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# New Innovations or Reforms in Agricultural Extension

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**Abstract**

Agricultural extension services are important for transferring knowledge, technologies, and innovations from research to farming communities, enhancing productivity, sustainability, and farmer livelihoods. Recent advancements in these services leverage innovative technologies and approaches, significantly improving efficiency and reach. Digital platforms and mobile apps facilitate real-time information sharing, while satellite and remote sensing technologies provide precise monitoring of crop health and soil conditions. The Internet of Things enables real-time farm management through connected agricultural devices and sensors. Innovative approaches include Farmer Producer Organizations, which enhance farmers' bargaining power and market access, and Public-Private Partnerships, which improve resource availability and service delivery. Agripreneurship encourages entrepreneurial practices, fostering innovation and sustainability. AI and machine learning tools revolutionize agricultural extension with advanced crop disease detection and yield prediction models, enabling early intervention and accurate forecasting. Community-based innovations like Farmer Field Schools promote participatory training and sustainable practices, while empowering women through targeted extension services enhances productivity and community development. Policy and institutional innovations, such as the National Agriculture Market for online trading and Krishi Vigyan Kendras for training and advisory services, play important roles in disseminating innovative practices. These innovations collectively transform agricultural extension, addressing modern challenges and ensuring the well-being of farming communities. Embracing these advancements is essential for the continued progress and sustainability of global agriculture.

**Keyword:** Innovations, Agriculture Extension, Disseminations, Technologies etc.

## INTRODUCTION

Agricultural extension process is the transfer of agricultural information and technology to the farmers and similarly transferring information from farmers to researchers. Agricultural extension services are crucial for helping farmers improve their practices and productivity by providing essential knowledge and tools. Over time, these services have evolved significantly due to the influence of technological advancements, environmental challenges, and changing market demands. This chapter explores the latest innovations and reforms

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in agricultural extension, focusing on how digital technologies, sustainability efforts, tailored services for diverse farmer groups, and public-private partnerships are transforming the sector. Digital technologies, such as mobile phones, the internet, and specialized software, have revolutionized information dissemination, allowing for real-time updates on weather, pests, and market prices, and facilitating instant communication between farmers and extension officers. E-extension services, including online training and webinars, provide farmers with access to valuable information and expertise from remote locations. Additionally, a strong emphasis on sustainability is now integral to extension services, addressing critical issues like climate change, soil degradation, and water scarcity by promoting practices such as integrated pest management, conservation agriculture, and organic farming. Modern extension services also introduce renewable energy solutions and water-saving technologies to enhance productivity while minimizing environmental impact. Recognizing the diverse needs of farmers, extension programs are increasingly tailored to support smallholder farmers, women farmers, and young Agripreneurship, who each face unique challenges.

**1. Technological Innovations in Agricultural Extension**

Technological innovation in agricultural extension is the process of using new or existing products, processes, and organizational forms to increase agricultural effectiveness, competitiveness, and sustainability. Technology plays an essential role in agricultural production and impact upon the life of farmers everywhere. Technical innovations such as the plough, irrigation, mills, crop rotations, fertilizers and much more have shaped the history of mankind time and time again. . For e.g. Robots, Temperature and moisture sensors, Aerial images, GPS technology, Satellite and GPS technologies, Sensors, Smart irrigation, Drones, Automation, Automated harvesters, and Autonomous tractor are the technological innovations in agricultural extension.

**A. Mobile applications and online platform services**

***(a) Kisan call center***

The Department of Agriculture & Cooperation (DoA&C), Ministry of Agriculture, Govt. of India launched Farmer Call Centres across the country on January 21, 2004, to deliver extension services to the farming community. The purpose of these call centres is to respond to issues raised by farmers, instantly, in the local 22 languages. There are call centres for every state which are expected to handle traffic from any part of the country. Queries related to agriculture and allied sectors are being addressed through these call centres. Farmers can access the KCC services by dialing a toll-free number, which ensures that they do not incur any cost for seeking advice. The helpline number is 1800-180-1551. The call centers are staffed with agricultural graduates and specialists who are trained to provide accurate and relevant information. These experts offer advice on a wide range of topics including crop management, soil health, pest and disease control, irrigation methods, weather forecasts, and market prices. KCCs are designed to be easily accessible to farmers across the country. The service is available from 6 AM to 10 PM, ensuring that farmers can reach out for help during most of the day. The Kisan Call Center initiative has significantly impacted Indian agriculture by bridging the information gap between farmers and agricultural experts**.**

***(b) e-sagu***

e-sagu is a Tele-Agriculture project started in 2004 by the International Institute of Information Technology IIIT, Hyderabad, and Media Lab Asia. e-sagu delivers farm-specific, query-less advice, typically once a week from sowing to harvesting. This service reduces the cost of cultivation and increases farm productivity as well as the quality of agri-commodities. e-sagu consists of three components. The main Center (1) is housed at the IIIT in Hyderabad. It consists of a team of about 20 agricultural experts and an Agricultural Information System comprising crop photos, farm database, weather data, etc. The service utilizes digital tools, including email, mobile apps, and web platforms, to communicate with farmers. This ensures that advice reaches farmers quickly, regardless of their location. Agricultural scientists and experts from various fields, such as agronomy, entomology, and plant pathology, collaborate to provide comprehensive and accurate advice to farmers. Trained coordinators collect field data, including photographs and descriptions of crop conditions, pest infestations, and disease symptoms. This data is at last sent to experts for analysis.

