Revitalizing Jute Farming:

A Case Study of ICARE Scheme in West Bengal, India

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Abstract:

The Jute-ICARE initiative by the Government of India aims to address climate change's impact and improve jute farmers' livelihoods. This study investigates the challenges and opportunities for jute farmers in adopting the scheme's technologies using the DPSIR framework and the social learning theory. Inadequate information dissemination to farmers and differing perspectives between policymakers and farmers on jute production concerning climate change are identified as significant challenges. However, policymakers can bridge the communication gap and understand the challenges and perspectives of jute farmers by incorporating their feedback while formulating policies. This will help promote the adoption of advanced ICARE technology and enhance the livelihoods of jute farmers. Active engagement and communication between policymakers and farmers are necessary to overcome the challenges and promote sustainable agricultural practices that benefit both the environment and the farmers.

Keywords: Jute farming, jute policy, Jute- ICARE, Social Learning Theory, System Thinking, DPSIR

Word count: 12,087

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List of Acronyms

CBC: Carpet Backing Cloth
CFSL: Central Forensic Science Laboratory
CO-58: A variety of jute seed
DPSIR: Driving Forces, Pressures, State, Impact, and Response
GHG: Greenhouse Gas
ha: Hectare
IGP: Indo-Gangetic Plain
JBC-5: A variety of jute seed

JBO-1: A variety of jute seed
JBO-2003H: A variety of jute seed
JBOH2003H: Another variety of certified jute seed
JRC-698: A variety of jute seed
JRC-80: A variety of jute seed
JRC: Jute Research Centre
JRO-128: A variety of jute seed
JRO-204: A variety of jute seed
JRO-66: A variety of jute seed
JRO-8432: A variety of jute seed
JRO204: A variety of certified jute seed
MGNREGS: Mahatma Gandhi National Rural Employment Guarantee Scheme
MoU: Memorandum of Understanding
MT: Metric Ton
MT: Ministry of Textiles
NABARD: National Bank for Agriculture and Rural Development
NFSM: National Food Security Mission
NINFET: National Institute of Natural Fibre Engineering and Technology
NJB: National Jute Board
NJDP: National Jute Development Programme
NRC: National Research Centre
NSC: National Seed Corporation
Quintal(q): A unit of weight
RRPS-27-C-3: A variety of jute seed
S-19: A variety of jute seed
SMS: Short Message Service
SONA: Microbial consortia developed by CRIJAF
TD: Tear Degree

1 Introduction

Jute is a natural fibre commonly known as the "golden fibre" (Stoczkowski., 2008), owing to its golden colour and high cash value. Jute ranks second (behind cotton) in global textile fibre production (Lakshme et al., 2019). Jute is used to create several fabrics such as hessian cloth, sacking, scrim, carpet backing cloth (CBC), and canvas. India is the world's largest producer of Jute, with an annual estimated production of 11.5 million bales of jute, which is approximately 60% of total global jute production (Sankar Das et al., 2019). Jute is a biodegradable crop that is primarily grown in the Ganges delta (Jahan., 2019). West Bengal ranks first in jute production in India, contributing to more than 80% of the country's total output (Mandal., 2015).

Despite India's better-than-average jute productivity, there is a significant gap between potential production under frontline demonstration[1] and actual yield at the farm level (Mahapatra et al., 2009). According to the ICAR- Central Research Institute for Jute and Allied Fibres (2021), the yield difference ranges by roughly 24 percent in West Bengal, according to estimates from the Directorate of Jute Development. The effects of climate variability are causing significant fluctuations in jute production. They are anticipated to have a long-term influence on yields (Sankar Das et al., 2019). The lower Indo-Gangetic Plain (IGP), where jute is grown, has experienced an increase in average temperature over the past 100 years and a significant variance in monsoon rainfall. The average annual surface air temperature has increased by 1.04°C (Singh et al., 2018). There has been a considerable decrease in rainfall during the monsoon season between June and August, increasing drought-like conditions in many parts of jute-growing regions as reported by (Ghosh, 2018).

The yield gap may be closed by implementing improved management techniques, and jute yield can rise (ICAR- Central Research Institute for Jute and Allied Fibres, 2021). Despite significant advancements in jute-related research, the quality of jute fibre produced in the nation remains a problem in jute production (Kumar et al., 2021). As a result, the cost of manufacturing jute products become high while the price of these finished jute products remain low (Chatterjee et al., 2020).

In this context, the State and the Central governments have taken several steps to increase the productivity and efficiency of jute farming. These include the development of less water-intensive retting alternatives, high-yielding cultivars, better-quality seed supply, and retting tank design (ICAR-Central Research Institute for Jute and Allied Fibres, 2021). Programs like Jute-ICARE and the National Food Security Mission-Commercial Crops (NFSM) (Jute) are concentrating on the adoption of

[1] Front Line demonstrations (FLDs) is a unique approach to provide an direct interface between researcher and farmers

improved agricultural techniques, automated retting, and enhanced marketing to assure higher returns for farmers (Commission for Agricultural Costs & Prices, 2021).

This thesis focuses on farmers in the Nadia, Hoogly, and North 24 Parganas districts of West Bengal and examines the social and environmental impacts of the jute ICARE scheme. The research aims to understand the implementation of the scheme and assess the challenges and prospects faced by jute farmers when adopting ICARE technologies. By investigating these aspects, the study sheds light on the specific experiences, barriers, and opportunities encountered by farmers in relation to the jute ICARE scheme. The steady rise in global warming is impacting highly vulnerable developing nations. Most developing nations depend heavily on the agricultural sector, which contributes to climate change through greenhouse gas emissions (GHG) and is negatively impacted by it. The research is guided by the following questions:

RQ 1. How do the farmers perceive the jute ICARE scheme?
RQ 2. What are the challenges of the jute ICARE scheme implementation by farmers?
RQ 3. How can these challenges be addressed?

I employed the DPSIR framework (described in detail in section 2.1) on the policy documentation and other literature on the ICARE scheme to understand the intended environmental and social outcomes of the jute ICARE scheme. For RQ1, I collected farmers' responses through semi-structured questionnaires about their perception of various aspects of the ICARE scheme and identified successes and shortcomings of the scheme through thematic analysis (described in detail in section 4.1) of their responses. Finally, I employed social learning theory in discussion section (described in detail in section 6) to understand the challenges in the implementation of the ICARE scheme for RQ2 and arrived at some suggestions for overcoming these shortcomings for RQ3. Since the impacts of climate change on the cultivation of jute is one of the many problems in sustainable development involving complex and dynamic socio-ecological systems, the DPSIR framework helped in carefully understanding the interactions between society and the environment and identifying the drivers and understanding the perspectives and objectives of the policy-makers and ICARE scheme community of practice as a whole towards the formulation and implementation of the ICARE scheme.

I used Social learning theory to analyze the performance of the ICARE scheme by understanding how aligned these perspectives of the "ICARE scheme community of practice" are with the "jute farmers' community of practice" (communities of practice are defined in section 2.2). The social learning theory provided insight into barriers between the two populations of practice and identified potential

solutions to overcome them for the improvement and successful implementation of the ICARE scheme.

2. Theory and analytical framework

I have used two analytical frameworks - DPSIR and Social Learning Theory to analyze the implementation of the ICARE scheme for jute cultivation. Since the impacts of climate change on the cultivation of jute, along with its socio-economic ramifications, is very complex, I employed the DPSIR framework to carefully understand the interactions between society and the environment and identify the states and impacts which led to the ICARE scheme (the response). The DPSIR framework, thus, helped me frame the problem (environmental and soci-economic) by identifying the drivers and understand the perspectives and intended effects of the policy-makers and ICARE scheme community of practice as a whole towards the formulation and implementation of the ICARE scheme. I then used social learning theory to analyze the performance of the ICARE scheme by understanding how aligned these perspectives of the "ICARE scheme community of practice" are with the "jute farmers' community of practice" (communities of practice are defined in section 2.2). The social learning theory lens gave me insight into barriers between the two populations of practice and identified potential solutions to overcome them for the improvement and successful implementation of the ICARE scheme to address the impacts identified in the DPSIR formulation. Therefore, the two frameworks complement each other to understand these aspects of the problem systematically.

2.1 DPSIR framework

The Driver-Pressure-State-Impact-Response (DPSIR) framework is a useful method for researching and studying human-environmental systems (Burkhard & Müller, 2008). In socio-economic situations, it can be beneficial to pinpoint the causal connections between the environment and human-caused activities. DPSIR models are interdisciplinary systematic approaches (Song & Frostell, 2012). In this framework, the precise cause-and-effect linkages in the recent past and the upcoming developments are supported with the DPSIR framework. The acronym DPSIR may be broken down to represent a series of events: external Drivers (D) exert Pressures (P) on the environment, changing its State (S), which has specific economic, social, or environmental Impacts (I), which leads to specific societal Responses (R) that feedback into the system (Kristensen, 2004).

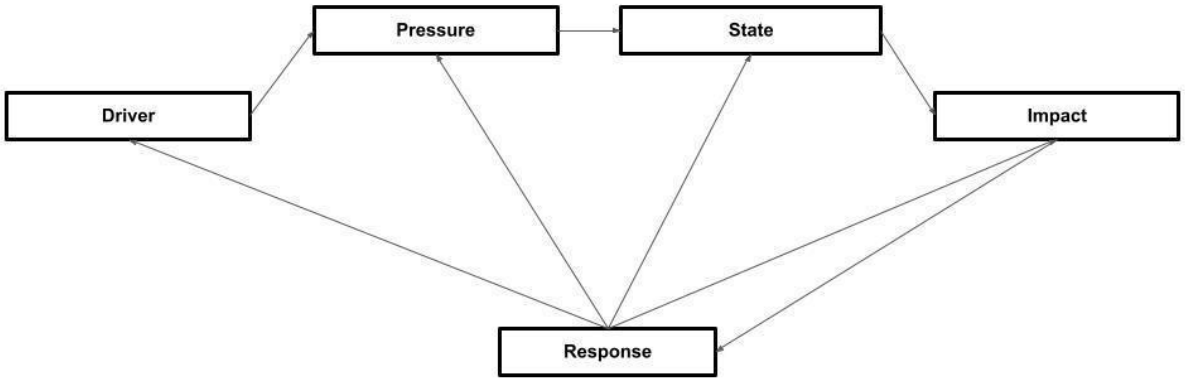

Figure 1: A generic DPSIR framework (own illustration).

As shown in Figure 1, "Drivers'' are autonomous, external causes (human or natural) that have a detrimental direct or indirect influence on environmental parameters. the environmental drivers include climate change and the growing demand for plastic use. "Pressures," which are variables that cause environmental change, are the direct results of the Drivers. The factors, which include heat waves, droughts, irregular rainfall, cyclones, and floods, were noted. The visible changes in the state of the environment as a result of the Pressures are known as the "State." In this example, the states are low jute quality, loans from middlemen for livelihood, Time consuming, and the changing cultivation time. The term "Impact" refers to the quantifiable expenses incurred by society and the environment due to a change in environmental circumstances. The quantifiable changes observed in this case are poverty, declining livelihood, high need for labour, and low yield. Finally, some social "Responses" are implemented to lessen and accommodate the relevant environmental challenges. In this case, the response taken by the government is the ICARE scheme.

