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ग्रामीण समृद्धि के लिए राष्ट्रीय विकास बैंक

Vision

Development Bank of the Nation for Fostering Rural Prosperity

मिशन

सहभागिता, संधारणीयता और समानता पर आधारित वित्तीय और गैर-वित्तीय सहयोगों, नवोन्मषों, प्रौद्योगिकी और संस्थागत विकास के माध्यम से समृद्धि लाने के लिए कृषि और ग्रामीण विकास का संवर्धन

Mission

Promote sustainable and equitable agriculture and rural development through participative financial and non-financial interventions, innovations, technology and institutional development for securing prosperity

RESEARCH CHRONICLE

July 2025

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Message from Chairman

Research and development (R&D) serve as the foundation for progress in agriculture and rural development. NABARD is committed to driving change, nurturing innovation, and strengthening the rural economy. It supports research on various aspects of agriculture, rural development, and related sectors, providing valuable insights into key challenges faced by farmers and rural communities. This Research Chronicle is a biannual publication of the Department of Economic Analysis and Research (DEAR) that aims to promote wider readership and facilitate a deeper understanding of the findings and policy recommendations resulting from the studies funded by NABARD's R&D initiatives.

The fourth edition of the Research Chronicle includes five articles authored by the Principal Investigators of completed studies on topics like the impact of long- term refinancing, Self Help Groups (SHGs) and Joint Liability Groups (JLGs), the participation of farmers and challenges in connecting the Agricultural produce Market Committee (APMC) to the electronic National Agriculture Market (e-NAM).

While presenting this edition of the Research Chronicle, I commend the Department of Economic Analysis and Research for its dedication in producing this insightful publication. I am confident that this publication will shape policy discussions within the organization and contribute significantly to the public discourse on farmers' welfare.

Shaji K.V.
Chairman

Message from Deputy Managing Director

NABARD plays a significant role in supporting research and development initiatives in the agricultural and rural sector, which in turn, helps foster innovation, entrepreneurship, and sustainable development in rural areas. Through collaborative engagement with researchers, institutions, and grassroots innovators, we strive to drive transformative change-enabling adoption of modern agricultural practices, promoting sustainable livelihoods, and fostering inclusive growth.

The fourth edition of the *Research Chronicle* presents significant findings and recommendations from completed studies, supported under NABARD's Research and Development Fund. These studies address a broad spectrum of agricultural and rural issues, such as the low adoption of Kisan Credit Card (KCC) scheme, issues and prospects of Indian handloom industry, impact of solar powered irrigation pump sets, etc. offering valuable insights and solutions.

I am delighted to introduce the fourth edition of *Research Chronicle* and extend my heartfelt congratulations to all contributing authors and the Department of Economic Analysis and Research (DEAR) for their commendable efforts. Their contributions to policy discourse help generate actionable insights that drive sustainable change at the grassroot level.

Dr. Ajay K Sood
Deputy Managing Director

Preface

Agriculture and rural development are dynamic fields, constantly evolving in response to emerging challenges. At the heart of this transformation lies Research and Development - a catalyst for innovation, sustainability, and community resilience. Whether it's enhancing food security, promoting eco-friendly practices, or understanding the livelihood experiences of farmers, research and development (R&D) plays a pivotal role in shaping India's rural future. For over 40 years, the Department of Economic Analysis and Research (DEAR) has been committed to supporting meaningful, impact-driven research. Through R&D Fund, DEAR has collaborated with reputed research institutions to carry out studies that reflect the real-world complexities of rural life and agricultural policy on the ground. These studies don't just generate knowledge - they offer actionable insights for NABARD and policymakers alike.

Traditionally, the findings from these studies have been published in the *NABARD Research Series*. However, acknowledging the need for more accessible and reader-friendly formats, NABARD launched the *Research Chronicle* - a publication that distills the essence of these studies into engaging articles authored by the principal investigators themselves. The goal is to expand the reach of this knowledge, foster dialogue, and encourage the practical application of insights. Now in its fourth edition, the *Research Chronicle* continues this mission. This edition features five thought-provoking articles, each bringing forward unique perspectives and evidence-based observations from the field.

The first article which is authored by Prof. Jyoti Chandiramani, Niharika Singh and team evaluates the socio-economic impact of NABARD's long-term refinance to SHGs and JLGs across Bihar, Maharashtra and Tamil Nadu, highlighting improvements in financial access, women empowerment and livelihood outcomes. The second article authored by Prof. Saudamini Das examines the factors affecting the low adoption of Kisan Credit Card (KCC) scheme in Uttar Pradesh, Bihar, and West Bengal, despite its benefits for small and marginal farmers. The third article written by Dr. Vani Harapanahalli and Appalayya Meesala investigates the decline of the Indian handloom industry, its current challenges, and proposes strategic pathways for its revival to help formulate effective

policies. The fourth article authored by Dr. Annasamy Narayanamoorthy highlights the significant increase in groundwater irrigation in India, its benefits and challenges, and the role of solar-powered irrigation pumps in mitigating groundwater over-exploitation and reducing electricity consumption. The fifth and last article authored by Dr. R. L. Manogna explores adoption and benefits of e-NAM in Goa, highlighting its potential to improve market access and income for farmers, while addressing challenges in infrastructure, digital literacy, and stakeholder awareness.

We would like to express our heartfelt thanks to Shri Shaji K. V., Chairman, NABARD, and Dr. Ajay K. Sood, Deputy Managing Director, for their visionary leadership and unwavering support in bringing out the fourth edition of the *Research Chronicle*. Their continued encouragement has been instrumental in shaping this knowledge initiative. We also gratefully acknowledge the efforts of Dr. Ashutosh Kumar, General Manager, Dr. Sohan Premi, Deputy General Manager, Ms. Anshumala, Assistant Manager, Ms. Bhakti Dogra, Economist and the dedicated team overseeing research initiatives under the R&D Fund of NABARD.

It is our belief that this publication will serve as a valuable resource for researchers, practitioners, and policymakers alike - offering meaningful insights into the evolving landscape of Indian agriculture and rural development.

Kuldeep Singh
Chief General Manager
Department of Economic Analysis and Research
NABARD, Head Office, Mumbai

Impact Evaluation Study on Long-Term Refinance Flowing to SHGs/JLGs

Dr Jyoti Chandiramani[1], Dr Niharika Singh[2], Sneha Kumari[3], Gargi Patil[4], Shuchi Misra[5], and Anagha Mitra[6]

Introduction

Microfinance is a financial service that provides small loans and other financial services to underprivileged and low-income households. Designed for promoting financial inclusion, which in turn helps low-income households increase their income levels, microfinance aims at poverty reduction and women empowerment – in both urban and rural areas. The Indian microfinance sector has witnessed phenomenal growth over the last three decades (especially after 1991) in terms of increase in the number of institutions providing microfinance and the quantum of credit made available to microfinance customers (RBI, 2021).

NABARD plays a key role in India's microfinance sector, supporting capacity building, awareness, and exposure for NGOs and SHGs. In collaboration with banks, governments, and NGOs, it has launched various initiatives to improve the lives of marginalized groups, especially rural women. NABARD's microfinance initiatives have thus significantly contributed to the development of rural areas by providing cost-effective and sustainable credit to the rural poor (RBI, 2008). Since 2006, NABARD has supported the Micro-Enterprise Development Program (MEDP) for matured SHGs and launched the Livelihood and Enterprise Development Program (LEDP) in 2015 to enhance employment opportunities and living standards. The study titled "Impact Evaluation Study on Long Term Refinance Flowing to Self- Help Groups (SHGs)/Joint Liability Groups (JLGs)" has been insightful in understanding the role of Self-Help Groups (SHGs) and Joint Liability Groups (JLGs) in improving the overall socio-economic conditions of the women. The major objective of the study has been to understand the impact of NABARD refinances on the Self-Help Groups (SHGs) and the Joint Liability Groups (JLGs) for the 03 States of Maharashtra, Tamil Nadu and Bihar. The study also focused on the health and sanitation needs of members, as well as

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financial literacy across three states. It highlighted how local conditions, and cultural factors influence financial awareness and literacy, which are key to financial inclusion.

There has been incredible growth in the number of SHGs in India and across the globe. India had over 112.23 lakh SHGs with 72 million members, including those set up before the National Rural Livelihood Mission (NRLM) in 2021. SHGs and JLGs have significantly contributed to women's empowerment by providing poor women in rural India with financial access and promoting socio-economic self-reliance.

Research Methodology

The study focused on three states - Bihar, Maharashtra, and Tamil Nadu - selected for their significant number of SHGs and JLGs. Maharashtra leads with 12.13 lakh SHGs, followed by Bihar with 9.18 lakh SHGs, and Tamil Nadu with 9.03 lakh SHGs. These states together account for 30.34 lakh SHGs, or 27 per cent of India's total 112.23 lakh SHGs (Microfinance of States in India, NABARD, 2021). Out of the total 91.29 lakh JLGs in India, the southern states, including Tamil Nadu, lead with 1.27 lakh JLGs financed in FY 2020-21 (Deshpande & Khanna, 2021). A multistage stratified sampling method was used to select states, districts, and blocks based on SHG numbers and geographical diversity. Data was collected from banks in the selected districts, with SHG and JLG leaders interviewed using semi-structured questionnaires, and individual members interviewed voluntarily. Details of districts/SHG/JLG covered in the study are presented in Table 1.

A total of 32 SHGs and 46 JLGs from 12 districts across three Indian states were surveyed, with control groups selected using purposive sampling. Of the 32 SHGs, 7 were in the control group and 25 in the experiment group, covering 96 SHG members and 129 JLG members. The experiment group was analyzed for socio-demographic features, and its impact on economic and social indicators was compared to the control group. In Bihar, all SHGs were part of the state-led 'Ajeevikas', while none of the NABARD refinanced SHGs in Tamil Nadu were part of the state-led SHGs.

This study uses both qualitative and quantitative methods for data analysis. To ensure diverse perspectives and eliminate bias, data triangulation was applied, incorporating field notes, focus group discussions, observations, stakeholders, and literature review.

Table 1: Details of the sample covered for the study

S. No.	Units	Number	Remarks
1	States	3	Maharashtra; Bihar; Tamil Nādu
2	Districts	12	Maharashtra (3) Tamil Nadu (3) Bihar (6)
3	Blocks		Blocks identified based on the purpose
4	Villages		Villages where SHGs/JLGs are prominent; Villages that are accessible
5	**SHGs**	**32**	
6	Experimental SHG Groups	25	Tamil Nadu – 9 Bihar – 10 Maharashtra - 8
7	Control SHG Groups	7	Tamil Nadu - 3 Bihar – 3 Maharashtra – 1
8	**JLGs**	**46**	
9	Experimental SHG Groups	39	Bihar – 14 Maharashtra -16 Tamil Nadu – 9
10	Control JLGs Groups	7	Bihar – 1 Tamil Nadu – 3 Maharashtra -3
11	Members of SHGs/JLGs	225	Members who voluntarily participated: SHG - 96 JLG – 129
12	Members of Experimental SHGs	78	Bihar – 25 Maharashtra – 25 Tamil Nadu -28
13	Members of Experimental JLGs	104	Bihar – 38 Maharashtra – 42 Tamil Nadu -24
14	Members of Control SHGs	18	Bihar – 8 Maharashtra – 3 Tamil Nadu – 7
15	Members of Control JLGs	25	Bihar – 7 Maharashtra – 9 Tamil Nadu – 9

Quantitative results were derived from descriptive statistics, pivot tables, and cross-tabulations using SPSS. To evaluate the impact of the refinance provided by NABARD through various sources to the SHGs and JLGs, the 'Theory of Change Framework', as shown in Figure below, was used. This helped the study to narrow down the indicators used for assessment.

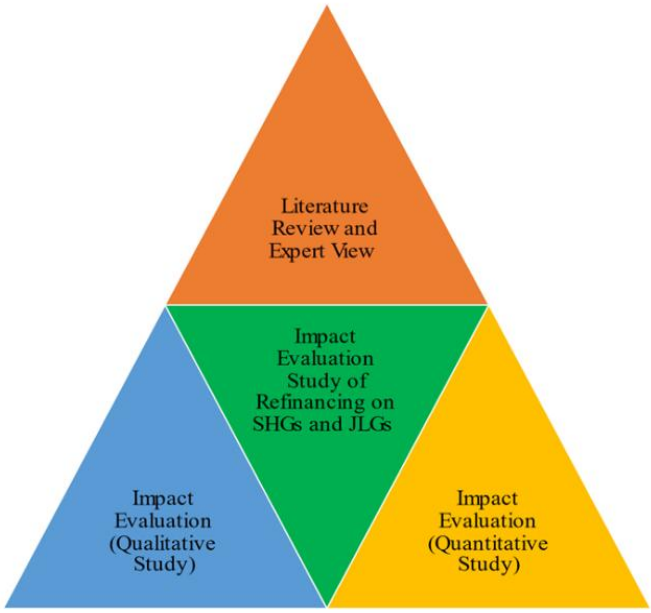

Figure 1: Triangulation Method for Impact Evaluation Study on SHGs and JLGs

Findings of the Study

Socio-Economic Perspective

The analysis depicts that the monthly contributions of SHG members in Bihar ranged from ₹10-20 per week, which accumulated in favor of the members' savings fund for the SHGs. The average annual savings of these SHGs ranged from ₹ 40,000 to 3,00,000. The SHG members of Maharashtra and Tamil Nadu contributed to the range of ₹ 500 to ₹1000 per month, and the average annual savings of the groups ranged from ₹ 5,00,000 to ₹6,00,000 for Maharashtra and from ₹ 1,00,000 to ₹5,00,000 for Tamil Nadu.

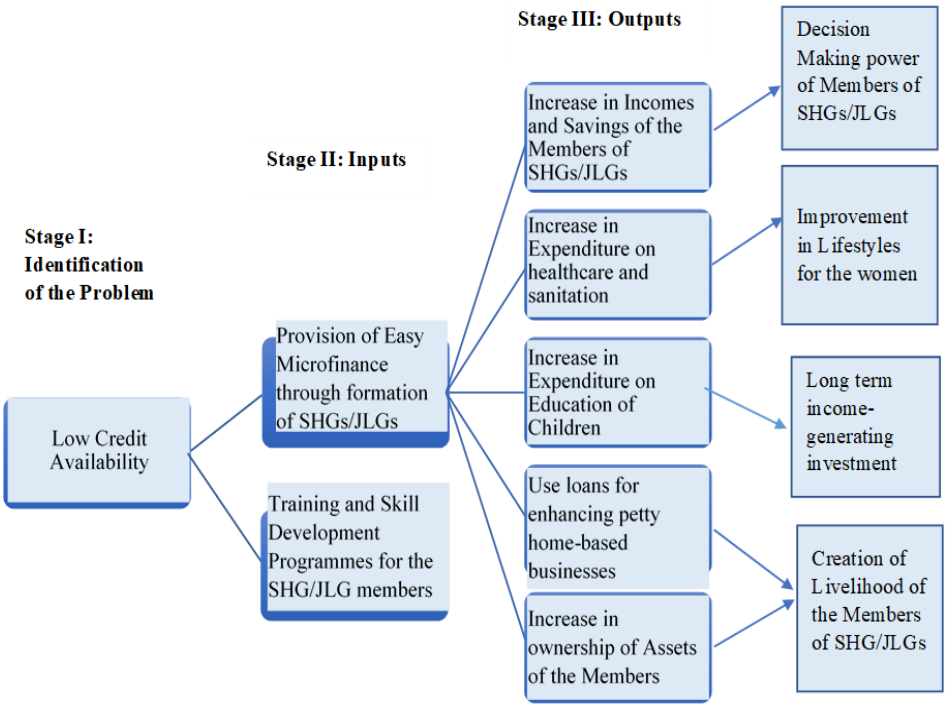

Figure 2: Theory of Change Framework

72 per cent of the members were covered under the below-poverty line (BPL) Scheme in Bihar. This result was in line with the report of the Multi-Dimensional Poverty Index of India by NITI Aayog. The remaining 28 percent, despite having income below the poverty threshold, lacked basic awareness of the government schemes and were, therefore, deprived of the benefits provided by the state. About 72 per cent of members in Maharashtra were above the poverty line. In Tamil Nadu, 75 per cent of the members existed below the poverty threshold, holding yellow ration cards.