***(c) IFFCO Kisan Sanchar Limited (IKSL)***

IKSL is a joint venture established in 2007 between the mobile operator Bharti Airtel and the Indian Farmers Fertilizer Cooperative Ltd (IFFCO). The company provides crucial information to farmers, including market prices, farming techniques (such as dairy and animal husbandry), weather forecasts, rural health initiatives, and fertilizer availability.

IKSL delivers five free daily voice updates in local languages, excluding Sundays, ensuring that even illiterate farmers can access valuable information. Additionally, a 24-hour helpline is available to address farmers' questions. The content for these services is developed with the help of agricultural universities, experts, and government departments.

***(d) m-Krishi***

Initiative by Tata Consultancy Services (TCS) started in 2007 to deliver customized advisory services to farmers on crop production, market information, weather forecasts, etc. m-Krishi is a high-end technical service, which involves installation of different kinds of sensors in farmers 'field to collect information on soil humidity and weather conditions. m-Krishi provides farmers with access to agricultural information and services through their mobile phones. This ensures that even those in remote areas can benefit from expert advice. m-Krishi provides accurate and timely weather forecasts, helping farmers plan their activities more effectively. This information is crucial for optimizing planting, irrigation, and harvesting schedules. The platform supplies up-to-date market prices for various crops, enabling farmers to make better decisions about when and where to sell their produce to maximize profits. Farmers receive guidance on best farming practices, including pest control, disease management, and soil health improvement. This advice is based on the latest research and developments in agricultural science. To accommodate varying literacy levels, m-Krishi delivers information through both voice and text messages. This ensures that all farmers, regardless of their literacy level, can benefit from the service.

***(e) e-Choupal***

Launched in 2000 by ITC Ltd.'s Agri-Business Division, e-Choupal revolves around a network of information centers situated in farming villages. These centers, known as "e-Choupal," are equipped with computers connected to the internet. They function as social forums for information exchange (the term "Choupal" refers to a traditional village meeting place in Hindi) and as e-commerce hubs, facilitating various agricultural transactions and activities. e-Choupal is seen as a successful initiative to establish a virtual market and address infrastructure challenges and the presence of multiple intermediaries in agriculture.

***(f) Kisan Suvidha***

Kisan Suvidha is an omnibus mobile app developed to help farmers by providing relevant information to them quickly. With click of a button, they can get the information on weather of current day and next 5 days, dealers, market prices, agro advisories, plant protection, IPM Practices etc. Unique features like extreme weather alerts and market prices of commodity in nearest area and the maximum price in state as well as India have been added to empower farmers in the best possible manner.

***(g) Mkisan application***

The Mkisan application, developed by the in-house IT team of the Department of Agriculture Cooperation (DAC) with assistance from CDAC Pune, facilitates access to advisories and information from experts and government officials. Users can receive updates from the Mkisan portal without needing to register directly on the website. mKisan aims to leverage mobile technology to empower farmers with relevant information and tools to enhance their productivity and income. The app provides farmers with access to real-time agricultural information, including weather forecasts, market prices of crops, agricultural news, expert advice, and government schemes and programmes.

***(h) Kheti Badi***

The Kheti Badi mobile app is a comprehensive agricultural tool designed to assist farmers in optimizing their farming practices. Developed to cater to the needs of farmers, the app offers features such as weather forecasts, crop management advice, market prices, and agricultural news updates. Additionally, it provides information on government schemes and subsidies relevant to agriculture. With its user-friendly interface, the Kheti Badi app aims to empower farmers with knowledge and resources to enhance productivity and profitability in their farming ventures.

***(i) Crop insurance mobile***

App Crop Insurance mobile can be used to calculate the Insurance Premium for notified crops based on area, coverage amount and loan amount in case of borrower farmer. It can also be used to get details of normal sum insured, extended sum insured, premium details and subsidy information of any notified crop in any notified area.

***(j) Digital Mandi***

India This App helps in checking the latest Indian agricultural commodities Mandi prices from different states and districts. Easy to use and intuitive, the app enables farmers, traders and

all others to know the updated Mandi price from anywhere. Its main features are: Browse through various commodity categories, Browse prices in different states, Simplified flow to reach the selected commodity's mandi price and Copy the mandi price of a commodity.

**B. Satellite and Remote Sensing Technologies**

Satellite and remote sensing technologies have revolutionized agricultural extension by providing valuable data and insights for informed decision-making. These technologies enable monitoring of various agricultural parameters such as crop health, soil moisture, and vegetation indices from space or aerial platforms. By analyzing satellite imagery and remote sensing data, agricultural extension professionals can assess crop conditions, detect pests and diseases, and identify areas requiring intervention.