2.2 Social Learning Theory

Problems in sustainable development involve complex and dynamic socio-ecological systems. They have uncertainty and indeterminacy as inherent characteristics, where it is only possible to identify some necessary information for solving them (Garmendia & Stagl, 2010). Owing to the uncertain nature of sustainable development problems, an approach where actors could adapt or adjust their decisions and frame of reference through learning is effective in developing solutions (Hjorth & Bagheri, 2006). Therefore, social learning theory serves as a very useful theory in sustainable development problems. Earlier theories of social learning stressed behavior changes. This can be traced back to (Bandura, 1977), who pointed out that learning may occur through imitation and emphasized the influence of norms and social context. Those concepts of the social learning theory

have been used and further developed in diverse subfields. Over the years, the later theories emphasized the creation of knowledge, changes in beliefs and attitudes, including adjusting actions versus guiding assumptions (single loop vs. double loop), and communities of practice (Argyris & Schon, 1978; Wenger, 2000). With all these ideas incorporated in the social learning theory, a concrete definition of 'social learning,' which has been widely popular, is given by Reed et al. (2010) as a process that occurs through social interactions and processes between actors within a social network and demonstrates that a change in understanding of not only in the individuals involved but also goes beyond the individual and becomes situated within wider social units or communities of practice.

Throughout history, human beings have formed communities that share cultural practices, where belonging to that community reflects their collective learning. Therefore, the social learning theory framework has been developed from the perspective of 'communities of practice', which are defined as a group or community of people/organizations, such as a workplace, a family, a group of friends, or any other community, that share competence that reflects their collective social learning (Wenger 2000). Analyzing the different forms of belonging to these communities of practice and the boundaries within and between different communities of practice is used to understand the social learning systems and barriers thereof.

According to Wenger, our belonging to a social learning system can be distinguished between three modes:

- *Engagement:* belonging through engagement refers to direct interactions, doing things together such as collaborating or exchanging information and technologies.
- *Imagination:* belonging through imagination refers to our perception of the community and our place in it and ourselves.
- *Alignment:* belonging through alignment refers to making sure that our local activities are aligned with other processes such that they can be effective beyond our direct engagement with the community of practice. Such alignments could be aligning perspectives and actions.

Understanding the level of belonging in terms of these different modes helps identify the different kinds of actions required to improve social learning systems.

Another concept introduced by Wenger is the 'boundary' of the community of practice. Experience and competence are in convergence within a community of practice, so when there is a divergence in experience from a new competence, it is referred to as the boundary of the community of practice. It

is important to understand the boundaries of communities of practice as it is where active learning can take place. However, if the divergence between the experience and competence is too large, it can serve as a barrier to new learning but only ensures the sense of not belonging. So, it is very insightful to analyze the boundaries between individuals and communities of practice or between different communities of practice to understand if the barriers can be overcome or not and the specific efforts that can enable that change, if possible.

I used social learning theory framework to analyze the implementation of the ICARE scheme in this thesis by considering the group of policy-makers, research institutes, government agencies like JCI, and extension centers (KVKs) who are responsible for drafting, development, and implementation of the ICARE scheme as one community of practice, that would be referred to as "ICARE scheme community of practice". I also considered the jute farmers in West Bengal, who were using traditional methods for jute cultivation and were susceptible to the effects of climate change, as the other community of practice and would be referred to in the thesis as the "jute farmers' community of practice". I analyzed the different modes of belongings to these two communities of practice and identified their boundaries and used them to understand the barriers and steps to overcome them. Using this framework, I analyzed the quality of social learning in the implementation of the ICARE scheme and actionable steps to improve them.

3 Background

3.1 Jute cultivation in India

Except for the hilly regions of the north and the plateau area to the west, the jute crop is planted throughout the state of West Bengal (Mandal, 2015). Murshidabad, Nadia, West Dinajpur, Cooch Behar, Hooghly, 24 Parganas (north and south), Malda, Bardhaman, Jalpaiguri, Howrah, and Midnapore districts are the primary producers of jute. Corchorus *capsularis* (white jute) is grown in the lowlands of West Bengal (Sankar Das et al., 2019).

The jute is a Kharif crop[2], and it takes approximately 120 days (April/May through July/August) till the harvest (Islam et al., 2012). The ideal temperatures for jute cultivation are above 25 °C and relative humidity levels of 70%-90% for optimal growth (Bakhtavar et al., 2019). Jute requires 160-200 cm of rain each year, particularly during the sowing season (Islam et al., 2012). The jute crop is mainly grown in alluvial or loamy soil (Islam et al., 2012). The suitable soil pH required for jute cultivation is 6 -7.5 (Das et al., 2014).

[2] the crops that are sown and harvested during the monsoon season in South Asia, which typically starts around June or July and extends till September or October.

3.2 Jute fibre extraction process

Jute fibre is extracted by retting after harvest. Retting is decomposing of the cellular tissues around fibre bundles in plants using microorganisms and moisture such that the fibre and stem get separated (Ali et al., 2015; Das et al., 2014). Jute stems are tied together and submerged in water as part of the retting process (Das et al., 2014). The most common method for removing fine fibres is water retting, which has been around for a century (Ali et al., 2015). Inside the jute stem, the fibres are stripped after the retting process, while the non-fibers are discarded (Das et al., 2014 ; Ali et al., 2015). Following this step, the jute fibres are dried outdoors and then cleaned. Finally, the jute fibres are dried on bamboo poles (Ali et al., 2015). The jute fibre extraction process is depicted in Figure 2. below.

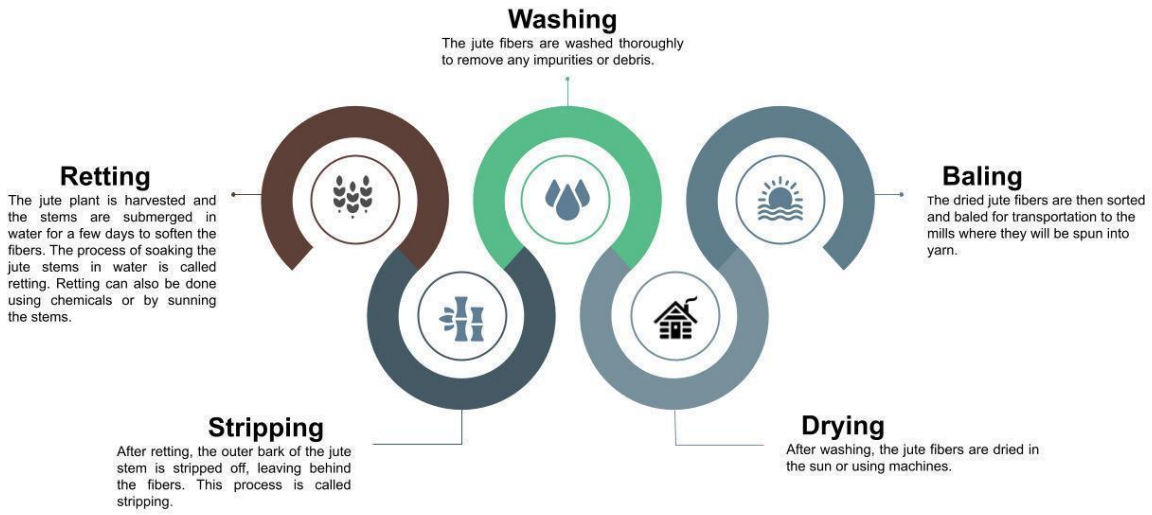

Figure 2. Schematic flow diagram of the stepwise Jute fibre extraction process (Own illustration)

Conventional retting is the primary method used to extract jute fibre. This type of retting separates the fibre from the woody stem without destroying the cellulose in the fibre. Pectin and hemicellulose are the principal non-fibrous cementing ingredients used by retting microorganisms (Ali et al., 2015; Banik et al., 2003).

There are various alternatives available for user-friendly techniques for extracting high-quality fibre which also conserve water, such as ribbon retting (Banik et al., 2003), fungal retting (Majumdar et al., 2021), microwave and ultrasound technologies (Nair, 2017), steam explosion (STEX) (Lee et al., 2020). There are a few factors that impact fiber quality, such as crop fertilization, plant age, quality of water used for retting, and finally, the pH and temperature of retting water (Chapke, 2009).

3.3. Use of jute fibre

Jute is used to make cloth for wrapping bales of raw cotton and to make sacks and coarse cloth. Fibres are woven into curtains, chair coverings, carpets, area rugs, hessian cloth, and backing for linoleum. While synthetic materials are replacing jute in many of these uses, some uses take advantage of jute's biodegradable nature (Singh et al., 2018). Diversified jute products are becoming more and more valuable to the consumer today. These are espadrilles, floor coverings, home textiles, high-performance textiles, geotextiles, composites, and more. Jute is also used to mark ghillie suits which are used as camouflage and resemble grasses or brushes. Apart from the textile industry, Jute is also used in automobile, pulp and paper, furniture, and bedding industries. The residual jute sticks are used as fuel in rural areas.

3.4. Socio-economic status of jute farmers and workers

Jute farmers: The majority are small and marginal landholders with limited financial resources. Most are middle-aged, have just completed their secondary education, and have ordinary or below-average income and expenses (Halder, 2021). Jute cultivation is labor-intensive that requires labour for basically all activities (from sowing to fibre extraction). As the price of human labour has recently increased because of the labour shortage and high wages, the cost of cultivation has increased (Halder, 2021). The lack of high-quality seed, greater input costs, infrastructure limitations for retting, unstable jute pricing, the lack of freely running water, etc., is some additional challenges that jute farmers must overcome. There is a sharp decline in the area dedicated to jute farming because of poor retting facilities and lack of freely flowing water sources. Due to the bulkiness of jute, producers incur additional costs while transporting the fibre from the field to the market (Commission for Agricultural Costs & Prices., 2021).

Jute mill workers: According to (Ghosh, 2016), almost 40% of the workers are working temporarily. Mostly, the income of permanent mill workers is €80 - 101 per month, but on the other hand, temporary workers' income is about €2.89 per day (Ghosh,2016). However, about two-thirds of mill workers live in company residences, typically semi-pukka and in bad condition (Ghosh, 2016). Approximately 2/5th are illiterate, and 3/5th are educated up to secondary classes (Ghosh, 2016). Furthermore, the sanitary condition is terrible since 80% of families obtain water outside their houses, and adequate solid waste disposal facilities are not accessible (Ahmad et al., 2019). A hygienic problem leads to a variety of health issues. The mill workers stop caring about themselves, especially during the early stage of sickness, as they are insecure about losing their jobs and are low-paid (Ahmad et al., 2019). However, workers are primarily suffering from back discomfort as a result of the brutal nature of their labour in the mills (Ahmad et al., 2019).

3.5. Jute-ICARE (Improved Cultivation and Advanced Retting Exercise) Programme for Increasing the Productivity and Quality of Jute

The program initiated by NJB in 2015 with the association CRIJAF and JCI will be governed by an MoU (Memorandum of Understanding). The Jute I-CARE program's goal is to provide proper pre- and post-harvesting operations to small and marginal jute farmers so that they can produce high-quality jute and fetch a higher price for it. This program will also sensitize the farmers about recent advanced technological know-how (National Jute Board, n.d.).