All the members interviewed of Scheduled Castes (SC) had never attended school in Tamil Nadu and Bihar, while in Maharashtra, all the members of SC had attended school till the tenth grade. In Tamil Nadu, 33 per cent of the members belonging to the general category were graduates, followed by Maharashtra. Bihar had the lowest percentage of graduates amongst the members surveyed. The Census data of 2011 also shows similar characteristics with the literacy level of Maharashtra at 82.34 per cent, Tamil Nadu at 80.09 per cent and Bihar at 61.80 per cent.

In Bihar, 48 per cent of surveyed members were self-employed in small, home-based businesses like pickle making, hay cutting, salon services, and papad production, while 24 per cent were homemakers, dependent on their husbands' income. In Maharashtra, no SHG members were unemployed, and 20 per cent of members in both Bihar and Maharashtra were involved in agriculture. The absence of factory workers in Bihar's SHGs suggests a lack of industries in the state.

Some of the oldest operating SHGs in Bihar have been working for more than fifteen years. In Maharashtra and Tamil Nadu, majority of the SHGs were in prevalence for one to five years of operation.

Members' Perception of the Benefits of Joining SHGs/JLGs

SHGs were primarily refinanced by NABARD through commercial banks. Members joined SHGs mainly for easy access to loans, as reported by both SHG members and banks. Financial literacy improvements were more noticeable in Maharashtra and Tamil Nadu compared to Bihar, with women becoming more knowledgeable about loans. This increased literacy also led to greater awareness of household and individual finances. According to SDG India 2020-21 by NITI Aayog, Bihar (16th in the gender equality index) ranks lowest amongst the three states. Our survey indicated that members of SHGs in Bihar had gained more empowerment and self-confidence compared to the other states. In Bihar, 12 per cent of the SHG members were trained through skill development programmes, mainly in the district of Aurangabad. Credit amount was also found to be used for skill development by some members.

Sources of Loans and Financial Literacy

While NABFINS was found to be active in processing loans to SHGs in Maharashtra, their operations were non-existent in Bihar and very limited in Tamil Nadu. NABFINS was active in processing loans for SHGs in Maharashtra, especially in Kolhapur, where members were involved in tailoring or ownership of small shops, with loans disbursed at 17.85 per cent rate of interest. NGOs formed the SHGs and provided training on financial needs. In Jalgaon, the members were unaware of NABFINS, struggled to repay loans, and were mostly uneducated. In Ahmednagar, SHG members were self-employed, took loans to improve their children's education, and lived in pucca houses.

One SHG took loans at 11-13 per cent rate of interest to start a flour mill in a backyard for extra income.

While the SHGs in Bihar took 100 per cent loans from commercial banks, the interest rates were high, which was a major concern. Members in Aurangabad had education (up to 10th grade) but lacked awareness of financial services. In Katihar, members were mostly uneducated and unaware of loan options. In Tamil Nadu, Regional Rural Banks (RRBs) were active in providing loans to SHGs. In Thoothukudi, women involved in fishing net production used loans to support their husbands' business. In Tiruppur, known for textiles, SHG members mainly used loans for personal consumption and survival.

Interest Rates and Loans

Interest rates on loans varied across states, with the highest rates in Bihar, where SHG members paid 21-25 per cent. In contrast, Tamil Nadu SHG members paid much lower rates of 1-10 per cent, while those in Maharashtra paid between 11-20 per cent. The majority of members in Bihar (12 out of 25) took loans up to ₹ 20,000 at the highest interest rates. The average loan in Bihar was ₹ 28,640 per member and ₹ 79,556 per SHG. In Maharashtra, loans ranged up to ₹ 60,000, with an average loan of ₹ 33,292 per member and ₹ 88,778 per SHG. Tamil Nadu had 32 per cent of members (9 out of 28) taking loans over ₹ 60,000, with an average loan of ₹ 98,312.5 per member and ₹ 305,861 per SHG. Excluding one outlier loan disbursement of ₹ 8,40,000, the average loan per member in Tamil Nadu was ₹ 70,843, and the average loan per SHG was ₹ 212,528, still higher than in other states.

End Use of Loans

SHG members in Tamil Nadu primarily borrowed loans for small businesses like textiles, ornaments, salt making, and fishing nets. Despite being with their SHGs for over five or ten years, the highest loan amount availed was ₹20,000. Loans of ₹20,001 to ₹40,000 were more common for members with more than two dependents. Loans up to ₹40,000 were mainly used for children's education or medical expenses. Larger loans were linked to more dependents.

Many women took loans for children's education, seeing it as a long-term investment. Household consumption was a priority, especially during COVID-19 when many lost jobs. A state-wise comparison showed that Tamil Nadu SHG members used loans mainly for household consumption, resulting in the highest percentage of non-income-generating loans. In Maharashtra, 36.4per cent of loans were used for petty businesses and 20.5 per cent for education. In Bihar, 29 per cent went to petty businesses and 14 per cent to education.

The pandemic notably influenced loan usage, with job losses driving small business creation and medical expenses rising. A comparison of loan usage revealed that Tamil Nadu SHG members primarily used loans for household consumption, while Maharashtra members used loans for petty businesses and children's education. In Bihar, loans were mostly used for medical expenses. The most common loan amount across states was under ₹20,000, primarily for education or online learning devices. Loans above ₹60,000 in Tamil Nadu were used for household consumption, while in Maharashtra, loans up to ₹40,000 funded home-based businesses. Bihar had the highest medical expenses, with loans ranging from ₹20,000 to ₹60,000.

Despite joining SHGs, many members had minimal savings, with most saving under ₹500 per month. In Bihar and Tamil Nadu, many had no savings beyond SHG contributions. However, 28 per cent in Aurangabad district of Bihar saved over ₹1500 on monthly basis, reflecting progress. Aurangabad is recognized as an aspirational district, with improvements in infrastructure (NITI Aayog SDG Report, 2020-21).

Despite higher GDP in Tamil Nadu and Maharashtra, 40 per cent of SHG members saved only up to ₹500 per month. In Bihar, 72 per cent invested in housing or land, followed by 16 per cent in cattle. In Maharashtra, 51 per cent invested in land and houses, 24 per cent in vehicles, and 10 per cent in televisions. In Tamil Nadu, 43 per cent invested in housing and land, 25 per cent in vehicles, and 11 per cent in televisions.

These primary investments significantly improved living conditions. Maharashtra had the highest number of loans for petty businesses, with 72 per cent of members above the poverty line. In contrast, Bihar's loans were mainly for household consumption, worsened by the COVID-19 lockdown and high interest rates, limiting livelihood creation. In Tamil Nadu, SHG members mainly invested in tailoring shops, especially in

Tiruppur, with ₹16 lakhs loaned for home-based businesses. Health expenditures were highest in Bihar, where 52 per cent spent over ₹5000 annually, largely due to migrant workers returning during the pandemic.

Most of the SHG members in Tamil Nadu had health insurance, but few members across the states were covered by private health insurance, and many were unaware of general health insurance schemes.

Water and Sanitation

Maharashtra reported full access to private toilets, followed by Tamil Nadu at 93 per cent and Bihar at 72 per cent, all under the Swachh Bharat Mission-Grameen (SBM-G). Since many members were from the BPL category with no savings, they used SHG loan funds to build toilets, which was reimbursed later. SHGs played a key role in providing loans for private toilets in rural areas. However, water access varies by season. Bihar had 60 per cent year-round access, while Maharashtra faced water shortages, especially during summer months.

Women Empowerment

The survey revealed that most SHG households listed the husband as the head of the family, with the highest proportion in Maharashtra (64). In contrast, Tamil Nadu had the lowest percentage of husbands as heads (57 %) and the highest percentage of women (SHG members) considering themselves the head of the family. Notably, 4 % of SHG members in Tamil Nadu reported their daughters as the head of the family. In Bihar, 60 per cent of financial decisions were made by the spouse alone or in consultation with them, while 28 per cent of members made financial decisions independently, reflecting increased awareness and empowerment. In Maharashtra, 80 per cent of financial decisions were made by the spouse, with only 12 per cent of respondents making decisions independently. There was no correlation between education level and influence on non-financial decisions, as even graduate SHG members had a strong influence on household matters. In Tamil Nadu, 32 per cent of non-financial decisions were made independently by SHG members, and 60 per cent were made jointly with their spouses. In contrast, in Maharashtra, these figures were 60 per cent and 52 per cent, respectively, for joint decision-making.

Comparison of Experiment and Control SHG Groups

Three experiment groups and one control group from each district were surveyed for the study. Due to the unavailability of data in Maharashtra and the unwillingness of the participants to disseminate information, only one control group from Kolhapur was surveyed. The target numbers for the experiment and control groups were achieved in other States. The overall comparison based on homogenous parameters showed similar results across each state, as can be seen below:

i. **Interest rates:** The rate of interest varied in the range of 12-24 per cent for the NABARD-financed SHGs as well as for the non-financed SHGs across states. There was no difference between the experiment and control groups.

ii. **Number of loans:** For NABARD-led SHGs or NABARD-refinanced SHGs, the number of loans received increased with the years of association with an SHG. This implied that the experience of members was an important indicator, as it increased their awareness levels. In the control group, loans were received irrespective of their year of joining the SHG.

iii. **Average loan amount:** NABARD-funded SHGs had an average loan amount of ₹ 19,940 those members withdrew in the past three years, whereas the control group had an average loan of ₹ 18,222. However, there was an outlier in the non-financed SHG group in Bihar's Katihar district, where the respondent had withdrawn a loan amounting to ₹ 1,37,000 as she was more focused on asset creation. She also had a regular source of income which made it easy for her to repay her loan and subsequently also took more loans. The rest of the members complied with the average of the group.

iv. **End-use of loan:** SHGs of the experiment group availed 45 per cent of loans for income-generating purposes (like petty business shops or children's education) while in the control group, SHGs availed only 35 per cent of the loans for income generating activities. The remaining 65 per cent of the loans were utilised for household consumption in the control group.

v. **Training programs:** No training programs were held for the control group whereas the SHG-PI held training sessions for the experiment groups during (i) the group's inception and (ii) during a crisis. Training programmes were conducted consistently in the district of Aurangabad in Bihar. Otherwise, there

was a general lack of training and skill development programmes through NABSKILLS.

Best Practices Followed by the SHGs

The SHG Federation in Bihar adopted inter-loaning practices, allowing smaller, financially weaker SHGs to borrow from stronger groups, easing the burden on banks. All SHG members in Bihar approached commercial banks for loans but preferred dealing with other SHGs due to fewer formalities. SHGs held regular meetings to share transaction records, ensuring full financial transparency. Decision-making was open and inclusive. ICICI Bank's bank linkage model involved Business Development Facilitators (BDFs) signing MOUs with banks for timely loan repayment. BDFs conducted regular meetings with SHG members, explaining loan processes and offering financial advice, earning incentives based on performance.

Policy Implications and Suggestions

The study highlights NABARD's success in creating livelihood opportunities and improving living standards for rural women through financial services. Despite three decades of operation, most SHGs had not initiated group activities, with members often taking up individual ventures without conducting feasibility analyses. To address this, members should be financially literate and able to perform feasibility studies, ensuring that SHGs fulfil both economic and social mobilization objectives. After analysing primary data, field observations, and stakeholder interactions, the study suggests the following policy recommendations:

i. Meticulous and regular awareness campaigns need to be conducted in the villages making SHG/JLG members aware of the rights and privileges available to them that the Central and State schemes provide.
ii. A framework needs to be implemented to monitor and assess the activities of women at regular intervals – over long run period.
iii. A devoted grievance-resolving mechanism should be set up. This was a recommendation that emerged from the focus group discussions whereby the incumbents wanted to have a dedicated grievance redressal cell.

iv. Only 17 per cent of the SHG members surveyed borrowed loans from NABFINS. Despite NABFINS starting its operations in 2009, the coverage remains low among the groups. There is a need to encourage higher penetration of NABFINS into rural credit, by establishing NABFIN centres and active participation of their representatives in remote rural areas.

v. Interest rates for borrowing money may be looked into for better coverage of SHG members by NABFINS. The average loan is very small which did not lead to any livelihood promotion. The members reported that NABFINS, though friendly, charged interest rates higher than other institutions and banks. The high rate of interest defeats the purpose of financial inclusion and SDG-10 to reduce inequality.

vi. Bank staff should be trained to address a requisite exposure to all the officials in rural banks for actively supporting the SHG Bank linkage and responding to the demand.

vii. There is a need to continuously innovate, and design new financial products targeted at rural groups like SHGs/JLGs.

viii. Continuous training and capacity building of SHG members, including financial literacy, should be undertaken by imparting training to an educated experienced SHG member, who would then motivate and train the other members.

ix. Small documentaries should be made to display the successful cases of SHGs and JLGs in regional languages. Many women have started earning their own livelihood based on their wisdom and experience. However, formal assistance in terms of business planning, adequate finance, and facilitation of market linkage are required for them to move forward.

x. Awareness, capacity building and skill upgradation were necessary to uplift the social dimensions and interactions of the groups. Investments in education should be encouraged – both for the members as well as for their children.

xi. The government should create a gender-neutral ecosystem for women entrepreneurs, developing adequate infrastructure, providing training, and creating innovative mentorship programs.

xii. Guidance from sector leaders in the form of village heads can help SHGs understand how to run a business.

xiii. Specialised training should be given on nutrition, climate change, clean energy, disaster management, first aid, sanitation, etc. Agencies that are working with SHG/JLG should facilitate the competencies and opportunities. Special

interventions should be offered to members who aim to achieve beyond their core functions and diversify into innovative areas like handicrafts, tourism, etc.

xiv. In Columbia, FUNDAEC gives loans only to those applicants who successfully complete a training programme. This ensures full comprehension, competency and timely payback by the group members. The same model could be adopted for the SHGs and JLGs in India

xv. There should be more support from the private sector for CSR activities and international funding. There needs to be multilateral bank support to SHGs / JLGs to ensure a higher competitive advantage.

xvi. Annual elections should be held to elect their leaders. However, the change of the leader after three years should be a mandate.

xvii. A system of internal auditing needs to be introduced, and audit findings should be presented in the SHG meeting regularly.