**Types of remote sensing technologies -** In agriculture, remote sensing techniques encompass various methods for collecting and analyzing data about crops and agricultural landscapes. Here are some common types of remote sensing used in agriculture

a. **Optical sensing:** The visible, near-infrared, and thermal infrared (TIR) portions of the electromagnetic spectrum are all detected by optical sensors. They offer insightful data on land cover, vegetation indicators, and crop health. Data from optical sensing is often obtained by aerial photography or satellite imaging.
b. **Multispectral sensing:** Throughout the electromagnetic spectrum, multispectral sensors collect data in a number of distinct bands. They make it possible to analyse particular wavelengths that are important for crop monitoring and vegetation health. Vegetation indices, such as the Normalised Difference Vegetation Index (NDVI) and the Enhanced Vegetation Index (EVI), are frequently calculated using multispectral data to evaluate crop conditions.
c. **Hyperspectral sensing**: Throughout the electromagnetic spectrum, hyperspectral sensors collect information in hundreds of discrete, contiguous spectral bands. The ability to analyse and identify certain materials and plant properties in detail is made possible by this great spectral resolution. Hyperspectral data is useful for nutrition evaluation, disease diagnosis, and in-depth crop categorization.
d. **Thermal sensing:** In the thermal imaging range of the electromagnetic spectrum, thermal sensors record data. They assess the radiation that is released by things, such as soil and crops, and how much of it is correlated with their temperature. Thermal sensing is helpful in monitoring crop health based on temperature fluctuations, identifying irrigation efficiency, and evaluating water stress.
e. **Radar sensing:** Regardless of the weather, radar sensors can collect data since they use microwave radiation to pierce earth, plants, and clouds. The backscattered signal, which is measured by radar sensors, contains information on the topography, crop structure, and moisture content. Mapping topography, tracking soil moisture, and determining agricultural growth phases are all made possible with the use of radar data.
f. **LiDAR sensing:** LiDAR (Light Detection and Ranging) sensors detect the duration between laser pulses and the return of reflected light. Regarding crop height, canopy structure, and terrain elevation, LiDAR data offers extremely precise three-dimensional information. Applications in precision agriculture, such as crop height estimate, terrain modelling, and canopy characterisation, can benefit from its utilisation.
g. **Unmanned aerial vehicles (UAVs):** These small-scale, high-resolution data collecting tools are made possible by UAVs fitted with a variety of sensors, including thermal, multispectral, and RGB cameras. Unmanned Aerial Vehicles (UAVs) offer comprehensive and prompt data for precision agricultural techniques, disease diagnosis, and crop monitoring.

**Application of remote sensing technology:**

*i.* **Crop Monitoring:** Satellites equipped with remote sensing instruments can capture images of agricultural fields from space. These images provide information about crop health, growth patterns, and the presence of pests or diseases. By analyzing these images, agricultural extension officers can offer timely advice to farmers on irrigation schedules, fertilization needs, and pest management strategies.

*ii.* **Yield Estimation**: Remote sensing data can be used to estimate crop yields even before harvest. By analyzing factors such as vegetation indices, soil moisture levels, and weather patterns, extension services can

provide farmers with accurate predictions of their expected harvest. This information helps farmers make informed decisions about marketing, storage, and post-harvest management.

*iii.* **Land Use Planning**: Satellite imagery can assist agricultural extension services in land use planning and management. By monitoring changes in land cover, such as deforestation, urbanization, or expansion of agricultural land, extension officers can identify areas of concern and develop strategies for sustainable land use practices.

*iv.* **Resource Management:** Remote sensing technologies help optimize the use of resources such as water and fertilizers. By assessing soil moisture levels and nutrient content from satellite data, extension services can recommend precise irrigation and fertilization schedules, reducing wastage and improving crop yields.

*v.* **Early Warning Systems:** Satellite data can contribute to the development of early warning systems for natural disasters such as droughts, floods, or wildfires. By monitoring environmental indicators such as temperature, precipitation, and vegetation health, extension services can alert farmers to potential risks and help them implement mitigation measures to minimize losses.

*vi.* **Precision Agriculture**: Remote sensing technologies enable precision agriculture practices by providing detailed information about variability within fields. By using data on soil properties, crop health, and microclimatic conditions, extension services can tailor management practices such as planting, fertilization, and pest control to specific areas within a field, maximizing efficiency and minimizing input costs.

*vii.* **Training and Capacity Building:** Satellite and remote sensing technologies also play a role in training and capacity building within the agricultural extension community. Extension officers can be trained to interpret satellite imagery and use geospatial tools for decision-making, allowing them to better serve farmers and address their specific needs.

**C. Internet of Things (IoT):**

Kevin Ashton first used the phrase "Internet-of-Things" (IOT) in 1999. The phrase "Internet-of-Things" originated from the work his team was doing to expand the internet to include "things." The phrase "smart" and "connected" simply refer to the "Internet-of-Things." The Internet of Things (IOT) is the constantly expanding network of physical items with an IP address enabling internet access, as well as the communication between these objects and other internet-enabled systems and devices. In 2018, the Internet of Things (IOT) was defined as a network of interconnected computing devices, digital and mechanical machines, objects, animals, or people that have the capacity to transfer data over a network without the need for human-to-human or human-to-computer interaction. These devices are assigned unique identifiers (UIDs). Precision agriculture utilises the Internet of Things (IoT) by employing robots, drones, sensors, and computer imagery together with analytical tools to monitor and gain insights from the fields. Physical equipment is placed on farms to monitor and capture data, which is subsequently used to gain insightful information.

