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NATIONAL AGRICULTURE SUMMIT

20-23 November 2024

SOUVENIR

"Harnessing Innovations in Agriculture and Allied Sciences"

Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu

Main Campus, Chatha, Jammu, 180009

National Agriculture Summit 2024
HARNESSING INNOVATIONS IN AGRICULTURE AND ALLIED SCIENCES

Souvenir

National Agriculture Summit-2024

20-23, November 2024, SKUAST-Jammu, Main Campus, Chatha, Jammu (J&K), India
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Shivraj Singh Chouhan
Minister of Agriculture & Farmers Welfare and Rural Development
Government of India

सत्यमेव जयते

Message

I commend Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu) for organizing the National Agriculture Summit 2024. Under the inspiring theme, 'Harnessing Innovations in Agriculture and Allied Sciences,' this summit serves as a remarkable platform for advancing forward-thinking solutions and sustainable growth in agriculture. Under the inspiring theme, "Harnessing Innovations in Agriculture and Allied Sciences," this summit promises to be a pivotal forum for advancing innovative ideas and solutions that will pave the way for a sustainable future in Indian agriculture.

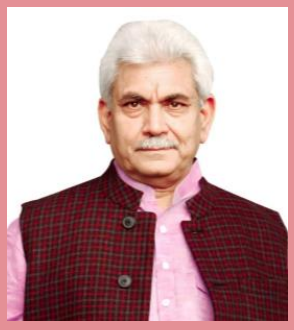
The Ministry of Agriculture and Farmers' Welfare is currently implementing over 50 initiatives to support farmers and modernize the sector. These include popular schemes like the Pradhan Mantri Fasal Bima Yojana (PMFBY) for crop insurance, PM-KISAN Samman Nidhi for direct financial support to farmers, and Rashtriya Krishi Vikas Yojana to promote agricultural development across states. Platforms such as Krishi Nivesh, National Agriculture Market (e-NAM), and AgriStack are utilizing digital tools to enhance investment, streamline agri-marketing, and improve access to data.

Innovative tools like Kisan Call Center, Krishi Decision Support System (DSS), Soil Health Card, and FARMAP 2.0 offer farmers direct support, crop guidance, and soil management insights. Specialized missions, such as the National Bamboo Mission, National Food Security Mission, National Beekeeping and Honey Mission, and Rainfed Area Development (RAD), address specific aspects of sustainable agriculture, from promoting horticulture and honey production to supporting bamboo and rainfed farming systems.

As India embraces cutting-edge agriculture technologies, we need collective efforts to inspire our farmers and equip them with modem tools. In this respect, the National Agriculture Summit of SKUAST-Jammu is a welcome effort for bringing change in the lives of the farmers.

I extend my best wishes to SKUAST-J[illegible] for [illegible] summit.

(Shivraj Singh Chouhan)



Manoj Sinha
Lieutenant Governor, U.T. of Jammu and Kashmir
Raj Bhawan

सत्यमेव जयते

Message

I am delighted to learn that the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu) is hosting the National Agriculture Summit 2024, from 20th to 23rd November 2024 at Jammu.

This Summit, under the theme "Harnessing Innovations in Agriculture and Allied Sciences", offers a significant opportunity for the experts, policymakers, researchers, progressive farmers, and industry leaders to explore new horizons in agricultural technologies and practices.

Jammu Kashmir is witnessing a new revolution in the agriculture and allied sectors. The Holistic Agriculture Development Program (HADP) and the Jammu Kashmir Competitiveness Improvement of Agriculture and Allied Sectors (JKCIP) are key drivers of this revolution, aimed at enhancing agricultural productivity, promoting sustainable practices, and fostering competitiveness. Through HADP, we are focusing on the modernization of farming techniques, improving infrastructure, and boosting farmer income through innovative interventions.

I congratulate the SKUAST-Jammu for its constant endeavors in driving agricultural innovation and capacity- building in the region. I am confident that the live demonstrations of new technologies, improved crop varieties, and technical sessions during the summit will greatly benefit the farming community, empowering them with the knowledge and tools needed to meet present and future challenges.

I welcome all the participants, and convey my felicitations to everyone associated with the publication of souvenir and best wishes for the success of the Summit.

