

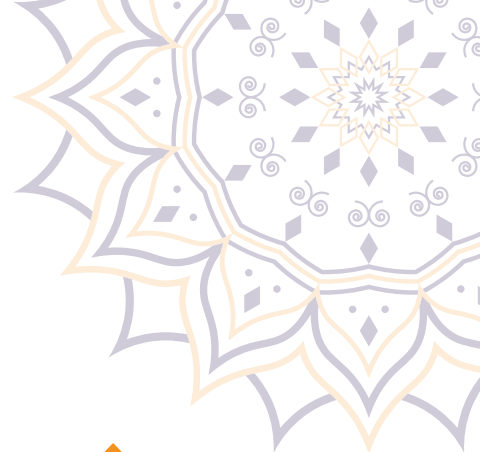
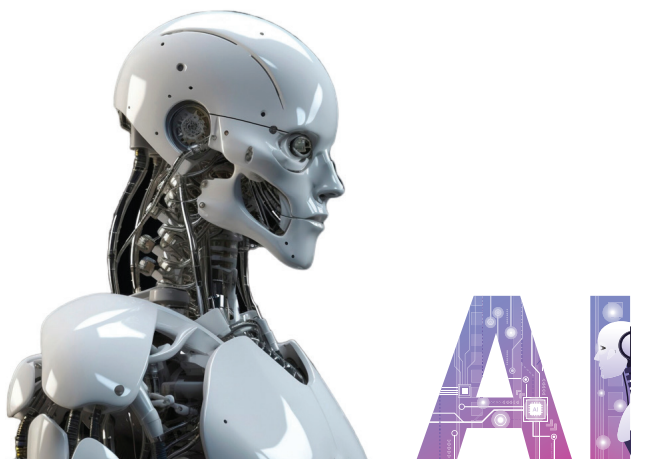
In collaboration
with PwC India



Harnessing **Generative AI** for Primary Agricultural Credit Societies (PACS)



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FROM THE CHAIRMAN



SHAJI K V
CHAIRMAN, NABARD

I am pleased to present this pioneering discourse, "*Harnessing Generative AI for Primary Agricultural Credit Societies*", which stands at the confluence of tradition and transformation. India's cooperative movement—anchored by over 106,000 Primary Agricultural Credit Societies (PACS) and serving more than 160 million members—forms the backbone of our rural economy. This discourse not only highlights the vast potential and scale of these grassroots institutions but also addresses the operational challenges they face in their mission to serve and empower farmers.

The Government of India's Centrally Sponsored Project to computerize all PACS, led by NABARD, represents a landmark step in the digital transformation of rural cooperatives. It is a foundational step that opens the door to future innovations and efficiency improvements. At NABARD, our core mandate is to promote sustainable and equitable rural and agricultural development, with a strong emphasis on strengthening Rural Financial Institutions (RFIs). In this context, Generative AI is not merely a technological advancement—it represents a transformative force.

Its potential to drive data-informed decision-making, mitigate credit risk, and democratize access to timely and relevant information aligns closely with India's development goals and the evolving needs of our rural ecosystem. This paper explores the possibilities of Generative AI, reflects on global best practices, and sets forth a bold vision for AI-enabled PACS that are more efficient, resilient, and inclusive.

Equally important is the emphasis on establishing a robust governance framework—one that is rooted in ethical principles, respects data sovereignty, and upholds the cooperative ethos. The vision laid out here is not just aspirational but actionable, offering a strategic roadmap for the future.

I am confident that through collaborative efforts, strategic investments, and a shared commitment to innovation, we can usher the cooperative sector into a new era—one where technology becomes a true enabler of prosperity and empowerment for rural India.

I extend my sincere appreciation to the Ministry of Cooperation, our partners, stakeholders, and the dedicated team behind this initiative for their thoughtful and timely contribution to this important discourse.



FROM THE

DEPUTY MANAGING DIRECTOR

This publication serves as an important exploration into the possibilities that Generative Artificial Intelligence can offer to transform the cooperative sector, especially the PACS in the post digitization era. Harnessing cutting-edge technology to fortify the institutions that are the cornerstone of our rural financial ecosystem can be the natural succession of digitisation. We live in a time where technology is rapidly redefining traditional frameworks and adopting AI-driven solutions presents an extraordinary opportunity for cooperatives to modernize, innovate, and achieve greater efficacy in serving the rural communities and regaining their status of being the main pillars for rural financial system of India.

The research presented here is grounded in the operational realities of PACS. It acknowledges their vast reach and financial clout while candidly addressing systemic challenges, such as the loan overdue, governance and manpower issues etc, which impacts their financial health and sustainability. It is precisely these challenges that present an extraordinary opportunity for innovation. Generative AI offers powerful tools to modernize operations, enhance credit risk modelling with greater precision, and create smarter, more resilient systems at the grassroots level.

NABARD, true to its mandate is deeply committed to nurturing a rural credit ecosystem that supports this technological leap. This involves building a supportive regulatory framework, investing in secure data infrastructure, and ensuring that AI adoption is inclusive and equitable. We must ensure that these powerful new tools are deployed with robust ethical guardrails, aligning with the fundamental spirit of cooperation that defines and characterizes these institutions.

As we envisage the future of AI-powered PACS, I am optimistic about its profound long-term impact on India's agricultural and rural empowerment. Together, guided by a shared vision and collaborative spirit, we stand at the brink of a technological renaissance for cooperatives.



G S RAWAT
DEPUTY MANAGING DIRECTOR,
NABARD



PREFACE



SANJAY KUMAR GUPTA
CHIEF GENERAL MANAGER,
CSDD, NABARD

As the department entrusted with the development of the cooperative sector, we are at a pivotal moment. This paper, **"Harnessing Generative AI for Primary Agricultural Credit Societies"** provides a comprehensive and data-driven perspective on the future of Primary Agricultural Credit Societies (PACS). Our analysis, as detailed within, shows that PACS on an average manage a massive working capital of over ₹4.09 lakh crore, but also face tangible challenges: nearly 35% operate at a loss, inadequate availability of skilled manpower and various issues like significant credit over dues, governance etc. that need to be addressed.

The confluence of traditional cooperative principles and emerging technologies like Gen AI offers an unprecedented opportunity to address these issues head-on. This research moves beyond theoretical possibilities by grounding its recommendations in hard data and global best practices. It directly links the capabilities of Gen AI to solving the core problems of credit risk, business viability, and last-mile service delivery.

Building on the success of our ongoing initiatives, such as the nationwide computerization of PACS, the integration of Gen AI is the logical next step in their evolution into modern, multi-service hubs for our rural populace and aspiring youth while PACS are making significant endeavours to foray into newer value adding activities and member centric services. The "Sahkar AI" proof-of-concept detailed herein offers a tangible glimpse into this future—a future where every PACS employee and member is empowered with data-driven insights.

This document is intended to be a strategic roadmap for policymakers, cooperative leaders, and technology partners. It is our hope that it will stimulate focused action, inspire innovative pilot projects, and guide the sector toward a future of enhanced efficiency, transparency, and sustainable growth, thereby enriching the economic and social fabric of rural India.

ABSTRACT/EXECUTIVE SUMMARY

This publication "Harnessing Generative AI for Primary Agricultural Credit Societies" delves into the transformative potential of Generative Artificial Intelligence (Gen AI) in revolutionizing India's cooperative sector, particularly focusing on Primary Agricultural Credit Societies (PACS). In an era where the amalgamation of traditional practices and state-of-the-art technology holds the promise of unprecedented progress, this document serves as a pivotal examination of how Gen AI can catalyze modernization, efficiency, and growth within PACS.



Technological Outlook as presented in paper

The paper critically emphasizes the integration of AI into Primary Agricultural Credit Societies (PACS) with pilot projects to test and refine AI solutions. The integration of Gen AI is seen to unlock avenues like refined risk management, credit allocation, and tailored agricultural strategies. There is a need to develop a robust data infrastructure to support high-quality datasets essential for AI model effectiveness in the PACS.

At the heart of the paper is an exploration of Gen AI models, including Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), and Transformers like GPT and BERT. Analyzing these models unveils their role in redefining rural governance, service delivery, and member engagement when integrated with digital ecosystems like ePACS. The potential to democratize access to expert knowledge, automate administration, and enhance decision-making through predictive analytics is profoundly discussed.