**IoT devices and equipment used in agriculture:**

1. Soil moisture sensors
2. Weather stations
3. Smart Irrigation Systems
4. Crop Monitoring Drones
5. Livestock Monitoring Devices
6. Smart Tractors and Farm Machinery
7. Greenhouse Automation Systems
8. Remote Sensing Devices
9. Smart Silos and Storage Systems
10. Automated Feeding Systems
11. Pest and Disease Monitoring Sensors
12. GPS-Based Tracking Systems
13. Nutrient Monitoring Systems
14. Automated Sorting and Grading Systems
15. Field Robotics

**D. Artificial Intelligence and Machine Learning**

Artificial Intelligence (AI) and Machine Learning (ML) are transforming agricultural extension services by enhancing decision-making, increasing efficiency, and improving the overall productivity of the agricultural sector. Agricultural extension services traditionally involve disseminating knowledge and technologies to farmers to improve their practices. AI and ML bring innovative solutions to these services, making them more effective and accessible:

**i. Precision farming -** Artificial intelligence (AI)-powered tools like as sensors, satellite imagery, and drones are used to gather data in real time on crop health, weather

patterns, soil conditions, and other topics. Farmers receive detailed suggestions on planting, irrigation, fertilisation, and pest management when this data is analysed. Increased crop yields and optimal resource utilisation are two benefits of precision farming.

ii. **Crop Surveillance:** AI-driven image recognition and computer vision systems facilitate automated crop monitoring. By analyzing images, these systems are able to identify diseases, pests, and nutrient deficiencies in crops. Additionally, they provide timely alerts and recommendations to address these issues, helping to mitigate crop losses.

iii. **Chatbots and Virtual Assistants**: AI-powered chatbots and virtual assistants offer farmers immediate access to information and guidance. Through chat-based interfaces or voice-activated systems, farmers can get advice on agricultural practices, receive weather forecasts, and check market prices.

iv. **Data analytics**: Artificial intelligence (AI) algorithms handle enormous amounts of agricultural data, assisting farmers and extension agencies in making data-driven choices. This includes choosing the best crop kinds for a given area, planning planting dates, and predicting disease outbreaks.

v. **Language processing**: AI models that use natural language processing (NLP) may convert agricultural material into regional tongues, making extension services more accessible to a wider range of farmers—especially in areas where linguistic origins are diverse.

vi. **Market Analysis:** AI-driven tools analyze market data, commodity prices, and demand trends. This enables farmers to make informed decisions about crop selection and timing for maximizing profit.

vii. **Climatic adaptation:** AI models help farmers adjust to changing climatic conditions by suggesting robust crop types, providing insights into climate patterns, and optimising water use.

viii. **AI-driven platforms for farm management:** These systems combine information from multiple sources, such as weather stations, Internet of Things sensors, and historical documents. By using these tools, farmers can keep tabs on agricultural activities, keep an eye on how resources are being used, and decide how best to allocate resources.

ix. **Education and training:** AI-powered e-learning systems give farmers access to resources and customised training modules, allowing them to learn new skills and keep current with industry advancements.

x. **Support for extension workers:** AI tools aid extension workers by furnishing them with pertinent information, suggesting best practices, and assisting in prioritizing interactions with farmers

In summary, AI is transforming agricultural extension by providing timely, data-driven insights and support to farmers and extension services alike. This technological progress has the capacity to improve agricultural productivity, sustainability, and resilience, tackling ongoing challenges such as climate change and food security.

## 2. Innovative Extension Approaches and Models

Innovative extension approaches and models in agriculture aim to improve the effectiveness of agricultural extension services by leveraging technology, community participation, and tailored communication strategies. These approaches and models show how programs are structured and organized to achieve local objectives. Some innovative extension approaches and models include:

### A. Farmers Producers Organisation

The acronym FPO denotes the Farmers Producers Organisation. A group of farmer-producers, it offers end-to-end services that encompass nearly every facet of farming, from inputs and technical support to processing and marketing, to assist small-scale farmers. The concept behind Farmer Producer Organizations is that farmers, who are the producers of agricultural products, can form groups. Department of Agriculture and Cooperation (DAC), Ministry of Agriculture, Government of India launched a pilot program for promoting member-based Farmer Producer Organisations (FPOs) during 2011-12, in partnership with state governments, which was implemented through the Small Farmers' Agribusiness Consortium (SFAC) (Dept. of Agriculture and Cooperation, Ministry of Agriculture, 2013).

A legal body known as a Producer Organisation (PO) is established by primary producers, such

as farmers, dairy farmers, fishers, weavers, and rural artisans. An organisation of producers of any produce, such as agricultural, non-farm, artisanal, etc., is referred to as a PO. A producer organisation, cooperative society, or any other type of legal structure that allows for member profit or benefit sharing can be referred to as a PO. Institutions of primary producers may also join PO in various forms, such as producer corporations. Farmers are the members of Farmers Producer Organisations (FPOs), one sort of PO. The Small Farmers' Agribusiness Consortium (SFAC) offers assistance in promoting FPOs for farmers.

Farmers own the producer organization, contribute to individual share capital, buy inputs, and sell their products through the FPO. Members of the Board of Directors are first elected or picked by those who make critical business decisions for the organization. Promoting organizations (NGOs, Commercial Bank, etc.) provide technical assistance and financial resources to help FPOs run smoothly.

**Need of Farmers Producer Organisation**

PO's primary goal is to provide farmers more money through their own organisation. Small producers lack the volume (inputs and produce combined) necessary to take advantage of economies of scale. Furthermore, there is a lengthy chain of middlemen in agricultural marketing who frequently operate in a transparent manner, leaving the producer with little of the value that the final customer pays.