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Examining Low Adoption of Kisan Credit Card (KCC) Scheme in the States of Uttar Pradesh, Bihar, and West Bengal

Saudamini Das[2]

Introduction

Limited access to institutional credit has been a long-standing problem for Indian agricultural farmers (Singh et al., 2008). This has impacted the performance of the sector which plays a significant role in the growth of the Indian economy. The Government of India introduced the Kisan Credit Card (KCC) scheme in 1998-99 to alleviate rural indebtedness and poverty by providing farmers with easy and timely credit. Designed by NABARD, the scheme has evolved to cover consumption expenditure, farm assets, and term loans for agriculture and allied activities, as well as livestock and fishery owners.

It also includes benefits like the Personal Accident Insurance Scheme and Atal Pension Yojana. Studies show that KCC has helped small and marginal farmers achieve higher returns, make timely loan repayments, increase agricultural market awareness, and reduce dependence on moneylenders (Nahatkar et al., 2002; Singh and Sekhon, 2005; Vedini and Durga, 2007; Kumar et al., 2021; Abhay et al, 2022).

However, the performance of the scheme is seen to be poor in eastern India, particularly Uttar Pradesh, Bihar, and West Bengal (NABARD, 2019; IFPRI, 2021). Eastern India is relatively poor. The dependency on agriculture is high, as is the concentration of small and marginal farmers who need institutional finance more (Kumar et al., 2020; Bista et al., 2012; Kumar et al., 2011).

Nearly 56 per cent of operational landholders in India are covered under the KCC scheme, whereas the coverage is only 17 per cent in Bihar, 91 per cent in Odisha, 44 per cent in West Bengal, and 44 per cent in Jharkhand (Agricultural Census, 2015-16). There is also wide discrepancy across districts. This study examines the issues related to the low adoption of the KCC scheme in Uttar Pradesh, Bihar, and West Bengal.

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Research Methodology

Objectives and Data

The study addresses the following issues: (i) incentivizing and inhibiting factors affecting adoption of KCC program, (ii) differential adoption rate of the scheme in different districts of the same state, (iii) social network issues hindering adoption, (iv) impact of introduction of RuPay cards, extension to include households engaged in fisheries and animal husbandry, involvement of BC, and the KCC saturation drive by covering the beneficiaries of PM Kisan under KCC scheme. The study examines these questions at three levels: the farmers' level (micro), the financial system level (regional), and the ecosystem level (macro).

The study used household surveys to explain slow adoption of KCC at the farmer level, bank surveys to explain the slow adoption rate at the financial system level, and secondary data from RBI and other reports/sources to examine the slow adoption at the level of the ecosystem.

Sampling Method and Sample Size Calculation

Three states, Uttar Pradesh, Bihar, and West Bengal, were selected for the study. After selection of the states, a four-stage selection method (district-block-villages-households) is adopted to sample the households so that the sample is representative of the state. Multiple criteria ending with a Poverty and Backwardness Score (PBS) is used to select the districts. First, the districts of the states were put into different groups depending on their agroclimatic zones, economic prosperity, and rural infrastructure. Next the PBS score of the districts were calculated using the multidimensional poverty index and the share of small and marginal farmers in the district. The district having the highest PBS (the most deprived) was selected from each of the groups. Table 1 shows the districts selected from each group in each state.

The sample size from a district was calculated with the help of Eq.1.

$$n = \frac{N * Z_{\alpha}^{2} * p * q}{e^{2} * (N-1) + Z_{\alpha}^{2} * p * q} \qquad (1)$$

Table 1: List of districts selected for the study

State/Zone	Name of district
1. Uttar Pradesh	
i. North-West Zone	Shrawasti
ii. South-West & Central Zone	Kaushambi
iii. North-East Zone	Siddharth Nagar
iv. South & South-East Zone	Chitrakoot
2. **Bihar**	
i. North-West Alluvial Plain Zone	Sitamarhi
ii. South Bihar Alluvial Plain	Jamui
3. **West Bengal**	
i. Gangetic Alluvial & Vindhyan Alluvial Zone	Malda
ii. Coastal saline zone	South 24 Parganas

Where n is the size of the sample to be studied from a district, N is the total population or total number of households in the district, Z is 95 per cent critical value, p (q = 1-p) is population proportion, and e is the margin of error. We have considered the total number of land holdings (TLH) as representative of the total number of households in a district. After multiple iterations, keeping the budget and time constraint in mind, the total sample size was fixed at 4,137 having parameter values e=0.03, Z=1.96, N=TLH. Table 2 shows the distribution of this sample across districts.

Two blocks are selected from each selected district with the help of District Development Managers (DDM) of NABARD where one block has a higher KCC prevalence or uptake and another with a lower uptake. The block-level sample selection was made representative of the district sample by using block weights. The following formula (Eq.2) is used.

$$n_{ih} = \frac{N_h}{\sum_h N_{ih}} * n_i \quad (2)$$

Where n_{ih} is the sample size of the h^{th} block of the i^{th} district. N_{ih} is the total number of individual land holdings (TH) in the h^{th} block of i^{th} district, $\sum_h N_{ih}$ is the total of all individual holdings of the two selected blocks (h=2) and n_i is the total number of

samples to be studied in the i^{th} district. The ratio $\frac{N_h}{\sum_h N_{ih}}$ is the block weight for the h^{th} block of the i^{th} district. Using this formula, the sample size of all 16 blocks was calculated (Table 2).

Table 2. Sample size of selected districts and blocks

State	District	District HHs Sample Size	Blocks	Blocks HHs Sample Size
Uttar Pradesh	Shravasti	611	Gilaula	318
			Hariharpur Rani	293
	Sidharth Nagar	351	Mithwal	235
			Lotan	116
	Kaushambi	584	Manjharpur	294
			Kaushambhi	290
	Chitrakoot	478	Karwi	271
			Pahari	207
Bihar	Sitamarhi	276	Dumra	198
			Bokhara	78
	Jamui	348	Jamui	211
			Barhat	137
West Bengal	Malda	516	Kaliachak l	331
			Kaliachak ll	185
	South 24 Parganas	972	Pathar Pratima	526
			Kulpi	446
	Total	**4,136**	**Total**	**4,136**

Finally, four villages were selected in each of the selected blocks. Villages in a block were selected in such a way that we have a village in each of the North, East, West, and South directions of block headquarters. While choosing villages care was taken to minimize the proximity of a selected village from the block headquarters to be cost-efficient in the survey. Villages which had approximately the same number of households were selected. Thus, the village selection was random and at the same time had some similar characteristics and features. Like blocks, the village sample of a block was calculated based on village weight. Village weight was the proportion of the total number of households in the village to the total households in all four villages of the block. The sample of the k^{th} village of the h^{th} block was calculated using the formula given below (Eq.3).

$$v_k = \frac{N_{kh}}{\sum_{k=1}^{4} N_{kh}} * n_h \qquad (3)$$

Where v_k is the sample size of the k^{th} village, N_{kh} is the total number of households of the k^{th} village in the h^{th} block, the denominator is the sum of the total number of households of all four villages under h^{th} block, and n_h is the sample size of the h^{th} block. Using Eq.3 the sample for a block was distributed proportionally among all the four selected villages of the block.

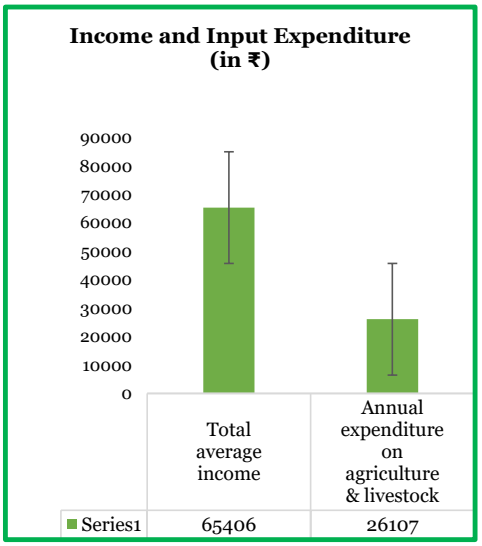
Findings of the Study

On average, the household size consisted of 6.5 members, half of them being women. On average, families have two working members, and the average annual income of ₹65,408, nearly 40 per cent of it comes from agriculture and associated activities.[3] The present year's (i.e., 2022) income was seen to be lower than the previous year's (i.e., 2021) income (₹69,398). Figure 2 shows the composition of income from different activities, and it clearly shows cultivation, which is the main work of 94per cent of the households, is not paying well. Income from forestry, wages/salary, etc. are higher but few households are engaged in these types of work.

Table 3: Broad features of sample household

Variable	Mean	Std. Dev	Min	Max
Family size	6.5	3.66	1	52
Number of women in HH	3.12	2.04	0	20
Number of earning members	1.59	0.95	0	9
Number of working women	0.39	0.73	0	9
Number of boys going to school	1.03	1.16	0	19
Number of girls going to school	0.96	1.08	0	9

[3] *Income was estimated by asking respondents to tick their list of income-generating activities and then to report the output or revenue generated, and the expenditures incurred on those activities during the year. Such information was asked for the last two consecutive years. The survey was done from December 22 to March 23. So, the present year income pertains to the year 2022 and the previous year, to 2021.*



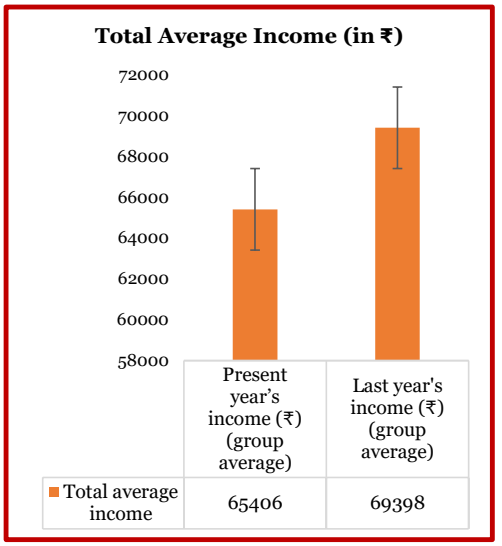


Figure 1: Income and Input Expenditure (in ₹); b) Annual average income (in ₹) of sample households

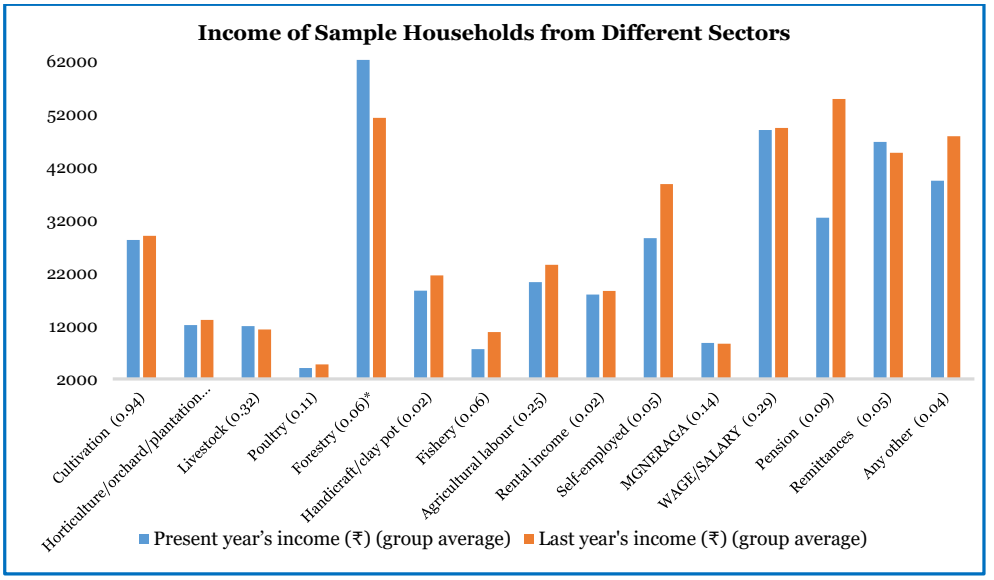


Figure 2: Composition of income of sample households from different sectors in the last two years (the figures in parenthesis show the proportion of sample households engaged in the activity) *Forestry as a source of income was reported only from West Bengal

The other detailed picture from Figure 2 is that the present year's income from livestock, forestry, remittances, and wage/salary are either higher or the same (though marginally in some cases) than the previous year's income whereas it is lower for all other activities.

The present year's income from agriculture is seen to be marginally lower compared to the previous year. However, this picture is not uniform across districts. A district-wise comparison of incomes from different activities, as shown in Figure 2, shows the present year's income to be higher than the previous year's for maximum activities including cultivation in Chitrakoot, Sidharth Nagar, Sitamarhi, and Jamui districts and lower in Kaushambi, Malda, and South 24 Parganas. Of the income from 15 activities reported in Figure 2, sample households in Malda reported a decrease in the present year's income from only agriculture-related activities whereas households in South 24 Parganas reported a decrease in 11 activities and households in Kaushambi reported a decrease in all the 15 activities. Thus, the lower reported income from Kaushambi and South 24 Parganas seems to have led to a lower average income in the present year compared to the previous year of the sample households.

Status of KCC in the Study Area

The level of awareness and holding of KCC by the sample households of the study districts are shown in Table 4. It shows a wide discrepancy regarding the level of awareness and KCC holding across districts. Awareness is low at 34per cent in Sitamarhi district and highest at 96per cent in Sidharth Nagar, though both are in the Terai region. In general, awareness is very high in Uttar Pradesh followed by West Bengal and Bihar.

Of the 2,794 households surveyed, 1,205 (43 %) households reported having a KCC card in their family and like awareness, card holding is also seen to be very diverse. The card holding is the lowest in West Bengal (just 4 % of the 498 households surveyed in Malda have KCC) and highest in Uttar Pradesh. Most of the KCC card holders are availed of the PM Kisan scheme as well. The PRI schemes (mainly interest subvention) seemed to be less known to people who have taken up the KCC cards except South 24 Parganas.

Figure 3 shows the landholding size of KCC holders in hectares and the distribution of KCC holders as per their landholding sizes. It clearly shows the maximum number of KCC households (61 % to have less than one hectare of land).

Nearly 96 per cent of the sample households who have KCC have less than three hectares of land or belong to marginal and small farmer class reflecting the upholding of the social justice clause in owning KCC.

Table 4: District-wise level of KCC awareness and holding of KCC in the study area

District	KCC awareness /response (2/1)	KCC holders (3/1)	KCC with PM Kisan (4/3)	KCC without PM Kisan (5/3)	Awareness of PRI (prompt repayment initiative) (6/3)
1	2	3	4	5	6
Chitrakoot (432)	387 (90%)	258 (60%)	185 (72%)	73 (28%)	167 (65%)
Kaushambi (436)	409 (94%)	335 (77%)	237 (71%)	98 (29%)	226 (67%)
Sidharth Nagar (357)	343 (96%)	329 (92%)	251 (76%)	78 (24%)	101 (31%)
Jamui (316)	207 (66%)	118 (37%)	99 (84%)	19 (16%)	63 (53%)
Sitamarhi (183)	63 (34%)	38 (21%)	23 (61%)	15 (39%)	26 (68%)
Malda (498)	350 (70%)	20 (4%)	14 (70%)	6 (30%)	11 (55%)
South 24 Parganas (572)	331 (58%)	107 (19%)	69 (64%)	38 (36%)	103 (96%)

Note: In the first column, the bracketed figures are the sample size of the districts and in other columns, the bracketed figures are percentages.

