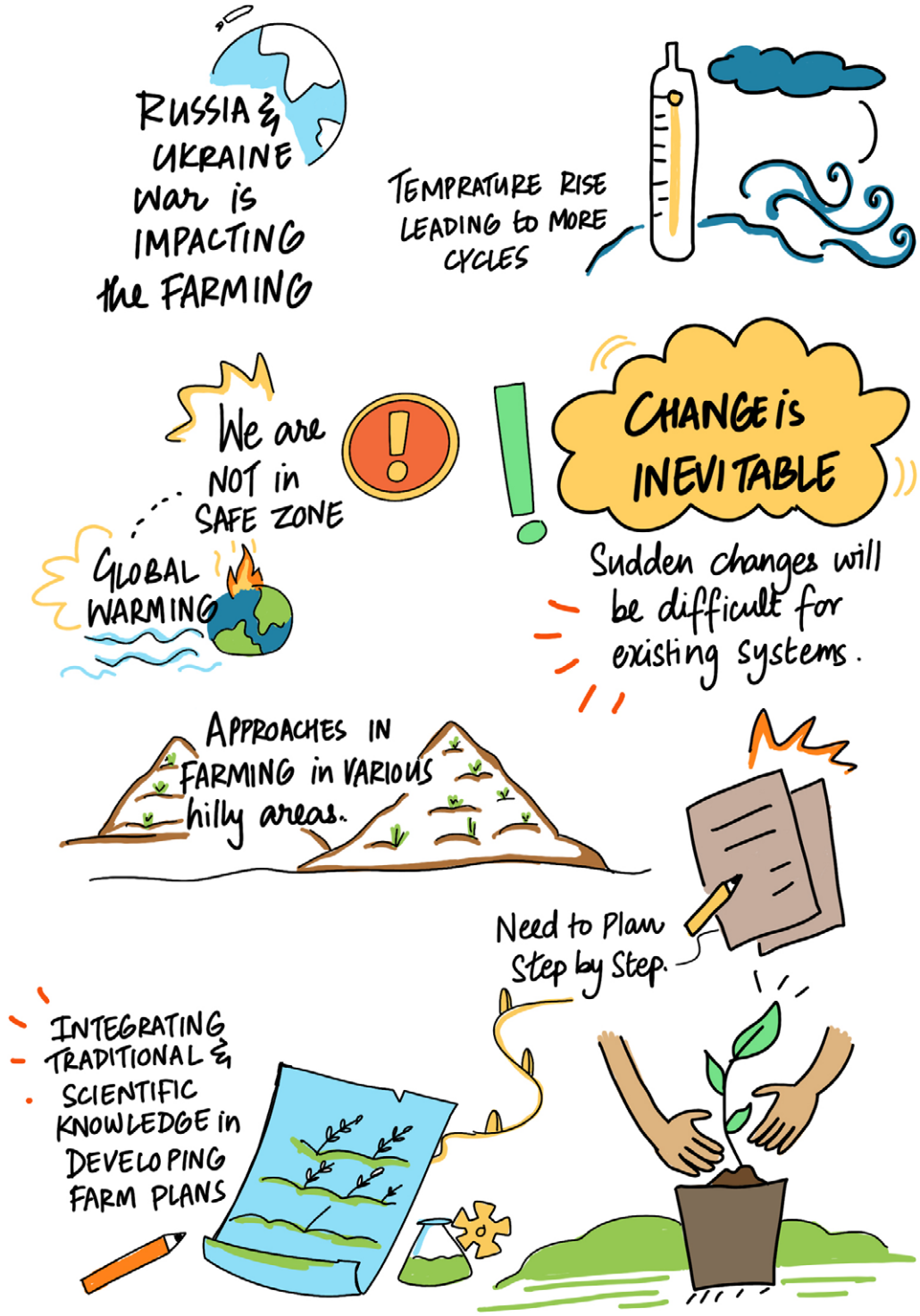

RUSSIA & UKRAINE War is IMPACTING the FARMING
TEMPRATURE RISE LEADING to MORE CYCLES
We are NOT in SAFE ZONE
GLOBAL WARMING
CHANGE is INEVITABLE
Sudden changes will be difficult for existing systems.
APPROACHES IN FARMING in VARIOUS hilly areas.
Need to Plan Step by Step.
INTEGRATING TRADITIONAL & SCIENTIFIC KNOWLEDGE in DEVELOPING FARM PLANS

Figure 12: Representative sketch of Shri K. Krishnankutty, Hon. Minister for Electricity, delivering a speech at the CREEA inaugural, EMC, Thiruvananthapuram. Illustration by Nitasha Nambiar.


AGRICULTURE is a PART of our CULTURE
NOT enough Support.
DAY to DAY REALITIES of FARMERS
COMPANIES MAKING MORE MONEY than Farmers.
share
CRASHING PRICES
LOSSES
Flood irrigation reaps huge energy savings
52 tonnes of tomato/ current world record 48
Flooding is used as irrigation here
24 lakh hectare land only 3 lakh hectare formed
PREPARE
PRODUCTION
PLAN
SHOULD CONSIDER IMPORT, EXPORT, INFORMAL FACTORS
A2 MILK - from Vechur cows
these cows are not available locally.
A1 milk - Lots of health CONDTITIONS (BP, Heartattack...)
ANOTHER POSSIBILITY:
FRUIT export to other countries with Planning

4.3. Process & Workshop

4.3.1. Pre-workshop Engagement

The CREEA consultations in each district were organized in close collaboration with the District Panchayat President and the Principal Agriculture Officer (PAO), with date and venue finalised in coordination with them. The pre-workshop phase included discussions with all district department heads and relevant stakeholders regarding the concept of CREEA, the programme schedule, and the workshop's overall objectives. The department heads designated participants for the workshop and appointed a representative to present on the various schemes available within their departments for building climate resilience.

The consultative workshops were formally inaugurated by the District Panchayat President who holds key roles as the Co-Chair of the District Disaster Management Authority (DDMA) and as the Chairperson of the District Planning Committee (DPC), responsible for reviewing and sanctioning district plans. The PAO presided over the event.

Image 10: Adv. Omalloor Sankaran, District Panchayat President, Pathanamthitta, addressing participants at the CREEA district-level workshop.

Image 11: Dr. P. K. Gopan, District Panchayat President, Kollam, addressing participants at the CREEA district-level workshop.

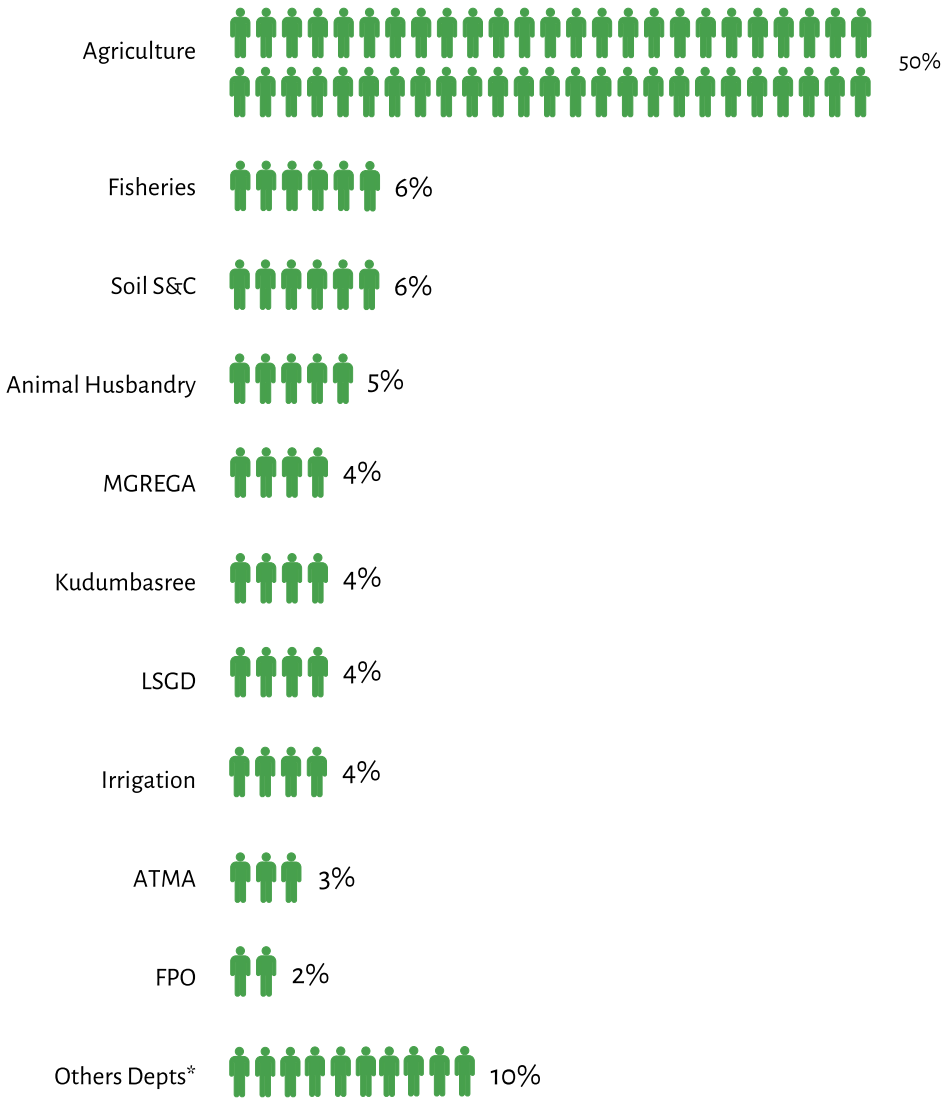
Image 12: Samshad Marakkar, District Panchayat President, Wayanad addressing participants at the CREEA district-level workshop.

Image 13: Participants at the CREEA district-level workshop, Malappuram.

The diverse representation of participants in each workshop underscores the integrated and multi-stakeholder approach of the CREEA initiative. Participants included grassroots officials and representatives from the Department of Agriculture Development and Farmers' Welfare (DoAFW), Department of Animal Husbandry, Dairy Development Department, Department of Fisheries, Agency for New and Renewable Energy Research and Technology (ANERT), Agriculture Technology Management Agency (ATMA), Krishi Vigyan Kendra (KVK), National Bank for Agriculture and Rural Development (NABARD), Kudumbashree, Electrical Inspectorate, Ground Water Department, Soil Survey and Soil Conservation Department, Navakerala Mission, Directorate of Environment and Climate Change (DoECC), Local Self Government Department (LSGD), Farmer Producer Organisation (FPO), Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGS), Department of Irrigation, Kerala Forest Research Institute (KFRI), Kerala State Biodiversity Board (KSBB), Kerala State Land Use Board (KSLUB), students and professors from Kerala Agricultural University (KAU) (see Figure 13).

Additionally, ten to fifteen students from KAU attended each district-level CREEA workshop and volunteered with the registration process, facilitated breakout group discussions, and compiled notes from all the sessions.

Department-Wise Participant Representation



Total Number of Participants - 1911

*Other departments include ANERT, Dairy Development, Ground Water, Water Resource, CWDRM, Electric Inspectorate, KILA, KSEB, KLDC, KVK, KAU, NABARD, Haritha Kerala Mission, KUFOS, RARS, Revenue, Environment & Climate Change.

Figure 13: Department-wise representation of participants

CRA Context Setting Presentation by Usha Kumari S

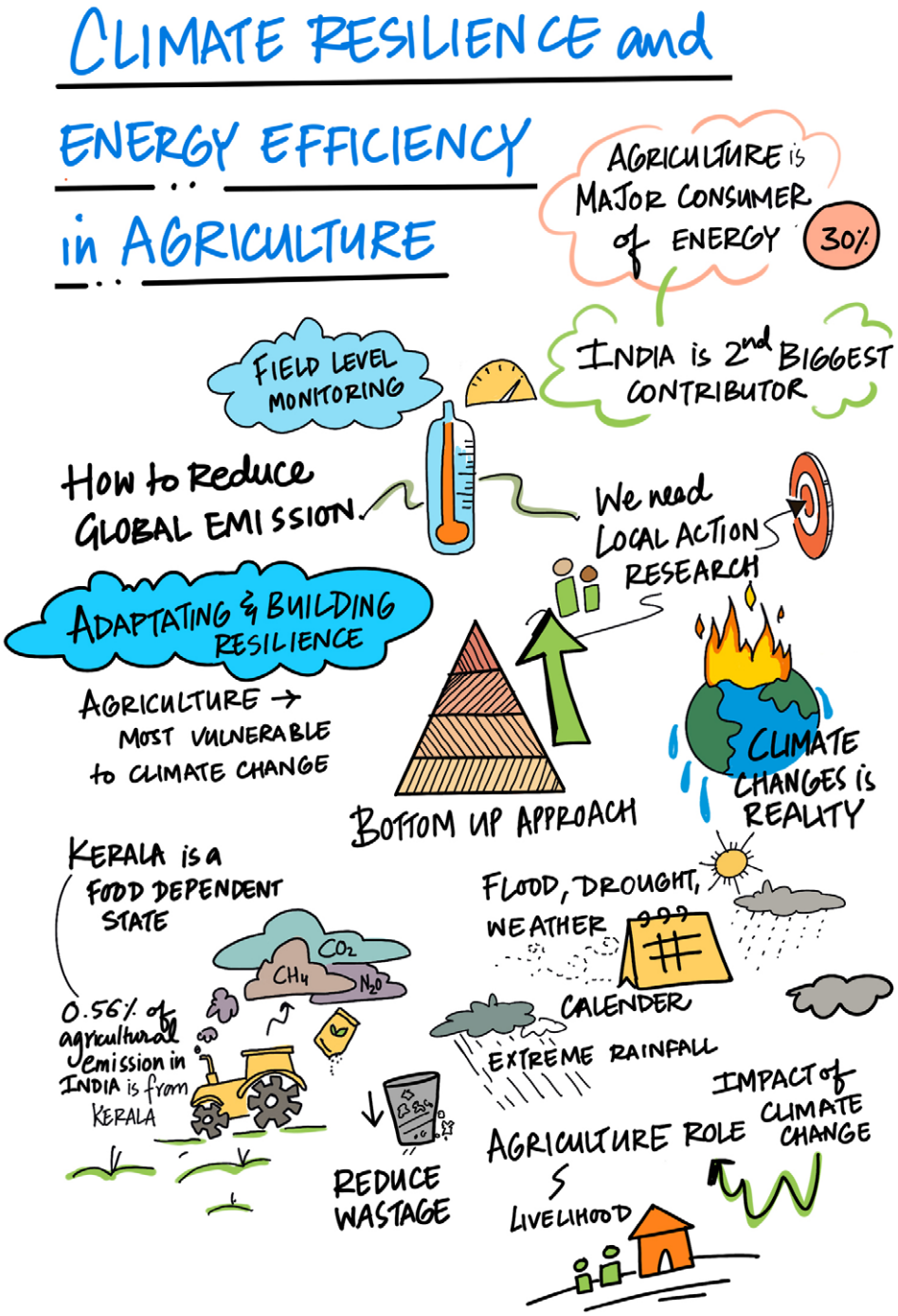


Figure 14: Representative sketch of the presentation by Usha Kumari S. on the context of Climate Resilient Agriculture during the district-level CREEA workshop. Illustration by Nitasha Nambiar.


RESILIENCE
ENHANCE BIODIVERSITY
NITROGEN EMISSION ↳ 300 times
HOME STEAD AGRICULTURE (Paddy)
RESCUE & RELIEF
Who are the Stakeholders
RESTORTING NATURE
REDUCE GHG emissions
SUPPORT SYSTEM for TRANSFORMATION
CROP & CLIMATE ADVISORIES
Understand the GAPs
ADAPTATION & SUSTAINABILITY throughout
EDUCATIONAL INSTITUTIONS
EMPOWERMENT
8.4 % of Total EMISSION
TAPPING the KNOWLEDGE of FARMERS
Support Policy & Programmes
We need RESILIENCE building Strategy.
POST HARVESTING INFRASTRUCTURE
Soil temprature
ORGANIC FARMING
Identify funds & Schemes
COMMUNITY NEEDS
LOCAL PRODUCTION SYSTEM
We need INTEGRATED PLANNING

4.3.2. Introduction to CRA & Presentation of CRA Related Schemes

The consultation opened with an introduction by Usha Kumari S on Climate Resilient Agriculture (CRA), emphasizing both the impacts of the climate crisis on agriculture and the sector's contribution to GHG emissions (see Figure 14). Her presentation explored the concept of CRA, outlining its key components and emphasising the importance of building resilience in the agricultural sector (see Annexure).

EMC presented a range of schemes and potential support for implementing energy efficiency and energy transition within the agriculture sector. Representatives from each department presented specific schemes within their departments that can be leveraged for building resilience, along with initiatives they have undertaken to enhance resilience using these existing schemes. NABARD provided insights into available grants and financial incentives for implementing climate-resilient and energy-efficient practices. This created a platform for resource sharing, highlighting the interventions already undertaken by various departments and demonstrating how existing schemes from EMC, NABARD, and others can be utilised effectively (see Annexure).