Manoj Sinha

(Manoj Sinha)

Omar Abdullah
Chief Minister,
U.T. of Jammu and Kashmir

सत्यमेव जयते

Message

It is a matter of immense pride that Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu (SKUAST-Jammu) is organizing the National Agriculture Summit 2024 under the theme "**Harnessing Innovations in Agriculture and Allied Sciences**". This summit, scheduled to take place from 20th to 23rd November 2024, is an excellent platform to foster dialogue, share knowledge, and explore the latest advancements in agricultural technologies and practices.

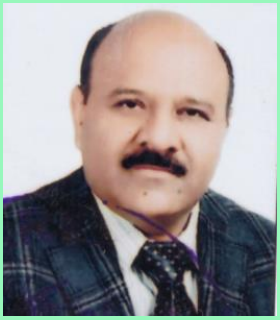
Agriculture remains the backbone of our economy, particularly in Jammu & Kashmir, where the sector supports the livelihoods of a large portion of our population. The Jammu & Kashmir is blessed with diverse agro-climatic conditions, offering immense potential for growth in agriculture and allied sectors. The Government of Jammu & Kashmir has launched several initiatives to strengthen this vital sector. These initiatives will be strengthened to modernize our agricultural practices, improve productivity, and ensure the economic well-being of our farming communities.

I am confident that SKUAST-.Jammu's efforts to promote cutting-edge research, innovation, and capacity-building will significantly contribute to the transformation of the agricultural landscape in our region. The live demonstrations of new technologies, improved crop varieties, and the various technical sessions planned during the summit will provide farmers with valuable insights and tools to address the challenges of the future.

I congratulate the Vice-Chancellor, faculty, students, and all stakeholders of Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu (SKUAST-Jammu) for their dedication and for organizing this important event. I am sure the 'National Agriculture Summit 2024' will inspire participants to work collectively towards a prosperous and sustainable future for agriculture in Jammu & Kashmir.

I extend my best wishes for the grand success of the summit.

Omar Abdullah



Surinder Kumar Choudhary
Deputy Chief Minister,
U.T. of Jammu and Kashmir

सत्यमेव जयते

Message

It is a matter of immense pride to pen this message for the souvenir of the National Agriculture Summit 2024, organized by Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. The theme of this summit, "Harnessing Innovations in Agriculture and Allied Sciences," is both timely and essential in addressing the challenges and opportunities in modern agriculture.

As someone who has had the privilege of being associated with SKUAST-Jammu in the past, I hold a deep sense of pride in witnessing the remarkable progress of this institution. Its unwavering dedication to advancing agricultural education, research, and outreach has significantly contributed to the empowerment of farmers and the agricultural development of the region.

The initiatives of the Jammu & Kashmir government will remain on sustainable agricultural growth. I am pleased to see SKUAST-Jammu playing a pivotal role in aligning with these initiatives, fostering innovation, and equipping farmers with the tools they need to succeed in a competitive agricultural landscape.

I am confident that the National Agriculture Summit 2024 will provide a dynamic platform for exchanging ideas, fostering collaborations, and formulating actionable strategies to benefit the fanning community. This effort will undoubtedly propel Jammu & Kashmir towards a more sustainable and prosperous agricultural future.

My heartfelt congratulations to the organizing team, and l extend my best wishes for the grand success of the summit.

(Surinder Choudhary)

Javed Ahmad Dar
Minister for Agriculture Production, Rural Development & Panchayati Raj, Cooperative and Election Departments,
U.T. of Jammu and Kashmir

सत्यमेव जयते

Message

I extend my warmest greetings to all participants and organizers of the National Agriculture Summit 2024, hosted by Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu) from November 20-23, 2024. This summit embodies our shared commitment to nurturing agricultural innovation and sustainable practices in our region.

Agriculture serves as the foundation of our economy, and as we confront numerous challenges, such as climate change and evolving market dynamics, it is crucial that we explore innovative ideas and solutions. This summit provides an invaluable platform for researchers, practitioners, and policymakers to exchange knowledge, showcase their advancements, and collaborate on transformative initiatives for our agricultural landscape.

I commend SKUAST-Jammu for its unwavering dedication to enhancing agricultural education and research, which are pivotal in empowering our farmers and ensuring food security. The insights gained from this summit will undoubtedly guide informed decision-making and effective policy implementation in the agriculture sector.