The objective of the ICARE scheme is to help jute farmers to overcome their challenges by providing them with certified seeds at a subsidized rate, seed drills to make line sowing easier, and nail weeders to do periodic weeding. With the help of SMS / Advisories to be sent to each registered farmer to inform them about newly developed technologies. Apart from that, the farmers' field-level demonstration with microbial retting formulations ("CRIJAF SONA", "NINFET SHATHI", and "IJIRA-SUBHRA") is to be conducted by institutions/organizations (National Jute Board, n.d.). The beneficiary farmers would be registered by the Jute Corporation of India (JCI) with various farmers' societies, cooperative organizations, Krishi Vigyan Kendra (KVKs), and farmers' clubs under National Bank for Agriculture and Rural Development (NABARD).

According to the ICAR-CRIJAF annual report (ICAR- Central Research Institute for Jute and Allied Fibres, 2021), in comparison to the control, the yield of jute fibre increased by approximately 10% in the Jute-ICARE area, and the fibre quality also improved (TD-2 and TD-3). Farmers who participated in the Jute-ICARE initiative received a better market price of €5 to €6 per quintal than those who used the conventional retting process.

Figure 3 demonstrates a significant extension gap, emphasizing the importance of educating farmers on using new agricultural technology. Farmers were also recommended to employ agro-advisories published by ICAR-CRIJAF regularly as part of the yield gap mitigation approach (ICAR- Central Research Institute for Jute and Allied Fibres, 2021).

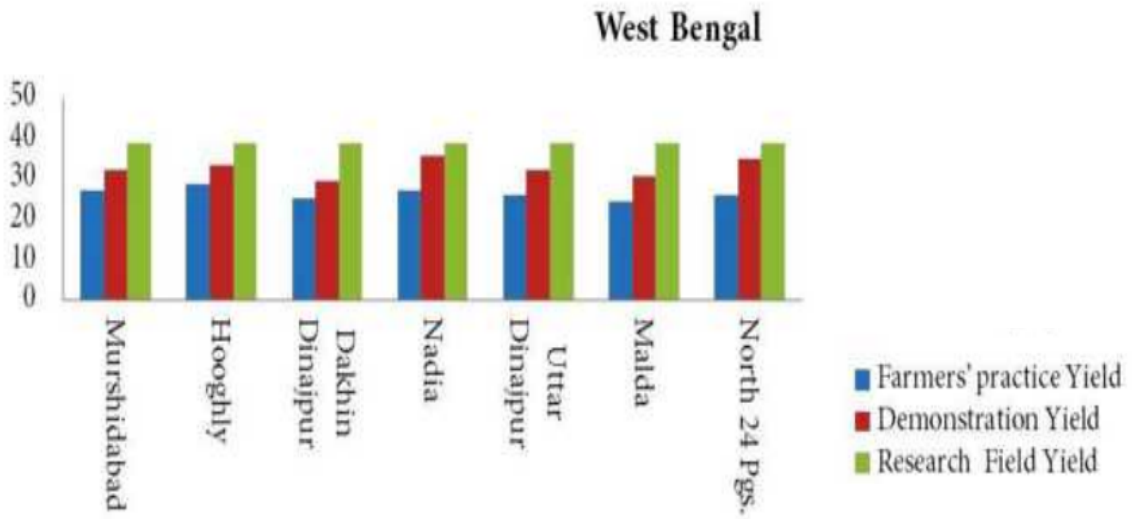

Figure 3: The agricultural yields obtained in the research labs compared to those obtained by farmers in the fields of the Jute growing districts of West Bengal. It demonstrates a significant gap between technology and extension in the case of jute research (ICAR- Central Research Institute for Jute and Allied Fibres, 2021).

The Central Research Institute for Research in Jute and Allied Fibres (CRIJAF) developed the SONA microbial consortia to increase fibre yield by 20% and grade by at least 1 ½ grades. Moreover, regular SMSs in regional languages on improved jute growing practices are provided to registered farmers. For demonstration purposes, seed drills and nail weeders were supplied to the farmers (Ministry of Textiles, 2017).

For the past seven years, NJB has been conducting the Jute-ICARE (Improved Cultivation and Advanced Retting Exercise) project in phases in collaboration with Jute Corporation of India Ltd. (JCI) and the Central Research Institute for Jute & Allied Fibres (CRIJAF) Ministry of Agriculture. The project has also been maintained under the National Jute Development Programme (NJDP), which has been approved for the years 2021-22 to 2025-26. Jute I CARE's physical achievements during 2015 - 2022 are depicted in table 1 (Ministry of Textiles, 2021).

Table 1: Jute ICARE's achievements during the period 2015 - 2022 (Ministry of Textiles, 2021)

Particulars	**ICARE-I (2015-2016)**	**ICARE-II (2016-2017)**	**ICARE-III (2017-2018)**	**ICARE-IV (2018-2019)**	**ICARE-V (2019-2020)**	**ICARE-VI (2020-2021)**	**ICARE-VII (2021-2022)**
No. of jute growing block/ state covered	4 blocks under West Bengal and Assam	14 blocks under West Bengal, Assam, Bihar, Odisha, Andhra Pradesh and Meghalaya	30 blocks under West Bengal, Assam, Bihar, Odisha, Andhra Pradesh and Meghalaya	69 blocks under West Bengal, Assam, Bihar, Odisha, Andhra Pradesh and Meghalaya	72 blocks under West Bengal, Assam, Bihar, Odisha, Andhra Pradesh and Meghalaya	130 blocks under West Bengal, Assam, Bihar, Odisha, Andhra Pradesh, Tripura and Meghalaya	140 blocks under West Bengal, Assam, Bihar, Odisha, Andhra Pradesh, Tripura, and Meghalaya

Land covered (ha)	12331	26264	70628	98897	106934	110893	125000
No. of farmers covered	21548	41616	102372	193070	243549	258324	30000
Certified jute seed provided (in MT) JRO204 & JBOH2003H variety	64	160	500	755	535	604	35 +765 on commercial basis
Seed drill machine	350	700	1200	1950	2550	3150	4150
Nail weeder machine	500	700	1200	1950	2850	3750	4950
CRIJAF SONA (MT)	83	273	206	610	612	500	650

The annual report of the Ministry of Textiles (Ministry of Textiles, 2021) stated that there was a significant achievement in jute production (yield) from existing 22/23 quintals per hectare to 26/28 quintals per hectare under the I-CARE program. The quality of jute fibre was observed to be one grade high. Moreover, there was an increase in Farmers' income by approximately €113,27/- per hectare as a result of improved productivity and quality (ICAR- Central Research Institute for Jute and Allied Fibres, 2021).

The following technologies were developed under the ICARE scheme:

Seed drill

Figure 4: Seed drill pulled by a jute farmer (Shambhu, 2019).

Jute farmers have traditionally used the broadcast method of sowing to take advantage of the limited soil moisture availability caused by summer rainfall (Chatterjee, 2022). Due to the small size of the seeds and the low rate, it is difficult to maintain the recommended seed rate in this method. Farmers

typically use a larger seed rate (7-8 kg/ha) than advised (Chatterjee, 2022). The overall yield of fibre decreases by about 10% to 15% as a result of uneven plant population and higher plant density (Chatterjee, 2022). This low-cost manual-driven Multi-Row Seed Drill has been created by ICAR-CRIJAF (Chatterjee, 2022). It helps to maintain an optimal plant population, thereby increasing productivity and production while being less expensive.

ICAR-CRIJAF Nail-weeder:

Figure 5: A farmer using ICAR-CRIJAF Nail-weeder (Banabethi, 2018)

The jute growers of West Bengal were facing the problem of weed infestation in their fields be it broad-leaved or sedge-type (Jha et al., n.d.). The herbicides available in the market were not effective in their field situations, restricting them from using them on a limited scale. Therefore, they were forced to depend on manual weeding (Jha et al., n.d.). This results in delayed completion of weeding and reduced farm profitability due to heavy dependency on manual labour (Jha et al., n.d.). This technology was disseminated by the peer farmer who was trained by the extension scientist of ICAR-CRIJAF and then transferred the technology by teaching fellow farmers (Jha et al., n.d.).

Microbial consortium

Due to the scarcity of slow-flowing water sources, the retting process in west Bengal was done on the roadside ditches, canals, ponds, and other stagnant water sources and this results in low-quality fiber quality (Jha et al., n.d.). As a result, they earned meager prices in the market. Moreover, the conventional retting technology took 21 days for the retting process (Jha et al., n.d.).

The CRIJAF microbial consortium also known as CRIJAF SONA was developed to get good quality jute fibre in stagnant water. It was observed that with the help of CRIJAF SONA the number of retting days was also reduced. It took 6-7 days less than the conventional retting process. Furthermore, the quality of fiber was also improved by 1-2 grades (Jha et al., n.d.).

HYV seed

Figure 6: The image provides a visual representation of the appearance of jute seeds (Indiamart, n.d.)

For jute cultivation, several varieties of jute seeds are available such as JBO-2003H (Ira), JRO-204 (Suren), S-19 (Subala), JRO-8432 (Shakti), JRO-128 (Surya), JRO-66 (Golden Jubilee Tossa), JRC-80, JRC-698, CO-58 (Sourav), JBO-1 (Sudhangshu), JBC-5 (Arpita), RRPS-27-C-3 (Monalisa) (National Food Security Mission., n.d.). But in the ICARE scheme, the JRO-204 variety of jute seeds was recommended (Singh et al., 2022). By integrating a pre-mature flowering resistance gene of African origin, the improved variety (JRO 204) of Tossa jute (Corchorus *olitorius*) changed the area where white jute (Corchorus *capsularis*) predominated and increased the yield of fibre (Singh et al., 2022). Moreover, they are reducing the detrimental environmental effects associated with increased levels of ozone (Singh et al., 2019).

3.6 Environmental and social objectives of the jute ICARE scheme

Based on the document review and analysis through the DPSIR framework, I identified the original motivation, and the intended environmental and social outcomes of the jute ICARE scheme by policy-makers.