Policy Outlook as detailed in paper

The paper stresses having a supportive regulatory framework to facilitate AI integration while ensuring it complements existing systems. It engages stakeholders to integrate technology with rational methodologies for effective empowerment and inclusion. Educate and train stakeholders to equip them with skills necessary to leverage AI technology effectively by investing in AI-related infrastructure and education to build capacity and expertise within the cooperative sector. The document presents the critical significance of PACS within India's agricultural and rural landscape,



tracing their historical evolution and their role in driving rural economies.

It further examines the CSPCP and the future pathways for technologically advanced cooperatives. Globally, the paper assesses trends and innovations influencing cooperative AI integration, highlighting collaborative initiatives like the GAIA (Generative AI for Agriculture Advisory) project. Policy recommendations are provided to encourage AI adoption, suggesting regulatory, infrastructural, and educational advancements. The ethical integrity of AI use is emphasized, advocating for data privacy, inclusivity, and alignment with core cooperative values.

In envisioning a future of AI-enabled PACS, the paper outlines a strategic roadmap and proof of concept initiatives that can have the long-term impact on India's agricultural and rural sector through co-operatives. The overarching vision is one of a technologically empowered and ethically grounded rural renaissance, embedding Gen AI as a catalyst for sustainable socio-economic development across the cooperative spectrum.





1. Introduction

Generative Artificial Intelligence (Generative AI) represents a transformative frontier in computational intelligence, wherein machines are endowed with the capacity to synthesize novel content—textual, visual, auditory, or multimodal—by extrapolating from learned patterns in vast datasets. Unlike traditional AI systems that are predominantly deterministic and rule-based, generative models leverage probabilistic frameworks and deep neural architectures to emulate human-like creativity and reasoning.

At the core of Generative AI lie sophisticated models such as Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), and Transformer-based architectures like GPT and BERT. These models are trained on extensive corpora, enabling them to internalize complex structures, semantics, and contextual nuances. The generative process is not merely a replication of existing data but a recombination and abstraction that yields outputs with originality and coherence.

The epistemological significance of Generative AI extends beyond its technical prowess. It challenges conventional paradigms of authorship, creativity, and cognition, raising profound philosophical and ethical questions. In practical terms, its applications span a multitude of domains—from automated content creation, drug discovery, and architectural design to personalized education and synthetic media generation. In fact, it is a matter of pride and efficiency to acknowledge that this publication's content creation is vastly automated and highly inspired from the content Generated using various Gen AI tools like chatgpt, Microsoft Co-Pilot and others

In the context of socio-economic systems such as agricultural cooperatives, Generative AI holds the potential to democratize access to expert-level insights, automate administrative functions, and enhance decision-making through predictive and prescriptive analytics. Its integration into digital ecosystems could catalyze a paradigm shift in rural governance, service delivery, and member engagement. This publication is an attempt to consolidate the Possibilities of AI for PACS. The paper begins by establishing the significant role co-operatives play in rural economy of the country. Further it gives a summary of foundational understanding on Generative AI for first time readers. Subsequently, the possibilities for using AI for various scenarios as is identified across the globe are listed with context to India. A proof of concept is imagined and depicted in the form of user interfaces on various channels using prompts showcasing how

co-operatives members, employees and key personnel can interact with and harness the potential of this technology. Further, details on policy recommendations to encourage a supportive regulatory framework is discussed. Ethical and social considerations on using AI in a value drive ecosystem like that of co-operatives has been investigated. In conclusion, the future of AI-Driven PACS is established with significant food for thought for the readers.

1.1. The Role of PACS in Rural Economy

Cooperatives have historically served as a cornerstone of India's rural economy, acting as institutions that empower small and marginal farmers, rural artisans, and local communities through democratic ownership and participatory governance. A cooperative is a voluntary, member-owned, and member-operated organization, wherein individuals come together to achieve collective economic goals. Each member holds an ownership stake and has a say in the management, ensuring equitable benefit-sharing and community accountability.

India's cooperative credit system operates through a structured three-tier architecture, comprising both short-term and long-term cooperative credit structures. The Short-Term Cooperative Credit Structure (STCCS) addresses seasonal and working capital needs for agricultural operations. It consists of State Cooperative Banks (StCBs) at the apex level, District Central Cooperative Banks (DCCBs) at the intermediate level, and Primary Agricultural Credit Societies (PACS) at the village level. According to NABARD's Annual Report 2023-24, the STCCS network includes over 1,06,000 PACS, 351 DCCBs, and 34 StCBs, serving as the main channel for delivering rural credit and agricultural input support across the country.


In parallel, the Long-Term Cooperative Credit Structure (LTCCS) caters to capital investment and asset creation needs of farmers and the rural sector. This structure comprises State Cooperative Agriculture and Rural Development Banks (SCARDBs) and Primary Cooperative Agriculture and Rural Development Banks (PCARDBs), depending on the state. These institutions provide long-duration credit for purposes such as land development, irrigation, mechanization, and agri-enterprise infrastructure. States like Tamil Nadu, Kerala, Punjab, and West Bengal have well-established LTCCS networks.




SHORT-TERM CREDIT COOPERATIVES

Performance of StCBs and Performance of DCCBs

9,774 Cr
Share Capital

34  **7.4%**
StCBs **Growth in**
Net Profit

26,486 Cr
Share Capital

351  **38.5%**
DCCBs **Growth in**
Net Profit

1920 Cr
Share Capital
1,00,000+
PACS

Over **35%** of agricultural
credit disbursed
Over **4 crore KCCs**
13 crore members
9 crore Active
Borrowers

Target: Computerize
63,000+ **PACS** by 2027

Budget: ₹ 2,516 crore
(Gol + NABARD)

Progress: Over 60,000 PACS
Computerised by May 2025



Ref: NABARD Annual Report 2023-2024



Cooperatives' Share in Rural Economy – Key Indicators

Sector	Share/Reach of Cooperatives
Rural Credit (Short-Term)	~19% of total agricultural credit (via STCCS including PACS)
Fertilizer Distribution	~35% of rural fertilizer distribution
Procurement of Agricultural Produce	~30% of wheat and 20% of paddy in select states (via cooperative marketing societies)
Milk Production	~20–25% of India's milk handled by dairy cooperatives (e.g., AMUL network)
Sugar Production	~35–40% of national sugar production via cooperative sugar mills
Storage Facilities	~15–18% of rural godown capacity managed by cooperative institutions
Rural Retail and Agri Inputs	~30% of agri-input retail in rural areas (via PACS & other cooperatives)

Beyond credit, cooperatives—particularly PACS—play a multi-functional role in rural development. They facilitate procurement and distribution of inputs, market linkages, fair price operations, and the implementation of Government schemes such as PMFBY, eNAM, and CSC services. Recognizing this multidimensional role, the Government of India has launched a Centrally Sponsored Scheme for the Computerization of PACS (2023–2027) to improve transparency, digitization, and data-driven decision-making.

In essence, cooperatives form the backbone of financial inclusion and socio-economic resilience in rural India. Their integration with technology, governance reforms, and diversified services holds immense potential for transforming rural livelihoods sustainably.

1.2. Significance of PACS in India's Agricultural Sector

1.2.1. Historical Context and Evolution

Primary Agricultural Credit Societies (PACS) constitute the foundational tier of India's cooperative credit architecture, conceived during the colonial era to counteract exploitative lending practices and catalyze rural economic resilience. Institutionalized post-independence under the Cooperative Societies Act, PACS were envisioned as democratically governed, community-centric entities facilitating access to agricultural credit, inputs, and market linkages.

Over the decades, PACS have metamorphosed from rudimentary credit dispensers into multifaceted rural institutions. By 2023, India had over 95,000 PACS,

covering nearly 90% of villages, serving as conduits for schemes like Kisan Credit Cards (KCC), fertilizer distribution, and procurement under Minimum Support Price (MSP) regimes¹. Their evolution reflects a dynamic interplay between agrarian policy, grassroots mobilization, and cooperative federalism. The Indian cooperative movement is one of the largest in the world with nearly 8 lakh cooperative societies (of the thirty lakh globally)². India accounts for nearly 27% of all cooperatives in the world. Over 20% of Indian population is estimated to be part of the cooperative movement in comparison to the global average of 12%.5 Of the 300 largest cooperatives in the world (by turnover/GDP per capita), 15 are from India with IFFCO at top position, followed by Amul. India ranks second in the Asia Pacific region (after Japan) and sixth in the world (after USA, France, Germany, Brazil, and Japan) in terms of number of cooperatives under this category.7 Among the top 300 cooperatives listed by turnover (US\$), IFFCO is placed 72nd, Amul 90th, and KRIBHCO 236th³.