Let us unite to harness the potential of our agricultural resources and strive for a sustainable and prosperous future for the farmers of Jammu and Kashmir.

I extend my heartfelt wishes for a successful summit.

Sd/-
Minister
APD, RDD &PR,
Coop. and Election Department

Dr. Himanshu Pathak
Secretary (DARE) &
Director General (ICAR)
Government of India

सत्यमेव जयते

Message

I am happy top know that Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST), Jammu is organizing a **National Agriculture Summit on "Harnessing Innovations in Agriculture and Allied Sciences"** during November, 20-23, 2024 at Jammu.

The theme of the National Agriculture Summit is highly relevant in view of the likely climatic adversities and their impacts on agriculture and allied enterprises. Effective risk management is crucial to increasing economic growth, improving food security and reducing poverty. Further, there has to be a better assessment of climate risks, understand the interconnections between different types of risks and improve agricultural information strategies. There is a need for innovative extension approaches in the changing climatic conditions and international market situations so that Indian farmers could be empowered with smart technologies to boost farm profitability and socio-economic status of rural India.

I wish the National Agriculture Summit grand success.

(Himanshu Pathak)

Atal Dulloo, IAS
Chief Secretary
Government of Jammu and Kashmir

सत्यमेव जयते

Message

There is a tremendous technological development in agriculture and allied fields. but the outcome and benefits of all such advancements have not reached to the farming community. For this, several extension approaches have been tried and succeeded in various locations and community, but no single approach could be claimed as the best for all situations and locations. Due to complexity of the social behavior of the farming community, there is always quest for the innovative approaches for food, nutrition and livelihood security in the rural areas. The enhanced production, processing and marketing in agriculture are vital for promoting remunerative rural employment and sustaining life support system livelihood security. There is a need to delve in length all the inter-related issues concerning agricultural growth and agri-preneurship development.

2. The theme of the National Agriculture Summit on "Harnessing Innovations in Agriculture and Allied Sciences" is very relevant and timely in the context of rural prosperity. The summit will cover all the important areas such as high tech agriculture and horticulture, precision livestock farming, dairying and fish farming, automation and digital agriculture, agri-mechanization, climate resilient farming, post harvest management, agricultural marketing and natural resources management .

3. I hope the farmers, scientists, experts, students, entrepreneurs, extension personnel and industry partners attending this National Agriculture Summit shall be highly benefitted.

4. I extend my sincere wishes for successful organization of the National Agriculture Summit, 2024.

(Atal Dulloo)

Shailendra Kumar, IAS
PRINCIPAL SECRETARY
to the Government
Agriculture Production Department
Government of Jammu and Kashmir

सत्यमेव जयते

Message

I am delighted to know that Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu is hosting **a National Agriculture Summit on "Harnessing Innovations in Agriculture and Allied Sciences"** from November, 20th -23rd , 2024 at Main Campus, Chatha.

Indian agriculture has a challenge to ensure food and nutritional security to meet the demand of ever-increasing population. Amidst this situation agriculture plays a pivotal role in the refurbishment of the green economy of our country to move towards another green revolution, however, emergence of large scale biotic and abiotic stresses, rampant degradation and depletion of natural resources and climate change impacts adversely on sustainability of agriculture. In this context, agriculture scenario in hilly state of J8nl{ ha to be at competitive position among other states of the country. Large number of small holders, shifting land use pattern, low intensity of agri-inputs and not so satisfactory seed replacement rate are affecting livelihood sustainability through agriculture in the region.

In this context, the theme of the National Agriculture Summit on "Harnessing Innovations in Agriculture and Allied Sciences“ is appropriate and need of the hour as we feel that there exists a gap between technology generation and its use by farmers, especially small and marginal farmers. The
organization of this summit is timely and it is expected to have greater impact in catalyzing our commitment to reach out to farming community in ensuring food and nutritional security to the future generation without putting stress on natural resources.

I wish the National Agriculture Summit a grand success.