As shown in Figure 4. DPSIR, the effects of climate change ('**D**river') in recent years have led to erratic rainfall and weather patterns, which has caused a severe ecological imbalance ('**P**ressure'). More importantly, such effects have caused a rapid deterioration in crop productivity and fibre quality for rain-fed crops like jute ('**S**tate'). With declining productivity and quality, the livelihoods of the jute farmers in the eastern part of India have also been adversely affected ('**I**mpact'). To mitigate this situation, the Government of India launched the Jute ICARE scheme ('**R**esponse') intending to enhance the livelihood of jute farmers through the mass upscaling of improved jute production technologies (as shown in Figure 7):

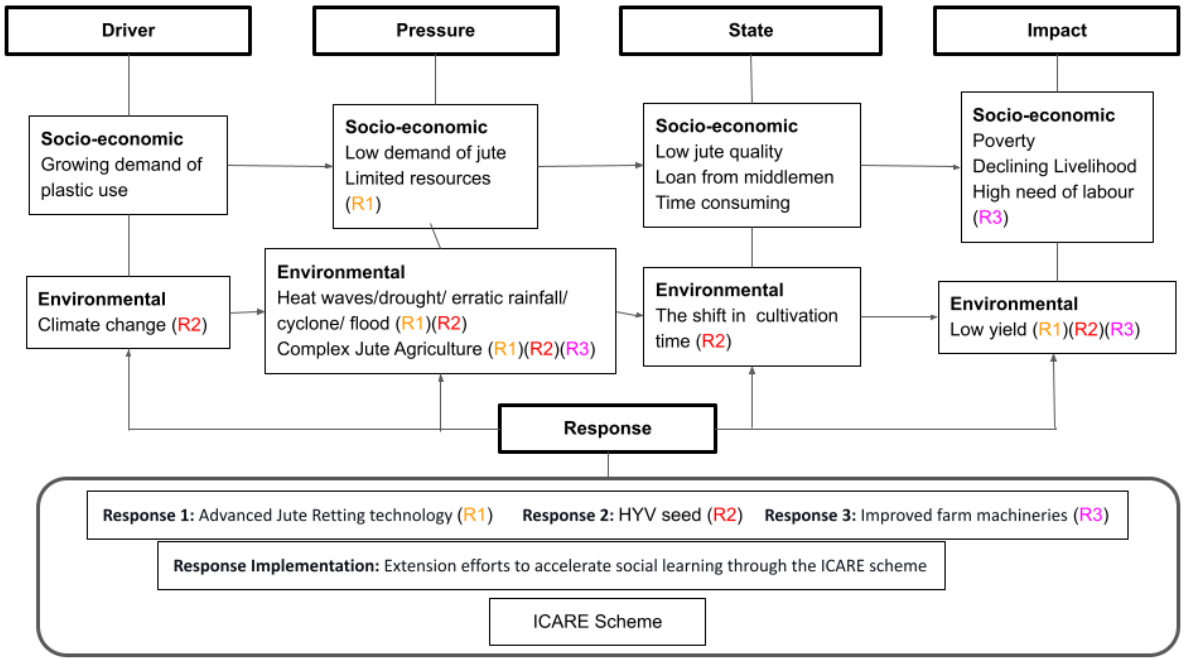

Figure 7: A DPSIR framework for the effects of climate change (including socio-economic ramifications) on jute cultivation with the ICARE scheme as a response (own illustration).

*3.6.1 **Response 1:** Advanced Jute Retting technology*

Jute is a rain-fed crop and traditionally has been dependent on natural rain cycles for cultivation in India (Majumdar et al., 2020). As discussed in section 1.2, the extraction of jute fibre from the crop is done through another water-intensive process known as jute retting. Water is the most important ingredient for the success of the retting process (Majumdar et al., 2020). In this process, the water is used to provide enough moisture for microorganisms to decompose the cellular tissues around the fibre bundles attaching them to the stem. To enable such an environment, the jute stems have to be submerged completely in the water for around 3 weeks (Majumdar et al., 2020). Finally, the fibres have to be thoroughly cleaned through multiple batches of washing with water (Majumdar et al., 2020). Additionally, the retting process requires free-flowing water which leads to an exorbitant wastage of already scarce water supply for the jute cultivators. The quality of the resulting jute fibres depends on how thorough the retting process was, adding to the water costs for the jute cultivators. To give an estimate of the amount of water used for retting through this conventional method, around 50,000 liters of water is used in the retting process for jute grown in 0.13 ha of land (Majumdar et al., 2020). In addition to requiring large quantities of water for the retting process, the water from the retting process through the traditional process is of very poor quality and is often unfit for reuse in other agricultural activities (Das et al., 2014).

With the erratic patterns of rain, jute farmers have to compromise on the distribution of water for cultivation versus retting (Ray et al., 2016). This is not only hampering the productivity of the jute crops, but the scarcity of water during the traditional jute retting process is leading to lower-grade jute fibres (Ray et al., 2016). The lower quality and quantity of jute fibres are having a direct impact on the livelihoods of the jute farmers and the rural population around the jute cultivation regions in the states of West Bengal, Assam, and Odisha.

In light of the prevailing situation, the policy-makers in the central government of India identified the jute retting process as a high-priority method in need of optimization to effectively alleviate the water scarcity impacts. The ICARE scheme was launched by the central government of India in 2015, which started by initiating research in Indian Council of Agricultural Research (ICAR) research institutes to develop technologies that can engender thorough retting of the jute fibres with limited water supply. The Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore played a central part in these research and development projects and made a breakthrough by developing a special consortium of microbes that could carry out thorough retting of jute fibres with significantly less water and also in an expedited manner. This microbial consortium was christened the 'CRIJAF SONA' and it reduced the water requirements by around 75% since it could be used in *in-situ* retting tanks as opposed to free-flowing water while also reducing the retting period from 3-4 weeks down to 1 week (Jha et al., n.d.). This optimized retting process not only reduced the time and water resources significantly but improved the quality of jute fibres by two grades (Jha et al., n.d.). Additionally, the residual water with the consortium of microbes also can be used as soil nutrients (Jha et al., n.d.). Upon reaching this milestone, the government was able to distribute the CRIJAF SONA technology among 360 thousand jute farmers in different jute-growing states of the country (Indian Council of Agricultural Research, n.d.).

Another breakthrough was made in a sister ICAR jute research institute National Institute of Natural Fibre Engineering and Technology (NINFET), which did not introduce any new microbe in the retting process but developed a microbial food supplement that accelerated the growth of native pectinolytic and xylanolytic microbes responsible for jute retting (Ray et al., 2022), thus improving the quality of the retting process without the need of huge quantities of water. This microbe nutrient solution was christened the 'NINFET-Sathi'. This formulation improved the quality of the fibre from TD-3 (using conventional methods) to TD-2 (using NINFET-Sathi) (Ray et al., 2022). It also cuts down the retting time significantly from 3-4 weeks to around 10-12 days and thus reduces the water requirement. The effective income of jute growers is projected to increase €181,29 to 226,61 per ha

by increasing the fibre yield significantly (Ray et al., 2020). Furthermore, the post-retting water containing NINFET-Sathi was found to meet water standards for aquaculture and irrigation and could be repurposed for irrigation of other crops like rice, Bengal gram, and Indian mustard (Ray et al., 2022). The Government estimated that the application of NINFET-Sathi retting technology holds the potential for jute farmers to harness a net additional income of nearly USD 257 per ha. (Ray et al., 2022).

The above innovations in jute retting are made available free of cost to the ICARE scheme registered farmers (National Jute Board, n.d.). The general mode of distribution is through popularization programs which the Jute Corporation of India (JCI) holds at different jute cultivation villages to showcase the developments with the ICARE scheme. Participating farmers are informed about the potential of these breakthroughs and provided with the NINFET-Sathi and CRIJAF-SONA for free. JCI also supplies CRIJAF SONA and NINFET-Sathi through local agencies to ICARE scheme registered farmers (National Jute Board, n.d.). This drive for free-of-charge distribution of these advanced jute retting technologies is to promote awareness among farmers about these technologies to bring about a social and technical change in jute retting from conventional methods.

The overall expectation through these innovations in technologies in the retting process is that these technologies would improve the quality and yield of the jute fibre with reduced water requirements while also making the residual water from retting useful for other agricultural activities like irrigation of crops. Along with the distribution of these technologies and know-how for free among jute farmers, the ICARE scheme is expected to engender a successful social change in the way farmers do the jute retting process.

3.6.2. Response 2: *High Yielding Variety (HYV) seed*

With climate change, there have been more frequent storms, floods, and other natural disasters along with erratic rain patterns (Singh et al., 2018). These changes have adversely affected the jute crop productivity and have significantly impacted the livelihood of the jute farmers (Singh et al., 2018). The government has therefore included the issue of optimizing jute crop productivity in the given climatic trends as part of the ICARE scheme (Singh et al., 2019).

To address this problem, CRIJAF was tasked to develop improved varieties of seeds that are more resilient to climate change as well as biotic stresses such as pest infestation and competition from natural weeds (Singh et al., 2019). ICAR-CRIJAF came up with another innovation breakthrough in this area, by developing an advanced variety of Tossa jute (Corchorus *olitorius*) named JRO 204 (Singh et

al., 2019). This jute variety was developed to decrease the white jute (Corchorus *capsularis*) crop population, which serves as a natural weed crop here, by incorporating pre-mature flowering resistance genes of African origin and improving fibre productivity. In addition to natural weed resilience, the crops from JRO 204 are also taller (10 to 13 feet against the normal height of 9 feet) (Ministry of Textiles, 2017). With longer crop height and natural weak resistance, the JRO 204 seed variety has improved the yield of the jute fibre. Furthermore, the JRO 204 variety was able to withstand drought conditions and was found to be yellow mite infestation resistant (Kar, 2019). The studies by (Singh et al., 2019) showed that JRO 204 has the potential of increasing the crop yield significantly (by 6 q/ha) from conventional seed varieties, resulting in an additional return of INR 22000/ha for the jute cultivators.

Under the ICARE scheme (National Jute Board, n.d.), the Jute Corporation of India (JCI) procures the improved seed variety - JRO 204 from the National Seed Corporation (NSC) and CRIJAF and sells these improved variety seeds at 50% of the market price to jute farmers. The remaining 50% is reimbursed by the Ministry of Agriculture (National Jute Board, n.d.). These improved seed varieties with their climate-resilience, and pest and weed-repellent properties are expected to significantly improve the productivity of jute crops for jute farmers. The farmers are being incentivized by JCI to adopt these seeds by making them available at a heavily subsidized rate (*Subsidy Scheme for Distribution of Certified Jute Seeds by JCI*, n.d.). So by increasing jute productivity and decreasing the cost for jute farmers, the ICARE scheme is expected to engender a successful transition in the way farmers do jute cultivation in the backdrop of climate change.

3.6.3. Response 3: *Improved farm machineries*

Apart from new technology in crop productivity and the retting process of jute, an extra bit of optimization in productivity could be achieved by the mechanization of agricultural practices. Such mechanization reduces human error, as well as reduces the labor cost. In the case of jute harvest and sowing season, there would generally be a scarcity of farm labour since it needed to be done at a particular time of the year for all the jute cultivation farms (Chapke, 2009). It was identified that sowing seeds and weeding are the two most labor-intensive processes that have an opportunity for optimization (Chapke, 2009). Thus, under the ICARE scheme, mechanization for these two processes was undertaken.

In this context, ICAR-CRIJAF came up with technological innovation for both processes. For sowing seeds, correct depth and separation between seeds are crucial to plant seeds at the right depth for

successful germination. Since these tasks are arduous and labor intensive, they are prone to human error which leads to lower yield. CRIJAF came up with a mechanized multi-row seed drill (Shambhu, & Thakur,. 2019). These contraptions were able to precisely sow the seed at the correct soil depth and spacing (plant-to-plant and row-to-row). It was observed that 50% less seed would be sown per hectare, or 3–4 kg (compared to 7-8 kg in broadcast sowing)(Shambhu and Thakur, 2019). Fifteen man-days of labour are saved on weeding and thinning. The manual jute seed drill mainly consists of a seed dispenser-cum-seed box, main shaft, drive wheels-cum-transportation wheels, furrow openers and seed covering device, etc. (Shambhu and Thakur, 2019). The spacing between furrow openers is as per recommended spacing for the olitorius/tossa jute (Shambhu and Thakur, 2019). When the seed dispenser rotates, the seeds are fallen through these orifices in the furrow made by the furrow openers this leads to the line sowing of jute seeds (Shambhu and Thakur, 2019). The CRIJAF-seed drills were distributed through local vendors (National Jute Board, n.d.). It was reported that the adoption of line sowing using seed drills would help in improving crop yield (Kar, 2020). The seed drill diminishes the scope of human error in sowing seed (increasing the germination efficiency to 90-95%), eliminates manpower shortages, and reduces the time of the sowing process (Shambhu & Thakur 2019).