The significance of PACS is not merely historical; it is a present-day reality defined by a colossal footprint in India's rural economy. As per National co-operative Database, and 'Ensure' database present with NABARD the following statistics testify the scale and importance of PACS:

¹<https://nabard.org>

²<https://cooperatives.gov.in/>

³<https://ndap.niti.gov.in/>



- **Reach of PACS:** There are 106,955 PACS in India, with a total membership of 160.38 million people. These societies have a presence in approximately 94.3% of all villages in the country. This unparalleled last-mile connectivity makes them the most critical channel for financial inclusion and agricultural support.
- **Substantial Financial Clout:** PACS are not small entities. They collectively command a Share Capital of ₹22,191 crore and hold Deposits of ₹1,97,239 crore. Their total Working Capital stands at ₹4,09,377 crore, demonstrating their role as significant financial intermediaries in the rural landscape.
- **Engine of Agricultural Credit:** In the 2022-2023 fiscal year, PACS issued Total Loans of ₹2,00,491 crore to 49.23 million borrowers. This credit enable the farmers to procure inputs, invest in equipment, and sustain their livelihoods.
- **Business diversification of PACS:** As per data collected from states during review of MoC initiatives, it is reported that more than 23,000 PACS have started operating as PDS/FPS units. More than 45,000 PACS are ready to start CSC operations. More than 37,000 PACS are offering PMKSK services.

However, the data also highlights persistent operational challenges that technology can address:

- **Profitability and Viability:** Of the functioning societies, only 47,794 are in profit, while a significant 37,357 operate at a loss. This indicates a pressing need for business diversification, operational efficiency, and new revenue streams—areas where Gen AI can provide substantial support.

This data-driven context establishes a clear "why" for technological intervention. The scale of PACS represents an opportunity for impact at an unprecedented level, while their operational challenges define the precise problems that Gen AI is uniquely positioned to solve.

1.2.2. CSPCP and Opportunities for Technological Advancement

The CSPCP initiative by NABARD has emerged as a landmark success in modernizing India's rural credit infrastructure. With over 60,000 PACS digitized and onboarded onto a robust ERP platform comprising 22 modules, the project has significantly enhanced operational efficiency, transparency, and service delivery at the grassroots level.

The ERP system supports a wide array of functions

including loan disbursement, procurement, warehousing, PDS operations, asset and HR management, and more. It also enables seamless integration with District and State Cooperative Banks through a Common Accounting System (CAS) and Management Information System (MIS), thereby reducing transaction costs and improving reconciliation.

The success of CSPCP is evident in its scale and impact: digitization has empowered PACS to evolve into Multi-Service Centers (MSCs), offering diversified services that support rural livelihoods. The ERP's adaptability—customizable to state-specific needs and available in vernacular languages—has ensured inclusive and effective implementation.

The core objectives of CSPCP include fostering efficiency, accountability, and profitability in PACS operations. By implementing a Common Accounting System (CAS) and Management Information System (MIS), the project ensures accuracy and uniformity in business conduct, with transaction-level data feeding into standardized reporting mechanisms. This transformation enables PACS to evolve into multi-service entities, offering a wide array of agricultural, financial, and non-financial services to rural communities.

A key strength of PACS—their captive member base—is leveraged to design personalized products and services, thereby uplifting the socio-economic fabric of rural India. The ERP system facilitates seamless integration with higher-tier cooperative institutions and government departments, promoting knowledge dissemination and policy alignment.

CSPCP has the potential to support Direct Benefit Transfer (DBT) mechanisms, ensuring accurate and targeted delivery of subsidies and funds. Through digital infrastructure like POS, mPOS, QR Code Readers, BHIM Aadhaar Pay, and more, PACS are empowered to offer cashless transactions in their establishments, such as fertilizer shops and seed units.

Moreover, the initiative aims to expand financial services to unbanked areas, enhance PACS performance, generate rural employment. Future technological advancements—such as AI-driven analytics, blockchain for secure records, and IoT-enabled logistics—can further amplify CSPCP's impact, aligning with the MoC's vision of "Sahakar se Samridhi".

2. Understanding Generative AI

This section details about foundational models and key aspects of Generative AI for first time readers. The type of data input and their implications on feedback are discussed with appropriate technically relevant references.

2.1. Foundational Models and Transformer Architectures

At the heart of Gen AI lies the transformer architecture, a paradigm-shifting innovation introduced by Vaswani et al. (2017)⁴. Transformers leverage self-attention mechanisms to model long-range dependencies in data, enabling scalable learning across vast corpora. Foundational models like GPT, BERT, and PaLM exemplify this architecture, trained on multi-modal datasets to acquire generalized representations of language, vision, and code.



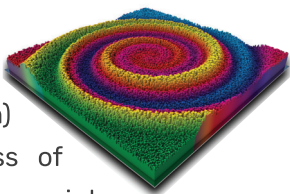
2.2. Emergent Capabilities and Scaling Laws

Gen AI systems exhibit emergent behaviors—capabilities not explicitly programmed but arising from scale. These include in-context learning, abstraction, and reasoning. Scaling laws empirically demonstrate that model performance improves predictably with increases in parameters, data, and compute, suggesting a quasi-continuous path toward artificial general intelligence (AGI).



2.3. Diffusion Models and Latent Space Manipulation

In image and audio generation, diffusion models (e.g., DALL·E, Stable Diffusion) simulate the reverse process of entropy, transforming noise into coherent outputs via iterative denoising. These



models operate in latent spaces, where semantic concepts are encoded as high-dimensional vectors, allowing for interpolation, style transfer, and concept blending.

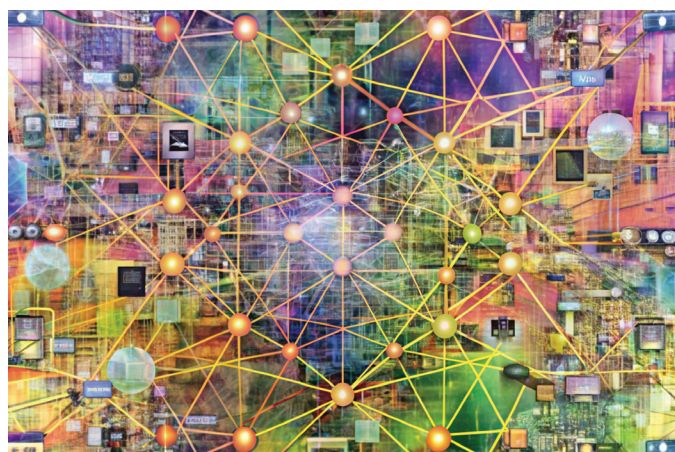
2.4. Reinforcement Learning from Human Feedback (RLHF)

To align Gen AI outputs with human values and preferences, RLHF is employed. This technique fine-tunes models using reward signals derived from human evaluators, bridging the gap between raw generative capacity and socially acceptable behavior.



2.5. Multi-Modality and Cross-Domain Generalization

Modern Gen AI systems are increasingly multi-modal, capable of processing and generating text, images, audio, and video⁵. This convergence enables cross-domain generalization, where knowledge from one modality informs another, enhancing creativity and contextual understanding.



⁴ https://proceedings.neurips.cc/paper_files/paper/2017/file/3f5ee243547dee91fbd053c1c4a845aa-Paper.pdf

⁵ <https://www.cs.toronto.edu/~emicha/papers/rlhf.pdf>

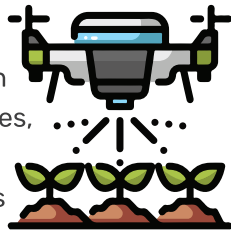
⁶ <https://bair.berkeley.edu/blog/2023/10/16/p3o/>

3. Global Trends and Innovations

Global trends and innovations across the agriculture, cooperative, banking, and digital governance sectors are experiencing dynamic transformations, driven by technological advancements and evolving socio-economic demands. These sectors, once operating independently, now increasingly intersect, fostering unprecedented opportunities for growth, sustainability, and community empowerment.

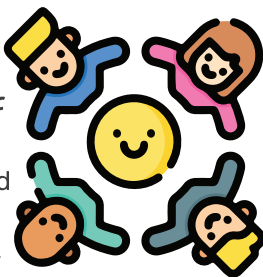
1. Agriculture Sector:

Global agriculture is undergoing a paradigm shift driven by precision farming, climate-smart practices, and biotechnological innovations. Precision agriculture leverages satellite imagery, IoT sensors, and AI to optimize inputs like water, fertilizers, and pesticides, enhancing yield while minimizing environmental impact. Innovations such as CRISPR-based gene editing are revolutionizing crop resilience and nutritional value. Meanwhile, vertical farming and hydroponics are redefining urban agriculture, enabling food production in constrained spaces. Climate resilience is a central theme, with nations investing in drought-resistant crops, carbon farming, and regenerative agriculture to combat the volatility of global weather patterns and ensure food security.