Image 14: Dr Muhammed Asif M, Department of of Animal Husbandry giving a presentation on CRA related schemes in CREEA district-level workshop, Kasargod.

4.3.3. Breakout Group Discussions

The breakout sessions were a pivotal component of the consultation process, designed to encourage active participation and identify localised and integrated solutions to the unique challenges faced by each district. Participants were organised into small groups based on agro-ecological zones, ensuring a diverse mix of stakeholders from various departments in each group. The groups discussed the current challenges they face, identified potential areas for intervention and explored avenues for collective action. Each group was assigned a facilitator to guide the discussions, ensuring structured and inclusive conversations. Given that the impacts of climate change span multiple sectors, an integrated approach that encourages collaboration across departments is crucial for developing effective solutions.

Image 15: Breakout group discussion by participants from Pampady and Vazhoor blocks during the CREEA district-level workshop in Kottayam.

After the breakout group sessions, representatives from each group presented key points from their discussions, including the major challenges and the potential solutions they identified (see Figure 15). All discussion points were compiled, and the key insights are addressed in the next chapter.

Image 16: Breakout group discussion by participants from Kothamangalam and Koovappady blocks during the CREEA district-level workshop in Ernakulam.

Image 17: Breakout group discussion by participants from Chengannur and Kayamkulam blocks during the CREEA district-level workshop in Idukki.

Image 18: Breakout group discussion by participants from Perambra and Thikkodi blocks during the CREEA district-level workshop in Kozhikode.

Image 19: Participants from Adimali and Devikulam Blocks presenting during the post-breakout group discussion at the CREEA district-level workshop in Idukki.

Image 20: Participants from Malampuzha and Palakkad blocks presenting during the post-breakout group discussion at the CREEA district-level workshop in Palakkad.

Image 21: Participants presenting during the post-breakout group discussion at the CREEA district-level workshop in Kannur.

Breakout Group Discussion, Thiruvananthapuram: Key Points

Figure 15: Representative sketch capturing key points from the breakout group discussion during the district-level CREEA workshop at EMC, Thiruvananthapuram. Illustration by Nitasha Nambiar.


BREAKOUT #4
• UNEXPECTED CLIMATE PATTERNS
• TIMELY WEATHER FORECASTING
• WILD ANIMAL ATTACK- SOLAR FENCING 1.5 acre - Rs 1.6 lakhs (2 days Withstand)
• KVK MODEL FARM
• PRECISION FARMING - Lease land farming are not able to gain advantage.
• HIGH COST of CULTIVATION. Labour charges of cultivation high
• PEST & DISEASE INFESTATION - Software/app based Solutions
• RECYCLE SOLAR PANELS
• SOLAR + WIND ENERGY SYSTEMS
• LOCAL WEATHER FORECAST AVAILABILITY
• CUSTOMISED SOLAR PANEL
BREAKOUT #5
• CROP & PEST CALENDER
• C4 PLANTS
• PPFM
• CHANGE in POLICY LEVEL (WILD ANIMAL ATTACK)
• SOIL ANALYSIS
• AFRICAN SNAIL (AWARENESS PROGRAM)
• No OWNERSHIP in COMMUNITY based PROJECT
• IRRIGATION DRAINAGE - RAINWATER HARVESTING, GROUND WATER RECHARGE
• WASTE MANAGEMENT. trend setters
• SMALL UNITS
BREAKOUT #6
• CREATING NEW CROP & PEST CALENDER
• NOW CASTING TECHNOLOGY
• DROUGHT TOLERANT & SHORT-DURATION CROPS
• PROPER CANNAL SYSTEM & MAINTENANCE SYSTEM
• RESTORATION of WATER BODY
• Unscientific CONSTRUCTION NOW NH- WATERLOGGING
• SOLAR PUMPS & LIFT IRRIGATION SYSTEMS at COMMUNITY LEVEL.
LEASE CULTIVATORS- CANNOT BEAR HIGH COST INDIVIDUALLY

4.4. Feedback & Evaluation of the Workshop

At the end of the workshop, participants were given a feedback form to evaluate various aspects of the event, including the relevance of the workshop, the agenda, knowledge gained, usefulness of materials, networking potential. A total of 511 participants (27%) completed the form (see Figure 16).

Key feedback from participants included the following:

- Emphasised the need for continuous engagement with CRA through regular consultations and workshops at various administrative levels
- Recommended creating an open, easily accessible resource repository that includes: (i) agriculture-related data bank; (ii) clear guidelines and support for developing projects based on the CRA framework; and (iii) a system to track CRA implementation, monitor challenges, and assess progress.
- Recommended documenting additional CRA case studies in video format, capturing initiatives from diverse agro-ecological zones across the state.
- In districts sharing forest boundaries, participants stressed the importance of including forest department officials, noting that an integrated approach to building resilience requires their active involvement.
- Suggested holding workshops at the beginning of the financial year to align with the budget cycle, facilitating the inclusion of CRA components in planning.
- Proposed conducting training sessions on modern tools and technologies, such as GIS to quantify climate-related impacts on agriculture and support data-driven decision-making.

As highlighted earlier, the breakout sessions were a pivotal part of the consultation process, fostering active participation and facilitating the identification of localised, integrated solutions tailored to each district's unique challenges. The next chapter will examine the main outcomes and key learnings from these discussions.

Feedback Form Analysis

Total Responses - 511 (27% of total participants)

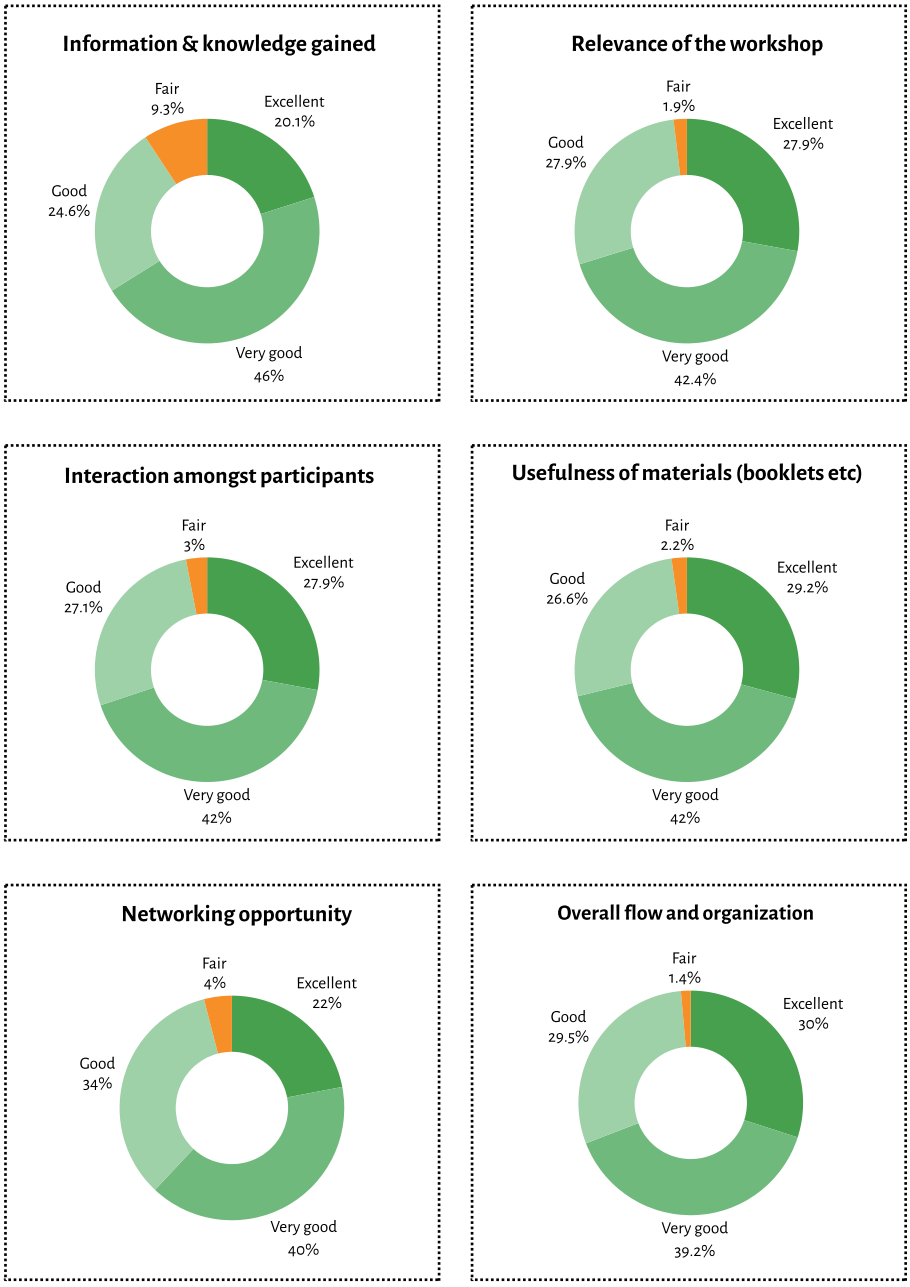


Figure 16: Feedback form analysis

5. Outcomes from the CREEA Consultative Process

5.1. Climate Change & the Food System: Stakeholder Insights

5.2. CREEA Management Approach

Introduction

The district CREEA workshops were instrumental in documenting the local level impacts of climate change on the agriculture and allied sectors in Kerala. Stakeholders identified several challenges, including those directly caused by climate change and those exacerbated by it (see Table 6 and Table 7). As shown in the figure, most concerns were common across districts. They ranged from climate impacts and pest infestations to labour shortages and marketing challenges. In this chapter, the impacts of climate change on the food system as identified by officers during the breakout group sessions have been summarised. Following this, we explore the various solutions proposed by stakeholders, organised within the CREEA management framework.

5.1. Climate Change & the Food System: Stakeholder Insights

5.1.1. Agriculture

Climate change is causing erratic rainfall, extreme temperatures, flooding, droughts, and seawater intrusion. These disruptions make it difficult to follow crop calendars and plan agriculture activities, leading to delays in cultivation. In Kerala, where agriculture is highly rainfall-dependent, unpredictable rains hinder crop cycles. Soil erosion complicates land preparation, and both floods and droughts result in crop losses. Strong winds particularly damage banana plantations. Weather fluctuations have affected pollination, crop growth, and overall productivity. Increased pest and disease outbreaks have further reduced the yield and nutrient quality of crops, fruits, and vegetables.

5.1.2. Fisheries & Animal Husbandry

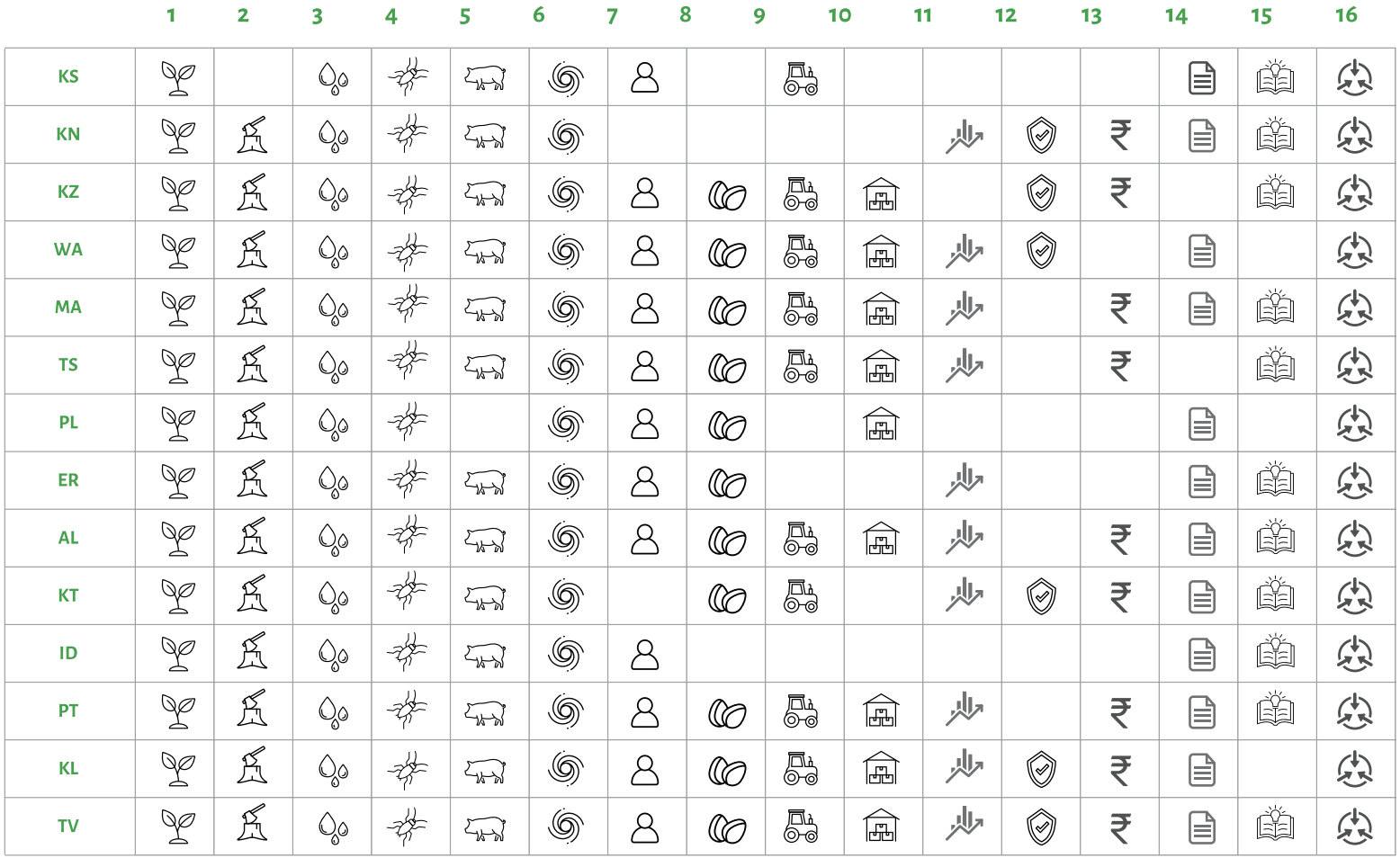
Reduced rainfall and water availability during the southwest monsoon have affected fish growth and survival. Temperature variations contribute to disease outbreaks and the spread of parasites, lowering yields and causing economic losses. In livestock, extreme heat has increased mortality and reduced fertility. Drought conditions have led to fodder and water shortages, raising the cost of rearing animals. Erratic weather has also contributed to the rise of diseases in livestock, affecting milk production and quality.

5.2. CREEA Management Approach

During the CREEA discussions and break-out sessions, the stakeholders identified several challenges that exist in the food system and also proposed potential solutions. Most of the issues raised and solutions identified have relevance across the state. From the perspective of operationalisation of CREEA, these have been grouped into the following four categories (see Figure 17).

Figure 17: CREEA Management Approach

Challenges Identified by Stakeholders during CREEA District-Level Workshops



Tabel 6: District-level challenges identified by stakeholders during the CREEA district-level workshops in Kerala

Description of Challenges Identified by Stakeholders during CREEA District-Level Workshops

1		Soil Health	Fertility loss, nutrient depletion, low micronutrients, reduced water retention, rising salinity & acidity, soil erosion.
2		Land Use	Fragmentation, urbanization, wetland conversion & insufficient conversion of fallow land to agriculture.
3		Water Management	Inadequate maintenance of water bodies and channels including siltation, waste dumping, invasive species invasion, and pollution. Poor drainage & waterlogging. Insufficient watershed management. Insufficient irrigation.
4		Pest & Diseases	Attacks by African snail, red palm weevil, rhinoceros beetle etc. Minor pests become major threats.
5		Wildlife Conflict	Attacks on agricultural land and crop damage by wild boars, monkeys, giant squirrels, elephants, peacocks etc.
6		Climate Change	Erratic weather, unpredictable rainfall, rising temperatures, and extreme events like floods, droughts etc.
7		Labour	Labour shortage, increasing labour costs, skill gap and absence of employment guarantee schemes.
8		Seeds & Bio-inputs	Lack of indigenous/climate-resilient seeds. Lack of and organic manure and bio-pesticides. Excessive use of chemical fertilizers & pesticides.
9		Machinery & EE	High machinery costs, along with maintenance and repair challenges. High energy consumption and fuel costs. Limited training on machinery use. Equipment not suited to local conditions or women farmers.
10		Post Harvest & Value Addition	Inadequate seed storage and limited post-harvest facilities, including insufficient storage space, godowns, and processing units for value addition.
11		Market	Huge price fluctuations, lack of marketing networks & strategies, absence of adequate *local* market systems.
12		Insurance & Compensation	Inadequate compensation and insurance for specific threats and partial damage. Administrative challenges in acquiring insurance.
13		Funding	Lack of funds for infrastructure development and natural resource management.
14		Policy	Weak regulation of land conversion, especially conversion of wetland paddy. Poor implementation of environmental protection measures. Lack of farm policies aligned with agro-ecological units.
15		Research & Education	Limited integration of traditional knowledge, inadequate research investment, poor scaling of pilot projects, and lack of capacity building on climate resilient practices and technology, especially for youth.
16		Convergence & Collaboration	Lack of inter-departmental integration and convergence in schemes, action plans, and funding.