To reduce the cost of weeding and increase the profitability of jute cultivation, CRIJAF also came up with a nail weeder to optimize the weeding process. Field-level testing on weed management through a nail weeder resulted in an increase of 10% in fibre yield gain over the manual weeding process (Kar, 2020). The nail weeder also reduced labour costs by about INR 14,000/ha (Kar, 2020). Additionally, it was shown that crop productivity increased by 18 to 24% while the expense of weeding and crop thinning was lowered by more than 55%. It was experienced that the conventional method of weeding took 8 – 10 man-days. But the CRIJAF nail weeder took 3 hours and 2 labours (Jha et al., n.d.). Therefore, it can be concluded that this machinery was quite productive, less labor-intensive, and took less time (Jha et al., n.d.). The net return after increased crop yield and labour cost savings was shown to be more than INR 32000/ha (Kar, 2020).

Both the process of manual seed sowing and weeding involves lots of drudgeries, especially for women, who are predominantly the farm labour force in rural India, as the critical period for weeding coincides with extremely hot and humid weather. The Jute Corporation of India (JCI) in consultation with the National Jute Board (NJB) procures Multi-row Seed drill and Nail Jute Weeder via a certified vendor from CRIJAF. JCI then hands over machines/ tools to local agencies permanently and loans to ICARE-registered farmers free of charge (Kar, 2019).

The overall impact of the mechanized seed drill and nail weeder is to reduce human labour costs, save time and maintain precision in the two most important steps in the life cycle of crop cultivation for maximizing yield. JCI conducts regular demonstrations for jute farmers to increase their awareness about the state-of-the-art mechanized tools available and how to access them to bring a social transition among jute farmers dependent on labour and time intensive, as well as error-prone manual steps (*Jute I-CARE – The Jute Corporation of India Limited*, 2021).

3.6.4. Response Implementation: *Extension efforts to accelerate social learning through the ICARE scheme*

To accelerate social learning to adopt the practices of the ICARE scheme, the awareness and popularization of the technologies among end-users are crucial. For the ICARE scheme, the central government's ministry of Textile advises all state Chief Ministers of the jute-growing states to incorporate the jute ICARE scheme under their respective state-level schemes - Rashtriya Krishi Vikas Yojana (RKVY)
(section: Indian Jute Policy) and create awareness among farmers about the ICARE technologies through the state agricultural extension centers, known as Krishi Vigyan Kendra (KVK). States have also been requested to supply farm implements under the Sub-mission in Agricultural Mission (SMAM) and construct Retting Tanks under Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) and RKVY.

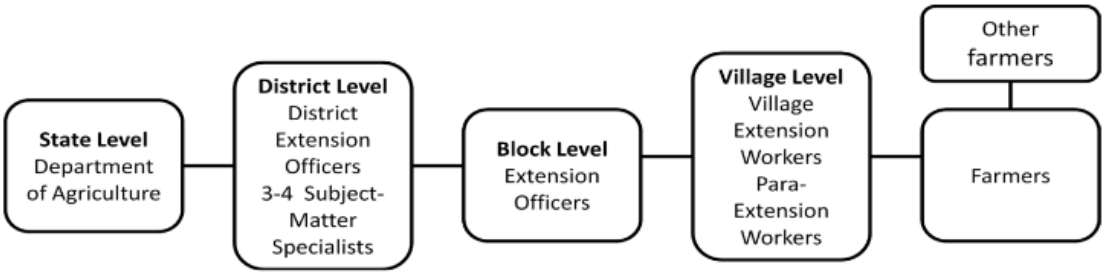

Figure 8: Information flow in the extension activities at the state-level (Claire et al., 2010).

Although Agricultural Extension is organized differently in each state, with wide diversity in personnel numbers and program focus, a generic outline of the information flow at the state level is shown in Figure 8. The extension staff of the state Department of Agriculture (DoA) operate at the district and block levels, which are administrative subdivisions. A block is a subdivision of a district. The numbers and capacity of the staff vary greatly throughout the country (Claire et al., 2010). The state-level extension efforts complement the JCI's outreach and demonstration programs and are expected to accelerate the social learning among jute farmers for adopting ICARE technologies.

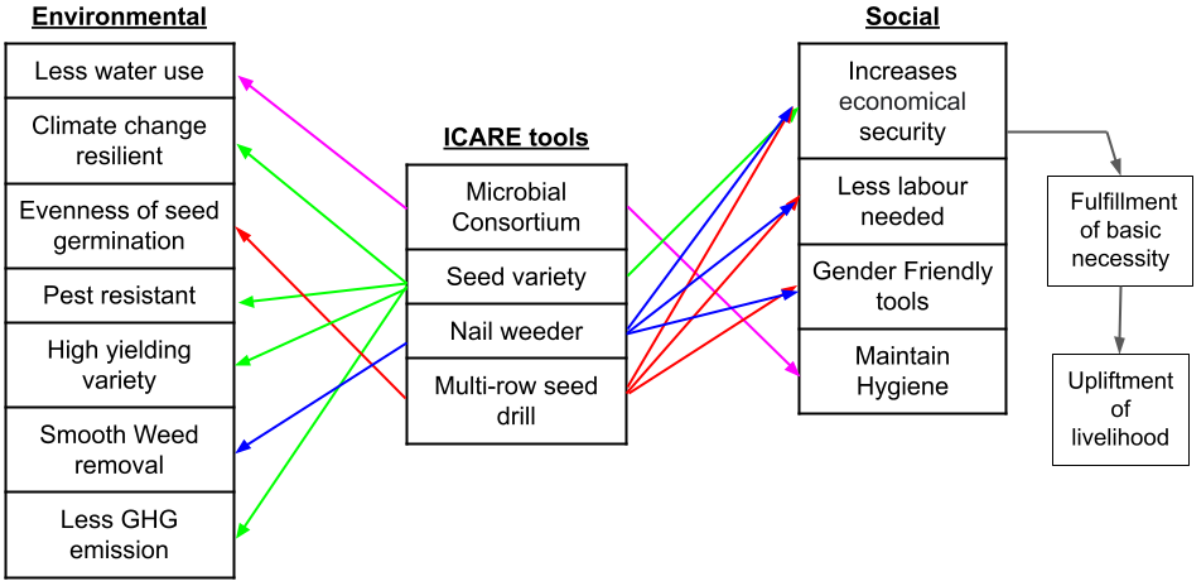

Figure 9: Schematic overview of ICARE technologies and their expected social and environmental impacts (own illustration).

The pain points addressed under the ICARE scheme are the primary bottlenecks in the productivity and fibre quality of the jute crop to cope with climate change. The ICARE scheme has led to the successful development of technology/tools solutions and is currently being promoted widely among jute farmers. It is expected a social change would occur with the mainstream adoption of these technologies in the jute cultivation workflow of the farmers. At the end of the day, these promising technologies/tools developed under the ICARE scheme have the potential of uplifting the livelihood of the farmers by cutting down water consumption, labour, and time expenses and improving the efficiencies in crucial steps in the jute crop lifecycle to increase the net profit from jute cultivation, depicted here in the schematic overview in Figure 9.

4 Methodology

4.1 Research Design

To answer the research questions, fieldwork in West Bengal was undertaken between September to November 2022 primarily in Nadia, Hooghly, 24 South Parganas, and 24 North Parganas. Primary and secondary data were collected and analyzed as presented in Table 2.

Table 2: Research Design.

Research questions	Data	Method
RQ1. How is the jute ICARE scheme perceived by the farmers?	Interview results	Thematic analysis & Semi-structured interview
RQ2. What are the challenges of the jute ICARE scheme implementation?	Literature review & Interview results	Literature review & interviews
RQ3. How can these challenges be addressed?	Literature review & Interview results	Literature review & interviews

4.2 Data Collection

Through the use of a literature review and primary data through semi-structured interviews, the thesis successfully addresses the chosen research questions and objectives.

4.2.1 Literature review

The initial research strategy of a thesis was to review the literature to understand the different policies about jute, I selected the jute ICARE scheme for my research as the policy is dealing with the pivotal point of the jute sector, and identify the key actors (Bryman, 2012; Hancock & Algozzine, 2006). The entire research process was constantly accompanied by literature searches on LUB search, Scopus, and Google Scholar. The goal was to understand the social and environmental outcome of the Jute ICARE scheme and also understand the jute ICARE scheme is different from conventional jute cultivation. With the help of the literature review, I was able to understand the objectives of jute ICARE scheme. As the thesis is focused on West Bengal it is important to comprehend the socioeconomic composition of the research location to understand the impact and adaptation of the Jute ICARE scheme. As a result, information on the socioeconomic indicators and agro-climatic conditions of the research region was gathered from several sources. For this research, a combination of peer-reviewed literature and gray literature was utilized. In total, 47 sources were examined, with 38 of them being peer-reviewed literature and the remaining 9 classified as gray literature.

4.2.2 Semi-structured interviews

I conducted a field survey according to an organized interview schedule. I visited four districts of West Bengal viz. Hooghly, Nadia, 24 Parganas (North) and 24 Parganas (South). To answer RQ1, semi-structured interviews were conducted with farmers to understand their perception of the jute

ICARE scheme. The interview was semi-structured to allow flexibility to pose follow-up questions to further substantiate answers (Roulston & Choi, 2018). A total of 58 participants were interviewed, including 19 from Nadia district, 15 from Hoogli district, 17 from North 24 Parganas district, and 7 from South 24 Parganas district. The inclusion of participants from different districts allowed for a comprehensive analysis of the ICARE scheme's implementation, while the control plot interviews in South 24 Parganas aided in identifying gaps and variations. For further details regarding the questions asked to the participants, please refer to the Appendix A

4.3 Data analysis

As discussed in section 3, the first theoretical framework - the DPSIR framework (section 2.1) was employed during the literature review to carefully understand the interactions between society and the environment and identify the states and impacts which led to the ICARE scheme (the response). The DPSIR analysis revealed the drivers viz. adverse effects of climate change such as erratic rainfall and weather patterns which lead to the implementation of ICARE scheme as the response. The semi-structured questionnaires were designed to focus on capturing the strength and weaknesses of the various aspects of the response to the drivers, from jute farmers. Thematic analysis (discussed below) of the responses of jute farmers to the semi-structured questionnaire revealed the successes and gaps in the perceived effects of the ICARE scheme and the ground reality. Finally, the second theoretical framework - the social learning theory (section 2.2) was used to understand the challenges in implementing the ICARE scheme that led to those gaps and insights into potential solutions to some of those challenges.