2. Co-operative Sector: Digital Integration and Socioeconomic Empowerment

The Co-operative sector could undergo a profound transformation driven by digitization and the possibility of Artificial Intelligence (AI), marking a paradigm shift in how financial institutions operate and strategize. AI's ability to process voluminous datasets with unprecedented speed and accuracy could catalyze innovations across various financial domains. The co-operative movement is evolving from traditional community-based models to digitally integrated, scalable enterprises. In countries like India, Kenya, and Brazil, cooperatives are being digitized to improve transparency, governance, and access to markets. Platform cooperativism—where digital platforms are owned and governed by users—is gaining traction as a counter-model to extractive tech monopolies. Innovations in blockchain are enabling decentralized record-keeping and trust-building among cooperative members. Moreover, cooperatives are increasingly



being recognized as vehicles for inclusive growth, especially in agriculture, housing, and financial services, empowering marginalized communities through shared ownership and democratic control.


3. Banking Sector: Fintech Disruption and Inclusive Finance

The banking sector is being reshaped by fintech innovations, central bank digital currencies, and AI-driven financial services. Digital-only banks and neobanks are challenging traditional institutions by offering seamless, low-cost services. AI is being used for credit scoring, fraud detection, and personalized financial advice, while blockchain is transforming cross-border payments and asset tokenization. In developing economies, mobile banking and digital wallets are driving financial inclusion, bringing millions into the formal financial system. Regulatory sandboxes and open banking frameworks are fostering innovation while ensuring consumer protection and systemic stability. In the realm of customer service, AI-powered chatbots and virtual assistants are revolutionizing client interactions by offering personalized, real-time support. These tools employ natural language processing to resolve queries efficiently, thereby enhancing customer satisfaction while reducing operational costs. Risk management has also been transformed through AI's predictive capabilities. By analyzing historical data and current market conditions, AI systems can forecast potential financial downturns and credit risks, enabling institutions to implement preemptive measures. Moreover, AI is pivotal in combating financial fraud. Advanced machine learning models can identify fraudulent activities by scrutinizing transaction patterns and flagging anomalies, thus safeguarding assets and ensuring regulatory compliance.



4. Digital Governance: AI, Data Sovereignty, and Citizen-Centric Services

Governments worldwide are embracing digital



governance to enhance transparency, efficiency, and citizen engagement. The use of AI in public services—from predictive policing to automated welfare distribution—is growing, albeit with ethical scrutiny. Digital identity systems like India's Aadhaar and Estonia's e-ID are enabling seamless access to services, while data sovereignty is emerging as a key concern, prompting nations to localize data and regulate cross-border flows. Innovations in e-participation, blockchain-based voting, and smart contracts are redefining democratic processes. The emphasis is shifting toward citizen-centric design, ensuring that digital transformation is inclusive, secure, and accountable.



In conclusion, AI's transformative impact on above key areas that seamlessly converge at co-operatives is characterized by enhanced efficiency, improved risk assessment, and a heightened focus on personalized customer experiences, heralding a new era of financial innovation and resilience. The convergence of these sectors could foster holistic development, where innovations in one area catalyze advancements in others. This interconnectedness is not only conducive for enhancing sector-specific growth but also for driving sustainable development, resilience, and empowerment at the community level.



4. Gen AI in Co-operatives – Possibilities

Generative Artificial Intelligence (Gen AI), with its capacity to synthesize information, generate content, and simulate human-like interactions, offers unprecedented opportunities to reimagine the operational, communicative, and developmental paradigms of co-operative institutions—particularly in the agrarian and rural sectors. The cooperative sector in India plays a crucial role in the rural economy, providing financial services, agricultural inputs, and market access to millions of farmers and rural households. With the advent of Generative AI (Gen AI), there is an unprecedented opportunity to enhance the efficiency, transparency, and impact of cooperatives.

NABARD has been pursuing technology at multiple fronts. NABARD champions the adoption of CBS across co-operative banks to ensure sustainable digitization and their role as building blocks of a co-operative grid across the country. NABARD, in its endeavor to enable access to latest technologies in the banking sector, is working to facilitate common platforms for various initiatives like Centralised Account Aggregator platform, Cyber Insurance, Common MIS Server, Centralised Payment System, etc.,⁷

At the core of Gen AI's promise lies its ability to democratize access to information and services. Primary Agricultural Credit Societies (PACS), which form the bedrock of rural financial inclusion, often grapple with challenges of outreach, literacy, and administrative inefficiencies. Gen AI-powered multilingual chatbots and voice assistants, tailored to local dialects and cultural contexts, can bridge this gap by enabling intuitive, real-time interactions between farmers and co-operative institutions. These systems can autonomously generate responses to improve the quality and inclusivity of agricultural advice for smallholder farmers, many of whom are members of primary agricultural cooperatives, on queries about loan eligibility, repayment schedules, dividend disbursements, and market prices—thus reducing dependency on intermediaries and enhancing transparency.

Gen AI can revolutionize data management and decision-making within co-operatives. By analyzing historical transaction data, weather patterns, and market trends, AI models can generate predictive insights that inform credit risk assessments, crop planning, and inventory management. This predictive intelligence, when integrated into co-operative workflows, can elevate the strategic capabilities of even the smallest societies, fostering resilience and sustainability.

Box 1: The GAIA Project

The **Generative AI for Agriculture Advisory (GAIA)** project, spearheaded by CABI in collaboration with IFPRI and other partners, represents a pioneering initiative aimed at transforming agricultural advisory services through the strategic deployment of generative artificial intelligence (GenAI) in **Kenya, India, and Ethiopia**. Launched in 2023, GAIA is structured in two phases. **Phase I** focused on prototyping GenAI-powered chatbots and testing their feasibility in delivering localized, expert-validated agricultural advice. Trials conducted in Kenya and India demonstrated high user engagement, with over 90% of testers indicating they would regularly use the chatbot. These tools were designed to bridge the digital divide by offering multilingual support and intuitive interfaces, particularly for smallholder farmers who often lack access to timely and reliable information.

Phase II, running from 2024 to 2027, expands the initiative's scope to include Ethiopia and integrates more complex functionalities such as real-time data inputs (e.g., weather, remote sensing), multimodal content delivery, and gender-responsive design. A key innovation is the development of a **Retrieval-Augmented Generation (RAG)** framework and a shared open-access corpus of agricultural content, curated from institutions like CGIAR and CABI. Beyond technical deployment, GAIA emphasizes **ethical governance**, licensing clarity, and content attribution. CABI has led efforts to create a GenAI Ethics Toolkit and flexible licensing models that safeguard intellectual property while enabling responsible AI use. Legal analyses across the three countries ensure regulatory compliance and equitable access.

In essence, GAIA exemplifies how GenAI can be harnessed to democratize agricultural knowledge, empower marginalized communities, and foster sustainable development in the Global South.



Box 2: SAP & BayWa – Germany

In Germany, BayWa, a major agricultural cooperative, in partnership with SAP, is using Gen AI to analyze satellite data and generate predictive insights on crop yields and resource management. BayWa and SAP have collaborated to use Gen AI for generating subsidy applications and compliance reports. These systems extract relevant data from farm records and government portals, auto-fill forms, and even generate explanatory narratives for auditors and financial institutions. This reduces administrative burden and ensures timely access to credit and subsidies. These tools are integrated into cooperative advisory services, helping farmers optimize inputs and adapt to climate variability. The AI copilot, Joule, supports natural language queries from farmers, enabling real-time, personalized recommendations. A subsidiary of BayWa, Vista GmbH, applies Gen AI to forecast agricultural productivity using geospatial data. This is particularly useful for cooperatives managing collective land and resources, allowing them to plan procurement, storage, and credit disbursement more effectively.

Gen AI chatbots could be harnessed to deliver agricultural training in local languages. These chatbots, built into platforms like Telegram, provide extension agents and farmers with instant access to agronomic advice, pest management strategies, and climate-resilient practices. The system could translate complex scientific data into culturally relevant, easy-to-understand formats, bridging the gap between research and grassroots implementation.