Shailendra

(Shailendra Kumar)

Dr. Rashmi Singh, IAS
Commissioner/ Secretary to the Government
Higher Education Department,
Civil Secretariat, Jammu/Srinagar
Government of Jammu and Kashmir

सत्यमेव जयते

Message

It is a pleasure to extend my warmest greetings to Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu (SKUAST- Jammu) on the occasion of the **National Agricultural Summit 2024, scheduled on 20-23 November 2024**. This summit stands as an essential platform for fostering dialogue, innovation and practical solutions for advancing agriculture in our region.

As we face the dual challenges of ensuring food security and adapting to climate variability, it is imperative that our youth gain meaningful exposure to agriculture and the diverse opportunities within -this sector. Today's graduates must not only be academically prepared but also equipped with practical skills that will empower them to excel in new agricultural enterprises. Through hands-on training and engagement with innovative technologies, they can acquire the capabilities to transform traditional practices, drive agribusiness growth and contribute significantly to sustainable development.

I am confident that this summit will play a crucial role in enhancing the knowledge and skills of our young minds helping them embrace agriculture not only as a livelihood but as a dynamic and rewarding career. I commend SKUAST-Jammu for its dedication to this cause and for hosting an event that emphasizes the vital role of youth in agriculture. My best wishes to all participants, organizers and contributors for a successful and impactful summit.

R Singh

Dr. Rashmi Singh (IAS)

Dr. U.S. Gautam
Deputy Director General (Agril. Extn.)
Indian Council of Agricultural Research

Message

I am delighted to learn that the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu is organizing a National Agriculture Summit on "Harnessing Innovations in Agriculture and Allied Sciences" during November 20-23, 2024 at its Main Campus in Chatha.

With the global population rising rapidly, the demand for natural resources, food, feed, and fibre continues to increase, placing immense pressure on agriculture to meet these needs sustainably. This challenge is further complicated by the limited availability of vital resources such as arable land, water, and fossil fuels, along with the unpredictable impacts of climate change. Meeting production targets while safeguarding these resources has become an urgent priority.

To address these complex issues and improve the quality and quantity of agricultural production in an environmentally responsible manner, it is essential to embrace smart and precise farming practices. Smart farming technology offers significant potential for sustainable agricultural production, allowing us to optimize resources and enhance productivity through a more precise, resource-efficient approach.

At this critical juncture, the organization of this National Agriculture Summit is both timely and relevant. I extend my warm greetings to the organizers and participants and wish the Summit great success in fostering innovation and progress in agriculture.

(U S Gautam)

Prof. B.N. Tripathi
Vice Chancellor
SKUAST-Jammu

National Agriculture Summit 2024
HARNESSING INNOVATIONS IN AGRICULTURE AND ALLIED SCIENCES

Message

SKUAST-Jammu's National Agriculture Summit (NAS) 2024 is an excellent platform for driving a transformative change in the agricultural landscape of Jammu and Kashmir and beyond. We are committed to spread pioneering technologies that have the potential to revolutionize agriculture and ensure these innovations reach the last mile, bringing benefits to every nook and corner. The crop varieties developed by SKUAST-Jammu have become well-recognized in J&K and neighboring states. Through our Krishi Vigyan Kendras (KVKs), we standardize modern technologies to ensure their location-specific adaptability under different agro-climatic conditions. In addition, mass extension programs such as the NAS are organized to bridge the gap between research and practical application, fostering an environment where farmers can directly benefit from our scientific advancements.

As part of this summit, the publication of a souvenir is a commendable initiative that encapsulates an array of advanced technologies recommended for the farmers. It covers all the essential areas such as apiculture, mushroom, horticulture, farm mechanization etc., as well as insights into significant government initiatives like the Holistic Agriculture Development Programme (HADP) and the Jammu & Kashmir Competitiveness Improvement Project (JKCIP). These initiatives represent our dedication to working hand in hand with government departments to bring comprehensive support and opportunities to our farming communities.

This NAS 2024 is a step forward in advancing the mission of SKUAST-Jammu, aiming to make agricultural innovation a tangible reality in the lives of our farmers. I extend my best wishes for the fruitful deliberations and successful outcomes from this summit and hope it strengthens our resolve to propel agricultural growth, self-sufficiency, and sustainability in Jammu and Kashmir.