Tabel 7: Key to Table 5 and brief descriptions of the challenges identified

5.2.1. Ecosystem Health Management

The resilience of the food production system—including agriculture, animal husbandry, and fisheries—is intricately linked to the health of the ecosystem, which encompasses the health of soil, water, air and biodiversity. Human interventions over the years, such as changes in land use, overexploitation of resources, and pollution, have significantly impacted these integral elements, thereby reducing the resilience of the food production system.

Ecosystem health management is a vital component of building climate resilience in agriculture. By promoting biodiversity, improving soil and water management, and adopting sustainable practices, farmers can enhance their ability to adapt to climate change. Collaborative efforts among stakeholders, including farmers, policymakers, and researchers, are essential for developing and implementing effective ecosystem management strategies. Emphasising ecosystem health not only supports agricultural productivity but also contributes to the overall sustainability of our food systems in the face of climate challenges.

Solutions Proposed during the CREEA Workshops

Soil & Water Health

- Conduct regular soil testing and quality monitoring to ensure optimal soil productivity. Establish block-level soil testing labs to provide timely guidance for better crop yields.
- Promote water conservation and erosion control through rain pits, vegetative cover crops such as pulses and vetiver.
- Conduct hydrological and environmental flow audits to map water flows, canals, and drainage systems in order to identify water logging issues.
- Restore and rejuvenate ponds, water channels, canal networks and irrigation channels. Ensure regular maintenance of water channels and ponds through community-monitored efforts, including renovation, de-silting, and strengthening of water body boundaries.
- Establish local water committees at the ward level to ensure efficient use of water.

- Prevent industrial pollutants from entering natural water bodies.
- Implement a comprehensive irrigation plan for paddy fields to ensure efficient irrigation under both drought and flood conditions.
- Promote sustainable waste management practices, such as composting and recycling, and implement Green Protocols in all institutions.
- Promote mixed diversity based agroforestry practices to enhance soil fertility and biodiversity. For instance, promoting coastal mangrove regeneration, bamboo and screw pine planting along stream banks.

5.2.2. Extreme Event Management

The risks due to climate change in agriculture are most often uncertain, unexpected and extreme. It ranges from severe pest infestation and wildlife attacks on standing crops, extreme rainfall, floods, droughts and landslides that jeopardize standing crops and upset crop calendars and any other event in the short term that is entirely unplanned for. The increasing incidence of human-wildlife conflicts leads to significant crop and livestock losses. In 2020-21 alone, 8017 cases were reported, with 6697 related to crop and property damage and 380 for cattle loss (Administration report, Forest department, 2020-21). The incidence of pests have increased, along with the emergence of new pests and diseases. There is also increased pest and disease infestation in fish and livestock.

Kerala's agricultural sector has been severely impacted by a series of extreme weather events in recent years such as the devastating floods of 2018 and 2019, which caused widespread crop and infrastructure damage. Unseasonal summer showers in March-April 2015 damaged crops and essential farming infrastructure. Additionally, in 2021, unusual winter rainfall in areas like Idukki devastated winter crops, including fruits and vegetables. Monsoon thunderstorms have also caused untimely rainfall that affected paddy crops in Kuttanad and Kole lands, further stressing paddy growers during abnormal winter rains in December and January. The recurrent mud slips and landslides in the mid and high ranges pose risks to local farming systems, while phenomena like heat bursts have scorched vegetation along the coast (GoK, 2024). These factors highlight the agricultural sector's vulnerability to extreme events, emphasising the need for urgent resilience-building measures.

Pest Infestation

- Implement pest and disease surveillance programmes in all Krishi Bhavans, including regular field monitoring and farmer advisory services.
- Establish active biodiversity committees to monitor disease threats in cattle and fish stock.
- Utilise solar-powered light traps and adopt prophylactic measures for early pest intervention.
- Promote time-tested biological, organic, and natural methods for managing pests, diseases, and weeds. Set up labs at the Panchayat or block-level to produce biocontrol agents. This will ensure the timely availability of quality biocontrol agents.

Weed Infestation

- Convert water hyacinth and other weeds into organic manure and value-added products.
- Promote and support manual weeding through MGNREGS.

Wild Animal Attacks

- Map and monitor conflict hotspots—areas with frequent crop damage, livestock attacks, or human-wildlife encounters. Track the frequency and extent of these incidents. Conduct detailed surveys to delineate forest boundaries, and develop action plans to better understand human-wildlife interactions. Design practical coexistence models, assess the forest's carrying capacity, regulate tourism in high conflict zones, and avoid promoting farm tourism in vulnerable areas.
- Preserve natural habitats to reduce wildlife encroachment into agricultural lands and implement scientific population management of wild animals. Employ ecological engineering techniques, such as planting trap crops like marigold and fruit-bearing trees in forest areas, to provide alternative food sources for wildlife.

- Use bio-fencing, solar fencing, geo-fencing, and trenches around agricultural areas. Employ sound deterrents at varying frequencies and products such as Herboliv to prevent wildlife attacks. Incorporate technologies such as AI-based early detection systems, drones, and alarms.

Extreme Weather Impacts

- Hyper Local weather forecast and early warning system tuned to the needs of farmers. Pilot in immediately vulnerable districts such as Wayanad and Idukki, then scale up across the state.
- Install local weather stations to enhance district-level forecasts from the India Meteorological Department (IMD) and the Kerala State Disaster Management Authority (KSDMA). Develop a network of Automated Weather Stations (AWS) across districts to deliver hyper-local forecasts and timely, crop-specific advisories.
- Revise crop calendars using recent climate trends and historical weather data to better align planting and harvesting with current conditions.
- Encourage community-driven weather monitoring initiatives.
- Deploy climate managers or extension officers at the Panchayat level.
- Set up agro-clinics in each block to offer weather forecasts and related agricultural support.
- Develop alternative water sources to reduce dependence on monsoon rainfall. Implement localised irrigation schedules based on real-time weather data.
- Incorporate weather forecasting into disaster management plans. Address flood and landslide risks through probability mapping in disaster management plans.
- Install protective shutters or gates to prevent saltwater intrusion into agricultural fields.
- Establish trained emergency response teams at the ward level. These volunteer groups should act swiftly to protect crops, cattle, and property upon receiving early warnings, and assist with post-disaster recovery.

5.2.3. Energy & Resource Management

Energy and resource management encompasses the entire spectrum from farm inputs and machinery management to human power and labour management in agriculture. It was highlighted during the district workshops that an over-reliance on chemical fertilisers leads to long-term degradation of soil health and the pollution of aquatic ecosystems. Sustainable resource management in agriculture such as promotion of organic farming methods also builds ecosystem health.

Energy management in agriculture, a critical component of CREEA, prioritises energy efficiency (EE) and Decentralised Renewable Energy (DRE), ensuring that all energy dependent farming interventions are both low-emission and climate-adaptive. It is a comprehensive approach where resource and energy use at every stage of the production cycle, both on-farm and off-farm, is examined for its linkages to emission mitigation and adaptation to climate impacts. Additionally, DRE-driven, community-led efforts play a crucial role in strengthening climate adaptation while addressing justice issues. These initiatives can provide and enhance livelihoods, reduce drudgery, and increase incomes, particularly for women and marginalised communities.

Solutions Proposed during the CREEA Workshops

Seeds & Inputs

- Strengthen state seed farms to produce climate-resilient, locally adapted seeds.
- Establish community seed banks at the local LSGI level to conserve genetic diversity, focusing on local crop varieties, climate-resilient seed varieties that are resistant to flood, drought, heat and pests.
- Establish panchayat-level seed farms to conserve local germplasm.
- Integrate Kudumbashree and MGNREGS to ensure timely supply of organic manure and good-quality seeds. Utilise the capacity of Karshika Karma Sena for the production and supply of agricultural inputs.

- Establish biogas units primarily for dairy farmers to process cow dung and utilise as bio-fertiliser, to reduce reliance on chemical fertilisers and to reduce methane emissions.
- Provide seeds and crop varieties with short-duration crop cycle.
- Promote climate-resilient fodder varieties to ensure adequate feed availability and establish localised fodder banks to store surplus for lean periods.
- Implement cluster-wise fodder cultivation to enhance soil health and prevent soil erosion and degradation. Carefully select high-quality, climate-resilient fodder varieties that fulfil the nutritional requirements of livestock, supporting improved growth, health, and overall productivity.
- Crop diversification and rotation with pulses to reduce nitrogen fertiliser use.
- Implement soil testing-based fertiliser management to reduce fertiliser use.
- Establish a procurement system for manure through the agriculture department.
- Screen for climate resilience and climate related stress tolerance in germplasm of indigenous varieties and propagate the same.

Machinery & Technology

- Enhance financial assistance and subsidies to reduce initial costs for adopting decentralised renewable technologies.
- Utilise solar power for machinery, irrigation pump sets, cattle farms, solar boats, and fish dryers to significantly reduce reliance on fossil fuels. This will also help to reduce overall operational costs.
- Promote energy-saving pump sets and fish driers with high star ratings.
- Ensure all schemes that involve the installation of machinery in agriculture prioritise energy efficiency and the use of renewable energy.
- Devise schemes to convert all energy and fuel utilising machinery in the agriculture sector to RE in a phased manner.
- Develop and promote machinery designed specifically for women farmers.

Labour

- Implement the *Jilla Labour Bank* Scheme to train and organise labourers. Collectivise unorganised labour into labour banks and cooperatives, such as Karshika Karma Sena, to ensure optimal employment. Support Farmer Producer Organisations (FPOs) in creating and managing labour banks.
- Conduct capacity building workshops to build a skilled labour force at the Panchayat or block level for tasks such as land and water management, harvesting, and post-harvest handling.
- Conduct skill-building programmes and workshops that offer hands-on training and practical guidance on farming practices, energy-efficient and renewable energy machinery, and value-added processes, with a focus on engaging youth.
- Revise the MGNREGS to incorporate activities related to agriculture, in order to increase labour support for farming and allied activities.

5.2.4. Institutional Management

Institutional mechanisms and management lie at the core of the CREEA approach. While the solutions proposed through CREEA address the hyper-local impacts of climate change and aim at decentralised mitigation through context-specific systemic practices, a strong overarching institutional framework is essential. Such a framework is necessary to leverage funding, enable effective implementation and monitoring, and provide consistent policy support. Tackling the multiple impacts of climate change through CREEA would require multi-departmental collaboration, a reimagining of farm planning policies based on agro-ecological units, and sustained funding by channelising various state and central government schemes. This would also aid in streamlining implementation of CRA solutions through the cooperation and collaboration of all relevant departments.

As shown in Table 12, all district-level workshops consistently emphasised the need for institutional collaboration and inter-departmental coordination to strengthen climate resilience in agriculture and allied sectors, highlighting the importance of a collaborative approach.

Post-harvest Facility & Value Addition

- Establish godowns, warehouses, silos, and ramps to minimise post-harvest losses.
- Identify gaps in storage needs in all panchayats and develop targeted schemes to build the necessary infrastructure.
- Promote community-led value addition facilities—processing units, cold storage, solar drying—through Kudumbashree, PACS, and FPOs.

Marketing

- Establish a statutory mechanism to support the Minimum Support Price (MSP) as defined by the Prof. M.S. Swaminathan Commission, aimed at stabilising agricultural prices and ensuring fair compensation for farmers.
- Strengthen and promote value addition and marketing through FPOs, PACS, CBOs, CSOs, and community collectives with seasonal marketing strategies.
- Establish public procurement and marketing centres at the Panchayat and block levels to increase market access. Strengthen and support local market outlets managed by FPOs, PACS, CSOs, CBOs and other community collectives. This will also ensure local food availability and enhance food security.
- Facilitate the marketing of organic products through government departments.
- Collaborate with cooperative banks for marketing support.
- Conduct awareness programmes on the value of locally produced food.

Insurance

- Develop a robust crop insurance programme that covers various climate risks, including floods, droughts, unseasonal rains, and extreme weather events.
- Increase the range of crops under the insurance schemes to cover all crops being cultivated in a specific agroclimatic zone.

- Update compensation amounts to reflect current cultivation costs.
- Ensure full coverage for post-harvest damages caused by untimely rains, particularly in the case of paddy.
- Tailor insurance covers for specific crops, such as providing wind and cyclone coverage for banana crops.
- Include land preparation costs in compensation for seedling-stage crop loss, instead of limiting support to seed replacement.
- Reduce the turnaround time from the government mechanism for verifying and reporting the damages. Compensations should be paid within a month of reporting of damage by the farmer.
- Invest in automatic weather stations (AWS) and advanced technologies such as Geographic Information Systems (GIS), satellite imagery, drones, and remote sensing tools to enable accurate and timely assessment of crop loss.
- Integrate crop loss from pest and disease infestations into weather-based insurance schemes.
- Strengthen the Pradhan Mantri Fasal Bima Yojana (PMFBY) by integrating climate-resilient approaches such as natural farming and agro-ecological practices. Additionally, it must expand coverage to include losses due to human-wildlife conflict.
- Offer insurance coverage for resilience-enhancing technologies such as drought resistant crops and weather forecasting tools.
- Create an exclusive insurance portal for farmers, insurers, and stakeholders to digitize insurance-related services, including easy enrolment, claims processing, and grievance redressal through mobile applications.
- Leverage subsidies from central and state governments, as well as agricultural boards, to lower premium rates.
- Introduce insurance schemes in the fisheries sector, including coverage for aquaculture under crop insurance programmes.
- Revisit and enhance comprehensive insurance schemes in the animal husbandry sector to strengthen climate resilience, especially for small and marginal farmers.

Funding

- Promote the recognition of agriculture as an ecosystem service that enhances soil health, water quality, and biodiversity, making it eligible for funding from institutions such as the World Bank.
- Enhance subsidies and funding for micro-irrigation systems.
- Leverage CSR funds, NABARD, RKVY, RIDF, and carbon credits to support soil and water conservation initiatives.

Research & Capacity Building

- Gather and consolidate hyper-local data on climate indicators.
- Build awareness on schemes and funding opportunities available for climate resilient and energy efficient farming systems.
- Conduct research and capacity-building workshops focused on innovative agricultural practices, climate-resilient agriculture strategies, marketing strategies, and value addition opportunities.
- Facilitate community participation by involving local communities in the design and implementation of research and extension activities, while integrating traditional knowledge to incorporate their ecological insights into agricultural development planning and extension services.
- Develop knowledge-sharing platforms to enable the exchange of best practices and innovations among farmers, researchers, and extension workers.
- Integrate agricultural topics into school curriculum and organise workshops to promote youth participation in agriculture.

Policy Gaps & Implementation

- Enforce strictly the *Kerala Conservation of Paddy Land and Wetland Act 2008* to prevent illegal land conversion and encroachment.
- Implement clear guidelines to prevent infrastructure projects from obstructing natural water flow. Ensure embankments do not block East–West water flow.

- Revise MGNREGs policies to include a wider range of agricultural and allied activities, enabling effective involvement of scheme workers in farming operations.
- Implement new legislation for fertiliser use based on soil test results.
- Impose restrictions on drone use for spraying chemical pesticides.

Collaboration & Convergence

- Establish platforms at the Local Self-Government Institution (LSGI) level to integrate schemes from agriculture and allied departments, aligning them with CRA goals, with a focus on enhancing production and improving livelihoods.
- Foster coordination between the forest department, LSGI, agriculture and allied departments. Establish a dedicated unit within the forest department to support coexistence strategies and ensure land and resources for agriculture are available without compromising forest conservation goals.
- Create an interdepartmental data bank accessible to stakeholders to support better decision-making.
- Promote Integrated Farming System (IFS) to diversify income sources and improve livelihood resilience. Introduce schemes that integrate agriculture with animal husbandry, including support for fodder cultivation and the establishment of designated community-managed grazing grounds.

Conclusion

This chapter has examined the main challenges and solutions identified by stakeholders during the CREEA consultation, organised into four categories that comprise the CREEA management approach (see Figure 18). The subsequent chapter will apply the CREEA management framework to examine three experimental CRA models in Kerala.

Figure 18: Word cloud representing key solution ideas shared during breakout sessions at district-level CREEA workshops. Colours correspond to categories in the CREEA management framework.