The bot operates in multiple regional languages and provides conversational support on agriculture practices, credit schemes, weather, and input use. Over 15,000 farmers across Kenya, India, Ethiopia, and Bangladesh have used it, collectively logging more than 300,000 interactions. For cooperative credit societies, this tool is transformative. It provides 24/7 assistance to members, reduces the burden on field agents, and ensures timely, personalized advice—especially in remote areas. AI-generated responses are drawn from credible agronomic and financial knowledge bases, ensuring farmers receive relevant and localized guidance. By integrating this chatbot with cooperative society operations, PACS or DCCBs can improve financial literacy, reduce credit misuse, and enhance farmer decision-making. Farmer. Chat exemplifies how generative AI can be a scalable, multilingual extension of agricultural extension and financial advisory services.

AI-powered tools could revolutionize co-operative banking by enhancing credit risk modeling, fraud detection, and client communication. Machine learning algorithms analyze historical and real-time data to assess borrower creditworthiness with greater precision, enabling more informed lending decisions. For fraud detection, AI systems monitor transactions continuously, identifying anomalies and flagging suspicious activities in real time.

Box 3: Crédit Agricole - France

Crédit Agricole has evolved into one of Europe's largest cooperative banking groups, with a presence in over 50 countries and assets exceeding €2 trillion as of 2025. Rooted in mutualist principles, the bank is owned by 12 million shareholders across 2,383 local banks, reflecting its deep commitment to democratic governance and regional development. The bank launched a comprehensive strategy to integrate GenAI into its operations, emphasizing responsible AI, data protection, and human-centric design. It has prioritized 36 GenAI use cases, spanning Retrieval Augmented Generation powered platform for its employees, client support, marketing content creation, KYC processes, ESG compliance, and internal collaboration tools. These applications aim to streamline workflows, personalize customer interactions, and reinforce Crédit Agricole's cooperative ethos of proximity and trust. To ensure scalability and security, Crédit Agricole has adopted a rigorous methodology involving data preparation, prompt engineering, environmental impact assessment, and continuous monitoring. A dedicated Data Lab and IA Factory lead these efforts, supported by a cross-entity taskforce focused on experimentation and acculturation. Importantly, the bank maintains a "human-in-the-loop" approach, ensuring GenAI augments rather than replaces human judgment. As it navigates regulatory landscapes like the EU AI Act, Crédit Agricole exemplifies how cooperative institutions can harness GenAI not merely for efficiency, but for ethical, inclusive, and sustainable Agriculture.

Consumer cooperatives can utilize Gen AI for real-time product description generation, localized promotional content, and trend forecasting. AI can help Co-operatives personalize the shopping experience and reduce food waste via dynamic pricing and demand forecasting.

Farm Drive revolutionizes agricultural lending in Kenya by using machine learning to create alternative credit scores for smallholder farmers. Traditionally excluded from formal financial systems due to lack of collateral and formal records, these farmers now gain access to loans by leveraging non-traditional data—such as

mobile phone usage, weather patterns, GPS farm data, and transaction histories. Farm Drive's platform compiles this data and applies AI algorithms to assess creditworthiness. The model reduces risk perception among financial institutions and ensures informed lending decisions. Over the years, Farm Drive has significantly improved access to credit for rural farmers, increased loan approval rates, and encouraged financial institutions to lend confidently to agricultural cooperatives. This has had a tangible impact on productivity, incomes, and financial inclusion. Its success has led to replication in other Sub-Saharan African countries and has established a benchmark for how AI can transform agricultural credit in the developing world.

Agri-business intelligence and price forecasting could leverage AI to revolutionize agricultural markets. By analyzing historical data, satellite inputs, and market arrivals, AI can forecast market trends for crops, milk, and grains. This empowers Primary Agricultural Credit Societies (PACS) and farmers to strategically time their sales, aggregate produce, and establish e-commerce or mandi linkages. As a result, PACS can diversify their operations by running digital mandi platforms, commodity trading desks, or collective warehousing. This approach not only enhances market efficiency but also boosts farmers' profitability and market access, promoting sustainable agricultural growth and resilience against market volatility.

Apollo Agriculture uses AI to streamline agricultural lending for smallholder farmers in Kenya and Zambia. Its core innovation lies in using behavioral data and machine learning to predict repayment capacity, detect fraud, and dynamically price credit. By analyzing past borrowing patterns, mobile phone data, and farming history, Apollo creates risk-adjusted credit scores. This allows cooperatives and Agri-credit societies to offer instant, fair loan offers—right at the point of sale. Apollo also deploys AI tools to monitor field officer behavior to preempt fraudulent practices, ensuring operational integrity. AI-generated insights help reduce non-performing loans and improve farmer engagement. The system also incentivizes responsible repayment by reducing interest rates for good borrowers. With Apollo, thousands of farmers who were previously unbanked now access critical resources—seeds, fertilizers, and insurance—on credit. It's a scalable model demonstrating how AI can support data-driven, farmer-centric cooperative credit in resource-constrained environments.

AI-enabled input and retail management could significantly enhance the operations of Primary Agricultural Credit Societies (PACS). By utilizing AI to optimize inventory, pricing, and demand forecasting for fertilizers, seeds, and pesticides, PACS-run retail outlets can achieve increased profitability. This technological advantage allows for more precise supply chain management, reducing waste and ensuring timely availability of products. Additionally, PACS can diversify their offerings by establishing smart rural marts, Agri-input franchises, or solar equipment distribution networks. These ventures not only expand their service portfolio but also cater to the evolving needs of the agricultural community, driving sustainable growth and community empowerment.

Digitized insurance and climate resilience products, powered by AI, offer transformative benefits in agriculture. By predicting crop risks and assessing flood or drought threats, AI facilitates automated insurance claims processing. This capability enables Primary Agricultural Credit Societies (PACS) to serve as agents for parametric weather insurance and crop loss mitigation funds, enhancing their service offerings. Such diversification opens new income streams through insurance commissions and the bundling of climate-risk credit products. This strategic expansion not only boosts PACS' profitability but also strengthens farmers' resilience against climate-related adversities, fostering sustainable agricultural development and community empowerment.

Taranis and Agri Predict are AI-driven platforms supporting agricultural cooperatives and credit societies by improving risk assessment and early warning systems. Taranis uses drone and satellite imagery combined with AI to provide hyper-local crop monitoring—identifying pests, nutrient deficiencies, and weather risks. This empowers farmer cooperatives and insurers to make real-time decisions about crop health, directly influencing lending and insurance terms. Agri Predict, developed in Zambia, functions as a mobile-based AI assistant that warns farmers about pests, diseases, and adverse weather using predictive modeling. It enables timely action and reduces crop loss risk. Both tools are valuable to cooperative credit societies, which often struggle to assess credit risk and recovery potential due to crop uncertainty. With accurate data from these platforms, societies can offer better-structured credit products, reduce default rates, and extend insurance-backed loans to smallholders. These technologies also help educate

farmers and create a virtuous cycle of data-driven agricultural finance.

Box 4: Gen AI in Vidarbha – Maharashtra India

Under the ambitious **Maha Agri-AI Policy 2025–2029**, Maharashtra has initiated a pioneering Generative AI use case tailored to the cooperative sector in Vidarbha. This initiative focuses on digitizing and interpreting the **State Cooperative Acts**, enabling local cooperative societies—especially in agriculture and rural credit—to access legal and procedural information through AI-powered chatbots and voice interfaces. The system uses multilingual GenAI models trained on statutory texts, government circulars, and procedural guidelines. Farmers and cooperative members can query the chatbot in Marathi or English to understand governance norms, audit procedures, election rules, and compliance requirements. This democratizes access to legal knowledge, reducing dependency on intermediaries and enhancing transparency.

Integrated with the Agricultural Data Exchange (ADeX) and AI Sandbox Environment, the Vidarbha pilot also supports real-time advisory and document generation for cooperative operations. By simplifying complex legal language and offering contextualized responses, the initiative empowers grassroots institutions and strengthens participatory governance in Maharashtra's cooperative landscape.

Data-driven member profiling and needs assessment in agriculture leverage AI and machine learning to

analyze transaction histories, cropping patterns, land records, and credit behaviors. This approach enables financial institutions to identify unmet financial needs such as dairy, fisheries, equipment loans, and Agri-processing units. By understanding these gaps, institutions can diversify their offerings and launch tailored products targeting non-crop segments. Examples of such products include farm machinery leasing, which allows farmers to access necessary equipment without large upfront costs, and cold storage microfinance, which helps farmers preserve produce and reduce post-harvest losses.