Factors Impacting KCC Adoption Rate

The adoption rate of KCC can be influenced by several factors, the most common as per theory and earlier studies are education, landholdings of farmers, and awareness about the KCC scheme among farmers. We ran logistic regressions to identify the variables affecting uptake. This regression is estimated for the entire sample as well as for the three study states separately (Table 5). As per Table 5, networks, especially the banking network, have played a significant role in increasing the KCC take-up, whereas private networks like relatives and friends have played a negative role and have dissuaded people from having the cards.

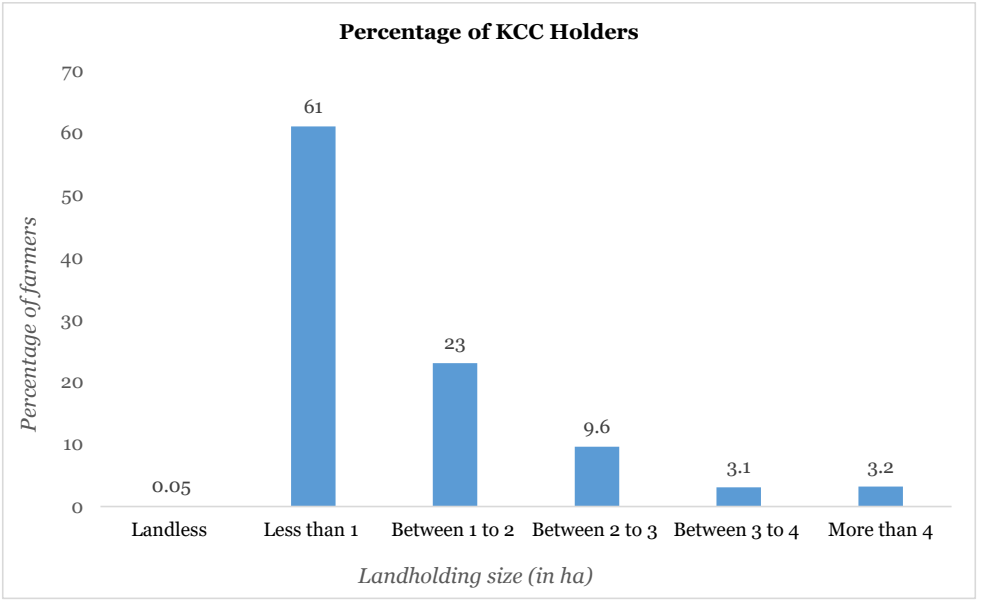


Figure 3: The distribution of KCC card holders as per their landholding size (in hectares)

Most surprising is the role of FPOs, especially in West Bengal, whose way of disseminating KCC information does not seem to have helped but has dissuaded people from going for KCC. People facing natural disasters like floods, unseasonal rain, etc. have a higher takeup of KCC which means KCC cards are helping people in climate change adaptation. Another interesting result is that people with PM Kisan cards and crop insurance also have higher KCC whereas people with life insurance have not opted for KCC. Probably the tying up of KCC with insurance and PM Kisan cards has provided good results.

Factors Impacting KCC Loan Take-up

As per the survey, some farmers (nearly 11 per cent) have taken up KCC cards but have not withdrawn the KCC loan amount for final use. There could be many reasons for this and the important ones that came from the survey are: (i) didn't need a loan (52 per cent), (ii) high rate of interest (18 per cent), (iii) crop uncertainty due to disasters (9 per cent), (iv) difficult to repay loans (7 per cent), etc. The possible reasons for not needing a loan could be the fear of indebtedness, dealing with the banks' cumbersome process, lack of investment opportunities in farming, etc.

Table 5: Logistic regression results (Marginal effect of factors on the probability of adopting KCC)

Explanatory Variables		Entire study area	Bihar	Uttar Pradesh	West Bengal
Source of KCC information	FPO	-0.125*** (3.23)	-0.079 (0.95)	-0.047 (1.25)	-0.06** (1.99)
	Banks	0.227*** (7.1)	0.256*** (3.51)	0.034 (1.19)	0.084*** (2.5)
	Relatives	-0.094*** (3.1)	0.015 (0.16)	-0.063*** (2.82)	-0.071* (1.76)
PM Kisan card holder		0.166*** (5.48)	0.026 (0.3)	0.04* (1.84)	0.065** (2.11)
Taken-LIC		-0.131*** (3.54)	-0.289*** (3.11)	-0.067** (2.14)	-0.033 (1.00)
Membership of any local group including SHGs		0.019 (0.31)	-0.118 (1.15)	-0.025 (0.51)	0.588*** (2.90)
Have insured crops		0.335*** (12.94)	0.334*** (4.89)	0.207*** (10.55)	0.122*** (2.63)
Have faced natural disasters in the last five years	Flood	0.221*** (7.3)	0.014 (0.12)	0.088*** (4.01)	0.105** (2.54)
	Draught	0.085*** (2.76)	-0.13 (1.2)	0.068*** (3.24)	-0.167*** (4.60)
	Unseasonal rain	0.104*** (3.31)	-0.026 (0.35)	0.053** (2.07)	0.065** (2.06)
	Hailstorms	0.034 (0.96)	0.219*** (2.79)	0.022 (1.02)	0.002 (0.04)
	Cyclones	-0.433*** (12.11)	-0.191 (0.88)	Dropped	-0.028 (0.73)
	Other disasters	0.134*** (3.2)	0.086 (0.6)	-0.003 (0.12)	Dropped
Size of land holdings		0.063*** (3.57)	0.066 (1.11)	0.008 (0.64)	0.085*** (3.26)
N		1,741	254	897	575
Pseudo R2		0.27	0.18	0.23	0.22
Log Likelihood value		-863.75	-142.23	-330.51	-236.81
LR Chi2 (14)		634.44	60.68	201.24	133.59
Pro of Chi2>0		0.00	0.00	0.00	0.00

Note: Dependent variable = Have KCC (having KCC=1, not having KCC=0)

Some farmers mention high interest rates as the reason. The KCC loan interest rate is the lowest among all the sources of loan available for farmers. Two possible reasons that farmers mention about this could be:

a. Farmers are not aware of the Interest subvention scheme (ISS) under KCC. This is most likely the reason because there is little awareness among farmers about the ISS. Even 55per cent of farmers who took KCC loans were not aware of the ISS let alone those who did not take loans.
b. Banks do not easily pass on the benefit of an ISS to farmers as they return loans usually with a delay. This creates a notion among the farmers that the lowest interest rate in a KCC loan is 7 per cent.

KCC Renewal by Farmers

Renewal refers to the process of extending the KCC after its five-year expiration period. A high renewal rate indicates that farmers realize the benefits and usefulness of the KCC scheme. More awareness and realization by farmers about its benefits can ultimately help in enhancing the adoption rate of KCC through farmers' networks. Out of a total of 1,205 KCC holders in the survey, 408 KCC holders renewed KCC at least one time.

Of those who renewed KCC, 36 per cent renewed it more than once. Like take-up, the renewal rate is also widely divergent across districts. The KCC has not been renewed in either Sidharth Nagar or Sitamarhi district. The renewal in Jamui and Malda is low. To identify the significant factors affecting the renewal of KCC, a logistic model was used to explore the role of networks and other exogenous factors (Table 6).
Table 6 shows that FPOs in Uttar Pradesh and banks in Bihar helped enhance KCC renewals, though the overall impact is modest. Households affected by disaster events, as seen in Table 5, are not renewing KCCs, likely due to repayment issues. This is evident by the crop insurance variable - those with insurance renew KCCs, as losses are covered. Table 6 also indicates that last year's agricultural income suggests crop failure as a reason for non-renewal. Farmers' concerns about disasters and repayment challenges were understood better through these findings.

Table 6: Logistic regression results (Marginal effect of factors on probability of renewing KCC)

Dependent variable = Have renewed KCC card (renewed KCC = 1, not renewed KCC = 0)					
Explanatory Variables		**Entire study area**	**Bihar**	**Uttar Pradesh**	**West Bengal**
Source of KCC information	FPO	0.085* (1.61)	0.052 (0.72)	0.208** (2.4)	0.053 (0.51)
	Banks	0.13*** (3.67)	0.109* (1.75)	0.061 (1.23)	0.043 (0.37)
	Relatives	0.036 (1.03)	0.011 (0.17)	0.01 (0.26)	-0.061 (0.65)
PM Kisan card holder		-0.04 (1.12)	-0.091 (0.90)	-0.013 (0.35)	-0.071 (0.83)
Taken-LIC		0.1 (0.26)	0.113 (1.06)	-0.015 (0.32)	0.094 (0.93)
Membership of any local group including SHGs		0.111 (1.42)	0.105 (0.94)	0.206* (1.94)	--
Have insured crops		0.151*** (4.41)	-0.017 (0.26)	0.108*** (2.9)	0.244** (2.50)
Have faced natural disasters in the last five years	Flood	-0.173*** (5.05)	-0.08 (1.29)	-0.245*** (7.13)	0.273 (1.41)
	Draught	-0.25*** (7.75)	--	-0.164*** (4.64)	-0.268 (0.98)
	Unseasonal rain	-0.06* (1.68)	0.051 (0.78)	-0.092** (2.17)	-0.12 (1.3)
	Hailstorms	-0.159 *** (4.79)	-0.077 (1.33)	-0.16*** (4.61)	-0.026 (0.18)
	Cyclones	0.289*** (4.43)	--	-0.133* (1.77)	0.086 (0.74)
	Other disasters	0.029 (0.69)	--	0.015(0.38)	--
Size of land holdings		0.001 (0.39)	-0.055 (1.11)	0.0005 (0.19)	0.048 (0.58)
Family size		-0.011** (2.31)	0.003 (0.24)	-0.007 (1.38)	-0.015 (0.83)

Explanatory Variables	Entire study area	Bihar	Uttar Pradesh	West Bengal
Number of earning members in the family	0.023 (1.18)	-0.004 (0.09)	0.028 (1.47)	-6.40E-02 (1.03)
Income from agriculture last year	0.000001 (1)	3E-07** (2.01)	-0.0000001 (1.04)	0.00E+00 (0.54)
Income from agriculture last to last year	0 (0.95)	-3E-07* (1.79)	0.00000012* (1.55)	0.00E+00 (0.56)
N	1,008	120	738	121
Pseudo R2	0.22	0.11	0.22	0.24
Log Likelihood value	-495.85	-46.51	-347.99	-53.64
LR Chi2 (14)	275.71	11.83	199.82	34.51
Pro of Chi2>0	0.00	0.755	0.00	0.007

Differential Adoption Rate in Different Districts of States

Multiple factors seem to be causing these differences, i.e.,

i. Level of awareness and outreach efforts by banks and financial institutions,
ii. Agricultural landscape and farmer demographics like different agricultural practices, agricultural assets holding, etc. (more asset holding is associated with more KCC holding)[4],
iii. Availability and accessibility of credit facilities like districts with well-established banking infrastructure, widespread branch networks, and convenient access to credit facilities are more likely to have higher adoption rates,
iv. Penetration of other credit options from formal and informal financial institutions for households like more availability of other credit options in a district has depressed the KCC loan adoption rate.

Except for Uttar Pradesh, the penetration of non-KCC loans is higher in other states, indicating the non-attractiveness of the KCC loans there. Of the different non-KCC sources, maximum dependency was seen to be on self-help group financing (36 per cent), money lenders (15 per cent), and private banks (13 per cent) followed by friends and relatives (11per cent).

[4] *Some 74% of tractor owners in Chitrakoot, 78% in Kaushambi, 94% in Sidharth Nagar, 50% in Jamui, and 40% in Sitamarhi have KCC, but such percentages are very low in West Bengal*

Social Influence and Norms

Farmers often rely on social networks for advice and guidance. If influential members within their social networks discourage the use of formal credit for any reason (genuine or ingenuine), farmers could refrain from considering not just KCC loans but also other formal credit loans from financial institutions. Social norms that favour traditional credit sources or discourage borrowing could also affect the adoption rates. The survey reported that 29per cent of farmers, who go for agriculture loans other than KCC, still rely on informal sources of credit. This informal source of credit includes friends/relatives, money lenders, and agricultural traders.

Policy Implications and Suggestions

In Uttar Pradesh, Bihar, and West Bengal, KCC adoption is influenced by factors like banking networks, education, landholding size, financial literacy, and farmer awareness. External factors, such as land record issues and agricultural loan waivers, also play a role. Banks prefer lending to SHGs due to higher repayment rates compared to KCC loans. In West Bengal, a lengthy, informal process involving intermediaries complicates KCC applications. The study highlights district-level differences in KCC adoption, with bank outreach and local agricultural conditions affecting farmer awareness and decision-making. Availability of formal and informal credit, along with cultural factors like fear of debt, also impact KCC uptake.

Understanding the factors behind varying KCC adoption rates is critical for designing region-specific interventions to improve adoption and financial inclusion. Three key social network challenges hinder KCC uptake: first, farmers often lack information about KCC and its benefits, as they rely heavily on word of mouth. Second, negative experiences with formal financial institutions, especially banks, reduce trust and are shared within farmers' social networks. Third, social influence plays a significant role, as farmers often seek advice from influential community members, such as Mukhiyas, who may discourage adoption if they have had negative experiences. Addressing these challenges by spreading information, rebuilding trust, and leveraging positive social influence can help enhance KCC adoption and promote financial inclusion in rural areas.

The study reveals five acceptability and activation challenges associated with RuPay cards. Many farmers are unaware of the RuPay card, and fewer know how to use it. Rural infrastructure is also lacking, with limited access to ATMs and POS machines, and poor connectivity that hampers transaction notifications. Additionally, due to low socio-economic status and literacy, farmers often prefer cash transactions. RuPay cards require documentation and have complex activation. Since many farmers earn daily wages rather than regular salaries, they often forgo obtaining one. Furthermore, bank mergers and a shortage of chips have also hindered card issuance.

The government launched a saturation drive in two phases. Our study assessed its impact, revealing improved adoption, with phase 2 outperforming phase 1 in all three states. The drive not only boosted composite KCC adoption but also encouraged separate KCC extensions for animal husbandry and fisheries. However, the uptake of KCC AHDF extensions increased during the drive and declined afterwards, reflecting farmers' experiences with banks.

Firstly, banks require documentation for a separate AHDF KCC extension, potentially discouraging some farmers. Secondly, farmers prefer the composite KCC because, they argue, the working capital requirements for AHDF activities could not be adequately met with a separate KCC extension. These factors likely influenced the declining uptake of KCC AHDF after the saturation drive ended. Business correspondents raise awareness about government schemes, including KCC, but inadequate incentives limit their role in driving KCC take-up.

Way Forward

The nature of factors influencing KCC adoption is multifaceted. To improve saturation and availability, policymakers should take a holistic approach to implement policies and actions. They should target awareness campaigns, streamline documentation processes, enhance financial literacy among farmers, foster trust in formal financial institutions, improve RuPay card infrastructure, and incentivize BCs. The study suggests two policy measures that can solve many ground-level challenges that policymakers face.

First, introducing a Credit Guarantee Fund for KCC loans – a CGFKCC scheme – would provide lenders with a guarantee against default, reducing risk and enhancing confidence, and, in turn, increasing the availability of loans, boosting KCC adoption,

promoting financial inclusion, stimulating agricultural growth, and supporting rural development. For the scheme to be effective and sustainable, however, implementation must be successful and monitoring continually.