6. CRA Experimental Models in Kerala

6.1. Aluva State Seed Farm, Ernakulam

6.2. CRA in Alathur Panchayat by Krishi Bhavan, Palakkad

6.3. CRA in Thirunelly Panchayat by TAPCo, Wayanad

Introduction

This chapter examines three distinctive case studies that were documented as part of the CREEA process to showcase innovative approaches to CRA practised in different parts of Kerala. The first case study focuses on a state owned seed farm that is practising organic farming with the goal of becoming a carbon neutral facility. The second case study explores a Panchayat-level initiative led by the Krishi Bhavan under the guidance of an Agricultural Officer. The third case study highlights a Farmer Producer Organisation (FPO), illustrating how the collectivisation of farmers can enhance resilience throughout the entire value chain, from production to market access. These experimental models represent diverse strategies implemented at varying scales—ranging from a state-owned farm to a Panchayat-level initiative—and involving different agencies in their efforts to build resilience to climate change. Referred to as experimental models, these initiatives underscore the dynamic processes of learning, sharing, paving the way for continual refinement in building resilience. All three initiatives have received state-level recognition, including awards for best State Seed Farm (2020), best Agricultural Officer (2015), and best FPO (2020).

The case studies are analysed through the lens of the CREEA management approach: ecosystem health management, extreme event management, energy and resource efficiency, and institutional management. These pillars serve as the primary focus areas for design and implementation of CREEA interventions (see Figure 19).

6.1. Aluva State Seed Farm, Ernakulam

6.1.1. Overview

The State Seed Farm (SSF) in Aluva, is a 120 years old farm located in the Ernakulam district. SSF in Aluva occupies a 13-acre island strip situated in the middle of the Periyar river. From 2012, the farm follows organic agriculture practices and strategies. A significant portion of the farm (~7 acres) is dedicated to paddy cultivation. This area serves as a 'live rice museum', conserving and showcasing several traditional rice varieties including *Raktashali, Black Njavara, Japan Violet, Vellathondi, Vellarikaima, Njavara, Manuratna, Vytila 10, Kumol Saul, and Aghoni Bora*. Four acres are used for vegetables, bananas, tuber crops, spices, coconut, and other tree crops. The remaining two acres

Figure 19: CREEA management approach

encompass ponds, canals, and wells. Over the past decade, as a result of organic farming practices, SSF Aluva has become not only carbon neutral but has also attained a carbon negative status. Between June 2021 to July 2022 the SSF Aluva recorded a surplus of 170.37 tonnes of carbon (Nameer, 2022).

The state agriculture department currently operates 33 seed farms (Department of Agriculture, Government of Kerala, n.d.). The Aluva seed farm is the first and only farm to implement the carbon neutral model. The government of Kerala has set an ambitious target to achieve Net Zero Carbon by 2050. This initiative by the Aluva seed farm has inspired the state agriculture department to implement the Aluva model in the other state farms to attain carbon-neutral status.

6.1.2. Components of Resilience

Ecosystem Health

The farm employs a variety of organic practices aimed at reducing greenhouse gas emissions and enhancing soil carbon sinks. These practices include the (i) use of locally prepared organic formulations for both cultivation and pest control; (ii) on-site recycling of crop residues and animal waste to enrich soil fertility; (iii) minimal tillage using manual tillers to preserve soil structure; and (iv) integrated duck rearing to improve soil aeration, control weeds, and reduce pest infestations. For pest management, the farm also employs biological insecticides, fish amino acids, and solar-powered LED bug traps. To further support organic farming and strengthen broader natural resource management, the farm adopts an Integrated Farming System (IFS) approach, incorporating complementary activities such as horticulture, livestock rearing, poultry farming, fishing, and aquaculture. In addition to these practices, the Aluva Seed Farm plays a crucial role in conserving traditional seed varieties and preserving the local gene pool (see Figure 20).

The primary focus of the farm is on mitigation and achieving net-zero carbon emissions. These practices nonetheless contribute to the resilience of the natural resources. By avoiding the use of chemical fertilisers and pesticides and cultivating traditional seed varieties, the farm enhances soil structure, fertility, and water retention, while also supporting biodiversity. Together, these integrated approaches promote the long-term health of soil and water systems, thereby strengthening resilience of the ecosystem.

Aluva Seed Farm: Components of Resilience

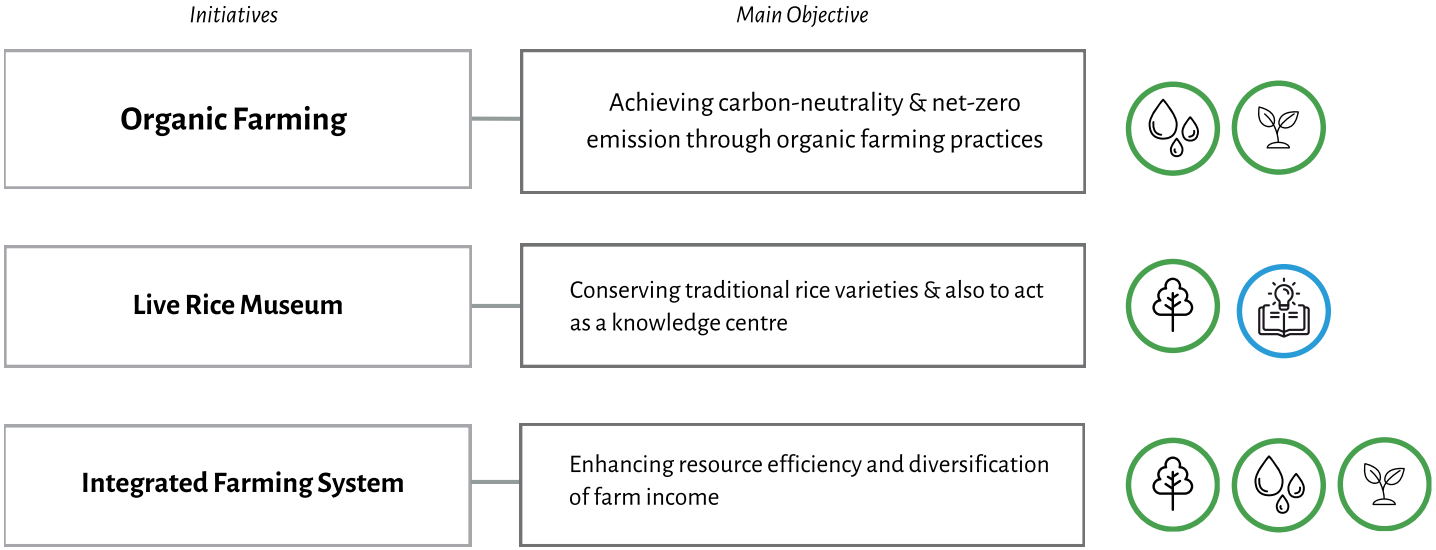


Figure 20: Key initiativees by Aluva state seed farm: Components of Resilience

6.2. CRA in Alathur Panchayat by Krishi Bhavan, Palakkad

6.2.1. Overview

Alathur Panchayat, located in Palakkad district, Kerala, encompasses a rich agricultural landscape, located within the Gayathri river basin. The local economy predominantly relies on agriculture and allied sectors. Spanning ~1,500 hectares, it supports diverse crops, including 629 hectares of paddy fields (early and late varieties), 475 hectares of mixed crops, and 37.8 hectares of mixed trees. Additionally, rubber (99 hectares), teak (9.2 hectares), and cashew (1.34 hectares) are cultivated.

To address the chllenges of climate change challenges, the Panchayat implemented a CRA model under the Alathur Krishi Bhavan, led by an Agricultural Officer. This unique initiative integrates existing central and state government schemes, funding mechanisms, and departmental efforts to achieve climate resilience. Currently, 1,500 farmers actively participate in the CRA project. This case study showcases the role of government institutions in fostering climate resilience by leveraging available resources and collaborating with multiple departments and agencies, including the Irrigation Department, Kudumbashree, Self-Help Groups (SHGs), and farmer collectives like Padasekhara Samithis. These forms of institutional involvement and inter-departmental collaboration are central to the CREEA approach.

The Krishibhavan in Alathur has implemented numerous projects. Key initiatives are categorised under the CREEA management approach as components of resilience (see Figure 21). In terms of the CREEA management categories they fall under, the significant overlaps between initiatives highlight their interconnected nature.

6.2.2. Components of Resilience

Ecosystem Health

Several initiatives in Alathur Panchayat enhance soil health, conserve water resources, and promote biodiversity. Since 2017-18, integrated organic farming has brought **17.78%** of agricultural land under organic cultivation, engaging **250 farmers.** Regular soil testing

is conducted, and nutrient management plans are developed based on the results. Practices such as incorporating straw, legume crops, and green manure into the soil effectively address nutrient deficiencies and improve overall soil health.

The *Jalasamrithi* initiative aims to recreate watershed development models and implement them with farmer participation to enable the conservation and efficient use of water. Alathur Krishi Bhavan has played a key role in rehabilitating irrigation infrastructure. Surveys were conducted to restore the Command Area Development Authority (CADA) canals and other adjacent canals. A total of Rs.29.23 crore was sanctioned under NABARD's RIDF XXVI scheme for the rehabilitation of irrigation canals and outfalls within the Panchayat, directly benefiting approximately 500 acres of paddy cultivation. To ensure the efficient management of water resources, Alathur Krishi Bhavan facilitated the formation of 14 Water Users' Associations (WUAs), involving 1,503 paddy farmers cultivating 650 hectares. These associations focus on preparing crop calendars, ensuring equitable water distribution, water conservation awareness, scientific irrigation planning, and irrigation infrastructure maintenance. For an irrigation project, a WUA must be formed by farmers cultivating a minimum of 40 hectares of land in one or more canal reaches of the project. Each WUA is structured with an 11-member executive committee, with one-third of its members representing the head, middle, and tail reaches of the canal. The Chief Engineer of the Irrigation Department is responsible for registering each WUA and issuing a certificate of registration, ensuring participatory water governance and sustainable agricultural practices in the region.

To combat waste management challenges, which severely impact water and soil health, the Alathur Panchayat operates its solid waste management plant at Kattushseri Vavveli. At this facility, waste is segregated and processed into organic compost, which is then distributed to farmers for Rs.8 per kilogram. Complementing these waste reduction efforts, non-biodegradable waste, such as plastic products, is also segregated and processed using a plastic shredding machine at the plant.

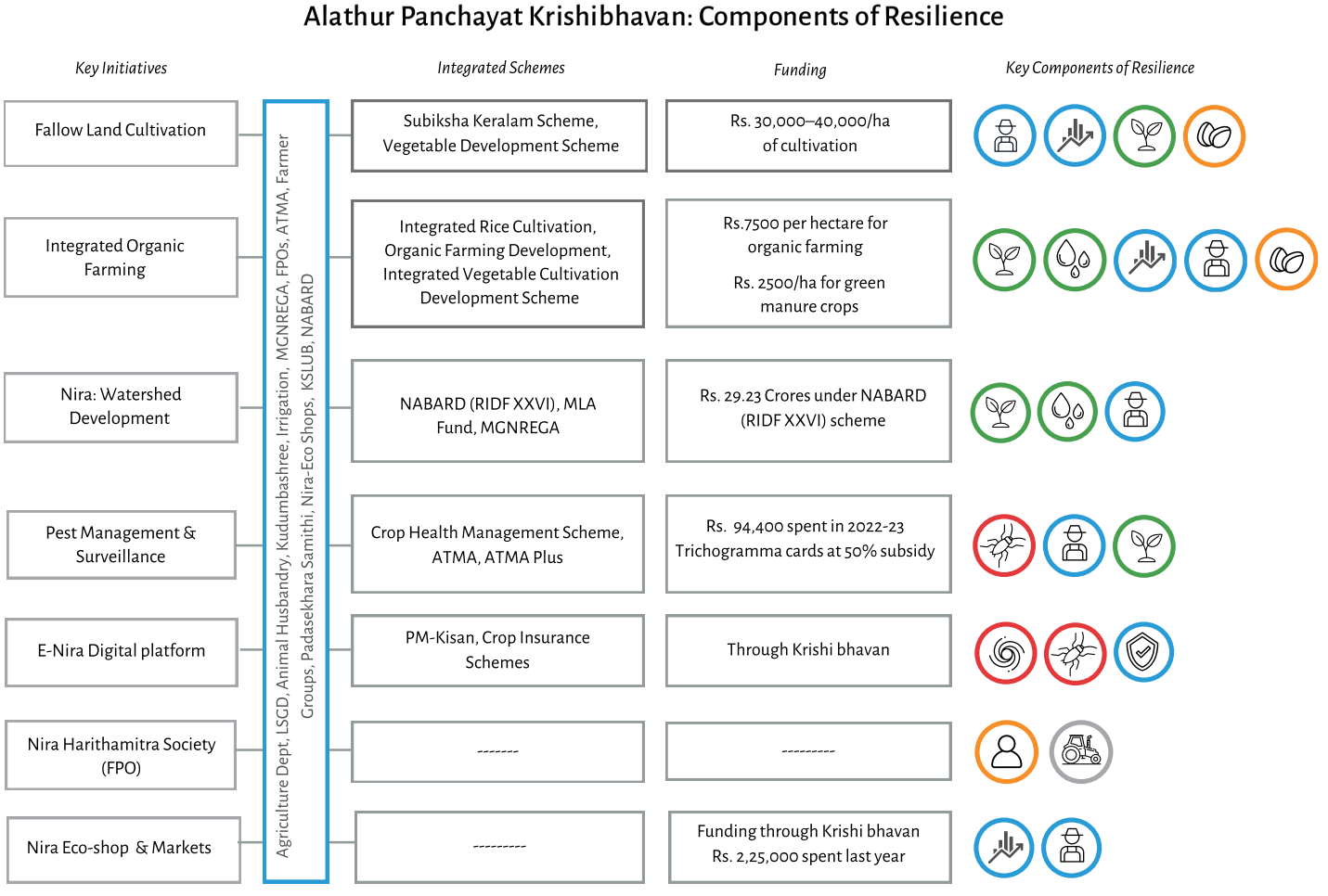
Building on its commitment to environmental sustainability and ecosystem health, the Panchayat undertook a Net-Zero Carbon Panchayat study in 2022-23, funded through its own resources. The study identified and mapped areas of carbon sequestration and emissions, providing key recommendations on emission control strategies and sector-specific interventions, including those for agriculture. These recommendations are being actively implemented, with ongoing efforts to achieve net-zero carbon status.

Image 22: Organic paddy cultivation in Alathur Panchayat, Palakkad, Kerala. (Credit: Ambareesh S)

Image 23: Eco-shop selling organic produce in Alathur Panchayat, Palakkad, Kerala (Credit: Ambareesh S)

Image 24: Plant Health Clinic at Krishi Bhavan, Alathur Panchayat, Palakkad, Kerala (Credit: Krishi Bhawan Alathur)

Image 25: Rehabilitated irrigation canals in Alathur Panchayat, Palakkad, Kerala. (Credit: Ambareesh S)



The grey circles represent conventional machinery that rely on traditional energy sources.

Figure 21: Key initiaties by Alathur Krishibhavan: Components of Resilience

Energy Efficiency & Resource Management

Inputs such as seeds, seedlings, bio-pesticides, and grow bags are provided under various schemes to support farmers. For example, under the *Rice Development Project*, 42,958 kg of rice seeds worth Rs.4,41,550 were distributed to 1,500 farmers in 2022-23 at a subsidised rate. Additionally, 3,000 kg of Daincha legume seeds, priced at Rs.70 per kg, were supplied with a Rs.10,500 subsidy to improve soil health. Under the *Vegetable Development Scheme* and *Tharishu Rahitha Alathur Scheme,* farmers receive subsidies on seeds, seedlings, grow bags, and planting materials for tuber crops.

The Nira Harithamitra Society, an FPO, integrates agricultural services and schemes to support farmers. To address labour shortages, Harithamitra society initiatives include *Koythinoru Kaythange*, which provides harvesting machines, and *Nira Sena,* a team of scientifically trained women who undertake planting operations. With support from the Agriculture Department and KSEB, 300 agricultural pump sets were provided to farmers. Of these, 50 have already been converted to solar powered systems under the PM-KUSUM programme, facilitated by ANERT. The remaining pump sets will be transitioned to solar in phases, depending on the availability of fund.

Extreme Event Management

The Plant Health Clinic at Krishi Bhavan, Alathur, serves as a vital hub for delivering demand-driven, community-based advisory services to farmers. Under the *Crop Health Management Scheme* of the Department of Agriculture, pest surveillance units are established in farmers' fields for five major crops—paddy, coconut, banana, vegetables, and pepper. These units regularly collect field data to monitor plant health. Based on this data gathered through fixed plots and rapid roving surveys, pest forecasts and advisories are issued biweekly, providing farmers with timely management strategies. These advisories are widely disseminated through local newspapers. These advisories are compiled monthly into a Pest News Bulletin, NIRA, which provides farmers with need based pest and disease management strategies. Pest News Bulletin updates are also disseminated through social media platforms, including *Padasekhara Samithi* groups, *Nira Harithamitra* Sub-Committee groups, and other social media groups.