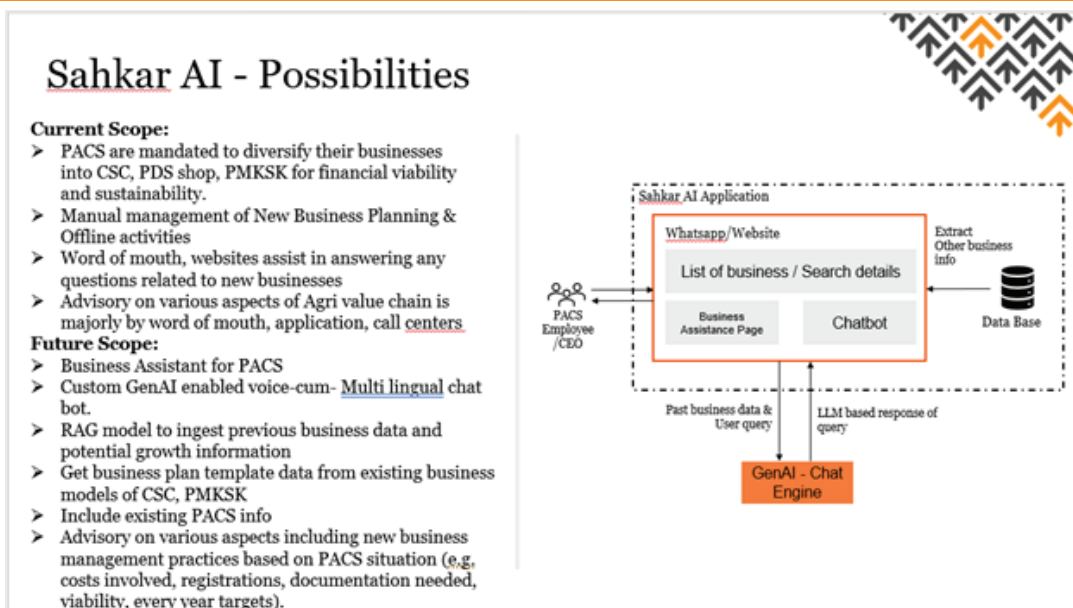
Box 5: Ama Krush AI – Odisha in India

Launched in 2023 by the Government of Odisha, Ama KrushAI is India's first generative AI-powered chatbot dedicated to agriculture. Developed using OpenAI's ChatGPT and IIT Madras's Bhashini language platform, it delivers personalized, multilingual advisory services to farmers across the state. Ama KrushAI is integrated with the Krushak Odisha database, which contains detailed records of farmers' land, crops, and livestock. This enables the chatbot to provide contextualized and farmer-specific guidance on agronomic practices, government schemes, and loan products from over 40 commercial and cooperative banks innovation. The chatbot not only answers real-time queries but also empowers farmers to make informed decisions, enhancing productivity and financial literacy. Ama KrushAI marks a significant step in democratizing agricultural extension services through GenAI.

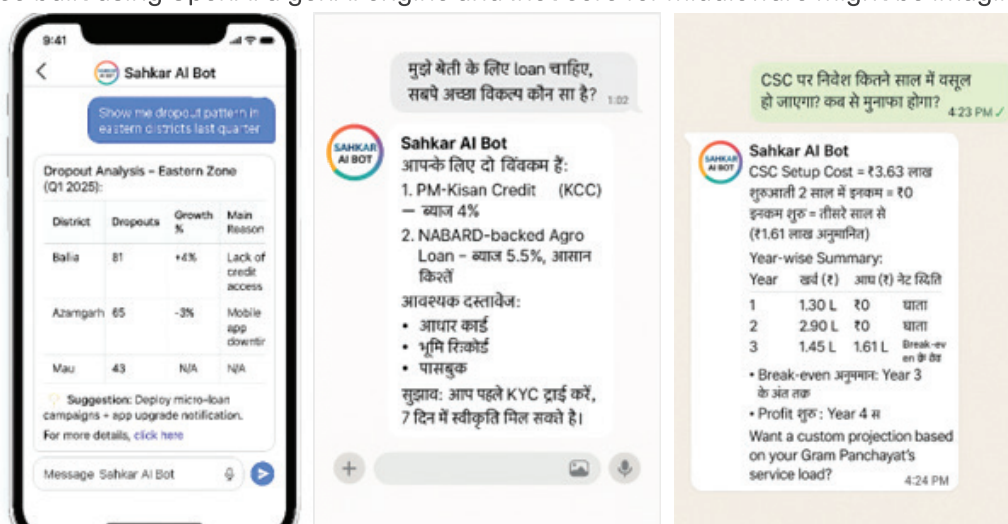


5. Proof of concept

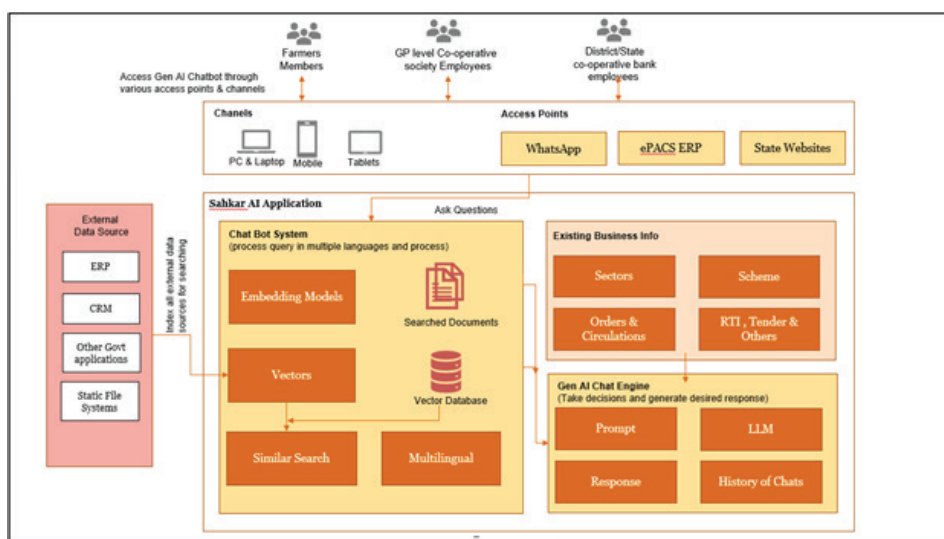
As a proof of concept, Sahkar AI can be envisioned as a voice-cum-chat Bot that acts as a Business assistant to PACS as well as advise its members on various aspects of the Agri value chain.



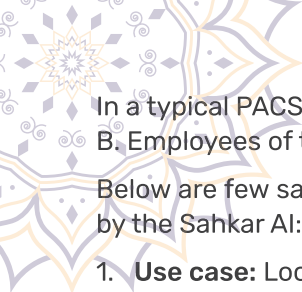
The User Interface built using OpenAI a genAI engine and .net core for middleware might be imagined as below:



Indicative User Interface of a voice-cum-chat bot for various channels like WhatsApp, Mobile App



Indicative architecture for Gen AI use cases in PACS



In a typical PACS ecosystem, following are the 3 segments of users: A. Farmers/ Members of Co-operative society
B. Employees of the Primary co-operative society C. Employees of District/State co-operative credit Bank.