Second, in addressing the challenges farmers face in taking KCC loans, end-to-end digitalization is crucial: automating the application process can expedite disbursement, deepen the KCC base, and encourage farmers to opt for formal credit channels. Integration with KYC databases and digitalized land records can improve transparency and reduce fraud. For digitalization to be safe and secure, however, farmers must be made financially and digitally literate. Incorporating these policy measures can help policymakers bridge the credit gap, promote financial inclusion, and accelerate agricultural growth. Effective implementation, complemented by financial literacy programmes and capacity-building initiatives, will maximize the benefits of these policies and revolutionize rural credit delivery.

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The Indian Handloom Industry's Issues and Prospects: A Study on Selected Districts of Andhra Pradesh and Telangana

Vani Harpanahalli[5] and Appalayya Meesala[6]

Introduction

The Indian handloom industry, once a major source of employment after agriculture, is now in decline and no longer requires large loans. Artisans, once passionate about the craft, are losing interest in continuing the occupation. This decline has raised concern among stakeholders, including financiers, vendors, and connoisseurs. Society seeks to understand the causes of this decline, the industry's strengths and weaknesses, and its prospects for survival and revival. In response, NABARD commissioned a study to examine the current conditions, causes of decline, and strategic pathways for revival. The study aims to help NABARD, and the government create policies to rejuvenate the industry. This article outlines the study's key findings, objectives, and methods.

The main objectives of the study are as follows:

i. To understand issues relating to working capital and credit flow as faced by the handloom industry in the cooperative sector compared to the industry outside the cooperative sector.
ii. To throw light on why banks are not approaching NABARD for refinancing of loans that they have given to the handloom weavers.
iii. To understand the problems relating to products and marketing of handloom products faced by the handloom industry in and outside the cooperative sector.
iv. To study the prospects and issues relating to the sustainability of handlooms in the cooperative sector and non-cooperative sectors.
v. To identify areas where NABARD, as a refinance banker, can intervene so that the conditions can be ameliorated.

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The Indian handloom industry accounts for 15 per cent of the country's cloth production, with 28.2 lakh looms, 31.44 lakh families, and 35.22 lakh workers, including 26.74 lakh handloom workers and 8.4 lakh allied workers (4th All India Handloom Census, 2019–20). Of the 35.22 lakh workers, 73.2 per cent (25.77 lakh) are independent, 6.3 per cent (2.23 lakh) work under cooperatives, and 19.4 per cent (6.84 lakh) are under master weavers. The industry remains predominantly outside cooperatives. The average number of working days has decreased from 234 in 2010 to 207 in 2019–20, with 58.4 per cent of weavers requesting support on credit supply, and over 55 per cent seeking design development, technology upgradation, and skill training. However, 56 per cent expressed an unmet need for credit, relying on expensive private loans.

India's crafts industry employs around 200 million people, with 3000 distinct artisan forms and 65,000 exporters (Crafts Council of India). Handicrafts exports in 2021–22 reached $4.35 billion, while production was estimated at $9.00 billion in 2020–21 (IBEF). However, artisans face challenges due to globalization, as domestic consumers increasingly prefer factory-made, low-cost products (Liebl & Roy, 2003). The survival of many crafts, particularly in India, is threatened, and many craftspeople struggle to make a living (Jaitly, 1984).

Government funding for traditional arts and crafts, including handlooms, is rapidly declining, despite these sectors preserving cultural heritage (Saraswat, 2015). Though handicrafts offer livelihoods for many families and preserve legacies, they are endangered and need protection. The government has invested significantly in the handloom sector over the past 70 years, with around 35 million people employed in this historic, decentralized economy (Bhagavathula, 2010). Despite its viability, the industry faces structural barriers, such as limited innovation and growth (Wanniarachchi et al., 2020), with periodic data failing to capture the industry's complexities (Niranjana & Vinayan, 2001). Challenges include lack of design innovation, poor quality, competition from power looms, rising yarn prices, and GST. The industry has declined in places like Visakhapatnam and Vizianagram but thrives in areas such as Uppada, Kanchi, Gadwala, and Pochampally. Master weavers have helped maintain competitiveness despite mill and power loom dominance, with 75 per cent of weavers working under them and marketing handloom textiles without government support (Bhagavathula, 2010).

Research Methodology

This study aimed to employ a *mixed methods approach*, which includes both *qualitative and quantitative* approaches, because of the complexities of the handloom industry concerns and the constraints of quantitative research using statistical methods. So, this combines an exploratory goal of identifying operational issues with an analytical goal of determining the causes of the issues found.

i. An artisan's existing or remaining in the occupation and financial prosperity are linked to specific occupational variables including: use of a modern loom, all family members being skilled, major product type, tendency to change the design frequently, ease of design change, employer efficiency, easy cash conversion of artisanal products, saleability of the woven product, a ready market for a weaver's new designs, adequate work from the employer, securing a reasonable price for a weaver's product, employer's continued support to a weaver, timely settlement of weaver's wage dues and availability of shared facilities.
ii. The type of fibre used in weaving, the employer classification (master weaver or society), and the accessibility of credit - all affect an artisan's inclination to leave their line of work.
iii. Product innovation and the type of fibre used in weaving determine financial backwardness or financial prosperity.
iv. Product type (*sarees*), assistance from the government, input availability, and employer efficiency determine an artisan's occupational satisfaction.
v. A weaver's ability to save money from weaving depends on input availability, weaving of silk and cotton in combination, and weaving of silk.
vi. Sufficient income from the occupation depends on product marketability, employer efficiency, and the weaving of silk.
vii. The occupational satisfaction of a weaver is determined by product innovation, credit availability, product marketability, government assistance, and input availability.

Study Respondents

Interviews were held with 76 interlocutors, including 31 primary society functionaries, 25 master weavers, 10 cooperative bankers, 5 bank managers of nationalized banks, and

5 activists for qualitative research, while 496 individual weavers were surveyed for the quantitative study. The study covered Srikakulam, East Godavari, Krishna, Prakasham, and Ananthapuram districts of Andhra Pradesh and Karimnagar/Medak, Nalgonda, and Mahaboobnagar districts of Telangana states.

The data collected from 496 handloom weavers were analysed with SPSS 20. The types of analyses include: (1) Odds Ratios; (2) Chi-Square Tests; (3) Logistic Regression; and (4) Multiple Regression. Interviews with a cross-section of industry actors covering 76 interlocutors yielded insights on several issues and their origins, while analysis of the weavers' survey data brought out the association between the current conditions and their origins, besides corroborating the interview findings. The interview manuscripts were scanned for critical issues and their causal connections.

Findings of the Study

Since the older population dominates this industry, the average weaver age is now 55, which profoundly influences what new designs he can weave, not to mention any revolutionary and sweeping changes that must be brought in to revive the industry. However, in certain weaver pockets in East Godavari and Ananthapur districts like Tatiparthi, Dharmavaram, and Uppada, the youth also have chosen weaving as their occupation due to its viability, and the strength of the specific products. A significant barrier to either the extension of the life span or the revival of this occupation is the industry's inability to attract young people to it, besides the high average age of the present weavers.

i. **Wage Parity Issues:** The wage earned by an artisan's family of three working on a loom is one-fourth of what is made in other low-skill jobs like shopkeeping, office assistance, counter selling etc. The wages associated with weaving are close to the subsistence level. 64 per cent of the weavers who participated in this survey stated that they don't make enough income, and 74.4 per cent of weavers said that they don't save money for their future from the earnings they make from this occupation. 77 per cent of the 496 weavers who responded to the study said they would not continue in this line of work, and 76.2 per cent of the respondents said they would not suggest it to their children.

ii. **Industry's Estimated Life Span:** The factors that predict longer life for this occupation include respect for the traditional dress culture, higher value, design-

intense crafts in specific clusters like Uppada, Gadwal, and Pochampally, and care for zero pollution, low power use, high employment, and sustainable development. The views of the interlocutors on the expected life span of the Indian handloom industry include:

a. This industry will disappear in 10 years according to eight of the interviewees while according to six of them, the industry is on the decline;
b. A significant number of interviewees (14) are of the view that this industry cannot survive without support from the government;
c. Four of the interviewees have a pessimistic view that the industry will disappear in 5 years;
d. Four of the highly optimistic interlocutors hold the view that the industry will experience a boom again, and nine people think that the industry is growing and has no dearth.

iii. **Favorable Image of Handloom Products:** When customers ask for handloom products, retail salespersons show power loom products as handloom products and sell them. This suggests that shoppers continue to have a favorable perception of handlooms. They associate handlooms with quality and durability.

iv. **Handlooms Ensure Sustainable Development:** The handloom industry can fulfil 15 of the 17 sustainable development goals set by the United Nations. For example, it can eliminate poverty and hunger due to the value created on the looms.

v. **Weak Primary Societies:** Most primary societies in the Telangana district are practically inactive, making low sales, coasting along with low membership, lacking vision and enthusiasm, and are seriously weak and precarious. Corruption in the cooperative sector is also a dominant theme.

vi. **Counterfeit Societies:** The counterfeit societies brought a curse on society; they created a more significant burden on legitimate societies. The government must be strict with fake societies.

vii. **Bond Between Weaver and Primary Society:** The study's findings indicate if there is a strong bond between the weaver and the employing society, the weaver is less likely to leave the occupation or become financially worse off, as demonstrated by the odds ratios calculated from the data.

viii. **Weak Primaries and Strong Master Weavers:** When weaver members of primary society don't get work from their societies, they turn to the master weavers who are many and able to give some work, though at a lower wage rate.

According to our odds ratios, if a weaver receives enough work from his employer, he is 2.041 times less likely to be financially disadvantaged and 1.642 times more likely to remain in the industry.

ix. **Primaries' Democratic Process Stalled:** The government failed to ensure proper and continued democratic management of both primary societies and apex societies; for example, elections were not held for primary societies for the last 5 to 10 years.

x. **Thriving Societies Face Low Production Challenges: S**uccessful societies have no marketing issues because of their quality, new products, designs, retail outlets, and prolonged existence. The following is a summary of dominant views identified from interviews on the management of primary cooperative societies:

   a. It is better for the weavers to work outside cooperative societies.
   b. Primaries are not able to provide work for artisans.
   c. Primary societies lack leadership.
   d. Some societies have large sums in fixed deposits.
   e. Elected bodies do good, but elections are not held.
   f. Weavers prefer to work in primaries.
   g. Primary societies are mismanaged.
   h. Stocks were held unsold in some societies.

xi. **Inadequacy of Apex Marketing Societies:** In Telangana, TSCO is the apex society, while in Andhra Pradesh, it is APCO. These apex bodies expect to sell the primaries' products at large volumes smoothly for which they need to have a large chain of retail shops, but such infrastructure is not available now. Their marketing capability was reduced due to a host of reasons. The following are the main viewpoints expressed by the interviewees:

   a. Apex Society delays payments inordinately.
   b. Apex Society does not purchase enough from primaries.
   c. A number of societies depend more on the apex society for sales.
   d. Apex Society did not revise the purchase price for a long time.
   e. Apex Society does not give enough wages.
   f. Apex Society failed to market the society's products.
   g. Some societies depend less on Apex Society for sales.

xii. **Master Weavers' Role in Preserving the Handloom Industry:** According to our odds ratios, a weaver is 2.160 times more likely to stay in the industry and 2.577 times more likely to have a better financial situation if they

work for an effective employer. Furthermore, working with a master weaver but not with a cooperative society increases the weaver's likelihood of staying in the occupation by 2.97 times (B = -1.089, Wald's=8.982, p = 0.003, Exp (B) = 0.337 (2.97)). Findings on the role of master weavers from the interviews held are:

a. Master weavers give more employment to weavers than societies.
b. Master weavers are not able to provide full-time work to the weavers in a significant number of cases, particularly during the pandemic season or during high raw material prices.
c. Master weavers invest heavily in weavers in the form of advances.
d. Master weavers manage their cash flow efficiently.
e. Master weavers pay dues to weavers on time, without delay.

xiii. **New Product Development:** According to our poll, 11.5 per cent of weavers lack the facilities to modify their designs, 25.2 per cent find it challenging to change their designs, and 42.5 per cent do not look for a change in their designs. Additionally, 22.6per cent of weavers don't change their designs frequently. The return from changing designs is poor for 30.4 per cent of the weavers.

xiv. **Routes to Increase Weaving Wages:** The different routes to increase weaving wages include: (1) weaving of high-value products; and (2) adoption of welfare pricing method by apex society and government. The government has a role in both approaches.

xv. **Saree Weaving Is More Remunerative:** Saree weaving is 1.884 (B = 0.633, Wald's = 3.95, p = 0.047, Exp(B) = 1.884) times more likely to keep the weaver happy in the occupation than weaving other kinds of products, according to the binary logistic regression.

xvi. **Product Marketability is Linked to Artisan's Wellbeing:** The weaving of marketable products raises the weaver's likelihood of earning adequately by 1.327 times.

xvii. **New Products Impose a Huge Burden on Artisans:** Interestingly, product innovation increases the likelihood of a weaver's financial insolvency by 1.199 times. This indicates that a weaver is required to bear the burden of product development and is more likely to experience financial insolvency due to the new designs produced. Viewpoints expressed by interviewees on new product development:

a. New products increase demand for our products.
b. New products facilitate an increase in weaving wages.

c. Weavers do not accept design changes.
d. Completely new designs are impossible on handlooms.
e. Traditional designs move fast.
f. We do not have skilled weavers to weave new designs.
g. New designs make up a good investment.
h. Better wages can bring youth into this occupation.
i. New designs give better margins.

xviii. **Constantly Rising Prices of Inputs:** The most unanimously resented and vociferously voiced concern of about 500 respondents is that the prices of silk yarn, cotton yarn, zari, and dyes and chemicals are always constantly rising. 62.5 of the weavers who participated in our poll disagreed with the statement that the prices of yarn, silk, dyes, and chemicals are reasonable. Weavers' happiness at work is influenced by input availability by 1. 242 times. The following are the dominant viewpoints extracted from the interviews on the constantly rising prices of inputs:

a. Prices of input (silk and yarn) are constantly on the rise.
b. Rising input prices undermine the marketability of products; consumers do not accept products with prices revised upwards based on input prices.
c. Rising input prices reduce weaver's wages.

xix. **Competition from Power Looms:** Power looms have grabbed most of the market legitimately belonging to the handlooms by imitation and fraudulent practices. The competition from power looms is aggressive and ruthless. The following are the themes uncovered from our interviews on power looms:

a. Unfair competition from power looms is behind the decline of handlooms.
b. Power looms produce in a day what it takes 7 days to produce on handlooms.
c. Power loom products are cheaper.
d. The government encourages power looms to kill handlooms.
e. Retailers prefer power loom sarees now.
f. Power looms produce high-quality products now.
g. There is unfair competition from power looms.

xx. **Weak Enforcement of Reservation Act:** The Handlooms Act of 1985 is poorly enforced. The enforcement apparatus is skeletal and runs with fewer

officials. The following are the main viewpoints concerning the implementation of the Handloom Act of 1985.

a. The Handloom Reservation Act is not enforced strictly.
b. Failure to enforce the Reservation Act is behind the decline of the handlooms.

xxi. **Cash Credit Issues:** The industry's decline is reflected in how the number of weavers weaving is fast declining, which, in turn, caused the decline in production, the staff size of the society, and the cash credit/loans from banks. The following is a summary of findings on cash credit facilities utilised by cooperative societies:

a. The loans from cooperative banks and NABARD impose a colossal interest burden for several primary societies.
b. For a few interviewees, cooperative and government banks do not have a favourable outlook towards the handloom industry.
c. Some do not get enough loans from cooperative banks.
d. NABARD should not insist on transacting through cooperative banks only.
e. The interest subvention benefits arrive late in some cases.
f. The loan processing is slow because of the delay with the government department.
g. Some societies have adequate funds and do not need cash credit.
h. There are a good number of cases where cash credit destroyed their societies financially due to penalties.
i. Many interviewees have the view that loans from money lenders are convenient and safe.
j. Loans from cooperative banks and NABARD require cumbersome documentation.
k. Some borrow from private lenders at a high interest rate.