4.3.1 Thematic analysis

I used Thematic analysis to examine the data from the semi-structured interviews to respond to RQ1. I utilized a qualitative data analysis technique called thematic analysis, which allowed me to organize the data into manageable topics and draw inferences from it (Kiger & Varpio, 2020; Castleberry & Nolen, 2018). My aim was to gain a deeper understanding of how the jute farmers perceived different aspects of the responses and initiatives. I employed the five-step Castleberry and Nolen (2018) technique: Compiling, dissembling, reassembling, interpreting (based on the number of times a particular topic was mentioned), and concluding.In order to address RQ2 and RQ3, I critically analyzed the findings from the literature review and RQ1 to identify the barriers to implementing the Jute ICARE plan between the two communities of practice. My objective was to determine how I could overcome these barriers by applying the principles of social learning theory.

4.4 Research ethics

According to Bryman (2012), the first ethical concern to consider is if the participants are experiencing any damage. Especially when dealing with small and marginal jute farmers, it is important to consider how the presence of research might affect them. In certain rural communities in India, oral communication holds significant cultural significance and is often perceived as a preferred mode of interaction. These communities tend to place a higher level of trust in face-to-face engagements, which can foster a greater sense of comfort and understanding between researchers and farmers. Acknowledging these cultural norms, I opted to obtain verbal consent from the respondents during our research endeavors.

To ensure clarity and transparency, I provided a comprehensive overview of our research objectives and the nature of the inquiries I intended to make. By engaging in verbal communication and seeking permission directly from the farmers, I aimed to establish a mutually respectful and informed environment conducive to meaningful participation in the research process. This approach allowed us to cater to the preferences and cultural nuances prevalent in the communities I worked with, promoting a higher level of engagement and cooperation. I also send our interview questionnaires to village leaders so that there is good supervision.

4.5 Selection and description of study area

I conducted this study in two villages from each of the four jute-growing districts in West Bengal, namely Nadia, Hooghly, North 24 Parganas, and South 24 Parganas. The primary aim of the study was to investigate the benefits of jute-ICARE technologies. To gather data for our research, I employed a semi-structured interview schedule and interacted with a total of 58 respondents. This approach allowed me to elicit comprehensive information and insights from the participants, ensuring a rich and diverse dataset for our analysis. I purposefully chose West Bengal for this study because I am from this state and I am familiar with the local language. Another reason for selecting these locations is that the jute ICARE scheme has been implemented in all of them except South 24 Parganas. I specifically chose South 24 Parganas as a control plot to better understand and identify any gaps in comparison to the other locations.

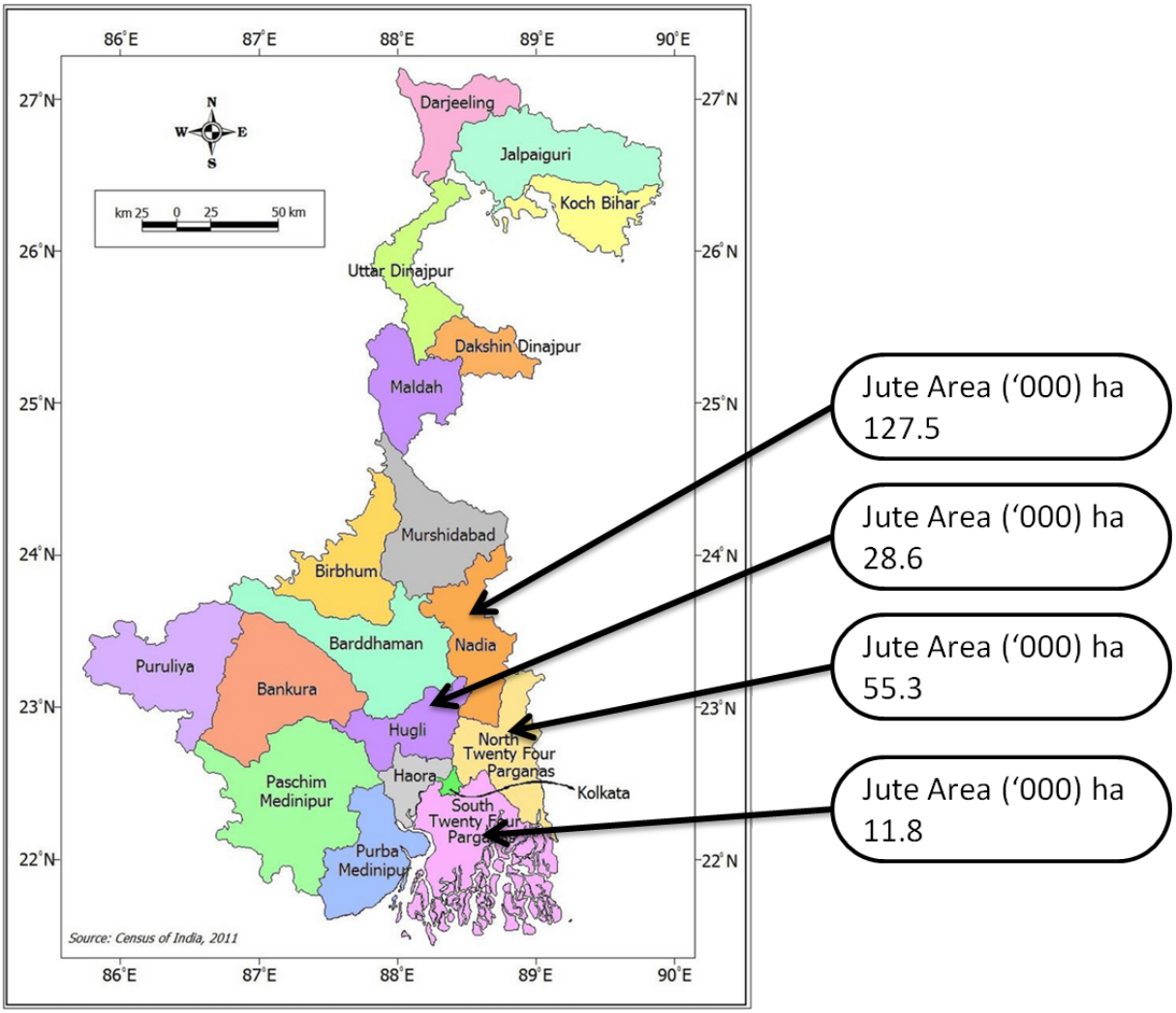

Figure 9: Map of survey area in (Hooghly, Nadia, North 24 Parganas, South 24 Parganas) of West Bengal (Saha, 2021)

4.6 Limitation of research

Some of the major limitations of this research have been discussed here. Additionally, I only interviewed farmers from three districts of West Bengal. It would have been valuable and insightful to interview farmers from other jute-growing districts of West Bengal and other jute-growing states (Assam, Odisha, and Bihar). The thematic analysis I used to parse and identify themes in the semi-structured interviews proved to be a highly flexible tool. However, it is important to note that at times, when developed from smaller study data, it may result in less consistent and cohesive themes. It is also worth mentioning that all the interviews were conducted in Bengali, the local language of the farmers, and subsequently translated into English, which may have led to some loss of context. For a more exhaustive analysis of the ICARE scheme, other stakeholders should have also been considered. It would have also been very insightful to interview more actors involved in the jute

ICARE scheme (CRIJAF scientist, NJB, JCI, KVK extension workers). Finally, the interactions of other jute and agriculture-related policies implemented in the same region with the ICARE scheme should provide a deeper understanding of the dynamics of the scheme.

5 Result and analysis

5.1. Perception of the jute ICARE scheme by the farmer's

Research question 1: How is the jute ICARE scheme perceived by the farmers?

With the help of primary data from semi-structured interviews of jute farmers, I observed a diverse response regarding the jute-ICARE scheme. The thematic analysis of the responses revealed several themes.

5.1.1. Lack of Knowledge

Some farmers were confused or seemed unaware of the name of the ICARE scheme, until I followed up with specific examples of ICARE technologies such as nail weeder, CRIJAF SONA, seed drill, etc. They were able to recognize the individual technologies but were unaware it was developed under the ICARE scheme.

"I don't know anything about any such scheme… Yes, we used CRIJAF SONA powder provided by the (local) ADO (Agricultural Development Office) office for retting jute fibre. In that, we get jute fibre quickly and the quality is very good"

"I use the seed that is provided … because it is cheaper than seed available in the market"

Figure 10: Interaction with jute farmers

This farmer was referring to the improved JRO 204 seeds developed by ICAR-CRIJAF under Jute ICARE and distributed at 50% of the market price by JCI.

In a few cases, the farmers had adopted many technologies from the ICARE scheme without being aware of the existence of such a scheme.

"Agricultural officials came to our village to demonstrate about CRIJAF SONA liquid .. we were told that it was developed by the CRIJAF institute in Barrackpore (West Bengal), but they did not mention this (ICARE) scheme."

There is an inherent value in brand recognition for any public scheme, as the farmers and related stakeholders can understand the complete scope of the scheme (Ferroni & Zhou, 2012). They also can provide feedback about the scheme through proper channels, such that it becomes easier for policy-makers and implementing government bodies to monitor the real-time progress of the scheme and be able to make changes promptly if required (Ray, 2017). Finally, the diffusion of knowledge and adoption of the technologies in the ICARE scheme from one farmer to another farmer is more efficient if there is good brand recognition of the ICARE scheme (Ferroni & Zhou, 2012). There is a wide scope for improvement in information dissemination and brand marketing by the agricultural extension professional at all levels - state, district, block, and local/village levels (Glendenning et al., 2010). One example of a lack of brand awareness about the ICARE scheme that prevented farmers from exploring other technologies was that most farmers did not know about the high-yielding varieties of jute seeds or how to produce them.

"The ADO did not provide any seeds … I did not know there was a common scheme for all these new jute technologies, I assumed CRIJAF SONA was an isolated product of the jute institute (CRIJAF) in Barrackpore."

These farmers did not know they could avail of these high-yielding varieties of seeds for highly subsidized prices under the ICARE scheme.

5.1.2. Popular ICARE tools

Among the adopters of ICARE jute technologies, the CRIJAF-SONA microbial consortium with multi-row seed drill was very popular.

"Using CRIJAF SONA powder I get a golden texture of the fibres and the retting is complete sooner. I no longer use mud and banana leaves to submerge 'jaks' (jute bundles) in the water as it is slow and makes dark patches in the fibre."

"I get CRIJAF SONA powder from the ADO (Agriculture Development Office) for free of charge. With 1 packet I am able to do retting twice on 1 bigha (0.1338 hectares) plot (water pond). It makes the retting process faster and with less water…"

Figure 11: Jute Farmers of Nadia district preparing their field for jute cultivation.

The jute farmers perceived the shortened retting time (retting time of 3-4 weeks was reduced to half) and produced higher quality fibres by the use of CRIJAF-SONA positively.

"We get seed drills at the ADO. These are easy to use, and I save on the labour cost of manual sowing and the number of seeds. Using seed drill plants are enough space that they are able to get sunlight uniformly for growth."

"It is easier for female farm workers to use the seed drill .."