The primary producers can take advantage of economies of scale by grouping together. Additionally, they will be more able to negotiate with large producers and input suppliers.

**Essential Features of a Producer Organisation**

- It is formed by a group of producers for either farm or non-farm activities.
- It is a registered body and a legal entity.
- Producers are shareholders in the organization.
- It deals with business activities related to the primary produce/product.
- It works for the benefit of the member producers.
- A part of the profit is shared amongst the producers.
- Rest of the surplus is added to its owned funds for business expansion.

**B. Public-Private Partnerships (PPPs) in Agriculture extension**

Public-private partnerships involve collaboration between a government agency and a private-sector company that can be used to finance, build, and operate projects, such as public transportation networks, parks, and convention centers. Financing a project through a public-private partnership can allow a project to be completed sooner or make it a possibility in the first place.

**Key Features of PPPs**

i. **Shared Responsibilities**: Both parties share responsibilities, risks, and rewards. The private sector may handle design, construction, financing, operation, and maintenance, while the public sector oversees regulation and policy.
ii. **Long-Term Agreements:** PPPs typically involve long-term contracts, often spanning 20-30 years or more.
iii. **Performance-Based Payments:** Payments to the private sector are often linked to performance metrics and milestones

**Types of PPP in agricultural extension**

i. **Build-Operate-Transfer (BOT):** The private sector designs, finances, builds, and operates a project for a set period before transferring ownership to the public sector.
ii. **Design-Build-Finance-Operate (DBFO):** The private partner is responsible for designing, building, financing, and operating the project.
iii. **Lease-Develop-Operate (LDO):** The private sector leases a facility from the public sector, upgrades it, and operates it.
iv. **Concession:** The private sector operates and maintains a public service or infrastructure while collecting revenue (e.g., tolls).
v. **Service contracts:** The private sector provides services to the public sector, such as maintenance and operation of public infrastructure, in exchange for payment.
vi. **Management contracts:** The private sector is responsible for managing a public sector facility or service, with the public sector retaining ownership and ultimate responsibility

**Benefits of PPPs**

i. **Efficiency and Expertise:** Private companies often bring specialized expertise and efficiency to projects.
ii. **Cost Savings**: PPPs can lead to cost savings

through innovative designs, efficient construction practices, and better project management.

iii. **Risk Management:** Risks such as construction delays, cost overruns, and operational inefficiencies can be transferred to the private sector.

iv. **Access to Capital**: PPPs can attract private investment, reducing the financial burden on public budgets.

Public-private partnerships (PPPs) provide a range of advantages for both public and private entities. Through harnessing the expertise, efficiency, and financial resources of the private sector, PPPs facilitate streamlined project execution, enhanced service standards, and reduced expenses over time. Moreover, they can stimulate economic growth and foster innovation while shifting specific project risks from the public to the private sector. In essence, PPPs offer a collaborative approach to tackling infrastructure and service delivery obstacles, benefiting all involved parties.

**3. Community-Based Innovations**

**A. Farmer Field Schools (FFS)**

Farmer Field Schools (FFS) represent a significant aspect of agricultural extension programs. These schools are designed to provide practical, hands-on education to farmers, typically in small groups or communities. Through FFS, farmers gain knowledge and skills directly applicable to their fields, learning techniques such as sustainable farming practices, pest management, and crop diversification.

In agricultural extension, Farmer Field Schools play a crucial role in empowering farmers to make informed decisions, improve crop yields, and enhance overall farm productivity. They create a platform for knowledge exchange, encouraging farmers to learn from each other's experiences and experiment with new methods in a supportive environment. The Farmer Field School is a form of adult education, which evolved from the concept that farmers learn optimally from field observation and experimentation. FFS empowers farmers to solve their field related problems by themselves and fosters participation, interaction and joint decision making among them.

**Principals of Farmer Field Schools (FFS)**

a. **Participatory Learning:** FFS emphasizes active participation and engagement from farmers. They are encouraged to share their experiences, observations, and ideas, fostering a collaborative learning environment.

b. **Experiential Learning:** FFS prioritizes hands-on learning experiences within farmers' own fields. This allows farmers to directly apply new techniques and practices, reinforcing learning through practical experimentation.

c. **Group Dynamics:** FFS typically operate in small groups of farmers who meet regularly. Group discussions, field demonstrations, and peer-to-peer learning are integral components, facilitating knowledge exchange and mutual support.

d. **Seasonal Focus:** FFS sessions are often structured around the agricultural calendar, addressing specific activities and challenges relevant to each stage of the farming cycle.

e. **Field-Based Inquiry:** FFS encourages farmers to ask questions, analyze problems, and conduct experiments within their own fields. This promotes critical thinking and problem-solving skills, empowering farmers to find context-specific solutions.

f. **Holistic Approach:** FFS sessions cover a wide range of topics beyond technical agricultural practices, including soil health, water management, pest control, and market access. This holistic approach addresses the multifaceted nature of farming systems.

g. **Facilitative Approach**: FFS facilitators serve as guides rather than experts, facilitating discussions, providing information, and encouraging farmer-led experimentation and decision-making.

h. **Gender and Social Inclusion:** FFS strive to be inclusive and equitable, ensuring the participation of women, youth, and marginalized groups. Efforts are made to address gender-specific needs and promote social cohesion within communities.

i. **Adaptability**: FFS programs are flexible and adaptable to local contexts, allowing for customization based on farmers' specific needs, resources, and constraints.

j. **Sustainability:** FFS aim to build farmers' capacity for long-term self-reliance and resilience, promoting sustainable farming practices that are environmentally friendly, economically viable, and socially acceptable.