Loan-related Challenges Facing Master Weavers and Weavers

The following are the issues unearthed concerning the access of loans from banks by master weavers and weavers:

a. The procedures of banks are cumbersome, so they do not approach banks.
b. The reluctance of entrepreneurs to take loans from banks is due

to the daunting paperwork.

c. Private loans are expensive.
d. Weavers cannot give collateral security for loans from banks.
e. Bank loans require massive paperwork which weavers cannot do.

i. **Goods and Services Tax (GST) on Handloom Products and Their Ingredients:** General Goods and Services Tax (GST), which is levied on handloom products for the first time, is killing the marketability of handloom products. The following are the dominant narratives of the interviews on GST on handloom products.

a. The GST of handloom products has undermined their marketability.
b. The higher GST rates on other inputs have severely affected the marketing of handloomproducts.
c. Rising input prices, power looms, and GST are three hostile forces bent on destroying the handloom industry.

ii. **Loom Technology in Use:** The kinds of high-value products that can be invented are determined by the various loom technologies used in the handloom industry. A loom with a lifting motor, jacquard, and dobby can produce high-value goods. A weaver is estimated to be 1.176 times worse off financially if he does not use a high-tech loom. Paradoxically, as evidence of the exploitation an artisan faces when new designs are woven on high-tech looms, a high-tech loom is linked to a 1.119 times higher inclination to quit than an old one.

iii. **Consumer Information to Weaving Artisans:** The weavers who naturally cling to their workplaces are distanced from the preferences of the market and so have no way to get to know what the consumers prefer. Master weavers and retail shop counter salespeople have access to information relating to consumer preferences. The following are the significant viewpoints of the interviewees concerning handloom product consumers:

a. Consumers do not accept our products with prices revised upwards based on input prices.
b. Retailers prefer power loom sarees now.
c. Retailers sell power loom products as handloom products.
d. Retailers always expect new designs from us.
e. Traditional designs move fast.

iv. **Evaluation of Cluster Development Programs:** The Cluster Development Program is intended to help the weavers with designs, training, and marketing.

However, the cluster development program did not achieve its purpose. The training given was inappropriate. The following is a set of viewpoints expressed by master weavers, society functionaries, bankers, and activists concerning handloom cluster development programs:

a. The cluster scheme did not serve the purpose fully.
b. The training under the cluster program is irrelevant and nominal.
c. The equipment given under the cluster program is improper, so sold or kept away from use.
d. For some, the cluster scheme is somewhat useful.

v. **Current Unique Business Conditions in the Handloom Industry:** The handloom industry is placed in the following commercial situations. They are generally opposed to the efficient operation of the industry. The following are the viewpoints of the interviewees.

    a. Retailers are taking a long time to clear dues, which testifies to poor demand for our handloom products.
    b. Contrarily, some master weavers hold the view that traders pay their bills immediately.
    c. Marketing of handlooms is an issue.
    d. For some master weavers, the handloom business is not profitable.

Policy Implications and Suggestions

The beleaguered industry, suffering disadvantages and injuries on various counts, requires a multipronged solution. The solutions to the industry's problems also should be primarily region-specific, except with wage increases which should be across the regions. To revive the handloom industry, interventions should address the challenges faced by both cooperative and non-cooperative weavers separately. Government support alone won't suffice due to the industry's characteristics and its vulnerability within a competitive market. The necessary support should focus on creating an enabling environment for growth and sustainability.

Production Side Interventions

Raw material prices impact on the handloom industry's survival significantly, and input costs should be subsidized for at least 10 years, with support from state and national

budgets. Availability of inputs directly affects weaver satisfaction, as shown by regression analysis. GST on handloom products and materials is detrimental, as confirmed by interviews.

The weak enforcement of the Handloom Reservation Act allows unfair competition from power looms and must be strengthened. New product development is key to the industry's sustainability, requiring government support in training, subsidies, wage loss compensation, and loom upgrades. These measures should be tailored to regional needs, as supported by regression analysis.

Finance Side Interventions

The cooperative loan process should be simplified, with performance tracking shifted to ICT for transparency. Collateral requirements for weaver loans should be redesigned using ICT and a permanent identification system to enable quick approvals and penalize defaulters. Interest subvention schemes, like those for farmers, should be introduced in both cooperative and non-cooperative sectors, funded by the government for at least a decade. Interviews support these measures.

Marketing Side Interventions

Apex marketing societies should be strengthened by both state and union governments to expand their sales networks and improve management. Government departments, which consume large amounts of cloth, can source it from the handloom industry, including non-cooperative sectors, with quality assurance via ICT-enabled transactions. Marketing assistance, including sales rebates and subsidies, should be provided to both cooperative and non-cooperative sectors, with all transactions enabled by ICT. Handloom firms should be supported in building their brands, focusing on product development, quality control, and expanding retail outlets. Marketing is essential for weaver satisfaction, income, and industry sustainability, as shown by regression analyses.

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Economic and Other Impacts of Solar-Powered Irrigation Pumps: An Empirical Study from Tamil Nadu

A Narayanamoorthy[7]

Introduction

Groundwater became a dominant source of irrigation water in the mid-1980s in India. From less than 6 million hectares (MHA) in 1950-51, the area under groundwater irrigation increased to 48 MHA in 2019-20, which is over two-thirds of India's net irrigated area. That is, the share of groundwater irrigated area to the net irrigated area has increased from 29 per cent to 68 per cent during the same period (MoAFW, 2022). Groundwater irrigation provides many added benefits to farmers as compared to other sources of irrigation. Therefore, over the last 50 years, Indian farmers have pumped massive investment into groundwater structures, which is estimated to be in the order of US$ 12 billion (Shah *et al*., 2006). Besides increasing cropping intensity, productivity and production of crops; groundwater irrigation also helps to enhance the wage rate (Bardhan, 1973; Narayanamoorthy and Bhattarai, 2004) and employment opportunities for agricultural laborers as well as to reduce rural poverty (Narayanamoorthy, 2001; Narayanamoorthy & Deshpande, 2003). While the positive benefits of groundwater irrigation are well known, the over-exploitation of groundwater has resulted in depletion of the water table, salinization and quality deterioration in different parts of the country (Narayanamoorthy, 2010; 2015; 2022).

With the expansion of groundwater-irrigated areas, many changes have also taken place in the power sector of India as there is a close nexus between groundwater irrigation and energy consumption. This is evident from the energisation of pump sets which increased from 5.13 lakhs in 1965-66 to 217.99 lakhs in 2019-20 (CEA, 2021a).

Many states have introduced flat-rate tariffs and free electricity for the agricultural sector, leading to a significant increase in electricity consumption. For example, the

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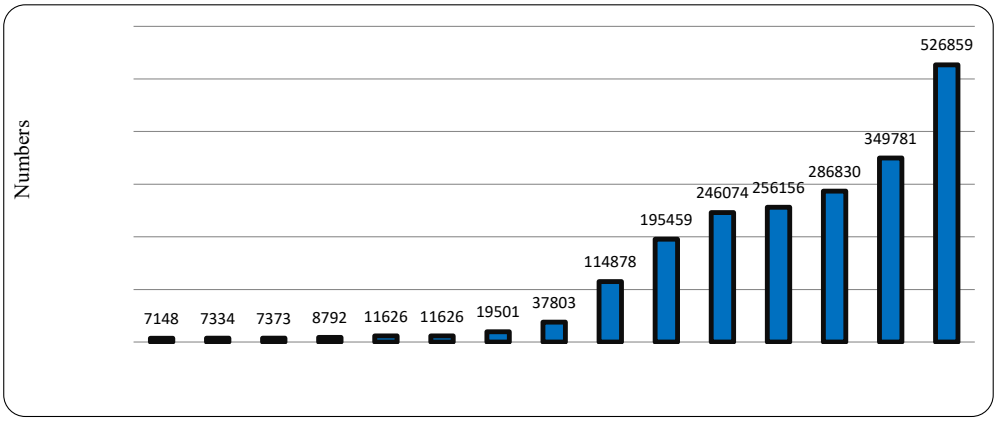
electricity needed to irrigate one hectare of groundwater has risen from 376 kWh in 1970-71 to 4618 kWh in 2018-19. These policies have contributed to the heavy exploitation of groundwater (Kumar, 2005). As a result, not only has the water level gone down drastically in most of the regions but also has resulted in an increased requirement of electricity to pump out per unit of water from wells (Shah, 1993; CGWB, 2021). The recent data published by the Central Groundwater Board shows that out of the total 6965 blocks assessed in India, the groundwater condition in 2529 blocks is in precarious condition (CGWB, 2021).

Solar-powered Irrigation Pumps (SIPs) help reduce groundwater exploitation, save electricity costs, increase farmer income, and lower CO2e emissions. While some argue solar power could threaten groundwater sustainability, this is not always the case. Unlike electric pumps that operate 15-20 hours a day, solar pumps can run only 7-10 hours due to limited sunlight, which helps reduce groundwater overuse. Studies show that solar pumps can decrease groundwater exploitation (Bassi, 2015; Shah, et al., 2018; CSE, 2019). To control groundwater over-exploitation, reduce electricity use, and phase out diesel pumps, solar-powered irrigation pumps have been promoted through attractive subsidy schemes by the central and state governments. For example, under the National Solar Mission in 2014-15, the Government of India aimed to install 1,00,000 solar water pumps annually, reaching 10,00,000 pumps by 2020-21, with support from State Nodal Agencies and National Bank for Agriculture and Rural Development (NABARD). Many state governments also introduced similar subsidy schemes to promote solar irrigation pumps (Shah, et al., 2017; CSE, 2019; IIEC, 2022).

In 2019, a very ambitious scheme namely PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) was introduced with a budget of Rs. 34,422 crores for installation of SIP aggregating 25.75 GW capacity of solar power. PM-KUSUM aims at "ensuring energy security for farmers in India, along with honoring India's commitment to increase the share of installed capacity of electric power from non-fossil-fuel sources to 40 per cent by 2030 as part of Intended Nationally Determined Contributions (INDCs)" (further details of the scheme can be seen from: https://www.india.gov.in/spotlight/pm-kusum-pradhan-mantri-kisan-urja-suraksha-evam-utthaan-mahabhiyan-scheme).

As a result of efforts taken by the centre and state governments, the number of SIP installed has increased from a mere 7,148 in 2008-09 to 5,26,859 in 2022-23 (Figure 1).

Figure 1: Installation of solar pumps in India, 2008-09 to 2021-23



Given the benefits of solar-powered irrigation pumps, many studies have been carried out on various aspects. One of the biggest benefits of solar pumps is that they help to bring newly irrigated areas and therefore, a few studies have analysed their impact on cropping patterns, the productivity of crops and income from crop cultivation (Kishore, et al., 2014 and 2017; Bassi, 2018; Gupta, 2019; Meena, et al., 2020). Since the solar pump is relatively a new technology, some studies have analysed their determinants including the adoption barriers (Kapoor and Dwivedi, 2017; Agarwal and Jain, 2018; Rathore, et al., 2018; Kumar, et al., 2019).

While some have focused on the aspect of promoting solar power as a remunerative crop (Shah, et al., 2017), others have analysed Karnataka's solar pump scheme of 'Surya Raitha' (Shah, et al., 2014; Durga, et al., 2021). Studies have also analysed policies including the problems associated with the solar pumps (Mishra, et al., 2016; Nathan, 2014; Bassi, 2015; Sahasranaman, et al., 2021). The role of solar pumps in groundwater exploitation, including its management, is also analysed by some studies (Shah et al., 2017 and 2018). In the context of scaling up demand-side management, Sreedharan, et al., (2020) have used multi-stakeholder cost-benefit regulatory frameworks for studying the solar pumping programmes. Comparative operational costs and benefits between diesel pumps and solar pumps have also been analysed by some studies (Kolhe, et al., 2002: Renjini et al., 2021; Hilarydoss, 2023). Solar pump involves a large amount of

fixed investment and therefore, some studies have estimated the life cycle cost and benefit-cost ratio to find out the viability of such investment (Sahasranaman, et al., 2018; Pande, et al., 2003; Basi, 2015; Gautam and Singh, 2020; Mantri, et al., 2020; Sreedharan, et al., 2020; Verma, et al.,2020).

Even though the solar pump helps reduce global warming by reducing CO2e emissions, studies have not attempted to estimate such reduction using survey data. Solar irrigation pumps save a considerable amount of water and electricity, but studies have not analysed these benefits in detail. Though many have estimated the benefit-cost ratio for the investment made on solar pumps, studies are also seldom available on the economic viability of SIPs using properly designed discounted cash flow techniques covering field-level data collected from the farmers using solar pumps and electric pumps. The loss of land due to the installation of solar panels and its opportunity cost and whether the deployment of solar pumps anyway benefits the women who are an integral part of farming have also not been studied so far. Solar-powered pumps provide different kinds of benefits to farmers and society, whereas electric pumps provide different sets of benefits.

Unless a comparative analysis is made using data collected from these two groups of farmers, it is difficult to judge whether the benefits generated from solar pumps outweigh the benefits of their counterpart electric pumps. Keeping this in view, an attempt has been made in this study to find out the benefits of solar irrigation pumps including their economic viability, using field survey data collected from four different districts in Tamil Nadu state.

Research Methodology

This study has been carried out using primary data collected from four districts of Tamil Nadu state. There are three plausible reasons for considering Tamil Nadu as a study area. First, Tamil Nadu is one of the important states in terms of using groundwater irrigation, which accounted for about 62 percent of its total net irrigated area in 2019-20. Second, the state also has a unique record of providing free electricity for irrigation pumps since 2006, which reportedly prompted the farmers to over-exploit the groundwater. Probably because of the depletion of the groundwater level, the requirement of electricity to create one hectare of groundwater irrigation is also very

high in Tamil Nadu (8643 kWh) as compared to India's average of about 4618 kWh in 2018-19. Third, the cumulative installation of solar pumps has also steadily increased in the state from 829 in 2008-09 to 6,646 in 2021-22, which is an increase of about 17 percent per annum (Table 1).[8] Because of these reasons, Tamil Nadu state becomes an obvious choice to carry out this study by using field survey data.

Objectives of the Study

i. To study the characteristics of the farmers who have installed solar-powered irrigation pumps.
ii. To study the cropping pattern of solar-powered irrigation pumps using farmers and the electric pump using farmers.
iii. To estimate the water savings due to the installation of a solar-powered irrigation pump.
iv. To estimate the electricity saving due to the installation of a solar-powered irrigation pump.
v. To estimate the reduction in CO2e emissions due to the installation of a solar-powered irrigation pump.
vi. To assess the land lost in solar panel installation and its opportunity cost.
vii. To find out whether women in farm households benefit from the deployment of solar irrigation pumps.
viii. To study the cost of cultivation and income of farmers using solar-powered irrigation and electric pumps.
ix. To estimate the net present worth and benefit-cost ratio for the investment made on the solar-powered irrigation pump, with and without subsidy.