The seed drill improved the efficiency of sowing – it cut down the cost of farm labour, and is convenient to use by farm workers. The seed drill requires fewer seeds than manual sowing which provides better yield due to better arrangement of crops such that they receive adequate sunlight and resources. Such preferences are useful information for policy-makers and research organizations to prioritize further technology development and compare the efficacy of other technologies under the ICARE scheme, as shown for similar case studies of agricultural policies (Ryan et al., 2003; Lemke et al., 2010).

5.1.3. Availability of ICARE tools

Almost 23 farmers out of 58 farmers who have used the multi-row seed drill expressed concerns about the availability of seed drills during the sowing season, as they are shared by many farmers at

the same time. As a result, some farmers still had to rely on manual operations for the sowing process.

"It is very difficult to get seed drill here during sowing season .. I had to do sowing manually this year."

"If seed drills are not available, we have to hire farm laborers who ask for a lot of money … about INR 8000 per bigha. With seed drills, we have to pay only INR 200-300."

Figure 12: The scene depicts an interaction with jute farmers, with one demonstrating jute length on the left, seated farmers engaging in discussion in the middle, and farmer on the right interacting. This clicked in Hoogly, 24 North Parganas and 24 South Parganas.

Allocation of inventory for these technologies/tools should be adjusted based on the demand at the local levels; it generally hinders the adoption of other technologies under the scheme by a wider population of jute farmers if they are unable to access the technologies they are willing (Hopper,1965).

5.1.4. Exploitation by middlemen

Out of 58 farmers, 5 farmers in South 24 parganas were the ICARE schem was not implemented, 7 farmers from Nadia, 3 farmers from North 24 parganas expressed that from the initial stage when the farmers start sowing jute seed, they have to approach the middlemen to help them financially by lending money for the initial capital required for farming.

"I have had to often borrow money from (local) traders to buy seed, and pesticides, on time... we then have to sell our jute fibre to them at the price they set. We do not get good prices."

These local traders (middlemen) in return often fix the price of their produce which is generally at a much lower price. After the extraction of fibre, these middlemen immediately buy the produce at the set lower price even if the quality of the jute fibre is higher and the farmers are unable to bargain. Therefore, they are unable to get fair prices for their good quality fibre. This adversely affects the livelihood of the farmers and hinders them from adopting any new technology.

The above categories in farmers' responses show that there is a sparse adoption of ICARE technologies by the jute farmers' community of practice (defined in section **2.2 Social Learning Theory**). The barriers preventing wider adoption of the ICARE technology and general awareness would be analyzed using social learning theory in the next section.

6 Discussion

I analyze the findings and literature review from sections 2.6 and 5.1 (RQ1) using social learning theory to identify the existing barriers between the ICARE scheme community of practices and the jute farmers' community of practices. I examine all three forms of belonging viz. engagement, imagination, and alignment between the two communities of practice.

Research question 3. What are the challenges of the jute ICARE scheme implementation?

Research question 4. How can these challenges be addressed?

6.1. Engagement

In this section, the belonging of the ICARE scheme community of practice and jute farmers' community of practice are analyzed for engagement through technology adoption and agricultural extension, to understand the existing barriers. With such analyses, the existing barriers between the communities of practice and the opportunities to overcome them can be identified.

6.1.1. Technology Adoption

Under the ICARE scheme, most of the niche technologies were either distributed free of charge or heavily subsidized. However, not all technologies were widely adopted by the jute farmers. Even though the JCI and other relevant institutions have conducted many demonstrations on the benefits of these new technologies in terms of increasing crop yield, fibre quality, and cutting time, labour and water costs to the jute farmers, there are several reasons behind the sparse adoption of these technologies.

The Interviews revealed that a few technologies were more popular among the jute farmers viz. the CRIJAF SONA microbial consortium, and the multi-row seed drill discussed in section 5.2. One of the

reasons was the selective ease of accessibility to these technologies. For instance, the improved climate- and biotic-stress-resistant high-yielding variety of seed JRO 204 is distributed directly from JCI offices, which may not always be in close proximity to some farmers. So, even though those improved seeds are sold at a heavily subsidized rate, the accessibility acts as a barrier to their broad adoption. On the other hand, CRIJAF SONA is available via local ADOs (Agricultural Development Offices) and KVKs (Krishi Vigyan Kendras) and thus happens to be one of the popular technologies among farmers.

The second reason for the sparse adoption of ICARE farm machinery - nail weeder and seed drill is due to the lack of timely availability as discussed in section 5.2. These mechanized tools are generally stocked at local centers and are loaned to farmers for use. However, during the sowing and weeding season, these tools are high in demand. As a result, many farmers who are willing to use the farm machinery do not get them when needed and have to use labour, time, and cost-intensive traditional ways. These farmers typically are not returning users to the technologies and they tend to not rely on them anymore. As a result, wider adoption is hindered.

Finally, existing private/corporate competitors – such as private seed companies which distribute 70% of the seeds to jute farmers, try to outcompete the ICARE technology distribution to maximize their profits (Sarkar and Majumdar, 2016). These companies do a better job in marketing their existing products in comparison to ICARE technologies. Hence, even though ICARE technologies are high-performance and more sustainable, and offered at heavily subsidized prices, the farmers end up buying products from corporate competitors.

Better marketing and ready accessibility of the ICARE technologies would help overcome these barriers.

6.1.2. Agricultural extension and farmers' feedback

The level of awareness about the ICARE scheme among jute farmers seems to be poor. This was apparent from responses during the interviews, as discussed in section 5.2, where many farmers had used ICARE technologies but did not know or were confused about the existence of the ICARE scheme. This suggested that at some point, the farmers had interactions with the extension personnel about the ICARE technologies but failed to learn more about the scheme or its importance. Although such an information gap points to some of the shortcomings of agriculture extension at the local level, there are a few other reasons as well.

The primary reason for the information gap in farmers about the brand recognition of the jute ICARE scheme is some shortcomings in information dissemination by agriculture extension personnel at the local level. There is more focus on demonstrating the technologies than communicating the overall narrative and motivation behind the schemes/policies. Such practices can be attributed to some of the documented weaknesses of the current state of agriculture extension in India, as stated here (Samanta *et al.,*2020). There is a lack of continuous skill upgradation of subject matter specialists (SMSs) or domain experts at the extension centers due to a lack of training facilities and funding. Other associated factors are the service conditions of the KVK scientists are not attractive and uniform, and there is a general job discontentment among personnel. KVKs are understaffed and overloaded with various activities (Samanta *et al.,*2020).

Another reason for the information gap is the general education level of the jute farming community. The jute farmers are generally small or marginal farmers belonging to the lower-income demographic, as discussed in section 1. As a result, they do not have enough education opportunities. Most of them have below secondary level education. It serves as a barrier for them sometimes to understand the intricacies and appreciate the overall policies/schemes. They are also often indifferent to proactively providing feedback about the technologies and ICARE scheme as well as any issues keeping them from using these to the KVKs.

The KVKs should explore other media such as social media – Youtube, Facebook, Whatsapp, etc., in interacting and disseminating information about ICARE and other policies for effective communication. Finally, there should be a proactive effort by the extension personnel as well as the jute farmers in seeking and providing feedback on the different aspects of the scheme they engage with. Such active involvement would help overcome the barrier of information gap and open-mindedness for both communities of practice in improving the scheme.

6.2. Imagination

This section discusses the belonging of the ICARE scheme community of practice and the jute farmers' community of practice through imagination by examining their differences in perspectives to identify the barriers. Their common grounds and shared interests are also evaluated to understand how to overcome these barriers.

6.2.1. Differences in perspectives

The community of practice for ICARE scheme development and implementation has a different perspective than the community of practice comprising jute farmers. The former community is concerned with the falling jute productivity and quality due to climate change and considers jute fibre as an important perspective of natural fibre in reducing plastic consumption, while the latter community is more concerned with the direct impact of waning jute productivity and quality on their livelihood as discussed in section 5.1.

Their approaches reflect this discrepancy in perspectives between the two communities of practice. The community of practice for ICARE scheme development and implementation, therefore, approached the problem by trying to optimize the efficiency and quality of the steps in the jute cultivation and retting process. As a result, technologies were developed to reduce the resource cost - labour, water, and time of different processes. However, for the jute farmers, it was more important to survive and protect their livelihood. Some measures included taking debt from middlemen and selling their produce for lower/unfair prices.

Due to these differences, the adoption of some of the ICARE technologies was hindered. If the farmer had already agreed to an unfairly low price for their produce, there was very little incentive for them to adopt modern ICARE technologies to improve the quality of jute fibre only to enrich the middlemen while settling for unfair prices. So, the ICARE scheme, despite having superior technologies, was not effective on many occasions in influencing the transformation of jute farming practices.

6.2.2. Common grounds and shared interests

Despite the differences between the two communities of practice, both want to improve the productivity, and resilience of the jute fibres and provide more sustainable livelihood for the jute farmers. Jute farmers have also shown higher interest in ICARE technologies like CRIJAF SONA as they can cut down the retting time by half.

So, it is apparent the common ground for both communities of practice is the upliftment of the jute farmers' livelihood. Therefore, through open engagement and suspension of judgment between the two communities of practice, each side can understand other perspectives and issues and leverage the common grounds and shared interests to improve the scheme. Such improvements in the scheme can effectively uplift the livelihood of the jute farmers.

6.3. Alignment

The belonging of the ICARE scheme community of practice with the jute farmers' community of practice is analyzed through alignment to understand how their perspectives and actions can be aligned with each other to overcome the existing barriers.

6.3.1. Aligning perspectives

The policy-makers might have some ideas about the perspectives of the jute farmers, which is reflected by some other policies such as the Kisan credit card (Section: Indian Jute Policy) to help farmers alleviate their financial woes and exploitation from middlemen.

However, it is not clear how much of the policy-makers perspective is known to the farmers. This is indicated from the interview with the farmers in section 5.2, where many of them did not even know the name of the ICARE scheme despite using its technologies. So, it might be likely that the farmer community may not be completely aware of the policymaker's perspective behind the development and implementation of the ICARE scheme.

There are plans for addressing some of the existing concerns and perspectives of the jute farmers by the policy-makers in future iterations of the ICARE scheme. However, the efficacy of such improvements would depend on how accurately the policymakers and the ICARE scheme community of practice as a whole can assess the perspectives of the jute farmer community of practice. The jute farmer community of practice should also engage actively in providing clear feedback to the ICARE scheme community of practice, and gaining more understanding of the big picture and perspectives of the ICARE scheme community of practice.

6.3.2. Aligning actions

There is not much alignment in the actions of the ICARE scheme community of practice and the jute farmers community of practice. The farmers who have benefited from the technologies of the ICARE scheme should also proactively help promote the scheme to their peers for better awareness of the scheme among the jute farmer community of practice.

The ICARE scheme community should prioritize improving the extension around the scheme. It should train the personnel in KVKs to provide personalized counseling using all available schemes to help the farmers. The ICARE scheme community of practice should seek feedback from the farmers about the technologies. The subject matter specialists (SMSs) at the KVKs should be thoroughly trained on the details of the technologies, such that they can explain the technologies to the farmers

efficiently and also can provide consultation with issues occurring while using the technologies. The accessibility of technologies should be improved for farmers to engender a wider adoption of the scheme. Finally, both communities of practice should try to gain more awareness about the state of the climate change trends to align their actions better.