**Characteristics of Farmer Field Schools (FFS)**

- Farmers as Experts
- The Field is the Primary Learning Material
- Extension Workers as Facilitators Not

Teachers

- The curriculum is Integrated
- Trainings Follows the Seasonal Cycle
- Regular Group Meetings
- Learning materials are learner generated
- Group dynamics/team building

Farmer Field Schools represent a powerful tool for enhancing agricultural productivity, improving livelihoods, and fostering sustainable development. By empowering farmers to take ownership of their learning and decision-making processes, FFS contribute to the advancement of resilient and inclusive agricultural systems worldwide.

**B. Gender and social inclusion**

Modern extension programmes are embracing socially inclusive and gender-sensitive strategies in recognition of the many roles that men and women play in agriculture. In addition to ensuring fair access to extension services, resources, and decision-making, these programmes seek to address gender inequities and advance women's empowerment. Extension programmes encourage more equitable and sustainable agricultural growth by include women in leadership positions, decision-making processes, and training.

**Case Study**: Through training in solar energy technology, the "Grameen Shakti" initiative in Bangladesh has given rural women the confidence to start their own solar businesses and contribute to the electrification of their communities. Founded by Nobel laureate Professor Muhammad Yunus, Grameen Shakti is a preeminent social business globally, dedicated to enhancing the lives of Bangladesh's rural populace. With the goal of promoting socioeconomic development, empowering women, generating green jobs, eliminating poverty, cutting greenhouse gas emissions, and fostering a healthy community, this initiative offers sustainable renewable energy solutions.

**4. Policy and Institutional Innovations**

**A. National Agriculture Market (eNAM)**

The National Agriculture Market (eNAM) is an innovative initiative launched by the Government of India in April 2016 to create a unified national market for agricultural commodities. eNAM aims to integrate existing agricultural markets (mandis) across the country into a single online platform, thereby enhancing the efficiency, transparency, and competitiveness of the agricultural supply chain.

**The e-NAM platform can help agriculture extension by:**

i. **Improving marketing opportunities:** The National Agriculture Market (eNAM) is enhancing marketing opportunities for farmers by creating a unified online platform that integrates various Agricultural Produce Market Committees (APMCs) across India. This system facilitates transparent and competitive pricing through real-time bidding, reduces intermediary roles, and ensures timely digital payments. Quality assurance, logistics integration, and access to comprehensive market information empower farmers to make informed decisions, achieve better price realization, and access wider markets. Additionally, eNAM provides inclusive participation opportunities for small and marginal farmers, supported by government incentives and holistic advisory services, thereby revolutionizing agricultural marketing in the country.

ii. **Promoting transparency:** The National Agriculture Market (eNAM) promotes transparency in agricultural extension by providing real-time price information, standardizing trading practices, and facilitating digital transactions, which ensure traceability and timely payments. By enabling direct transactions between farmers and buyers, reducing intermediaries, and integrating quality assurance services, eNAM ensures fair and competitive pricing. The platform also offers accessible market information and transparent auction processes, supported by regulatory oversight to enforce compliance, thereby fostering a fair, efficient, and trustworthy market environment

iii. **Ensuring quality:** eNAM integrates with quality assaying services to provide standardized grading of agricultural produce. These assaying services evaluate the quality of the produce based on predefined parameters, ensuring consistency and reliability in quality assessments.

iv. **Streamlining procedures:** The e-NAM helps to streamline procedures across integrated markets. It also provides a single window service for all APMC-related information and services, including commodity arrivals, prices, and buy and sell offers.

**B. Krishi Vigyan Kendras (KVKs) in Agriculture Extension**

Krishi Vigyan Kendras (KVKs) are agricultural extension centers in India, designed to apply agricultural research and provide practical training to farmers. They play a crucial role in transforming Indian agriculture by serving as knowledge and resource hubs for farmers, researchers, and other stakeholders. The first KVK was established in 1974 at Puducherry. The number of KVKs has risen to 731 till now. The KVK scheme is 100% financed by Govt. of India and the KVKs are sanctioned to Agricultural Universities, ICAR institutes, related Government Departments and Non-Government Organizations (NGOs) working in Agriculture area.

KVK, is an integral part of the National Agricultural Research System (NARS), aims at assessment of location specific technology modules in agriculture and allied enterprises, through technology assessment, refinement and demonstrations. KVKs have been functioning as Knowledge and Resource Centre of agricultural technology supporting initiatives of public, private and voluntary sector for improving the agricultural economy of the district and are linking the NARS with extension system and farmers.

**Mandates of KVKs:** KVKs were established by the Indian Council of Agricultural Research (ICAR) with the following mandates:

- **On-Farm Testing:** Conducting on-farm testing to identify the location specificity of agricultural technologies under various farming systems.
- **Frontline Demonstrations**: Demonstrating the latest agricultural technologies to farmers to showcase their efficacy in real farm situations.
- **Capacity Building:** Organizing training programs for farmers, rural youth, and extension personnel to enhance their skills and knowledge.
- **Resource Center:** Serving as a resource center for agricultural technology and providing advisory services to farmers.