The sample farmers have been selected from four districts namely Dindigul, Pudukkottai, Sivagangai and Virudhunagar, where a total of 204 (19.40 per cent of the state's total) farmers have installed solar pumps to irrigate the crops during 2019-20. There are two main reasons for selecting these four districts for the study. First, these districts have an average level of adoption of solar pumps concerning the state's average. Second, these four districts also have relatively less coverage of irrigation (the irrigation

[8] In many states, the number of solar pumps is exactly the same in 2008-09 and 2013-14. This stagnation in the adoption of solar pumps could be due to the absence of attractive subsidy schemes. This scenario has changed completely after the introduction of PM-KUSUM scheme, under which Tamil Nadu state provides 70-90% of capital subsidy for different categories of farmers.

and other agro-economic characteristics of the selected districts are explained in detail in chapter 2 of the report).

Table 1: Trends in adoption of solar pumps - Major states in India (2008-09 to 2021-22)

States	2008-09	2013-14	2021-22	Compound Annual Growth Rate (%)		
				2008-09 to 2013-14	2013-14 to 2022-23	2008-09 to 2022-23
Andhra Pradesh	613	613	34045	0	49.44	30.71
Bihar	139	139	2813	0.00	35.09	22.20
Chhattisgarh	93	240	119282	17.12	86.05	61.14
Gujarat	85	85	13981	0	66.58	40.52
Haryana	469	469	46260	0	58.27	35.81
Jharkhand	--	--	17231	--	--	--
Karnataka	532	551	7734	0.59	30.23	19.54
Madhya Pradesh	87	87	25138	0.00	76.23	45.90
Maharashtra	228	239	50623	0.79	70.84	43.36
Orissa	8	56	10856	38.31	69.34	61.75
Punjab	1821	1857	17446	0.33	25.11	16.26
Rajasthan	283	4501	113841	58.58	38.13	49.15
Tamil Nadu	829	829	8503	0	26.21	16.79
Uttar Pradesh	751	575	48695	-4.35	55.88	32.07
West Bengal	48	48	673	0	30.22	19.25
All India	7148	11626	526859	8.44	46.43	33.20

Source: MOSPI (Statistical Yearbook of India-various years) and GOI (Energy Statistics India-various years).

As regards the sample selection, a total of 304 sample farmers have been selected for this study: 152 solar irrigation pumps using farmers and 152 electric irrigation pumps using farmers. These 152 solar pumps using sample farmers account for 15 per cent of the total solar pump installed in Tamil Nadu. From each district, the sample farmers from the solar pump category have been selected by following the proportional sampling method.

In addition to a sample survey, a multi-stakeholder consultation has also been done to understand the overall working condition of the solar pump including its promotional schemes. For this, a detailed consultation has been made with a total of 20 stakeholders; 2 sales executives and 3 Assistant Engineers working with the Agricultural Engineering Department from each selected district.

While the farmers who installed the solar pump during 2019-20 have been selected as the sample farmers, the field data from the sample farmers has been collected for the agriculture year 2021-22 (reference period of the data). The data has been collected from the sample farmers using a pre-tested interview schedule. The impact of solar irrigation pumps on different parameters has been studied by making a comparative analysis between solar pumps using farmers and electric pumps using farmers.

Determinants of Solar Pump Adoption

As one of the objectives of the study is to find out the determinants of the adoption of solar irrigation pumps, a logit regression analysis has been carried out to study the determinants. It is a known fact that the adoption of new technology in agriculture is determined by many social and agro-economic factors, which also vary from crop to crop. Generally, logit regression is used to find out the effect of change in the independent variables on the probability of adoption of a technology when the participation fits into a dichotomous choice, essentially taking on the value of 1 for the adoption of a technology and zero for the non-adoption of a technology (Suresh, et al., 2007; Devi, et al., 2014 and Suvedi, et al., 2017). Taking the data of the adopters and non-adopters of solar pumps, a logit regression has been estimated using the variables that are expected to influence the adoption or non-adoption of solar pumps. The reduced form of the logit regression model used for the estimate is given below:

$$Z = a + b_1AGE + b_2CI + b_3CMT + b_4EDU + b_5FAM + b_6FAS + b_7IRA + \mu \quad \ldots\ldots (1)$$

where,

Z = dependent variable (1 for solar pump adapters & 0 for non-adopters)

AGE = Age of the farming head (in years)

CI = Cropping intensity (in percent)

CMT = Community of the farmer (0 for SC/ST and 1 for other farmers)

EDU	= Education of the farming head (in years)
FAM	= Family size (in numbers)
FAS	= Farm size (in acres)
IRA	= Gross irrigated area to cropped area (in per cent)
a	= constant to be estimated
b	= regression coefficient to be estimated
μ	= error term

Of the seven independent variables included in the regression model, four are demographic variables (age, community, education and family size) and the remaining three (cropping intensity, farm size and irrigated area) are agro-economic variables. Many earlier studies have also used these variables while studying adoption behavior of the farmers in different farm technologies. Therefore, it is expected that these variables one way or the other would determine the adoption of solar irrigation pumps.

Estimating CO2e Emissions

Reduction in CO2e emissions is one of the biggest advantages of climate-friendly solar irrigation pumps. Therefore, an attempt is made to estimate the reduction in CO2e emissions based on the working hours of the pump. For estimating CO2e emissions based on the working hours of the pump, a factor of 0.935 has been used, as the coal-fired power plant generates 0.935 kg of CO2e emissions for every unit of electricity generation in India (CEA, 2021).

Estimating NPW and BCR

A key issue with solar irrigation pumps is their economic viability for farmers due to the large, fixed investment. Past studies on this topic often lacked proper methodology, relying on a few farmers or ignoring factors like the pump's lifespan, opportunity costs, depreciation, and subsidies. To assess the economic viability, both the Net Present Worth (NPW) and Benefit-Cost Ratio (BCR) have been calculated using the discounted cash flow technique.

The NPW represents the difference between the present value of benefits and costs over the solar pump's lifespan, accounting for capital and depreciation costs. An investment is considered economically viable if the present value of benefits exceeds the costs. The

BCR, derived by dividing the benefit stream's present value by the cost stream's present value, indicates economic viability if it is greater than one. Obviously, a BCR greater than one implies that the NPW of the benefit stream is higher than that of the cost stream, which is also clearly detailed by Gittinger (1984). The NPW and BCR can be defined as follows:

$$NPW = \sum_{t=1}^{t=n} \frac{B_t - C_t}{(1+i)^t} \quad \text{..... (2)}$$

$$BCR = \frac{\sum_{t=1}^{t=n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{t=n} \frac{C_t}{(1+i)^t}} \quad \text{..... (3)}$$

where,

B_t = benefit in year t

C_t = cost in year t

t = 1,2, 3,....n

n = project life in years

i = rate of interest (or the opportunity cost of investment)

As reported earlier, fixed capital is required for installing solar pumps and therefore, it is necessary to consider the income and cost stream for the whole life span of solar pump investment. However, it is difficult to generate the actual cash flows for the entire life span of solar pump investment because of the absence of observed temporal information on benefits and costs. Therefore, certain realistic assumptions are employed to estimate the cash inflows and cash outflows for solar pump investment, which are:

a. The life period of the solar irrigation pump is considered as 5, 15 and 25 years, as the industry standard for most solar panels' life spans is 25 to 30 years.[9] The cost of cultivation (production cost) and income (value of output) generated using the solar irrigation pump are assumed constant during the entire life period of the solar pump.

[9] *Though the industry standard for most solar panels' life spans is 25 to 30 years, it is not yet empirically proven in India, especially in solar pumps. Due to storms and cyclones, which are frequent visitors to Tamil Nadu, the panels may get affected, requiring complete replacement. Considering this, we have assumed a life period of 5 years as the worst scenario, 10 years as the medium scenario and the best possible scenario as 25 years for computing NPW and BCR.*

b. Differential rates of discount (interest rates) are considered to undertake the sensitivity of investment to the change in fixed capital cost. These are assumed at 10, 12 and 15 per cent as alternatives representing various opportunity costs of capital.[10] The crop cultivation technology is assumed to be constant for all crops during the entire life period of the solar irrigation pump.

c. Besides studying the determinants of the adoption of solar pumps using logit regression and estimating the NPW and BCR, a comparison has been made between the solar pump using farmers and the electric pump using farmers in all the parameters relevant to the objectives of the study.

Findings of the Study

i. The household characteristics of the sample farmers using SIP and EIP are not the same. The average age of the farming head using SIP was found to be significantly less as compared to EIP-using farmers. Like age, the farming experience of the solar pump-using farmers was less than compared to the electric pump-using farmers. The level of education was relatively better among SIP-using farmers (9.36) as compared to EIP-using farmers. The survey also reveals that over 99 per cent of SIP using sample farmers were from other backward communities (OBCs).

ii. The landholding size of SIP using farmers was relatively smaller than its counterpart EIP using farmers. The average landholding size of SIP-using farmers was 3.47 acres per household, whereas the same was 3.83 acres per household for EIP-using farmers.

iii. The main source of irrigation used for cultivating crops by both SIP and EIP-using farmers is groundwater. The groundwater area accounted for about 73 percent of the net cropped area of SIP using farmers, whereas the same accounted for about 89 percent for EIP using farmers.

iv. A significant difference was observed in the net cropped area, gross cropped area as well as in gross irrigated area between the two categories of farmers.

[10] *The data available from the Bank Bazzar website (www.bankbazzar.com) shows that the agriculture loan interest rate across various banks in India varies from 7.00-14.25 percent per annum (as of April 16, 2024), excluding the processing fee. Additionally, the farmers will be incurring a good amount of transaction costs to get the loan. Keeping this in view, discount rates are assumed as 10, 12 and 15 percent.*

There was also a difference in the cropping intensity (CI) between the two categories of farmers. The average CI was about 209 percent for SIP-using farmers, whereas the same was about 218 percent for EIP-using farmers. The average gross irrigated area of the solar pump using farmers before its installation was only 0.38 acres per household, which increased to 6.74 acres per household after the installation, an increase of about 18 times. As a result, the gross cultivated area of SIP using farmers increased from 3.12 acres to 7.28 acres per household. The cropping intensity increased from 100 percent to about 210 percent. The average gross irrigated area of the solar pump was 6.44 acres per household.

v. The cropping pattern of solar pump users changed significantly after installation. Before, foodgrain crops covered 89 per cent of the area, but this dropped to 29 per cent after installation. Commercial crops like coconut, sugarcane, and cotton, which were not grown before, became prevalent after solar pump installation. Afterward, the cropping pattern of solar pump users aligned more closely with that of electric pump users.

vi. The logit regression estimated to find out the determinants of solar irrigation pumps reveals that among the variables that turned out to have a positive sign of coefficient, the education of the farming head was the only variable that significantly influenced the adoption of solar pumps. Two of the agro-economic factors, namely cropping intensity and farm size were negatively and significantly influenced the adoption of solar pumps. The logit regression results suggest that factors such as education of the farmer, cropping intensity and farm size are more likely to influence the adoption of solar irrigation pumps.

vii. There were differences in the ownership pattern of groundwater structures by the solar and electric pump-using farmers. The electric pump using farmers owned a total of 163 pumps, whereas the solar pump using farmers owned a total of 152 pumps. The average horsepower (HP) size of the pump was relatively higher (6.13) for the solar pump using farmers as compared to the electric pump using farmers (6.64). Except for a few farmers belonging to the category of electric pumps, all other farmers were using 5 HP size pumps, which is different from the solar pump using farmers where 56 out of 152 farmers were either using 7.5 HP pump or 10 HP pump.

Table 1: Summary results of the study – solar versus electric pumps

S. No.	Parameters	Solar pumps	Electric pumps	% Change (Solar over Electric Pumps)
1	Number of sample farmers	152	152	--
2	Farm size (acres)	3.47	3.83	-9.40
3	Gross irrigated area (acres)	6.74	7.93	-15.01
4	Net cultivated area (acres)	3.47	3.76	-7.77
5	Gross cultivated area (acres)	7.28	8.21	-11.33
6	Cropping intensity (%)	209.80	218.35	-3.92
7	GIA to GCA (%)	92.56	96.54	-4.12
8	Foodgrains area (acres)	2.08	2.26	-7.96
9	Non-foodgrains area (acres)	5.19	5.95	-12.77
10	Non-foodgrains area to GCA before solar pumps (%)	10.80	--	--
11	Non-foodgrains area to GCA after solar pumps (%)	71.34	72.47	-1.56
12	HP size of pumps	6.13	5.64	8.69
13	Operating hours of pumps per day	6.85	11.23	-39.00
14	Irrigated area by solar pumps (acres)	6.35	--	--
15	HP hours of water use per acre (all crops average)	1044.91	1301.37	-19.71
16	Potential electricity saving - all crops average (kWh/acre)	783.63	--	--
17	CO2e emission reduction - all crops average (Kg/acre)	732.74	--	--
18	Cost of cultivation (A2+FL) - all crops average (Rs/acre)	75,844	74,189	2.23
19	Productivity of paddy (quintal/acre)	20.63	19.98	3.25
20	Productivity of sugarcane (quintal/acre)	863.27	834.33	3.47
21	Productivity of vegetable crops (quintal/acre)	93.86	68.18	37.67
22	Value of crop output - all crops average (Rs/acre/annum)	1,84,278	1,77,017	4.10
23	Net income - all crops average (Rs/acre/annum)	1,08,434	1,02,828	5.45

Source: Computed using field survey data.

viii. The average operating hours of pumps by the solar pump-using farmers was 6.85 hours per day, whereas the same was about 11.23 hours per day for the electric pump using farmers, the difference between the two was about 39 percent.

ix. The allocation of irrigated areas differed between solar and electric pump-using farmers. Water-intensive crops like paddy and vegetables made up 26 per cent of the irrigated area for solar pump users, compared to 22 per cent for electric pump users. Solar pump farmers also allocated more area to sugarcane. Overall, solar pump users dedicated less irrigated areas to foodgrain crops (19 per cent) compared to electric pump users (25 per cent).

x. The water use pattern differed between solar and electric pump-using farmers. Although the number of irrigations and hours per irrigation were similar, solar pump farmers used fewer HP hours for almost all crops (except pulses). The highest water savings were in coconut (42.60 per cent), followed by tree crops (42.65 per cent) and sugarcane (33.08 per cent). Solar pump farmers also saved significant water in more water-intensive crops like paddy (15 per cent), vegetables (15.51 per cent), and maize (24.04 per cent) compared to electric pump users.

xi. Farmers using solar pumps can save significant electricity across different crops, with an average saving of 783.68 kWh/acre. Savings vary from 1637 kWh/acre for sugarcane to 45 kWh/acre for gingelly. Farmers growing paddy, groundnut, coconut, cotton, and vegetables can save 322-416 kWh per acre. If all electric pump users switch to solar, potential savings could rise to 976 kWh/acre.

xii. The reduction in CO2e emissions from potential electricity savings was significant across crops, averaging 732 kg/acre. However, it varied by crop, with the highest reduction of 1531 kg/acre in water-intensive sugarcane and the lowest of 42 kg/acre in low-water-consuming gingelly (sesame seeds).