In addition to surveillance and advisory services, the clinic also offers hands-on support to farmers through diagnostic services, training programmes, and eco-friendly pest

management initiatives. Farmers can bring affected plant samples to the clinic, where diagnostic tools help identify the root causes of crop issues. A dedicated museum houses specimens of pests and diseases, along with an insect zoo that provides a learning platform for farmers to observe pest life cycles, particularly those of new or emerging pests. The clinic maintains a knowledge bank, an online and offline resource for crop cultivation, pest identification, and management practices. It also promotes sustainable farming by training farmers in bio-control methods, such as using Pseudomonas, Trichoderma, Azospirillum, and Trichocards. Bio-pesticide control methods, such as Trichoderma and Trichogramma cards, are produced by a Kudumbashree unit in partnership with Biological control Division of KAU. These cards are made available to farmers at a 50% subsidy.

Bio-intensive pest management practices have been implemented across 150 hectares in various *padasekharams*, significantly reducing reliance on chemical pesticides.

Institutional Management

Alathur Panchayat has implemented several initiatives to create **new livelihood opportunities.** The Trichocard production unit, established in 2019-20, is operated by a Kudumbashree group with technical support from KAU's Biological Control division. Additionally, under the *Subiksha Keralam Scheme*, 25 acres of fallow land were identified and utilised for vegetable cultivation, creating new avenues for income generation. Beyond farming, this initiative generates employment opportunities by engaging Agro Service Centers, Kudumbashree groups, and *Karmasena* in tasks such as preparing grow bags and producing planting materials for tuber crops. Additionally, initiatives by the Harithakarma Society, such as *Koythinoru Kaythange* and *Karmasena*, further expand employment avenues for the local community. This initiative not only promotes sustainable agricultural practices but also provides new income opportunities for women from marginalised communities.

Farmers can apply for schemes such as **royalty benefits, crop insurance, natural disaster claims,** and the central government's PM-KISAN scheme through the E-Nira platform, implemented as part of a comprehensive agricultural development initiative. The establishment of Nira stores and Eco Shops and village markets, in collaboration with organic farmers, provides direct **market access** and ensures fair pricing for organic products such as rice, vegetables, and dairy. On an average, these eco-shops procure 150–

200 kilograms of fruits and vegetables from farmers per day, thereby supporting local agricultural livelihood. Krishi Bhavan also plays a key role in building **awareness and capacity** through extension programmes, including internship programmes, awareness programmes, farm field schools, and a seed festival featuring over 100 varieties of native rice and vegetables. These initiatives promote organic farming, pesticide-free production, water conservation, and the preservation of native seed varieties.

A core component of CREEA is the **integration** of departments and agencies. Most initiatives in Alathur are implemented through interdepartmental convergence, involving the Agriculture Department alongside the Irrigation Department, Animal Husbandry, LSGD, ATMA, KAU, NABARD, and other relevant agencies.

6.3. CRA in Thirunelly Panchayat by TAPCo, Wayanad

6.3.1. Overview

TAPCo, the Thirunelly Agri Producer Company Ltd., is a Farmer Producer Organisation (FPO) based in Thirunelly Panchayat, Wayanad. Registered in 2017 with support from NABARD, TAPCo was founded to address critical issues such as the shrinking paddy land ecosystem, the loss of traditional rice varieties, and the deterioration of soil and groundwater health in Wayanad. TAPCo focuses on collectivising farmers to cultivate organic rice varieties indigenous to Wayanad, aiming to expand the area dedicated to organic farming. Starting with ten farmers who collectivised in 2017, TAPCo now collaborates with 83 farmers, collectively managing approximately 193 acres of paddy land. The organisation produces nine rice varieties including *Njavara, Gandhakashala, Wayanadan Thondi, Valiachennellu, Mullankaima, and Paal Thondi,* each with distinct properties suited for different culinary preparations.

The FPO supports farmers throughout the entire value chain, from seed supply to market access, addressing uncertainties at every stage of the food value chain. Currently, it assists over 300 farmers by providing high-quality seeds and inputs while ensuring that certified organic produce from 100 of these farmers reaches the market. TAPCo operates with core values and a motto centred on ecological sustainability, economic viability, and social justice.

Image 26: Student field visit to TAPCo at Thrissilery Village , Wayanad, Kerala. (Credits: Ambareesh S)

Image 27:Training in organic cultivation practices organised by TAPCo for the Tribal women SHGs under the Kudumbashree in Thirunelly Panchayath, Wayanad (Credits: TAPCo).

Image 28: Traditional paddy varieties cultivated at the Rice Diversity Block maintained by Mr Johnson, Chairman, TAPCO at the Thrissilery Village, Wayanad, Kerala. (Credits: Ambareesh S)

Image 29: Organic paddy processing unit of TAPCo at Thrissilery village, Wayanad, Kerala (Credits: TAPCo).

6.3.1. Components of Resilience

Ecosystem Health

TAPCo employs organic farming practices that eliminate chemical inputs, safeguarding soil and water health while supporting the diversity of life dependent on these resources. The organisation conducts regular soil testing and provides seasonal soil nutrient analysis for all member farmers, offering advisories to improve soil health. By cultivating traditional and indigenous rice varieties, TAPCo contributes to seed sovereignty and plays a vital role in conserving the local gene pool. Maintaining a local gene pool is considered one of the best insurance systems for farmers, as these varieties reflect the local climate and topography. They also exhibit valuable traits such as pest resistance and tolerance to drought and flooding, making them resilient to extreme weather events that are increasingly frequent due to climate change.

Extreme Events Management

Climate change is characterised by erratic and unpredictable weather events, making hyper-local weather forecasting crucial for farmers to effectively plan their crop cycles. In Wayanad, a pilot action research project has been initiated in collaboration with the Hume Centre for Ecology and Wildlife Biology and Cochin University of Science and Technology (CUSAT). These initiatives involve collecting meteorological data on rainfall and temperature from satellite imagery to develop a forecasting model tailored specifically for the Wayanad district, covering a 5 km x 5 km grid. The model generates short-term (1-3 days), mid-term (7-10 days) and long-term forecasts. As part of this initiative, farmers across the district have been equipped with rain gauges and thermometers, allowing them to collect daily data on temperature fluctuations and rainfall occurrences. This data is integrated into the forecasting model developed by Hume, enhancing its accuracy. Based on these forecasts, TAPCo provides crop management advisories to its member farmers. This information enables the organisation to deliver weather-based organic farming guidance to over 5,000 farmers in the district. The mid-term forecasts assist farmers in preparing and planning their activities, such as determining the optimal days for adding liquid manure or tilling the soil. In contrast, the short-term forecasts, also known as nowcasts, help farmers decide on farm activities for the current day or the following day.

TAPCo Farmer Producer Organisation: Components of Resilience

Initiatives	*Agencies/Departments involved*	*Key Components of Resilience*
Hyper-Local weather forecast	Humes, Cochin University of Science and Technology, TAPCo	
Organic Farming Practices	TAPCo, Department of Agriculture	
Pest & Disease Surveillance Systems	TAPCo, Agricultural Research Institutions	
Karshaka Vijnana Vibhava Kendram (KVVK)	TAPCo, Local Farmers, Agricultural Universitie Students	
Farming Calendar	TAPCo, Farmers	

Figure 22: Key initiatives by TAPCo Farmer Producer Organisation: Components of Resilience

In addition to forecast advisories, an annual lunar-based farm calendar, drawing on traditional knowledge, has been developed to support crop management and planning of crop cycles. The calendar that TAPCo publishes every year has a column that highlights extreme weather events historically reported in each month (e.g. heat wave in the month of April) and suggests corresponding adaptation strategies. The calendar also acts as an action research tool where farmers are encouraged to put down their farm activities, observations on weather and the crop status of their field. Each year, these insights are used to update the calendar, incorporating revisions and more refined adaptive strategies for the upcoming year.

For pest attacks and management, TAPCo has established an extension system that continuously monitors the pest-weed-disease complex and provides timely alerts to farmers. This system operates with the active involvement of farmers who regularly engage with the extension team and agriculture research institutions in the district in sending alerts, identifying pests and diseases and in finding appropriate remedies.

Energy & Resource Management

TAPCo provides access to traditional paddy seed varieties for the upcoming season. These local seeds are valued for their nutritional and medicinal properties, require fewer resources, and exhibit climate-resilient properties.

The first year of support involves close monitoring by the field officer, who guides farmers through several key practices. This includes assessing soil nutrient levels to inform management decisions, revitalizing soil with green manure, and implementing effective seeding techniques. Farmers are also educated on preparing and applying organic manure at various growth stages and utilising organic pesticides and practices to combat pest attacks. Additionally, the field officer recommends rotating paddy crops with legumes at the end of the season for soil rejuvenation. Finally, they assist farmers in navigating the Participatory Guarantee System (PGS) for organic certification when they are ready. This structured approach ensures comprehensive support throughout the transition to sustainable farming practices.

Institutional Management

TAPCo supports farmers throughout the supply chain, with an assured market and fair price for their commitment. TAPCo procures paddy at the farm gate, offering immediate

payment via cheque at prices significantly higher than both the state Minimum Support Price (MSP) and local market rates. These prices are determined by calculating the cost of cultivation and expected yield for each variety for the season. This relieves a farmer of concerns regarding storage, transportation, and the returns on their crop. TAPCo has established a model in which farmers who are registered with the FPO will have their entire produce procured by the collective at a price decided before sowing. This gives farmers the power to decide what to sow, a choice they are deprived of under the government's single-price procurement system.

The organisation also focuses on research and capacity building. TAPCo has opened a Farmer Knowledge and Resource Centre (KVVK) in Kattikulam town, the administrative headquarters of Thirunelly Panchayat. This centre consolidates all research and extension activities undertaken by the FPO under one roof, functioning as a farmer-led participatory research unit. It serves as a hub where farmers and other interested individuals can access information on organic farming practices, traditional seeds, and CRA strategies. Additionally, KVVK offers opportunities for students of agriculture and allied disciplines to participate in internships, gaining hands-on experience and contributing to CRA initiatives (see Figure 22).

Conclusion

These three case studies offer crucial insights into the journey toward CRA, highlighting diverse approaches that operate across different scales and involve various stakeholders and agencies in distinct ways. The Aluva Seed Farm demonstrates how a state-owned seed farm can transition to a carbon-neutral model while serving as a knowledge hub for rice varieties, inspiring other state-run seed farms to adopt similar sustainable practices. The Alathur Model illustrates how a Panchayat-level initiative, under the committed leadership of the Krishibhavan, can leverage funding, integrate multiple departments and schemes, and strengthen institutional management to build climate resilience, exemplifying the core principles of the CREEA approach. Additionally, the TAPCo model emphasises the importance of collectivising farmers and integrating traditional and scientific knowledge, while underscoring the need for robust extension support systems to address uncertainties related to weather and marketing. We believe that many more such initiatives are being undertaken by both farmers and government bodies in the state, and documenting them will not only enhance our understanding but also highlight the importance of diverse, locally specific approaches to building climate resilience.

7. Flagship Ideas for Transition towards CREEA in Kerala

Focus Theme A: **Integration & Convergence Planning (ICP)**

Focus Theme B: **Risk & Emergency Planning**

Focus Theme C: **Climate Resilient Farming System**

Focus Theme D: **Net Zero Agriculture & Energy Efficiency**

Focus Theme E: **Capacity Building - Knowledge & Skills**

Introduction

Drawing on ideas and insights generated from the district level workshops and the case studies of climate-resilient & energy-efficient agricultural practices in the state, we have arrived at broad frameworks for implementable flagship project ideas. The project ideas are organised under five key themes (i) Integration and Convergence Planning, (ii) Risk & Emergency Planning, (iii) Climate Resilient Farming Systems, (iv) Net Zero Agriculture and Energy Efficiency and (v) Capacity Building - Knowledge and Skills (see Figure 23).

These projects can be custom tailored to particular agro-ecological circumstances, institutional and funding requirements, crop characteristics and farm community needs. They can be undertaken either through the Agriculture department or through interdepartmental collaborations including the State IT Mission and other Special Purpose Vehicles or through public, private and civil society instituions/partnerships. The operationalisation of CREEA flagship projects will establish working models for climate resilience that can be adopted throughout the state and the country, and adapted to local challenges, needs, available funding, and institutional support.

Focus Theme A
Integration & Convergence Planning (ICP)

Idea 1	Resilient Agriculture and Climate Risk Tracker (RACRT) and Early Warning System

Objective

To build an integrated real-time, web-based decision support system for Climate Resilience and Energy Efficiency in Agriculture (CREEA) Kerala. The tracker will provide timely insights to LSGIs, policymakers, farmers, administrators, and other stakeholders by integrating climate data, farm-level data, schemes, information on extreme weather events, and institutional interventions to enable transparent and participative decision-making.

Pathways for a Transition towards CREEA

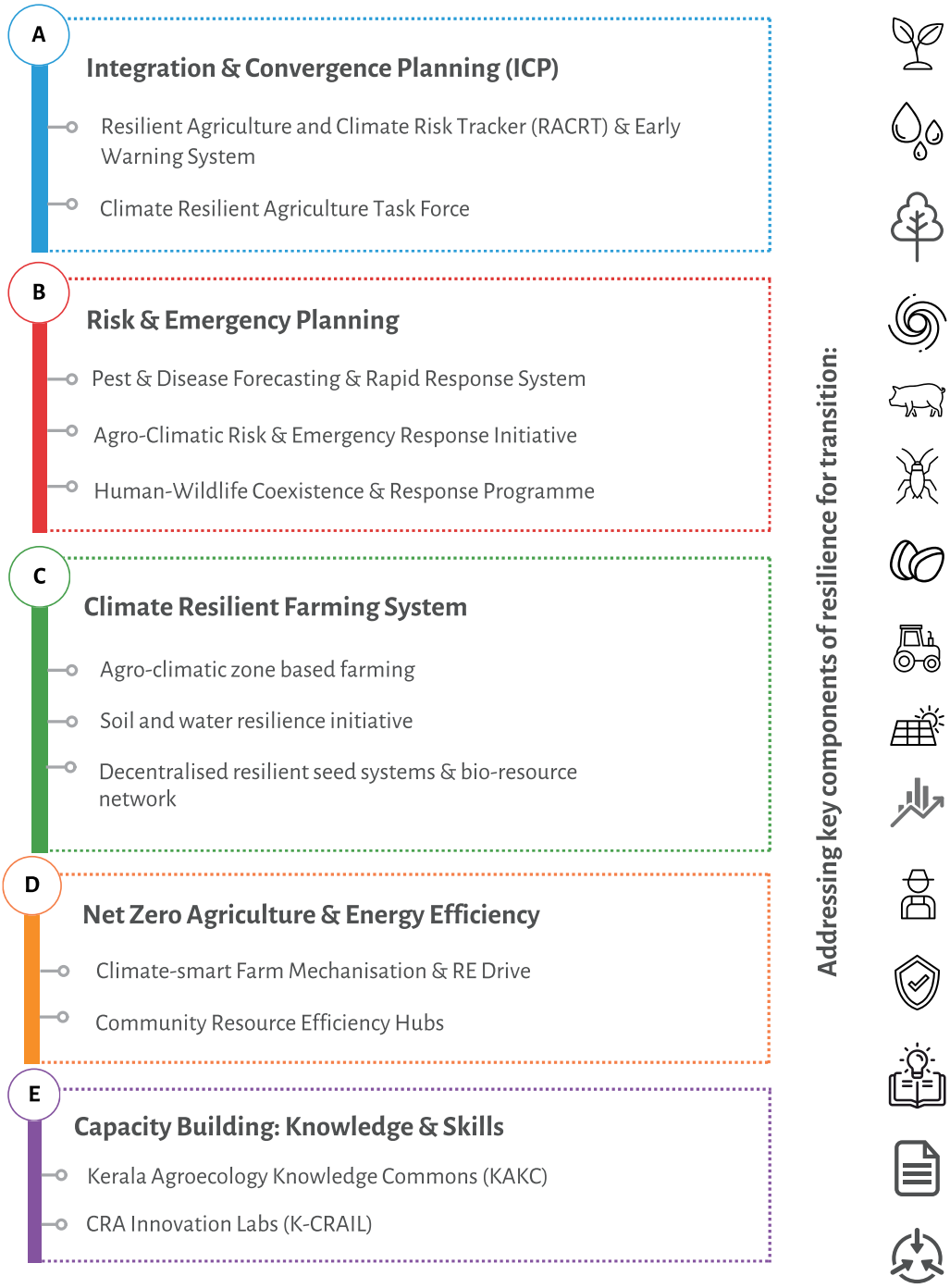


Figure 23: Pathways for a Transition

Short Description

This digital platform can be an open-source platform for tracking various indicators pertinent to CREEA. It will function as a comprehensive dashboard, collating multi-departmental and multi-scale data from farm to state levels. Key data points will include weather indicators, water and energy use, soil health, land use, productivity, pest and disease occurrences, as well as disaster risks and vulnerabilities. The dashboard will integrate both static and dynamic data and enable tracking, visualisation, and analysis, to support planning and real-time decision-making. Additionally, it will collate information on relevant schemes, programmes, and projects, enabling progress tracking and impact assessment. While the dashboard will collate information from various sources, it will also allow farmers and agricultural officers to input real-time data for informed and timely decision-making.