In addition, KVKs produce quality technological products (seed, planting material, bio-agents, livestock) and make it available to farmers, organize frontline extension activities, identify and document selected farm innovations and converge with ongoing schemes and programs within the mandate of KVK.

**Objectives of KVKs**

- To work together on on-farm testing (OFTs), improving and documenting technologies for creating region-specific sustainable land use systems, with Subject Matter Experts from State Agricultural Universities, Scientists from the Regional Research Stations (NARS), and State Extension Personnel.
- To organize front line demonstrations (FLDs) in various crops to generate production data and feedback information.
- To organize long term vocational training courses in agricultural and allied fields for the rural youths with emphasis on 'Learning by Doing' for generating self-employment through institutional financing.
- To organise training so that Extension Workers in the operational regions are regularly informed about new developments in agricultural research.
- To act as the state's resource and information hub for agricultural technology, assisting governmental, corporate, and nonprofit projects aimed at boosting the state's agricultural industry.

KVKs play a pivotal role in transforming Indian agriculture by acting as knowledge and resource hubs, enhancing the agricultural economy, and fostering sustainable agricultural practices. They provide critical linkages between research, extension systems, and farmers, ensuring the dissemination and adoption of improved agricultural technologies across India.

**Strategic Collaborations of KVK and other initiatives for Enhancing Agricultural Development:**

i. **Linking KVKs with Common Service Centres (CSCs)**: On July 16, 2019, an agreement was made with the Indian Ministry of Electronics and Information Technology to connect KVKs and CSCs. As a result, 3.5 lakh CSCs and KVKs have partnered to offer technology solutions to farmers who visit CSCs with issues relating to agriculture. Linking Krishi Vigyan Kendras (KVKs) with Common Service Centres (CSCs) represents a strategic collaboration aimed at leveraging technology to empower farmers and enhance agricultural services. This initiative seeks to bridge the gap between agricultural extension services and digital access for farmers across

India. Farmers can access various technology solutions through CSCs, such as mobile applications for weather forecasts, market prices, and agricultural best practices.

ii. **Role of KVKs in Jal Shakti Abhiyan of Ministry of Jal Shaki:** In all, 466 melas have been organized by 243 KVKs under Jal Shakti Abhiyan with participation of 257408 farmers and school children in first phase up to 30.09.2019. Similarly, on October 2, 2019, 91 KVKs under Jal Shakti Abhiyan hosted 91 melas, in which 56746 farmers and schoolchildren took part. Numerous events were held, such as a discussion on water conservation and efficient use of water, including the use of micro irrigation systems; a live demonstration of drip and sprinkler irrigation systems; Nukkad Natak; farmer-scientist interaction; a quiz competition on water management; a drawing and rangoli competition; film shows on the significance of water conservation and micro irrigation; a demonstration of roof-top rainwater harvesting; a sharing of farmers' experiences; an exhibition; the distribution of tree saplings; farmer appreciation; and more.

iii. **Establishment of District Agricultural Meteorological Units (DAMU) under KVKs:** District Agro-Met Units (DAMUs) have been established in the grounds of 199 KVKs under the terms of an agreement with the India Meteorological Department (IMD) to provide Agro-met Advisory Services in the local language throughout the nation through KVKs to serve the farming community in various Agro-climatic zones in order to reduce the risk due to climatic aberration and improve productivity. Under the initiative, the KVKs have hired 116 SMSs and 93 Agro-met Observers, of whom 103 staff members have received training.

## 5. New Initiatives by Agricultural Extension Division

### A. Knowledge system and Homestead Agriculture Management in Tribal Area (KSHAMTA)

The Knowledge System and Homestead Agriculture Management in Tribal Area (KSHAMTA) initiative aims to enhance agricultural practices and livelihoods in tribal regions by integrating traditional knowledge with modern agricultural techniques. This program empowers tribal communities by combining indigenous practices with scientific methods to promote sustainable agriculture. KSHAMTA focuses on capacity building, providing training and skill development to improve the socio-economic status of tribal farmers. It encourages sustainable farming practices, such as soil health improvement, water conservation, and biodiversity enhancement. The initiative also emphasizes integrated farming systems, including crop production, livestock rearing, horticulture, and agroforestry, to boost nutrition and food security through diversified homestead production.

Key components of KSHAMTA include establishing knowledge centers, conducting on-farm demonstrations, and offering continuous advisory services through field visits and ICT tools. Community participation is central to KSHAMTA, involving tribal farmers in planning and implementing agricultural interventions, fostering collaborative problem-solving, and decision-making. Infrastructure development for water management, soil conservation, and post-harvest processing is prioritized to improve market access and storage facilities. The program leverages partnerships with governmental agencies, NGOs, research institutions, and the private sector to enhance resources and technical support.

### B. In-situ Crop Residue Management

Under the project "Awareness for In-situ Crop Residue Management", 60 KVKs of Punjab, Haryana, Uttar Pradesh and Delhi are working with focus on promotion of agricultural machineries, demonstrations, training and other Information, Education and Communication (IEC) activities for in-situ management of crop residues. Across the three states under IEC activities, selected villages were targeted to sensitize people about the harmful effect of residue burning, benefits of in-situ residue management and government schemes of availability of subsidized machines.