xiii. The average cost of cultivation was slightly higher (2.23 per cent) for solar pump-using farmers (Rs. 75,844/acre) compared to electric pump-using farmers (Rs. 74,189/acre). However, solar pump-using farmers spent less on 6 out of 10 crops, including key water-intensive crops like paddy (1.19 per cent) and sugarcane (7.13 per cent), compared to electric pump users.

xiv. There was no uniform trend in crop productivity between the two groups of farmers, but solar pump-using farmers achieved higher yields in water-intensive crops like paddy, coconut, sugarcane, and vegetables. Paddy yields were 3 per cent higher, and vegetable yields were 37 per cent higher for solar pump users. Solar pump farmers also harvested higher cotton yields compared to electric pump users.

xv. The average net income (in terms of cost A2+FL) for solar pump-using farmers was Rs. 1,08,434/acre, about 5.45 per cent higher than the Rs. 1,02,828/acre for electric pump-using farmers. Solar pump farmers earned higher net income from key crops like paddy, coconut, sugarcane, cotton, and vegetables. For paddy, net income was 4.34 per cent higher, and for sugarcane, it was 10.33 per cent higher for solar pump farmers compared to electric pump users.

xvi. The land required for solar pump installation was calculated based on panel size. Each panel (6.77 feet by 3.39 feet) occupies 22.95 square feet. For 5 HP, 7.5 HP, and 10 HP pumps, 15, 20, and 22 panels are needed, respectively, resulting in land loss ranging from 344 square feet for 5 HP pumps to 505 square feet for 10 HP pumps.

xvii. The opportunity cost of land lost due to solar pump installation was Rs. 862/acre for 5 HP pumps, Rs. 1,150/acre for 7.5 HP pumps, and Rs. 1,265/acre for 10 HP pumps. The highest opportunity cost was found in tree crops, followed by vegetables and sugarcane. The opportunity cost for paddy, a water-intensive crop, was the lowest, at Rs. 118/acre for 5 HP pumps and Rs. 175/acre for 10 HP pumps.

xviii. Most of the farmers have accepted that the installation of solar pumps one way or another benefits the women. The important benefits listed by the respondents were:

   a. Women farmers can operate the solar pump easily, which is not possible with diesel pumps.
   b. Women used to spend a considerable amount of time fetching water for drinking and domestic purposes earlier that has reduced now due to solar pumps.
   c. Women can work in their farm contributing to crop cultivation, instead of going for wage work earlier.

d. Since the solar pump works only during daytime, women farmers can manage the irrigation work without any fear and other security issues.
e. By working on their farm, work time flexibility for women has increased.
f. The stress faced by the women has been reduced substantially by working on their farm.
g. The women can rear quality milch animals due to the availability of water from solar pumps.

xix. The HP size of the solar pump determines the requirement of fixed capital cost. The capital cost for a 5 HP pump comes to Rs. 1,69,612 with subsidy, but it increases to Rs. 2,42,303 without subsidy. For 10 HP pumps, the capital cost increases from Rs. 3,07,741 with subsidy to Rs. 4,39,630 without subsidy. The farmers using solar pumps received 70 per cent of the capital cost as a subsidy through PM-KUSUM scheme, jointly implemented by the central and Tamil Nadu state governments.

xx. The NPW of solar pump investment for one acre was slightly higher with subsidy than without, across all HP sizes, discount rates, and life periods. For a 5 HP pump, the NPW was Rs. 4,67,138/acre without subsidy and Rs. 5,32,040/acre with subsidy at a 12 per cent discount rate and 15-year life. For a 10 HP pump, the NPW was Rs. 3,65,625/acre without subsidy and Rs. 4,83,383/acre with subsidy.

xxi. The BCR of solar pump investment is higher with subsidy than without, across all pump sizes and life periods. For a 5 HP pump with a 15-year life, the BCR was 1.58 without subsidy and 1.75 with subsidy at a 15 per cent discount rate. For a 10 HP pump, the BCR was 1.34 without subsidy and 1.56 with subsidy. The BCR increases significantly when calculated with a 12 per cent or 10 per cent discount rate and a 25-year life period.

xxii. The investment in solar pumps with a 5-year life period at a 15 per cent discount rate without subsidy was not financially viable to the one-acre holding farmers, as the estimated BCR was only 0.99. This suggests that farmers owning one acre of land should not adopt solar pumps with 10 HP as the capital cost for such a pump size is much larger than 5 HP pump.

xxiii. The BCR increases when estimated to be one hectare of land instead of one acre. At a 10 per cent discount rate with a 15-year life, the BCR for one acre

was 1.89 under subsidy, but it rose to 2.25 for one hectare. Similarly, under the subsidy condition, the BCR increased from 1.69 for one acre to 2.13 for one hectare.

xxiv. The year-wise computation of net present worth under different discount rates indicates that the farmers with one hectare of land could recover the entire capital cost of the solar pump from their income within two years when they use 5 HP and 7.5 HP pump, whereas the 10 HP pumps owning farmers could recover the entire capital cost within three years, at a 10 percent discount rate under subsidy condition with a 15-year life period.

Policy Implications and Suggestions

Though the study shows that the solar irrigation pump generates many economic and other benefits to the farmers, the following recommendations may be considered to increase the adoption of solar irrigation pumps on a large scale:

i. The study finds that solar irrigation pumps save water and electricity, increase income, and reduce CO2e emissions. While subsidies are not vital for economic viability, they are important for encouraging adoption, especially among small farmers. Tamil Nadu offers a 90 per cent subsidy for SC/ST farmers, but a 100 per cent subsidy could boost adoption. The study suggests phasing out subsidies as the technology proves its benefits.

ii. While there are no major complaints about solar pumps, farmers request block-level service centers for quick repairs.

iii. Awareness of subsidy schemes and solar pump benefits is low, with farmers unclear about costs and subsidies. Governments should use TV ads and other channels to boost awareness and adoption.

iv. About 63 per cent of electric pump users cite free electricity as the main reason for not adopting solar pumps. State governments could ration supply or redirect subsidies to increase solar pump adoption.

v. Farmers report delays in processing subsidy applications. A clear timeline and a single-window system or Special-Purpose Vehicle could help speed up the process.

vi. Some farmers using solar pumps have adopted drip irrigation, increasing productivity. Governments should offer financing options to encourage this combination.

vii. Policymakers could integrate PMKSY-Per Drop More Crop and PM-KUSUM to promote both micro-irrigation and solar pump adoption.

viii. To reduce groundwater over-exploitation, solar pump adoption could be mandatory in over-exploited districts, as classified by the Central Groundwater Board.

Solar irrigation pumps offer key benefits, including enabling high-value crop cultivation, boosting productivity and income, and promoting environmental sustainability by reducing groundwater use and CO_2 emissions. This can lower public costs and help lift smallholders out of poverty. Widespread adoption supports global warming mitigation, aligning with COP23 targets. Governments should raise awareness and promote solar pumps to maximize these benefits.

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Assessing farmers' participation and challenges in linking Agricultural Produce Market Committee (APMC) mandi markets by e-National Agricultural Market (e-NAM): Evidence from the state of Goa

R L Manogna[11]

Introduction

e-NAM aims to unify India's agricultural markets through digital integration, linking existing APMC mandis into a national electronic platform. Managed by the Small Farmers Agribusiness Consortium (SFAC), e-NAM streamlines agricultural marketing, enhancing transparency, price discovery, and trade efficiency. Despite its success in several states, Goa's implementation faces challenges, particularly in infrastructure and stakeholder adoption. The study examines e-NAM's adoption and benefits in Goa, focusing on smallholder participation, pricing, and the potential of Negotiable Warehouse Receipts (NWRs) to improve market efficiency. Key findings reveal that e-NAM offers multiple benefits to farmers, such as higher price realization through broader market access, the convenience of online payments, reduced travel and paperwork, and improved transparency. Farmers using e-NAM, especially vegetable growers, report significant improvements in income and annual expenditure (Dey et al., 2023). These findings highlight e-NAM's potential to provide tangible financial benefits, expanded market access, and higher economic returns for participants. Agricultural marketing has evolved significantly over time, transitioning from traditional barter and local village markets to advanced systems incorporating ICT, digital marketing, and global virtual platforms (Ranjith Kumar et al., 2020). The study also recommends strategies to address challenges in Goa, including improving infrastructure, enhancing software capabilities, educating farmers on e-NAM's features, and addressing concerns related to resource requirements and digital literacy. A holistic approach, involving both government and private sector support, is essential for enhancing e-NAM's effectiveness and increasing adoption across the state.

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Adoption and Operational Challenges

e-NAM adoption is influenced by regional market dynamics, crop types, and stakeholder awareness. Effective implementation requires targeted training programs that address content relevance, methodology, and language. Regional disparities affect benefits, with northern farmers seeing better price realization. A Chi-Square test on 174 farmers, 30 officials, and 30 traders revealed significant differences in terms of awareness, i.e., 66.7 per cent of farmers and 83.3 per cent of traders were unaware of e-NAM, while all officials were aware. The results (Pearson Chi-Square = 55.1407, p-value = 0.000) suggest the need for improved information dissemination, particularly for farmers and traders. Despite technological benefits, smallholder farmers remain unaware of e-NAM's incentives. Awareness, digital literacy, and regional disparities must be addressed to improve e-NAM adoption, especially among underserved populations. Educational attainment and age strongly influence smallholder awareness and registration behaviors. Some of the key findings are as follows:

Awareness of e-NAM: The logistic regression model indicates that both age and education are crucial determinants of awareness about e-NAM. Older individuals and those with higher education levels are more likely to be aware of the portal. This suggests that experience and educational background play a role in understanding and accessing digital agricultural platforms.

Registration on e-NAM: When it comes to actual registration on the e-NAM platform, education proves to be a significant factor. Individuals with higher levels of formal education are more likely to register on e-NAM. In contrast, age does not have a significant effect on registration, indicating that factors other than age might influence an individual's decision to register.

Strategies for Enhancing e-NAM Adoption in Goa

To advance e-NAM adoption in Goa, strategies should focus on infrastructure, software, education, and research. Integrating mandis with WDRA-accredited warehouses and cold storage is essential for a cohesive national market. Upgrading e-NAM software to manage trade, automate processes, and resolve disputes will improve efficiency. Educating farmers, especially those with limited tech skills, is crucial for better market

access and transparency. Collaboration with banks and ongoing research will refine e-NAM, addressing barriers and improving its impact.

Despite the rollout of e-NAM in April 2020, farmers continue to struggle with digital literacy and find the portal challenging, leading to low adoption rates. They still rely on intermediaries, which undermines the goal of direct transactions. Traders are hesitant due to concerns about tax liabilities and transparency, while commission agents fear losing their traditional roles. Technological and infrastructural issues, such as connectivity problems and lack of advanced features, hinder e-NAM's effectiveness. Incorporating AI and IoT could improve functionality.

Goa faces inadequate infrastructure for warehouse-based trading, with local mandis lacking electronic bidding, weighment systems, and integrated warehouses, limiting the use of warehouse-based trading. NWRs provide financial flexibility, but the lack of e-NAM integration prevents its full utilization. Recommendations include enhancing infrastructure, encouraging private sector participation, and implementing capacity-building programs, with a strong monitoring framework to ensure effective implementation.

Economic Impact of e-NAM on Farmer Price and Viability

The e-NAM (Electronic National Agriculture Market) portal offers real-time price information and transparent transactions, bridging the gap between farmers and traders while reducing transaction costs. However, many farmers prefer traditional market practices due to low awareness of e-NAM's benefits. A paired t-test shows a significant difference in registration rates: all farmers visiting APMCs are registered with e-NAM, while fewer non-visitors are. The p-value of 0.0031 indicates that physical market interactions promote e-NAM adoption, with exposure within APMCs increasing the likelihood of registration.

Cost-Benefit Analysis

The cost-benefit analysis of e-NAM shows a negative mean net benefit of -0.55, indicating that respondents feel the costs outweigh the benefits. This perception varies by familiarity with e-NAM. Despite benefits like reduced transaction costs, more efforts are needed to highlight its advantages. ANOVA results show younger, educated individuals with smartphones are more likely to use e-NAM, emphasizing the

importance of digital literacy. Limited adoption and negative perceptions hinder e-NAM's effectiveness, suggesting the need for targeted educational programs to improve its financial viability.

Therefore, the findings highlight a need for targeted interventions to improve e-NAM adoption among less educated and younger farmers. Strategies should focus on bridging the educational gap and enhancing digital literacy to facilitate broader engagement with the platform.

i. ***Educational Initiatives:*** Given the strong link between education and both awareness and registration, educational programs that inform and train farmers about e-NAM could enhance participation rates. These programs should be accessible and tailored to the needs of different demographic groups.

ii. ***Technology Accessibility:*** Ensuring that technological tools and resources are available and user-friendly is critical. This includes providing support and assistance to farmers with lower educational backgrounds to navigate and utilize the e-NAM portal effectively.

iii. ***Focused Outreach:*** Outreach efforts should be directed towards younger and less educated farmers to increase their awareness and registration on e-NAM. Customized communication strategies and hands-on support could improve their engagement with the platform.

Policy Implications and Suggestions

i. **Targeted Training and Digital Literacy Programs**: Development and implementation of tailored training programs for farmers, focusing on technological literacy, content relevance, and delivery methods. Emphasizing smartphone usage and online platforms to bridge the digital divide, particularly among older and less educated farmers, to increase e-NAM adoption and utilization.

ii. **Increased Outreach and Awareness Campaigns**: Increasing use of local media, digital platforms, and community engagement to raise awareness of e-NAM's benefits, especially in remote areas. Highlighting success stories, providing hands-on training, and targeting younger, less educated farmers with clear communication and practical demonstrations to improve adoption.

iii. **Address Regional Disparities**: Customizing e-NAM implementation strategies to address regional differences, providing additional support and incentives to farmers in underrepresented areas to ensure equitable access to the platform's benefits.

iv. **Enhance Technological Compatibility and Infrastructure**: Focusing on improving e-NAM's technological integration with existing systems for a better user experience. Invest in upgrading mandis with e-NAM facilities, including electronic bidding and weighment systems, and establishing accredited warehouses to support seamless operations and market integration.

v. **Improve Access to Technology and Resources**: Facilitating access to smartphones and other digital tools for farmers, potentially through subsidies or partnerships with technology providers. Ensuring that resources, tools, and support systems are accessible, particularly for farmers with lower educational levels.

vi. **Comprehensive Stakeholder Engagement**: Fostering collaboration among farmers, traders, commission agents, and warehouse operators through workshops and feedback mechanisms. This will ensure that e-NAM implementation is aligned with stakeholders' needs and address concerns, driving successful adoption.

vii. **Incorporate Advanced Technologies**: Integrating AI and IoT into e-NAM to enhance decision-making, real-time data access, and platform efficiency, making the system more effective for farmers and traders.

viii. **Promote Policy Reforms and Private Sector Participation**: Encouraging policy reforms such as tax breaks for traders and subsidies for farmers to support e-NAM adoption. Additionally, encouraging private sector investments in e-NAM infrastructure, including warehouse establishment and logistics services, to bring in additional resources and expertise.

ix. **Optimize Resource Allocation and Capacity Building**: Addressing concerns about e-NAM's resource requirements by demonstrating practical advantages and providing clear, supportive resources. Implementing training programs to increase awareness and improving participation in the platform, enhancing overall utilization.

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