6.4. Contribution to sustainability

In this thesis, understanding the Jute ICARE scheme and its implication for farmers' society, environment, and economy contributes to sustainability science by gaining insights in class of sustainable development problems at the nexus of three sustainability challenges, climate change, water scarcity and land use change (Jerneck et al., 2011). The jute plant has carbon sequestration ability, which can help sequester half a billion tonnes of carbon annually in the tropics, equivalent to 1.8 billion tonnes of carbon dioxide (Mandal et al., 2007). A holistic approach taken here in understanding the socio-political and scientific dimensions associated with the ICARE scheme is crucial for coming up with practical solutions to environmental management problems in sustainability science (Jerneck et al., 2011; Kates & Parris 2005; Bakker et al., 2008). Addressing the shortcomings of the ICARE scheme, as outlined in the thesis, can offer potential solutions that contribute to the expansion of jute cultivation and the production of jute goods. This, in turn, has the potential to foster a shift in consumer behavior, encouraging them to reduce their reliance on plastic. As consumer awareness of the detrimental impact of plastic grows and their preference for sustainable materials increases, there is a corresponding rise in the demand for eco-friendly alternatives like jute. This connection between reducing plastic consumption and the subsequent demand for jute is supported by market trends and studies on consumer behavior. By implementing effective solutions, the ICARE scheme can play a pivotal role in promoting jute cultivation, stimulating the production of environmentally friendly jute goods, and ultimately aiding in the reduction of plastic usage. It will assist in improving the economy by engaging in global commerce (Mandal et al., 2007).

7 Conclusion

This research sought to analyze the implementation of the jute ICARE scheme and identify the barriers and opportunities experienced by jute farmers in adopting the technologies of the ICARE scheme. With the help of a scheme documentation review and DPSIR framework, identified the original motivation, the he environmental and social objectives of the jute ICARE scheme, and the intended effects of the scheme were evaluated. To understand the actual state of the implementation, primary data in the form of semi-structured interviews of the jute farmers in three

jute-growing districts of West Bengal was conducted. With the help of thematic analysis, the common concerns, feedback, and success of the scheme were extracted. Using the lens of social learning theory, the barriers and opportunities for the jute farmers and policy-makers were identified. The main barriers were poor information dissemination by the agricultural extension personnel about the ICARE scheme to the jute farmers. Another barrier was the difference in perspective of the policymakers and the jute farmers about the state of jute production in the backdrop of climate change. Some of the opportunities from barriers were a more holistic approach by the policymakers to understand the perspectives and problems encountered by the jute farmers hindering them from transitioning to improved ICARE technologies. In this context, bolstering the agricultural extension infrastructure with funding and training would go a long way in closing the information gap among jute farmers about the ICARE scheme and also obtaining real-time feedback from farmers to improve the scheme for wider adoption. The policymakers should also leverage other policies to alleviate the associated problems that jute farmers face in adopting the ICARE technologies and improving jute fibre quality and productivity. The jute farmers should also partake in popularizing the technologies they find useful and reach out to the KVKs and other agencies responsible for implementing the ICARE scheme to provide their feedback and suggestions. This research can help identify the specific areas to improve in the jute ICARE scheme such that it reaches its full potential in uplifting the livelihood of jute farmers in India and making the production of jute fibre more sustainable in the face of climate change.

7.1 Future research And Reflection

The Jute ICARE Scheme in India promotes sustainable jute agricultural production. While considering the Social Learning Theory and DPSIR framework, broader aspects such as socio-economic impact, environmental sustainability, market demand, policy support, knowledge dissemination, collaboration, and continuous improvement are vital for its success and long-term sustainability

In future research directions, the other actors in the ICARE scheme should also be studied, including the CRIJAF scientists, NJB, JCI, and KVK personnel. Such would provide an understanding of all the levels and their interactions in the policy. A more holistic approach could also be taken in analyzing the ICARE scheme by considering other policies and their influence on ICARE scheme implementation to gain a deeper understanding of the ICARE policy implementation.

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Appendix A

This section presents the questions of semi-structured interviews conducted with Jute farmers to explore their perceptions and attitudes towards the Jute ICARE Scheme. The interviews provide valuable insights into the farmers' perspectives, allowing for a comprehensive understanding of their opinions regarding the scheme's implementation and effectiveness.

In English

Stakeholders contacted	Example Questions
Jute growers from different districts of West Bengal, India	In how much area you use for cultivating jute crop? Can you explain the jute retting process?

Topic area	Example questions
Stakeholder profile	● Can you introduce yourself? ● How long you are doing jute farming? ● What are the other field crops you grow apart from jute? ● Other than you who else from your family is participating jute farming practices?
Perception towards ICARE scheme	● What are the technologies you are using for jute cultivation? ● Which technology do you think is more effective out of other technologies? ● How you procure the inputs (seeds/microbial consortia/seed drill/weeder machine etc.) for jute cultivation?
Knowledge dissemination	● How you learn to use these ICARE technologies?
Challenges	● What are the challenges you face with ICARE technologies?
Benefit(s)from stakeholder	● After adopting jute-ICARE scheme, do you notice any impact?
Suggestion(s) from stakeholder	● Would you like to share your suggestion(s) to improve jute-ICARE scheme?

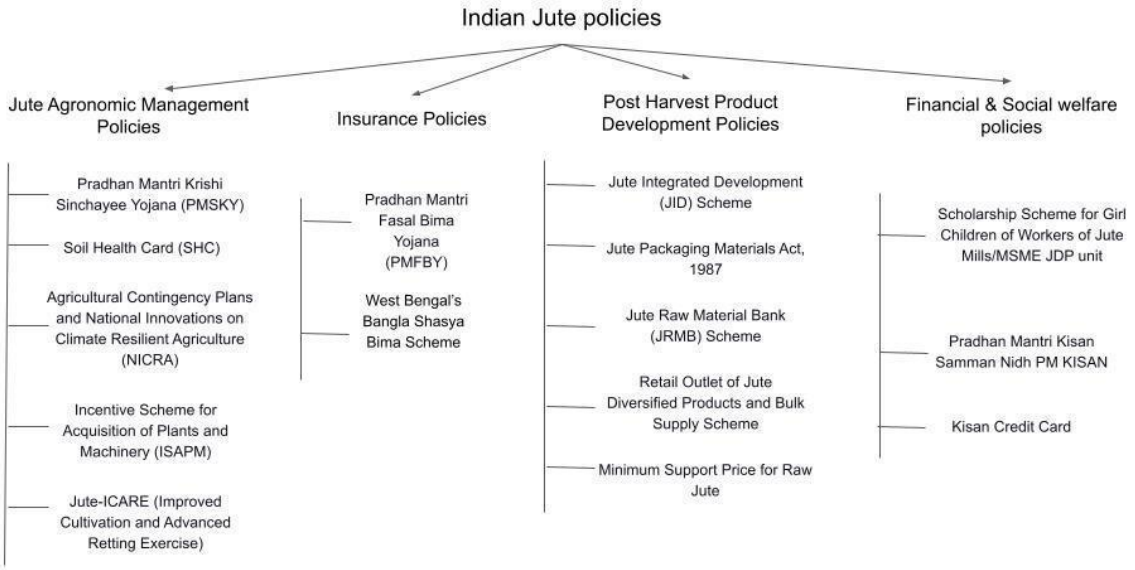
In Bengali

	Example questions
ভারতের পশ্চিমবঙ্গের বিভিন্ন জেলার পাট চাষকারীরা	আপনি কতদিনের জন্য পাট চাষের জন্য কত একর এলাকা ব্যবহার করেন? আপনি পাট আংশিক পাকানোর প্রক্রিয়াটি সম্পর্কে ব্যাখ্যা করতে পারবেন?

বিষয়	প্রশ্নসমূহ
স্টেকহোল্ডার প্রোফাইল	● আপনি নিজেকে পরিচিতি করতে পারবেন? ● আপনি কতদিন ধরে পাট চাষ করছেন? ● পাট ছাষের বাইরে আপনি আর কোন ফসল চাষ করেন? ● আপনার পরিবারের কে আর কে পাট চাষের কর্মসূচি অনুসরণ করছে?
ICARE পরিকল্পনায় প্রতিদৃষ্টি	● আপনি পাট চাষের জন্য কোন প্রযুক্তি ব্যবহার করছেন? ● অন্যান্য প্রযুক্তির মধ্যে কোনটি আপনি আরও কার্যকর মনে করেন? ● পাট চাষের জন্য আপনি কিভাবে উপাদানগুলি (বীজ / মাইক্রোবিয়াল কনসোরটি / সীড ড্রিল / ওইডার মেশিন ইত্যাদি) সংগ্রহ করেন?
জ্ঞান প্রসার	● আপনি কিভাবে এই ICARE প্রযুক্তিগুলি ব্যবহার করার জন্য শিখেছেন?
চ্যালেঞ্জগুলি	● ICARE প্রযুক্তিগুলি সম্পর্কে আপনার কি চ্যালেঞ্জগুলি আছে?
স্টেকহোল্ডারদের উপকার	● Jute-ICARE পরিকল্পনার পরে, আপনি কি কোনো প্রভাব দেখেছেন?
স্টেকহোল্ডারদের পরামর্শ	● আপনি কি জুট-ICARE পরিকল্পনাকে উন্নত করার জন্য কোনো পরামর্শ দিতে চান?

Appendix B

Jute is an important cash crop of West Bengal with increasing demand. However, with the recent trends in climate change, the productivity and fibre quality of the jute crop has been adversely affected. In response to these effects, high-yielding biotic and abiotic stress tolerant seeds, and water conservation techniques have been developed. To disseminate and implement these research outputs and techniques through various policies, the organizations in the government machinery, both federal and state, are used. The key organizations in the government machinery have been described in Table 1. In the following section the government policies/initiatives, which are relevant for addressing the climate change-related issues for jute crops, have been discussed in detail, including how they have been implemented and their resulting impacts so far. Although I have tried to classify these policies into four separate categories, these policies are interlinked to one another and somewhat mutually complementary. Therefore a holistic view of the response to climate change effects on the jute crop should be taken by considering all these policies in tandem.


Indian Jute policies
Jute Agronomic Management Policies
Insurance Policies
Post Harvest Product Development Policies
Financial & Social welfare policies
Pradhan Mantri Krishi Sinchayee Yojana (PMSKY)
Soil Health Card (SHC)
Agricultural Contingency Plans and National Innovations on Climate Resilient Agriculture (NICRA)
Incentive Scheme for Acquisition of Plants and Machinery (ISAPM)
Jute-ICARE (Improved Cultivation and Advanced Retting Exercise)
Pradhan Mantri Fasal Bima Yojana (PMFBY)
West Bengal's Bangla Shasya Bima Scheme
Jute Integrated Development (JID) Scheme
Jute Packaging Materials Act, 1987
Jute Raw Material Bank (JRMB) Scheme
Retail Outlet of Jute Diversified Products and Bulk Supply Scheme
Minimum Support Price for Raw Jute
Scholarship Scheme for Girl Children of Workers of Jute Mills/MSME JDP unit
Pradhan Mantri Kisan Samman Nidh PM KISAN
Kisan Credit Card