Convergence of Departments/Agencies Suggested

The RACRT platform will require cross-sectoral collaboration involving Agriculture and Farmers' Welfare Department, Fisheries Department, Animal Husbandry Department, Dairy Department, Department of Irrigation, LSGIs, Kerala State Planning Board, Kerala Agricultural University (KAU), KSDMA, IMD, Land Use Board, Water Resources, Forest and Wildlife, KVKs, KSUM, IT Department, KSEB, ANERT, EMC, NABARD.

Actionable Points

1. Development of a web and mobile application for the dashboard
2. Multi-scale data collection and integration
3. Deployment and adoption by registered stakeholders
4. Integration with insurance and loss and damages relief
5. Capacity building for LSGIs, and other institutional stakeholders for utilising the tracker for better decision-making
6. Ensure effective utilisation of the dashboard and tracker

Expected Outcomes

1. Real-time, data-driven decision making
2. Multi-stakeholder tracker system strengthens institutional convergence and governance
3. Bottom-up early warning and risk preparedness system to addresses last-mile gaps
4. Tracking key parameters such as soil health, water, and resource use
5. Data-driven planning enables efficient resource management

Idea 2 Climate Resilient Agriculture Convergence Task Force

Objective

To establish a multi-tiered governance mechanism that fosters convergence and integrates all related departments, schemes and stakeholders to build climate resilience and energy efficiency into agriculture planning and implementation at all levels of governance - panchayats, block and district as well as the state level.

Short Description

In order to incorporate climate resilience and energy efficiency into agricultural planning and implementation at the panchayat, block, district, and state levels, a Climate Resilient Agriculture Convergence Task Force may be established that would aim to create a multi-tiered governance mechanism brining together all relevant departments, schemes, and stakeholders at all levels.

In order to provide a coordinated response to climate issues, this Task Force will converge policy, funding, and technical expertise across agriculture, water management, renewable energy, biodiversity protection, disaster risk reduction, and rural development. The Task Force will guarantee the effective implementation of climate adaptation and mitigation policies, promote cross-sectoral collaboration, and bolster institutional capacities.

The Task Force will contribute to reducing vulnerabilities, improving energy efficiency, conserving water and soil, and developing a climate-resilient food system by integrating scientific knowledge, farmer experiences, local/state/central level resources and policy frameworks. The Task Force will serve as a nodal mechanism to monitor and mainstream climate-resilient agriculture practices across Kerala.

Convergence of Departments/Agencies Suggested

Agriculture and Farmers' Welfare Department, Fisheries Department, Animal Husbandry Department, Dairy Department, Irrigation Department, LSGIs, Kerala State Planning Board, KAU, KSDMA, IMD, Land Use Board, Water Resources, Forest and Wildlife, KVKs, KSUM & IT Department, KSEBL, ANERT, EMC, NABARD.

Actionable Points

1. Establish Climate Resilient Agriculture Task Forces at state, district, and block levels
2. Develop district-level climate resilience action plans
3. Integrate climate resilience into agriculture planning
4. Integrate climate-resilient agriculture guidelines in all Panchayat Development Plans (PDPs).
    - Ensure crop diversification, water-efficient irrigation, and soil conservation are included in agriculture extension programmes
    - Promote renewable energy-based mechanisation in state agriculture policy.
    - Strengthen farmer advisory service and establish knowledge networks
5. Promote climate-resilient agriculture practices
6. Scale up renewable energy in agriculture
7. Ensure climate finance and incentives
8. Develop Climate Risk Management and Early Warning Systems

Expected Outcomes

1. Climate resilience integrated into agricultural governance
2. Disaster preparedness and reduced climate risks.
3. Better adoption of renewable energy in agriculture
4. Better water and soil conservation practices
5. Lower farm input costs and higher farmer incomes
6. Farmer-led innovations in climate adaptation adopted
7. Increased access to climate finance and insurance
8. Improved departmental and stakeholder convergence
9. Resilient food systems and sustainable biodiversity conservation
10. A model for climate-resilient agriculture governance

Focus Theme B

Risk & Emergency Planning

Idea 1	Pest and Disease Forecasting & Rapid Response System

Objective

To establish a real-time pest and disease surveillance, forecasting, and rapid response system for crops at the Krishi Bhavan (panchayat) level, ensuring proactive management of such outbreaks. This initiative will set up community and technology-driven scouting, Rapid Response Teams, early warning advisory mechanisms to avoid/ minimise crop losses, insurance and compensation mechanisms, and crop-recovery packages to support recovery.

Short Description

Climate change-driven shifts in pest and disease patterns pose a growing threat to crop cultivation and animal husbandry, requiring real-time surveillance and rapid response. Using crop stages, pest life cycles, beneficial species, and weather patterns, the Krishi Bhavan (Panchayat) level Pest and Disease Forecasting and Rapid Response System combines farmer-led scouting, pest monitoring stations, expert advisory systems, and digital tools to predict outbreaks.

Agroecological interventions will be used to monitor, forecast, and manage epidemics using Rapid Response Teams (RRTs), comprising master farmers, farmer collectives (FPOs, SHGs), trained community resource persons, and agricultural experts. A parallel system will address livestock diseases in cattle and poultry. Since both streams would engage with more or less the same set of farmers within a given panchayat, a convergence at the panchayat level is desirable.

Centralising pest and disease data, predictions, and remedies in a computerised database will improve decision-making and reduce the reliance on pesticides. Advisories and surveillance will be made possible by digital applications. The system will strengthen insurance, compensation, and recovery, ensuring timely relief for farmers.

Convergence of Departments/Agencies Suggested

Agriculture and Farmers' Welfare Department, Fisheries Department, Animal Husbandry Department, Agricultural Technology Management Agency (ATMA), LSGIs, KAU through RARS, Kerala Veterinary and Animal Sciences University (KVASU), Federation of Milk Societies, India Meteorological Department (IMD), FPOs, KVKs, NABARD.

Actionable Points

1. Establishment of pest monitoring field stations at the community level across the state
2. Development of a web and mobile application for the pest and disease dashboard.

3. Creation of agro-climatic zone-based research mechanism for pest disease management using this surveillance and forecast mechanism
4. Deployment and adoption of rapid response teams at LSGI levels by stakeholders
5. Integration with crop and livestock insurance and loss and damages relief
6. Capacity building for LSGIs, and other institutional stakeholders for utilising the surveillance and forecasting for better decision making

Expected Outcomes

1. Effective localised pest and disease management mechanism thus removing uncertainties and risks for the farmers
2. Efficient and accessible assessment and compensation mechanisms
3. A scalable and replicable surveillance and response model applicable across different crops and regions
4. Reduction in the use of synthetic pesticides in the state

Idea 2 Agro-Climatic Risk and Emergency Response Initiative

Objective

To enhance Kerala's agricultural resilience to climate events by integrating a state-wide digital weather grid with hyper-local (at least 5 kmx5km) weather information for local-level climate-informed crop and farm planning, risk reduction strategies, and disaster response mechanisms. This initiative will strengthen flood, drought and landslide preparedness, supported by ward-level emergency response teams, insurance and compensation mechanisms and post-disaster crop recovery packages to restore farms and livelihoods after a disaster event.

Short Description

One of the most important requirements for climate resilience in agriculture is the hyper-local weather intelligence to support farm-level planning, risk reduction, and

disaster preparedness. The Agro-Climatic Risk and Emergency Response Initiative will integrate a State-Wide Digital Weather Grid, with a resolution of at least 5km x 5km, to provide real-time, short-term (24-hour), medium-term (7-day), and long-term (up to 3 months) weather forecasts. This will help the farmer plan their activities effectively and ensure a reduction in crop losses due to soil erosion, labour inefficiency, and material wastage caused by intense rain or lack of timely rain in the business-as-usual scenario.

Deployment of digital weather gauges with the help of farmers to create a network along with satellite information from weather radars can help in creating accurate weather forecasts at the hyper-local level possible. The dissemination of these forecasts could be through the apps run by the Agriculture department like KATHIR and also be enhanced through the WhatsApp groups at the LSGI level or through farmer collectives. Additionally, Ward-level Emergency Response Teams (WERTs) may be formed to prepare for and respond to floods, droughts, and landslides, ensuring seamless coordination with disaster management authorities, insurance and compensation mechanisms, and post-disaster crop recovery programmes. These forecasts can also become warning systems for disaster management functionaries at various levels.

Convergence of Departments/Agencies Suggested

Department of Agriculture and Farmers' Welfare, Fisheries Department, Animal Husbandry Department, LSGIs, KAU, KSDMA, IMD, FPOs, KVKs, NABARD & financial institutions, Climatology Department, Kerala Startup Mission, International Centre for Free and Open Source Software (ICFOSS), Hume Centre for Ecology, EQUINOCT, CUSAT.

Actionable Points

1. Establishment of a network of local weather stations across the state
2. Setting up a district-level hub that coordinates with various institutions to create hyper local weather models
3. Develop AI-driven hyperlocal weather models integrating real-time sensor data and satellite imagery
4. Expand dissemination of forecasts through KATHIR, LSGI networks, WhatsApp groups, and farmer collectives

5. Capacity building for LSGIs, farmers and other institutional stakeholders to utilise weather intelligence for decision making
6. Integrate weather forecasting with crop insurance and loss compensation mechanisms
7. Deploy Ward-level Emergency Response Teams (WERTs) for disaster preparedness and post-disaster response
8. Strengthen climate resilience in fisheries and animal husbandry through targeted weather advisories

Expected Outcomes

1. Enhanced farm-level climate resilience.
2. Reduced crop losses and input wastage
3. Improved disaster preparedness and response
4. Seamless integration of climate risk management
5. More effective crop insurance and compensation
6. Strengthened community-led climate action via Ward-level Emergency Response Teams (WERTs).
7. A scalable, data-driven model for climate-smart agriculture governance in Kerala.

Idea 3	Human-Wildlife Coexistence & Response Programme

Objective

To develop a community-driven response framework for addressing human-wildlife conflicts in vulnerable agricultural areas while ensuring coexistence alongside crop and farmer security. This programme will integrate early warning systems, wildlife conflict response teams, crop and farm protection measures, insurance and compensation mechanisms, and crop recovery packages to help affected farmers in recovery.

Short Description

Human-wildlife conflicts are worsening as a result of habitat fragmentation, changing land-use patterns, and climatic uncertainty, putting farmers' lives, property, and livelihoods, as well as food security and biodiversity conservation, at risk. The Human-Wildlife Coexistence & Response Programme aims to develop a science-based, community-driven response framework to lessen conflicts and foster harmony between wildlife and human settlements.

The effort will include farm protection measures, wildlife conflict Rapid Response Teams (RRTs), real-time early warning systems, insurance and compensation schemes, and other interventions to limit losses and ensure farmer security. Ecological remedies, modern deterrent technologies, and traditional wisdom will be combined to minimise agricultural damage, prevent human casualties, and support farm recovery. The initiative will strengthen local governance institutions, train communities, and establish a fast response network to ensure timely and effective action. Through a convergence approach, this programme will balance conservation priorities with farmer protection, ensuring sustainable human-wildlife coexistence in vulnerable agricultural regions.

Convergence of Departments/Agencies Suggested

Forest & Wildlife Department, Department of Agriculture & Farmers' Welfare, Animal Husbandry Department, LSGIs, KFRI, KVASU, KSBB, KSDMA, NABARD, financial institutions & insurance agencies, FPOs, SHGs, NGOs, conservation groups, community based organisations.

Actionable Points

1. Establish community-based wildlife conflict Rapid Response Teams (RRTs) for real-time interventions.
2. Develop and deploy early warning systems using drones, AI and sensor-based technologies, camera traps, and community monitoring.
3. Implement crop and farm protection measures such as trenches, bio-fencing, sound-based deterrents, and community-led guarding systems.
4. Strengthen effective compensation and insurance mechanisms for crop and livestock damage caused by wildlife.

5. Integrate agroecological solutions like wildlife-friendly farming practices to reduce conflict risks.
6. Train farmers and local communities on wildlife conflict preparedness and prevention, safe response strategies, and alternative cropping patterns.
7. Enhance coordination between departments through district-level coordination cells for quick action.
8. Establish a digital wildlife conflict database to track patterns, help in planning, and guide interventions.
9. Promote community-led habitat restoration and corridor management to reduce wildlife intrusion into farms.
10. Engage local governance and policy mechanisms to institutionalise sustainable coexistence strategies.

Expected Outcomes

1. Reduction in human-wildlife conflicts
2. Improved farmer security and livelihood protection
3. Sustainable coexistence between agriculture and wildlife
4. Enhanced community participation in conflict management
5. Minimised crop and livestock losses
6. Increased use of non-lethal conflict mitigation measures
7. Stronger institutional coordination and policy integration
8. Data-driven decision making
9. Ecological balance and wildlife conservation
10. A scalable and replicable model for human-wildlife coexistence

Focus Theme C

Climate Resilient Farming System

Idea 1	Agro-climatic Zone Based Farming

Objective

To further the agro-climatic zone based farming system being implemented in Kerala, by making it climate-responsive and adopting agroecological farming systems. This includes crop planning, land use, and climate adaptive farming practices, integrating homestead agroforestry, food forests and nutrition gardens and ensuring a dynamic annual agro-climate-responsive crop calendar that makes farming resilient.

Short Description

Kerala has 13 Agro-climatic zones and 20 Agro-climatic management zones with different soil, climatic profile and evolving cropping systems due to markets and climatic changes. Kerala's coastal and highland regions have become more vulnerable threatening agricultural stability and farmer livelihoods. To increase resilience and maintain productivity, a well- planned, climate-responsive strategy is necessary.

The Agro-Climatic Zone-Based Farming initiative aims to strengthen Kerala's existing agro-climatic farming system by integrating climate-adaptive, agroecological practices. This comprises homestead agroforestry, soil conservation, sustainable water management, and multi-cropping techniques, all of which have a great deal of unrealised potential, especially in the midlands. A dynamic annual agro-climate-responsive crop calendar can be developed to guide crop planning, land use, and risk mitigation, ensuring sustainable productivity, economic viability, and ecological balance. The initiative will support the branding and marketing of climate-resilient products such as pokkali rice, organic spices, carbon-neutral coffee, and low-input homestead produce, fostering a robust and sustainable agricultural economy across Kerala.

Convergence of Departments/Agencies Suggested

Department of Agriculture and Farmers' Welfare, Coconut Development Board, Indian Institute of Spices Research, CTCRI, Medicinal Plants Board, Arecanut and Cocoa Development Board, Kerala State Biodiversity Board (KSBB), Coffee Board, State Horticulture Mission, State Land Use Board, research institutions, LSGIs, industry & market linkages.

Actionable Points

1. Map climate change induced challenges in existing cropping systems across different agro-ecological zones.
2. Conduct community-led action research to develop sustainable farming models tailored to local agro-climatic conditions.
3. Design climate-responsive crop combinations integrating soil conservation, water management, and biodiversity enhancement.
4. Develop energy-efficient infrastructure for harvesting, storage, processing, and transportation to reduce carbon footprint.
5. Promote multi-cropping and agroforestry systems for resilience against extreme weather conditions.
6. Strengthen governance and policy frameworks to support agroecological transitions at the panchayat, block, and district levels.
7. Establish regular monitoring and adaptive management mechanisms to ensure continuous refinement of farming strategies.
8. Develop market linkages for ecosystem-based products like pokkali rice, organic spices, carbon-neutral coffee, and low-input homestead produce.
9. Support farmers in landscape-level adaptation measures such as watershed restoration, soil health improvement, and agro-biodiversity conservation.
10. Integrate climate-resilient farming into agricultural schemes for sustained investment and long-term impact.

Expected Outcomes

1. Enhanced understanding and preparedness for climate vulnerabilities across agroecological zones.
2. Strengthened agricultural economy leading to increased investment opportunities and rural development.
3. Increased employment in sustainable farming and agri-enterprises, creating new livelihood opportunities.
4. Revival of traditional and healthy food systems through market-driven, sustainable food businesses.
5. Expanded scope for research and innovation in climate-adaptive farming.
6. Recognition of Kerala's agroecological farming models as replicable frameworks for climate resilience.

Idea 2	Soil and Water Resilience Initiative

Objective

Restore and maintain soil health, hydrological connectivity, and natural flow to improve the resilience of farm systems and ecosystem health.

Short Description

Over 95% of our food is produced on land, with soil and water playing crucial roles. Understanding the interconnectedness of these resources is essential for building a climate resilient agricultural system. The Soil and Water Resilience Initiative (SWRI) aims to address the critical challenges posed by climate change, land degradation, and water imbalances (floods and droughts) through i) a Total Soil Health Programme, ii) a Cover the Soil campaign programme, and iii) restoring hydrological connectivity and natural flow regimes programme. These efforts include integrated soil and water monitoring systems, block-level soil laboratories, organic soil enrichment, cover crops, green mulching, water balance studies, natural flow restoration, climate-adaptive water management, and local water governance (Water Commons) to sustain irrigation and rainfed farming systems against climate risks.