Various awareness programmes including more than 100 panel discussions were telecast on DD Kisan and publicity materials were distributed among more than 4.5 lakh stakeholders. Similarly, around 700 awareness programs at village, block and district levels and 75 Kisan Melas with about 2 lakh participants were organized. Moreover, 400 hands-on trainings for about 20000 farmers, tractor owners and machine operators were organized. Frontline Demonstrations in more than 12000 ha area were organized. About 200 exposure visits, 250 field days and harvest days were also organized in which more than 10000 farmers were oriented to the technologies. The festival of Baisakhi was

celebrated as "No Crop residue burning day". As a result, in Punjab, Haryana and UP, about 18.7%, 31.0% and 52.0% reduction in number of burning events were observed in 2019 as compared to that in 2018, 2017 and 2016, respectively.

**Importance of Innovations in Agricultural Extension Programs**

i. **Increase productivity and efficiency -** Innovative approaches and contemporary technology are frequently combined to create new trends. Farmers may be able to produce more food with less resources thanks to these improvements that may boost output. In a world where the need for food is always rising, this is very important.

ii. **Adoptation to changing conditions -** A few of the difficulties facing agriculture are changing market demands, water shortages, and climate change. New developments in extension services give farmers the information and resources they need to reduce risks and make wise decisions, enabling them to adjust to these shifting circumstances.

iii. **Technology Adoption** - Precision farming has to include digital tools and processes as technology develops quickly. Extension services are essential in assisting farmers in comprehending and successfully using these technologies, which improves farm management and decision-making.

iv. **Capacity building and knowledge transfer -**Extension programmes in agriculture act as a link between farmers and research organisations. Through the dissemination of research-based knowledge and training facilitation, these programmes provide farmers with the necessary tools to execute best practices.

v. **Global food security -** Ensuring food security is a key challenge, given the predicted growth in the global population. Global food security depends on improved food production, less post-harvest losses, and effective supply chains—all of which are facilitated by new trends in agricultural extension.

vi. **Rural Development -** A significant portion of rural economies rely heavily on agriculture. Extension programmes support rural development, job creation, and poverty reduction by encouraging contemporary techniques, adding value to agricultural goods, and facilitating farmer-market connections.

vii. **Improved livelihoods -** Farmers' earnings may be greatly increased by integrating value chain development, Agripreneurship, and market access into extension programmes. By establishing direct connections with customers and participating in higher-value activities, new trends enable farmers to lessen their reliance on intermediaries.

viii. **Youth and Gender Empowerment -** Focusing on gender inequality in agriculture and involving young people are two of the newest themes. Extension programmes promote social inclusion and rural development by offering equal access to resources for both genders and by enticing youth to pursue farming via the adoption of new technologies and entrepreneurial possibilities.

## CONCLUSION

Agricultural extension systems are pivotal in bridging the gap between research institutions and farming communities, fostering the adoption of advanced technologies and sustainable practices. The chapter underscores the importance of innovations in agricultural extension to address the dynamic challenges posed by environmental, economic, and technological shifts. Emerging tools and models have redefined traditional extension approaches, making them more accessible, participatory, and impactful. Technological innovations such as mobile applications, IoT, AI, and remote sensing have revolutionized agricultural practices. These tools facilitate real-time decision-making, precision farming, and effective resource management. For example, platforms like e-Sagu, m-Krishi, and e-Choupal provide localized, timely advisories, empowering farmers to improve productivity and reduce costs. Remote sensing technologies enhance crop monitoring and yield estimation, while IoT-based solutions optimize water use and soil health management. The integration of AI in agriculture is particularly transformative, offering predictive analytics, disease detection, and market insights, thereby enabling informed decision-making. Innovative extension models like Farmer Producer Organizations (FPOs) and Public-Private Partnerships (PPPs) have created significant value by strengthening collective bargaining, improving market access, and mobilizing resources. FPOs empower smallholder farmers to achieve economies of scale and negotiate better prices, while PPPs bring together public resources and private expertise to enhance service delivery and

infrastructure. Community-based approaches, such as Farmer Field Schools (FFS), emphasize experiential learning and participatory decision-making, fostering self-reliance among farmers. The chapter also highlights the importance of inclusivity in agricultural extension. Gender-sensitive and socially inclusive programs ensure equitable access to knowledge, tools, and markets for women and marginalized groups. Initiatives like Grameen Shakti in Bangladesh exemplify how empowering women with technological training can contribute to rural electrification and socio-economic development. Policy and institutional reforms play a crucial role in scaling these innovations. The National Agriculture Market (eNAM) promotes transparency and efficiency in agricultural trade, while Krishi Vigyan Kendras (KVKs) serve as knowledge hubs to disseminate region-specific technologies. Programs like KSHAMTA and initiatives for in-situ crop residue management address localized challenges, integrating traditional practices with modern solutions. In conclusion, the transformation of agricultural extension systems is critical for addressing modern agricultural challenges. By leveraging technology, fostering collaboration, and ensuring inclusivity, agricultural extension can enhance productivity, sustainability, and resilience in farming systems. These reforms not only improve farmer livelihoods but also contribute to global food security and rural development. Embracing and scaling these innovations will be essential to meet the demands of a growing population while safeguarding natural resources and the environment.

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