Below are few sample prompts that each of the user could potentially feed to the bot and the possible responses by the Sahkar AI:

1. **Use case:** Local language supported Sahkar AI Bot to advise farmers on various topics like their credit limit, on crop health, advice on market prices for a crop , availability of nearest Mandi, advice on best option to avail loan, advice on options for purchasing seeds, fertilizers, advice on weather.☒

a. Target Audience - Farmers & co-operative members

b. Channel – Website, WhatsApp, Facebook Messenger

c. Prompts

Sl. No	Use case	Prompt
1	Credit Limit Inquiry	Farmer: मेरा किसान क्रेडिट कार्ड कितना limit दिखा रहा है ? Sahkar AI Bot: नमस्ते! आपके किसान क्रेडिट कार्ड की limit ₹1,20,000 है। आप अभी तक ₹85,000 का उपयोग कर चुके हैं। शेष limit: ₹35,000 क्या आप उपयोग की जानकारी चाहेंगे ?
2	Crop Health Advice	Farmer: मेरी धान की फसल में पीले पत्ते हो रहे हैं, क्या करें ? Sahkar AI Bot: यह Zinc deficiency या fungal infection हो सकता है। कृपया खेत की फोटो भेजें या अपने क्षेत्र का नाम बताएं। आपके क्षेत्र में सुझाव: Zinc Sulphate 21% @10kg/acre का छिड़काव करें। बारिश के बाद दवा न डालें।
3	Market Price Information	Farmer: आज गेहूं का रेट क्या चल रहा है ? Sahkar AI Bot: पता चल रहा है कि आप लखनऊ जिले से हैं। आज लखनऊ मंडी में गेहूं का भाव ₹2,150 प्रति क्विंटल है। कल ₹2,130 था - आज थोड़ा बढ़ा है। क्या आप पास की मंडियों के रेट जानना चाहेंगे ?
4	Nearby Mandi Availability	Farmer: मेरे पास की मंडी कहाँ है ? Sahkar AI Bot: आपके गांव से 8 किमी दूर गौरीगंज मंडी है। – समय: सुबह 6:00 दोपहर 2:00 – सेवाएं: गेहूं, धान, आलू, प्याज के लिए उपयुक्त – संपर्क: मंडी ऑफिस 1234567890
5	Loan Option Advice	Farmer: मुझे खेती के लिए loan चाहिए, सबसे अच्छा विकल्प कौन सा है ? Sahkar AI Bot: आपके लिए दो विकल्प हैं: 1. PM-Kisan Credit Card (KCC) – ब्याज 4% 2. NABARD-backed Agro Loan – ब्याज 5.5%, आसान किश्त • आधार कार्ड • भूमि रिकॉर्ड • पासबुक सुझाव: आप पहले ट्राई करें, 7 दिन में स्वीकृति मिल सकती है।

2. Use case: Sahkar -AI: Acting like a business assistant in local language. Diversifying into new business, Common Service Centre(CSC), Ration shop, Retail, Medicine shop, Business plan making.☒

a. Target Audience - Gram Panchayat level Co-operative society employees

a. Channel – Website, WhatsApp

b. Prompts (Setting up a CSC)

c. Prompts

Sl. No	Use case	Prompt
1	Managing Business (English)	<p>Employee: Based on my membership base, in how many years will a new business like CSC become profitable</p> <p>Sahkar AI Bot: Based on your balance sheet and membership, if we assume 50% conversion, your organisation will become profitable in 2 years.</p> <p>Auto prompt: Would you like a supporting business model and cashflows</p>
2	Can I Get a Loan for Setting Up a CSC? (Bengali)	<p>Employee: CSC শুরু করার জন্য কি আমি ঋণ পাব?</p> <p>Sahkar AI Bot: হ্যাঁ, সমবায় সমিতি কর্তৃক CSC-এর জন্য ঋণ পাওয়া যায়।</p> <p>CSC ঋণের নগদ প্রবাহের বিবরণ:</p> <ul style="list-style-type: none"> - মোট বহির্গমন: ₹1,306.80 কোটি টাকা - মোট বিনিয়োগ: ₹1114.69 কোটি টাকা - মোট ক্ষতি: ₹192.11 কোটি <p>ঋণ প্রকল্পটি 3 বছর ধরে পর্যায়ক্রমে উপলব্ধ।</p> <p>বছরভিত্তিক ঋণের প্রয়োজনীয়তা:</p> <ul style="list-style-type: none"> - Year 1: ₹435.60 কোটি - Year 2: ₹290.40 কোটি - Year 3: ₹145.20 কোটি (আয় শুরু)
3	What Are the Salary Requirements for CSC Staff? (Gujrati)	<p>Employee: CSC માં કર્મચારીઓનો પગાર કેટલો હશે?</p> <p>Sahkar AI Bot: પગાર વિગતો (વાર્ષિક):</p> <ul style="list-style-type: none"> - ક્લાર્ક: ₹૧,૨૦,૦૦૦ થી ₹૧,૮૦,૦૦૦ - ડેપુ ઍસ્ટ્રી ઓપરેટર: ₹૬૦,૦૦૦ થી ₹૮૬,૦૦૦
4	What Equipment Do I Need to Buy? (Marathi)	<p>Employee: मला CSC साठी संगणक आणि इंटरनेट खरेदी करावे लागेल का?</p> <p>Sahkar AI Bot : आनंदाची बातमी! CSC प्रकल्पात संगणक, इंटरनेट आणि सॉफ्टवेअरची किंमत ₹0 मानली जाते. हे केंद्र सरकार किंवा राज्यस्तरीय सीएससी मिशनद्वारे पुरवले जातील</p>

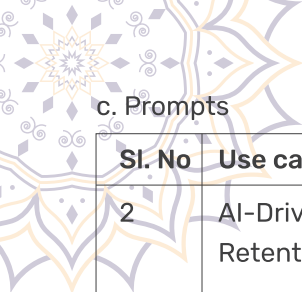
3. Use case: Smart chatbot Sahkar AI Bot to crunch state legislative acts, Bye laws, co-operative guidelines and assist the co-operative society in navigating legal aspects. Also identifying patterns to improve member engagement and retention strategies

a. Target Audience - District/State co-operative bank employees

b. Channel - Website, WhatsApp

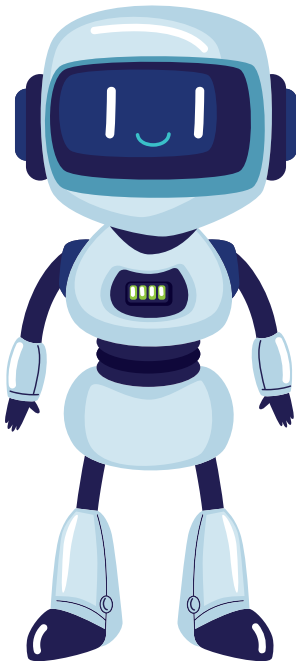
c. Prompts

Sl. No	Use case	Prompt
1	AI-Driven Member Engagement & Retention Insights (Periodic Push from Chatbot (Weekly Insights))	<p>Periodic Push from Chatbot (Weekly Insights) Weekly Member Retention Insights Week: June 15-21</p> <p>Active members: 13,254</p> <p>Dropped members: 217 (↑12%)</p> <p>High Drop Zones: Basti (37), Ghazipur (29), Fatehpur (21)</p> <p>Common Exit Reasons:</p> <ul style="list-style-type: none"> - Loan processing delays - Unresponsive service desks <p>Actionable Suggestion:</p> <ul style="list-style-type: none"> - Automate SMS reminders for pending loan approvals in Basti. - Trigger loyalty incentive for 3-year+ members in Ghazipur. <p>[Tap to view pattern insights by age group]</p>



c. Prompts

Sl. No	Use case	Prompt																
2	AI-Driven Member Engagement & Retention Insights (User prompt)	<p>User: Show me Member dropout pattern in eastern districts last quarter.</p> <p>Chatbot:</p> <p>Dropout Analysis – Eastern Zone (Q1 2025):</p> <table><tr><th>District</th><th>Dropouts</th><th>Growth %</th><th>Main Reason</th></tr><tr><td>Ballia</td><td>81</td><td>+9%</td><td>Lack of credit access</td></tr><tr><td>Azamgarh</td><td>65</td><td>+4%</td><td>Mobile app downtime</td></tr><tr><td>Mau</td><td>43</td><td>-3%</td><td>N/A</td></tr></table> <p>Suggestion: Deploy micro-loan campaigns + app upgrade notification.</p> <p>For more details, click here.</p>	District	Dropouts	Growth %	Main Reason	Ballia	81	+9%	Lack of credit access	Azamgarh	65	+4%	Mobile app downtime	Mau	43	-3%	N/A
District	Dropouts	Growth %	Main Reason															
Ballia	81	+9%	Lack of credit access															
Azamgarh	65	+4%	Mobile app downtime															
Mau	43	-3%	N/A															
3	AI to Interpret Legislative Acts, Byelaws, and Guidelines (User prompt)	<p>User: Explain clause 12 of the 97th Constitutional Amendment in context of Primary Co-op Societies.</p> <p>Chatbot: Clause 12 of 97th Amendment – Summary:</p> <p><i>Establishes the right of members to access information, audit results, and management transparency.</i></p> <p>For Primary Co-op Societies:</p> <ul style="list-style-type: none">- Must maintain digital record of all board meetings- Make AGM outcomes publicly available within 30 days																



⁷ NABARD Annual report 2023-2024

6. Policy Recommendations

Generative AI (Gen AI) holds transformative potential for India's PACS, particularly in agriculture and rural development. This section provides points for further deliberations on policy recommendations to encourage innovation and AI adoption, create a supportive regulatory framework, and invest in AI infrastructure and education. This summary on policy can enhance the productivity, sustainability, and inclusivity of the pacs, driving socio-economic growth in rural areas:

6.1. Encouraging Innovation and AI Adoption

Incentivize AI Startups and pacs by Launching targeted grants, tax incentives, and innovation challenges for startups and cooperatives developing Gen AI solutions for rural and agricultural applications could lead the way. Encouraging Public-Private-Academic Collaborations to Facilitate partnerships between research institutions, AI labs, and cooperative federations to co-develop domain-specific Gen AI tools could lay the foundation for long run innovation. Encouraging Pilot Programs in PACS and Agri-Coops by facilitating Funded pilot projects that integrate Gen AI into Primary Agricultural Credit Societies (PACS) for crop advisory, credit scoring, and multilingual training could attract further ideas into the sector.