Convergence of Departments/Agencies Suggested

Department of Agriculture and Farmers' Welfare, Directorate of Animal Husbandry, Department of Soil Survey & Soil Conservation, LSGIs, Water Resources Department, Groundwater Department, KSLUB, National Bureau of Soil Survey & Land Use Planning (NBSS&LUP), NABARD.

Actionable Points

1. Identify knowledge gaps and management challenges, and research priorities of soil and water resources in a changing environment;
2. Share and promote sustainable soil and water management practices to address water scarcity and soil degradation challenges;
3. Develop tools, frameworks and schemes to guide integrated management and governance of soil and water resources; and
4. Initiate communication and partnership strategies for promoting soil health, restoring hydrological connectivity and natural flow regimes, improving water quality, and reducing soil pollution.

Expected Outcomes

1. Improved soil health and hydrological connectivity - enhance land's capacity to withstand extreme climate events such as droughts, floods and heatwaves
2. Healthy soils act as a carbon sink, contributing to Kerala's net zero carbon initiative
3. Improved natural flow regimes enhance water availability and quality
4. Increased agricultural productivity and greater resilience to climate change impacts.
5. Increased awareness and adoption of sustainable practices among stakeholders.
6. A robust network of partnerships dedicated to soil and water resilience.

Idea 3	Decentralised Resilient Seed Systems & Bio Resource Network

Objective

To establish a multi-tiered, farmer-led seed and bio-resource network to ensure seed sovereignty and organic input self-sufficiency across Kerala. It includes community seed banks at panchayat/farmer collective levels, indigenous germplasm hubs, crop diversity blocks, cluster-level bio-resource centres and block-level bio-control labs for organic input production and sustainable pest and disease management.

Short Description

By creating a multi-tiered, farmer-led network, the Decentralised Resilient Seed Systems and Bio-resource Network aims to ensure seed sovereignty and organic input self-sufficiency in Kerala. Due to a lack of timely organic alternatives, farmers currently rely on markets or government subsidies for seeds and inputs, leading to delays, increased insect and disease attacks, and a reliance on chemical fertilisers.

In order to preserve and share climate-resilient seeds, this project will create agricultural diversity blocks, community seed banks, and indigenous germplasm centres at the panchayat level. Block-level biocontrol labs and cluster-level bioresource centres will help to support pest management and the production of organic inputs. This approach will be led by farmer collectives with the support of specialists, guaranteeing sustainable, climate-adaptive, and localised agriculture. By reducing input costs and dependency, this network will enhance resilience and accelerate Kerala's agroecological transition, fostering a self-reliant and climate-resilient farming system.

Convergence of Departments/Agencies Suggested

Agriculture & Farmers' Welfare Department, Fisheries Department, Animal Husbandry Department, Soil Health and Department of Soil Conservation, Kerala State Seed Development Authority, State Seed Farms, National Bureau of Plant Genetic Resources, KAU, Seed Savers/Farmers Organisations Conserving Seeds, LSGD, KSBB, NABARD & Financial Institutions.

Actionable Points

1. Identify the current seed-related issues
2. Map the seed supply system including cost
3. Mapping of traditional seed varieties
4. Engagement with National Bureau of Plant Genetic Resources (NBPGR) to make seeds available for trials in different agroecologies
5. Establish a multi-tiered farmer-led seed network - community seed banks at the panchayat level, indigenous germplasm hubs, crop diversity blocks
6. Establish bio-resource centres for organic inputs based on local needs - cluster-level bio-resource centres, block-level biocontrol labs
7. Training and capacity building of farmers/farmers collectives
8. Fellowships for seed savers / independent seed experts willing to work with farmers
9. Seed festivals
10. Enhance seed production, exchange, and farmer access
11. Provide capacity building and technical support
12. Ensure policy and financial support
13. Strengthen market and distribution linkages
14. Establish a quality control and monitoring mechanism

Expected Outcomes

1. Reduced risk due to high quality seeds and planting materials
2. Improved knowledge of seed diversity and seed production
3. Decentralised seed and input production
4. Food and nutrition security
5. Greater self-sufficiency in organic inputs

6. Biodiversity conservation and sustainable farming
7. Better soil health
8. Timely availability of bio inputs
9. Climate adaptation and resilience
10. Lower production costs for farmers
11. Strengthened rural livelihoods

Focus Theme D

Net Zero Agriculture & Energy Efficiency

Idea 1	Climate-smart Farm Mechanisation & Renewable Energy Drive

Objective

To promote agro-climatic zone-based farm mechanisation that is inclusive of both small and marginal farmers, promoting energy-efficient and renewable energy powered machineries. This initiative will facilitate the transition of irrigation, production, storage and post-harvest processing to solar, biogas, and other renewable sources, reducing fossil fuel dependence, contributing to state and national net zero goals.

Short Description

By combining energy-efficient, renewable energy-driven mechanisation suited to various agro-climatic zones, the Climate-smart Farm Mechanisation and Renewable Energy Drive seeks to revolutionise farm operations. This programme will assist small and marginal farmers in making the shift to low-carbon, economical, and sustainable production systems by encouraging solar, biogas, and other clean energy options. The goal is to gradually transition all major farming operations—such as irrigation, tillage, harvesting, storage, and post-harvest processing—away from reliance on fossil fuels, and lower input costs, increase farm productivity, and support state and federal net-zero targets. Cluster-based, community-driven models that can be implemented at the ward/panchayat

level will be promoted by this programme. In order to ensure long-term sustainability and resilience in agriculture, the drive will also establish local service hubs that will train farmers in adopting renewable energy sources and climate-smart machinery.

Convergence of Departments/Agencies Suggested

Agriculture & Farmers ' Welfare Department, Animal Husbandry Department, Fisheries Department, Dairy Development, Department of Industries and Commerce, LSGD, Power Department, ANERT, NABARD, College of Agricultural Engineering and Technology Thavanur, KAU, APJ Abdul Kalam Technological University and its affiliated colleges, Directorate of Technical Education and all Polytechnic Colleges, Indian Institute of Management Palakkad, KAU, EMC.

Actionable Points

1. Assess local energy and mechanisation needs
2. Facilitate renewable energy-based farm mechanisation
3. Create climate-resilient mechanisation hubs
4. Provide capacity building and training
5. Enable financial and policy support
6. Strengthen market and supply chain linkages

Expected Outcomes

1. Reduced fossil fuel dependency
2. Lower farm input costs; higher net incomes
3. Increased farm productivity and efficiency
4. Decentralised renewable energy adoption
5. Climate resilience and carbon emission reduction
6. Improved rural employment
7. Sustainable market integration

Idea 2	Community Resource Efficiency Hubs

Objective

To establish Community Resource Efficiency Hubs (CRE Hubs) that act as a common facility primarily for agro-fish-dairy processing and as service centres that integrate solar-powered drying, storage and value-addition facilities for produce from the region. These are decentralised low-carbon food processing and farm-service units providing cluster facilities for helping to increase rural employment and entrepreneurship, improve local incomes and ensure sustainable low-food mile market linkages.

Short Description

A CRE Hub would serve as a focal point for decentralised energy transition within a community, offering access to information, resources, and support to implement sustainable practices. It would improve resource efficiency and establish micro-enterprises in agro-fish-dairy post-harvest and processing. The CRE Hub will also include warehousing facilities and equipment relevant to the local crops and region. These Hubs will become community centres of excellence in energy conservation and efficiency, waste reduction, and circular economy in agricultural post-harvesting and processing and can also provide essential market linkages through online and offline sales platforms. By focusing on energy efficiency and resource conservation, these hubs play a crucial role in the broader framework of Energy and Resource Management within the CREEA initiative. Furthermore, they act as catalysts for decentralised energy transitions while providing vital livelihood support to local communities.

Convergence of Departments/Agencies Suggested

Agriculture and Farmers' Welfare Department, Animal Husbandry Department, Fisheries Department, Department of Industries and Commerce, LSGD, ANERT, NABARD, ICAR-CMFRI, ICAR-CIFT, Department of Post Harvest Technology, KAU, EMC.

Actionable Points

1. Identify local resources: Conduct a thorough assessment of local agricultural resources, energy needs, and existing infrastructure.
2. Develop a strategic plan: Create a roadmap outlining the hub's objectives, target audience, and operational strategies.
3. Design renewable energy facilities: Plan and construct facilities powered by renewable energy sources for post-harvest processing and warehousing.
4. Equip the Hub: Procure necessary equipment for processing, storage, and distribution that aligns with local agricultural practices.
5. Identify funding opportunities: Research grants, subsidies, and partnerships that can provide financial support for the hub's initiatives.
6. Plan for long-term sustainability: Develop a business model that ensures the Hub's financial viability and ongoing community support.
7. Facilitate knowledge sharing: Create platforms for sharing best practices and success stories related to circular economy initiatives.
8. Offer training programmes: Develop training modules for community members on sustainable practices, energy efficiency, and the use of new technologies.

Expected Outcomes

1. An assured mechanism for post-harvest management including, drying, storage, and transport all at local levels will provide significant relief to the farmer.
2. Local-level accessible post-harvest and warehousing facilities to farmers/fishers.
3. A network of renewable energy-based post-harvest and processing facilities at farmer-accessible levels that enhance decentralised energy transition in the agricultural sector.

Focus Theme E

Capacity Building - Knowledge and Skills

Idea 1	Kerala Agroecology Knowledge Commons (KAKC)

A Hybrid Farmer-Centric Digital & Peer-to-Peer Knowledge and Capacity-Building System for Climate Resilient and Energy-Efficient Agriculture

Objective

To establish a decentralised knowledge and learning ecosystem that integrates human-centric peer-to-peer knowledge exchange with digital tools to enhance climate resilience and energy efficiency in Kerala's agricultural landscape.

Short Description

The Kerala Agroecology Knowledge Commons (KAKC) is a decentralised farmer-led knowledge-sharing system integrating peer-to-peer learning with digital agroecology advisory services. At the panchayat level, it establishes Farmer Knowledge Hubs (FKH), where experienced farmers serve as mentors through Participatory Field Schools and Farm Learning Circles (FLCs). These centres provide real-time access to climate alerts, farmer-led innovations, and local agroecology practices by connecting to a state-wide digital information commons.

The hybrid model would include farmer-led peer learning networks (field-based knowledge exchange), an AI-powered digital knowledge platform (app, chatbots, and farmer video documentation, that can be integrated in the KATHIR app), a localised innovation documentation and scaling framework and a data-driven decision-making system facilitated by integration with RACRT (Resilient Agriculture & Climate Risk Tracker). By combining traditional knowledge with AI-driven insights, KAKC enables institutions, LSGIs, and farmers to collaborate on the development, documentation, and implementation of energy-efficient and climate-resilient agricultural solutions at all levels.

Convergence of Departments/Agencies Suggested

Department of Agriculture and Farmers' Welfare, LSGIs, KAU and KVKs, NABARD, FPOs, Kudumbashree, Organisations with Agroecological research and training expertise.

Actionable Points

1. Establish decentralised Peer Learning Circles (FLC) and Farmer Knowledge Hubs (FKH) at the Panchayat level.
2. Develop and implement Kerala Agroecology Knowledge Commons, a digital knowledge platform.
3. Train youth, master farmers, SHG members as community agroecology mentors
4. Create a voice-based knowledge system and an AI-powered farmer chatbot in Malayalam.
5. Organise district-specific agroecology learning exchanges and farmer innovation meets.
6. Ensure integration with Resilient Agriculture & Climate Risk Tracker (RACRT)

Expected Outcomes

1. An ecosystem of farmer-led education and capacity building
2. Enhanced agroecological social and digital knowledge networks
3. Strengthen climate resilience through community based information exchange
4. Data-driven decision-making that incorporates AI insights and local knowledge
5. Inclusion of marginalised farmers, women, and young people in the knowledge system.

Idea 2	Kerala Climate Resilient Agriculture Innovation Labs (K-CRAIL)

A Decentralised Farmer-Led Innovation and Field Research Platform for Climate-Resilient Agroecology & Energy Efficiency

Objective

To create farmer-driven, decentralised agroecology innovation hubs where farmers, researchers, startups, and policymakers co-develop, test, and scale climate-resilient and energy-efficient agricultural solutions.

Short Description

The Kerala Climate Resilient Agriculture Innovation Labs (K-CRAIL) will function as farmer-led living laboratories at the panchayat, block, and district levels, focusing on climate risk preparedness, renewable energy-based farm mechanisation, and biodiversity resilience. In addition to facilitating peer-led trials on bio-inputs, climate-resilient cropping, micro-irrigation, and pest management, these labs will strengthen farmer-to-farmer learning networks by documenting successful local adaptations and enabling participatory farmer experimentation, co-research, and real-time innovation testing.

To ensure that scientific research is co-developed and validated with farmer wisdom, these labs will combine hyperlocal climate risk data (from RACRT) with farmer-led solutions. Farmer-led seed and bio-resource networks, an AI-driven innovation and risk mapping platform with an open-source farmer innovation database and climate adaptation dashboard, and community-led innovation laboratories for farmer-scientist-startup collaborations and field trials are some of the key features.

Convergence of Departments/Agencies Suggested

Department of Agriculture and Farmers' Welfare, Fisheries Department, Animal Husbandry Department, KAU, KVKs, NABARD, financial institutions, Agroecology NGOs, FPOs, SHGs, Kerala Startup Mission (KSUM) & IT Department for Digital Innovation Integration, Forest & Wildlife department, Water Resources Department, LSGIs.

Actionable Points

1. Establish Climate Innovation Labs led by farmers at the block and panchayat levels.
2. Organise participatory field research trials and innovation hackathons.
3. Create am open source climate innovation database and integrate it with RACRT.
4. Scale optimal practices, establish digital farmer-to-farmer extension networks.

Expected Outcomes

1. Co-creation and field testing of agroecology solutions by farmers.
2. Integration of traditional knowledge with climate-resilient innovations.
3. Enhanced farmer networks to facilitate the exchange of knowledge among peers.
4. Decentralised and resilient management of seeds, soil, and water.
5. Scaling of low-carbon, climate-adaptive farm mechanisation.
6. Potential local level innovations get scaled up.

Conclusion

These flagship projects offer a structured, multi-stakeholder approach to addressing the complex challenges in Kerala's agricultural sector. Their success depends on a strong commitment from all relevant departments to integrate these strategies into action plans, five-year strategies, and annual implementation roadmaps, while actively engaging and empowering communities, local leaders, and institutions to co-develop region-specific solutions.

Kerala has a rich history of grassroots innovation and collective action. By strengthening these foundations, investing in sustainable solutions, and fostering cross-sectoral collaboration, a more resilient and equitable agricultural future can be realised—one that serves as a model for the rest of the country.

Key Takeaways

- The report introduces the **Climate Resilience and Energy Efficiency in Agriculture (CREEA)** framework for addressing the climate change challenges in Kerala's agriculture, animal husbandry and fisheries sectors. It outlines the core principles, **objectives, and thematic components** of the framework.

- Documents **hyper-local climate impacts and vulnerabilities** across Kerala, based on inputs and insights from district-level consultations and secondary research.

- Presents the **process and structure of the CREEA district-level workshops**, including the timeline, departments involved, and the participatory, cross-departmental planning approach adopted.

- Showcases how the workshops facilitated a multi-stakeholder and **interdepartmental consultation platform** to enable collaborative planning and convergence.

- Presents a **management approach for CREEA** that emerged from the consultation process, organised around four key themes: (i) Ecosystem Health Management (ii) Extreme Event Management, (iii) Energy and Resource Management (iv) Institutional Management.

- Documents a range of **field-level Climate Resilient Agriculture initiatives** implemented by both governmental and non-governmental agencies, illustrating diverse approaches that integrate climate resilience and energy efficiency in agriculture.

- Identifies a set of **flagship projects that are feasible and essential** for implementation of CREEA, aligned with five priority areas: (i) Integration and Convergence, (ii) Risk and Emergency Planning, (iii) Climate-Resilient Farming Systems, (iv) Net-Zero and Energy-Efficient Agriculture Capacity Building and (v) Skill Development.

Concluding Remarks

The Climate Resilience and Energy Efficiency in Agriculture (CREEA) initiative in Kerala represents a critical step towards addressing the multifaceted challenges posed by climate change to the agricultural landscape. By fostering a collaborative approach that integrates local knowledge and participatory strategies, CREEA aims to build resilience within the food production system while promoting energy efficiency. The insights gained from state and district-level consultations underscore the urgent need for transformative practices that not only mitigate the adverse impacts of climate change but also enhance food security and sustainable livelihoods.

The outcomes of the CREEA initiative highlight the importance of localised solutions and interdepartmental collaboration in tackling climate challenges. The proposed solutions across key areas such as Ecosystem Health Management, Extreme Event Management, Energy and Resource Management, and Institutional Management provide a comprehensive framework for action. Furthermore, the innovative case studies presented demonstrate the potential for scalable models of climate-resilient agriculture that can serve as benchmarks for future initiatives.

As Kerala moves forward, the recommendations for flagship actions outlined in this report serve as a roadmap for transitioning towards a more resilient and energy efficient agricultural sector. By prioritising collaboration, technology adoption, and sustainable practices, the CREEA initiative not only addresses the immediate challenges posed by climate change but also lays the groundwork for a sustainable agricultural future in the state. The commitment to grassroots involvement and multi-stakeholder engagement will be pivotal in ensuring that these initiatives are effectively implemented and adapted to the unique needs of local communities.

CREEA is a practical framework and a call for coordinated action across institutions and stakeholders to prepare for, respond to, mitigate, and adapt to the challenges posed by climate change in the agriculture, dairy, and fisheries sectors. It integrates principles of energy efficiency, emission reduction, and sustainable livelihoods. CREEA offers a pathway for transition towards a climate-resilient future—where innovation, collaboration, and community-driven solutions ensure that livelihoods thrive and ecosystems endure.

References & Resources

Chapter 1

Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. https://www.ipcc.ch/report/ar6/wg2/

Intergovernmental Panel on Climate Change. (2019). *Climate change and land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems (Chapter 5: Food security)*. https://www.ipcc.ch/srccl/chapter/chapter-5/

Brander, K., et al. (2018). Climate change implications for fisheries and aquaculture. In B. Phillips & M. Pérez-Ramírez (Eds.), *Climate change impacts on fisheries and aquaculture: A global analysis* (pp. 45–60). John Wiley & Sons. https://doi.org/10.1002/9781119154051.ch3

Doney, S. C., et al. (2012). Climate change impacts on marine ecosystems. *Annual Review of Marine Science, 4*(1), 11–37. https://doi.org/10.1146/annurev-marine-041911-111611

Heikonen, S., et al. (2025). Climate change threatens crop diversity at low latitudes. *Nature Food*, 1–12.

Nayak, P., & Solanki, H. (2022). Effect of climate change on crop production in India. *International Journal of Agriculture, Biology and Climate Dynamics*. https://iabcd.org.in/index.php/iabcd/article/view/52

Food and Agriculture Organization. (2024). *The unjust climate: Measuring the impacts of climate change on rural poor, women and youth*. Rome: FAO. https://doi.org/10.4060/cc9680en

Yang, Y., et al. (2024). Climate change exacerbates the environmental impacts of agriculture. *Science, 385*, eadn3747. https://doi.org/10.1126/science.adn3747

Parker, R. W. R., et al. (2018). Fuel use and greenhouse gas emissions of world fisheries. *Nature Climate Change, 8*(4), 333–337.

Ritchie, H. (2021). Drivers of deforestation. *Our World in Data*. https://ourworldindata.org/drivers-of-deforestation

Schneider, M., Goldman, L., Weisse, M., Amaral, L., & Calado, L. (2021, December 3). Soy Production's Impact on Forests in South America. Global Forest Watch.

Gutiérrez-Vélez, V. H., et al. (2023). Projecting global oil palm expansion under zero-deforestation commitments: Direct and indirect land use change impacts. Research Gate.

World Resources Institute. (2024). Deforestation linked to agriculture indicator. *Global Forest Review*. https://research.wri.org/gfr/forest-extent-indicators/deforestation-agriculture

Ritchie, H. (2019). Food production is responsible for one-quarter of the world's greenhouse gas emissions. *Our World in Data*. https://ourworldindata.org/food-ghg-emissions

Tubiello, F. N., Karl, K., Flammini, A., Gütschow, J., Xueyao, P., Obli-Laryea, G., ... & Conchedda, G. (2022). Greenhouse gas emissions from food systems: Building the evidence base. Earth System Science Data, 14(4), 1795–1809. https://doi.org/10.5194/essd-14-1795-2022

Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science, 360*(6392), 987–992. https://doi.org/10.1126/science.aaq0216

Chapter 2

Pound, B., Lamboll, R., Croxton, S., Gupta, N., & Bahadur, A. V. (2018). *Climate-resilient agriculture in South Asia: An analytical framework and insights from practice*. Action on Climate Today.

Shilomboleni, H., Epstein, G., & Mansingh, A. (2024). Building resilience in Africa's smallholder farming systems: Contributions from agricultural development interventions—a scoping review. *Ecology and Society, 29*(3).

Chapter 3

Department of Economics and Statistics, Government of Kerala. (2022). *Land utilisation statistics* [Data set]. https://www.ecostat.kerala.gov.in/dataset/78

Department of Economics and Statistics, Government of Kerala. (2022). *District wise crop statistics* [Data set]. https://www.ecostat.kerala.gov.in/dataset/28

Kerala State Planning Board. (2020). *Economic review 2020*. Government of Kerala. https://spb.kerala.gov.in/economic-review/ER2020/

State Planning Board, Thiruvananthapuram, Kerala, India. (2022). *Economic review 2022*. https://spb.kerala.gov.in/economic-review/ER2022/

State Planning Board, Thiruvananthapuram, Kerala, India. (2023). *Economic review 2023*. https://spb.kerala.gov.in/economic-review/ER2023/#:~:text=The%20per%20capita%20GSDP%20of,per%20cent%20in%202021%2D22

Ramakrishnan, R., & Ramachandra, T. V. (2016). Four decades of forest loss: Drought in Kerala. Indian Institute of Science (IISc), Bengaluru, India.

Pinheiro, A. (2017, June 29). How Kerala is making the transition towards healthy, home-grown food. *STEPS Centre*. https://steps-centre.org/blog/kerala-making-transition-towards-healthy-home-grown-food/

State Planning Board, Government of Kerala. (2012, February). *Report of the Working Group on Food Security*. https://spb.kerala.gov.in/sites/default/files/inline-files/03.pdf

Das, S., Shaji, E., Kumar, A. P., & Sooryanarayana, K. R. (2019). Proceedings of the Brain Storming Session on 'Surface Water and Groundwater Resources of Kerala: Management Issues, Policies, Future Strategies'. *Geological Society of India, 94*(4), 437–440.

CEIC Data. (n.d.). Chemical fertilizers: NPK consumption: Kerala. Retrieved December 14, 2024, from https://www.ceicdata.com/en/india/chemical-fertilizers-nitrogen-phosphate-and-potash-npk-consumption-by-states/chemical-fertilizers-npk-consumption-kerala

Kerala State Electricity Board Limited. (2021). *Power system statistics 2020-21*. https://old.kseb.in/index.php?option=com_jdownloads&view=download&id=24152:power-system-statistics-2020-21&catid=70&Itemid=810&lang=en

Department of Fisheries, Government of Kerala. (2022). *Kerala fisheries statistics at a glance, 2022*. https://fisheries.kerala.gov.in/sites/default/files/2023-07/fisheries_0.pdf

Walia, A., & Nusrat, N. (2020). *Kerala floods 2018* (pp. 1–106). National Institute of Disaster Management.

Malhotra, S. K., Cheriyan, H., Meena, B., Kumar, M., & Sreekumar, S. (Eds.). (2021). *Spices statistics at a glance 2021* (pp. 1–106). Directorate of Arecanut and Spices Development, Ministry of Agriculture and Farmers Welfare, Government of India. https://www.researchgate.net/publication/357205026_Spices_Statistics_at_a_Glance_2021

ICAR-Central Marine Fisheries Research Institute. (n.d.). *CMFRI ePrints: Open access repository*. https://eprints.cmfri.org.in/

Government of Kerala. (2024, April). Climate change and Kerala's agriculture scenario. *Kerala Calling*. https://keralacalling.kerala.gov.in/?p=2988

Chapter 5

Kerala Forest Department. (2022). *Administration report 2020–21*. Government of Kerala. https://forest.kerala.gov.in/images/abc/AR_Book_2022.pdf

Chapter 6

Department of Agriculture Development and Farmers' Welfare. (n.d.). *Departmental farms*. https://keralaagriculture.gov.in/en/offices-institutions/

Nameer, P. O. (2022). Carbon footprint assessment of State Seed Farm, Aluva. Kerala Agricultural University. https://www.researchgate.net/publication/366976041_Carbon_Footprint_Assessment_of_State_Seed_Farm_FINAL

Resource Persons

K. G. Sreeja

Designation: Research Director, EQUINOCT Community Sourced Modelling Solutions LLP
Phone: 7045282062 | **Email:** kgsreeja@gmail.com

Dr. Sreeja K.G. is an Agricultural Economist with deep expertise in agroecology and climate-resilient agriculture. She holds a PhD in Agroecology & Agricultural Systems from NIAS, Bangalore, and completed her post-doctoral research on climate change impact assessment at IIT Bombay. She is the Research Director at EQUINOCT, a tech startup focused on community-sourced climate solutions, and co-founder of Dharaa Livelihood Initiative, supporting indigenous women's enterprises and Resilient Destinations Foundation (RDF), which promote indigenous enterprises and climate-resilient destinations through multi-sectoral partnerships.

Usha Kumari S

Designation: Independent Consultant and Founder Member, Thanal
Phone: 9567157197 | **Email:** ushathanal@gmail.com

A founding member of Thanal and a former agriculture officer, Usha Kumari S focuses on research, documentation, and writing on agroecology, climate change, biodiversity, and the politics of food and health. She is also a founding member of the Save Our Rice campaign and serves as a steering committee member of the Alliance for Sustainable and Holistic Agriculture (ASHA).

Priya Pillai

Designation: Director - State Climate Action, Asar Social Impact Advisors Pvt. Ltd.
Phone: 9999357766 | **Email:** priya.pillai@asar.co.in

With 20 years of experience in environmental and social justice issues, Smt. Priya Pillai works closely with grassroots movements and NGOs focusing on climate, energy, gender equality, and forest rights. She is currently pursuing a PhD on the socio-ecological impacts of large-scale renewable energy at the University of Technology Sydney, Australia. As the Director - State Climate Action at Asar Social Impact Advisors Pvt. Ltd., she collaborates with partners in Tamil Nadu and Kerala on climate change and sustainability, particularly in resilience building, adaptation in agriculture, energy transition, decentralised renewables, carbon-neutral districts and panchayats, and climate literacy.

C. G. Madhusoodhanan

Designation: CEO, EQUINOCT Community Sourced Modelling Solutions LLP

Phone: 9833428230 | **Email:** ceo@equinoct.com

Dr. C. G. Madhusoodhanan holds a PhD in Water Resources Engineering from IIT Bombay. He specialises in assessing the hydrological impacts of climate and human interventions in the energy-land-water-climate nexus.

Rajesh Krishnan

Designation: CEO, TAPCo

Phone: 7559915032 | **Email:** rajeshecologist@gmail.com

Rajesh Krishnan holds a Master's degree in Ecology from the Salim Ali School of Ecology, Pondicherry University. He is committed to sustainable farming and rural livelihoods, bridging the gap between agricultural-environmental practices and policies. He engages with farm-level initiatives and policy groups at gram panchayat and national levels. For his contributions to farming, he received the State Youth Icon Award (2017) from the Kerala government.

Sridhar Radakrishnan

Designation: Policy Consultant

Phone: 9995358205 | **Email:** sridhar.keralam@gmail.com

A trained engineer, Shri. Sridhar Radakrishnan is dedicated to issues related to Environmental Health and Justice. His work spans multiple domains, including Climate, Sustainable Agriculture & Food Sovereignty, Environmental Policy & Advocacy, and Ecosystems & Land Use Policy.

Jayaraman Chillayil

Designation: MD, EQUINOCT Community Sourced Modelling Solutions LLP

Phone: 9447602966 | **Email:** md@equinoct.com

Dr. Jayaraman Chillayil, a PhD holder in Energy Management, has 28 years of industrial experience and is a two-time Fulbright Fellowship awardee. He has published several research papers and edited a publication for the Science and Technology Centre for NAM Countries, New Delhi, on Cleaner Production and Sustainable Development.

Annexure

CREEA Materials

Scan the QR code or follow the link below to access key resources related to the CREEA programme.

Link to the online folder with resources related to CREEA - https://shorturl.at/5HciB

CREEA Online Resources:

1. CREEA Programme Brochure & Programme Schedule (English & Malayalam)
2. Presentation: Introduction & Context of Climate Resilient Agriculture (CRA)
3. Presentation: Decentralised Renewable Energy (DRE) Intervention in the Agriculture Sector
4. CRA Booklet
5. Video Documentaries of CRA Experimental Models in Kerala
6. Detailed Documentation of District-Level Concerns & Solutions from Breakout Group Discussions

Organising Team

Usha Kumari S

Independent Consultant and Founder Member, Thanal

Sreeja K G

Research Director ,EQUINOCT Community Sourced Modelling Solutions

C.G Madhusoodanan

CEO, EQUINOCT Community Sourced Modelling Solutions

Sridhar Radhakrishnan

Policy Consultant

Priya Pillai

Director - State Climate Action, Asar Social Impact Advisors

Rajesh Krishnan

CEO, Thirunelly Agri Producer Company

Jayaraman Chillayil

MD, EQUINOCT Community Sourced Modelling Solutions

Manjula K

State Climate Action Lead, Asar Social Impact Advisors

Hari Subbish Kumar

Senior Programme Manager, State Climate Action, Asar Social Impact Advisors

Indu Periodi

Program Officer, State Climate Action, Asar Social Impact Advisors

Amjad Anwar

Program Associate, State Climate Action, Asar Social Impact Advisors

Abhay Vishnu

Data Analyst, EQUINOCT Community Sourced Modelling Solutions

Image Descriptions & Credits

Cover Photo
Image: Women transplanting traditional paddy varieties in Thrissilery Village of Wayanad, Kerala
Photo credit: Uma Sannasi, TAPCo

Chapter 1
Intro Image: Drought in Wayanad district

Chapter 2
Intro image: An early morning scene from Vincent's backyard in Ezhikkara, Ernakulam, marking the commencement of the pokkali sowing season.
Photo credit: Preethi Sreenivasan

Chapter 3
Intro image: Crop loss in Koratty, Thrissur district, due to heavy winds in early June.

Chapter 4
Intro image: Context-setting session during the CREEA district-level workshop in Kottayam
Photo credit: Veena Maruthoor & Jean Nattar

State-level energy transition workshop photos: Veena Maruthoor and Jean Nattar

District-level CREEA workshop photos:

Thiruvananthapuram, Kollam, Pathanamthitta, Alappuzha and Kottayam
Photo credits: Veena Maruthoor and Jean Nattar

Idukki, Thrissur, Palakkad, Malappuram, Kozhikode, Wayanad, Kannur and Kasaragod
Photo credits: Mridul Pradeep

Ernakulam:Priyanka Gopalan

Chapter 5
Intro image: Breakout group discussion by participants from Vellangallur and Maala blocks during the CREEA district-level workshop in Thrissur
Photo credit: Mridul Pradeep

Chapter 6
Intro image: Paddy art with traditional paddy varieties in Thrissilery Village, Wayanad, Kerala
Photo credit: Uma Sannasi, TAPCo

Chapter 7
Intro image: Paddy diversity block maintained by Mr. Johnson, Chairman, TAPCo, at Thrissilery Village, Wayanad, Kerala | Photo credit: Uma Sannasi, TAPCo

Supported by

Energy Management Centre (EMC):

Energy Management Centre (EMC), under the Power Ministry of the Government of Kerala, aims primarily to remould and instrumentalise the energy sector as a catalyst in promoting a development process that is economically-ecologically sustainable. With a view to making the energy sector achieve such a lead and catalytic role, EMC has evolved a novel and comprehensive energy management approach and institutional philosophy encompassing the management of energy technology systems.
https://keralaenergy.gov.in/

Department of Agriculture Development & Farmers' Welfare:

The Department of Agriculture Development & Farmers' Welfare is a key ministry of the Government of Kerala managing agriculture development through promoting scientific methods of cultivation and welfare of farmers of the state through various policies and programmes. The department's vision is to attain self-sufficiency in food production through enhanced agricultural productivity of agricultural commodities so as to make agriculture a sustainable and viable vocation providing livelihood support.
https://keralaagriculture.gov.in/

Organised by

Asar Social Impact Advisors Pvt. Ltd:

Asar Social Impact Advisors is a startup in the environment & social justice impact space with a commitment to building climate resilience & ambitious climate action. We identify challenges & opportunities, research them, verify ground truths, and understand local contexts, in order to build innovative strategies that are rooted in reality. Asar convenes multi-stakeholder conversations and helps build relationships between various key actors to be able to sustain collaborations essential to deliver real-world impact.
www.asar.co.in

EQUINOCT Community Sourced Modelling Solutions:

EQUINOCT is a tech start-up that provides science-based solutions for addressing the impacts of climate change, working with communities, institutions, and governments.
www.equinoct.com