6.2. Creating a Supportive Regulatory Framework

Having a robust Ethical AI Guidelines for PACS to develop sector-specific AI ethics frameworks that emphasize transparency, data privacy, and community governance, aligned with cooperative principles is of paramount importance. Focus on data Sovereignty and Federated Learning to Promote cooperative data ownership models and federated learning to ensure that rural data is used responsibly and benefits local communities is non-negotiable. Providing for Regulatory Sandboxes to Establish AI sandboxes for PACS to experiment with Gen AI applications under relaxed compliance norms, enabling innovation without legal risk will be encouraging new ideas.

6.3. Investing in AI Infrastructure and Education

Establishing robust, sovereign data infrastructure is a foundational imperative for India's digital future.

Prioritizing on-premises infrastructure over cloud-based solutions ensures greater control over data governance, security, and sovereignty—especially in sectors like agriculture and finance where data sensitivity is paramount.

A transformative initiative would be the creation of Rural AI Infrastructure Hubs—dedicated centers for AI innovation embedded within rural districts. These hubs to be equipped with high-performance computer resources, access to cloud credits, and repositories of open-source generative AI models customized for local agricultural and financial use cases. Such infrastructure would democratize access to cutting-edge technology and catalyze grassroots innovation.

Equally critical is the enhancement of digital literacy among cooperative members, who form the backbone of India's rural economy. Launching a national capacity-building program aimed at training cooperative leaders and members in digital governance, AI fundamentals, and data stewardship would empower communities to leverage digital tools effectively. This initiative could unlock new efficiencies in cooperative operations, financial inclusion, and service delivery. To ensure inclusivity and cultural relevance, States must actively support the development and localization of open-source generative AI platforms in regional languages. This would not only bridge the digital divide but also foster sustainable technology adoption across diverse linguistic and socio-economic landscapes.

Together, these interventions represent a holistic blueprint for embedding AI into India's rural and cooperative ecosystems—driving innovation, equity, and resilience from the grassroots.



7. Ethical and Social Considerations

The integration of Generative AI (Gen AI) into the PACS sector presents a profound opportunity to reimagine rural development, financial inclusion, and participatory governance. However, this technological evolution must be tempered with a rigorous ethical framework that safeguards human dignity, equity, and democratic agency. Three interrelated pillars—data privacy and security, inclusive AI design, and value alignment with cooperative principles—must guide this transformation.

7.1. Ensuring Data Privacy and Security

In PACS ecosystems, data is not merely a technical asset—it is a socio-economic resource embedded in community trust. Gen AI systems, which rely on vast datasets for training and inference, must be designed to uphold data sovereignty. This entails not only compliance with privacy regulations (such as India's Digital Personal Data Protection Act) but also the empowerment of PACS to own, govern, and monetize their data. Techniques like federated learning and differential privacy offer promising avenues to train AI models without compromising individual or collective privacy. Moreover, robust cybersecurity protocols must be institutionalized to protect sensitive financial and agricultural data from breaches, manipulation, or surveillance.

7.2. Promoting Inclusive and Equitable AI Solutions

Gen AI must not replicate or amplify existing socio-economic disparities. In the cooperative context—where members often include smallholder farmers, women, and marginalized communities—AI systems must be linguistically, culturally, and contextually adaptive. This requires the development of multilingual models, inclusive datasets, and participatory design methodologies that reflect the living realities of rural India. Furthermore, equitable access to Gen AI tools must be ensured through digital infrastructure investment, AI literacy programs, and subsidized deployment in underserved regions. Inclusivity is not a peripheral concern—it is central to the cooperative ethos of mutual benefit and democratic participation.

7.3. Aligning AI Initiatives with Cooperative Values

The cooperative movement is founded on principles of brotherhood, self-help, solidarity, and democratic control. Gen AI, if deployed without ethical guardrails, risks undermining these values by centralizing decision-making and commodifying community knowledge. Therefore, AI governance in cooperatives must be transparent, accountable, and participatory. This includes mechanisms for algorithmic auditability, member consent, and ethical oversight. AI should augment—not replace—human judgment, and its deployment must be guided by community-defined goals rather than market-driven imperatives. In this regard, cooperatives can pioneer a model of “ethical AI by design”, where technology serves collective empowerment rather than extractive efficiency.

In conclusion, the ethical deployment of Gen AI in the cooperative sector is not merely a technical challenge—it is a philosophical imperative. It demands a synthesis of innovation with integrity, and progress with justice. By embedding privacy, inclusivity, and cooperative values into the DNA of AI systems, India can chart a path toward a technologically empowered yet ethically grounded rural renaissance.

⁸ <https://www.meity.gov.in/static/uploads/2024/06/2bf1f0e9f04e6fb4f8fef35e82c42aa5.pdf>

8. Conclusion and Future Vision: AI-Enabled PACS

It is evident that AI can play a transformative role in helping Primary Agricultural Credit Societies (PACS) diversify their business models beyond traditional crop loans and achieve long-term viability and sustainability. Challenges such as viability, lack of access to finance, inadequate resources will affect multiple sectors including Agriculture, Co-operatives. The advent of emerging technologies must therefore be viewed from a macro-industry perspective in order to drive value along the entire supply chain, which will help build resilience, agility, efficiency and transparency for the various aspects cross cutting multiple sectors.

The National Bank for Agriculture and Rural Development (NABARD), in collaboration with the Government of India and cooperative banks, is establishing a ₹1,000 crore Shared Services Entity (SSE) to digitally empower rural cooperative credit institutions. Designed as a pay-per-use platform, this SSE is uniquely positioned to host Generative AI (GenAI) services tailored to the needs of State Cooperative Banks (StCBs), District Central Cooperative Banks (DCCBs), and Primary Agricultural Credit Societies (PACS). Given that most cooperatives lack the resources to independently invest in advanced technologies, the SSE offers a scalable, cost-efficient infrastructure for deploying GenAI tools. These include AI-powered chatbots for multilingual client support, automated document generation for compliance, and intelligent credit risk modeling systems. The pay-per-use model ensures affordability and flexibility, allowing even the smallest PACS to access cutting-edge solutions without capital expenditure. With RBI and government backing, and integration into the Core Banking Solution (CBS)

ecosystem, the SSE is poised to become a transformative enabler of AI-driven governance, financial inclusion, and operational transparency across India's cooperative banking landscape.

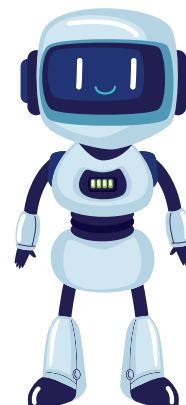
A strategic roadmap for AI integration into PACS could begin with a comprehensive assessment of existing operations to identify areas where AI can add value, such as assisting/training PACS personnel, risk management and credit allocation. Pilot projects can test AI solutions, allowing iterative refinement. Education and training are essential to equip stakeholders with the skills needed to leverage AI effectively. Building robust data infrastructure is critical, as high-quality datasets are the foundation for powerful AI models. Continuous evaluation and adaptation will ensure that AI solutions remain relevant and effective amid changing agricultural landscapes. This strategic approach will unlock the full potential of AI, driving innovation and sustainability in agriculture.

It is imperative that policy architects adopt a systems-oriented perspective when evaluating emergent technological paradigms, thereby cultivating digital public infrastructures, policies, and programs that enhance the accessibility and affordability of technology solutions. Yet, it must be underscored that technology, in its essence, functions merely as an enabler, not an omnipotent remedy. The locus of empowerment resides with PACS sector stakeholders themselves, who must exercise sagacious discernment by integrating rational methodologies and harnessing the avant-garde instruments of technological innovation.



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