Prof. B.N. Tripathi

Dr. Amrish Vaid
Director Extension
SKUAST-Jammu

National Agriculture Summit 2024
HARNESSING INNOVATIONS IN AGRICULTURE AND ALLIED SCIENCES

Message

It is the matter great pleasure that Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu is organizing a National Agriculture Summit on "Harnessing Innovations in Agriculture and Allied Sciences" from November, 20th -23rd, 2024 at Main Campus, Chatha.

Agriculture is susceptible to short term changes in weather and to seasonal, annual and long term variations in climate. Crop yield is the culmination of a diversified range of factors. Parameters like soil, seed, pest and disease, fertilizers and agronomic practices significantly influence crop yield. Burgeoning population, along with human induced climate change and associated ecological problems are increasingly becoming a limited factor for enhancing farm productivity and ensuring food security for the rural poor. Achieving improved and sustainable agriculture production and productivity largely depends on the advancement of agricultural research and its effective application at farmers' field through transfer of technology.

The summit will cover all the important areas such as technical advances and innovation in agriculture and allied vocations, agripreneurship development, natural resources management, women empowerment, precision farming, public-private partnership, processing, value- addition and marketing.

I look forward to the National Agriculture Summit with the anticipation that the discussions will culminate in a set of concrete recommendations to develop appropriate strategies for sustainable development in agriculture and poverty alleviation in the country.

I extend my gratitude to my colleagues for their exceptional support.

(Amrish Vaid)

National Agriculture Summit 2024
HARNESSING INNOVATIONS IN AGRICULTURE AND ALLIED SCIENCES

Message from Organizing Secretaries

It is a privilege to welcome you to the National Agriculture Summit 2024, organized by Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST), Jammu, from 20th to 23rd November. Under the theme "Harnessing Innovations in Agriculture and Allied Sciences," this summit is designed as a comprehensive event that includes a Farmers' Symposium and an Agriculture Fair& Exhibition to encourage open discussions among academia, industry, government bodies, and farmers, fostering meaningful collaborations that will benefit our agricultural sector in the long term.

We are delighted to host a diverse gathering of stakeholders, including scientists, officials from state department, policymakers, industry leaders, NGOs, FPOs, startups, entrepreneurs, farmers, and students, all united by a shared commitment to advancing Indian agriculture especially in Jammu region.

This summit is an embodiment of our collective vision to transform agriculture through innovation, collaboration, and sustainability. With sessions focused on pioneering research, cutting-edge technologies, and sustainable practices, the summit provides a platform for addressing both the opportunities and challenges facing agriculture and allied sciences today.

As Organizing Secretaries, we extend our heartfelt gratitude to all participants, exhibitors, sponsors, and partners who have supported this endeavor. We would also like to acknowledge the dedicated efforts of our organizing team, whose hard work has been instrumental in bringing this summit to life.

We are confident that this summit will inspire valuable insights, foster new partnerships, and contribute positively to the agricultural landscape of India.

Thank you once again for your participation and support in making this event a memorable success.

Sd/-
Organizing Secretaries

Contents

1. SKUAST Jammu: A Journey of Growth and Groundbreaking Achievements in Agriculture and Allied Sciences

B.N. Tripathi

SKUAST-Jammu's Strong Performance in NIRF 2024 Rankings

In the 2024 National Institutional Ranking Framework (NIRF) results, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu) made a commendable entry into the rankings, securing the 20th position in the Agriculture and Allied Sectors category and 13th Rank amongst Agricultural Universities. This achievement highlights SKUAST-Jammu's commitment to academic excellence, research, and its role in advancing agricultural education in the region.

Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu) came into existence on 20th September, 1999 following the amendment in Sher-e-Kashmir University of Agricultural Sciences and Technology Act, 1982, through the State Legislature. The establishment of SKUAST of Jammu has in its background aspirations, commitment and missionary zeal to cater the needs of Jammu Division for the region-specific advances through education, research and extension in the field of agriculture.

The university is mandated to address the basic, strategic and applied research related to enhanced production in agriculture and allied sectors (livestock health improvement and quality-based products). SKUAST-Jammu is striving to achieve high standards of excellence in education, research and extension for the betterment of farming community of the region.

The university comprises distinct faculties, including the Faculty of Agriculture, Faculty of Veterinary Sciences & Animal Husbandry, Faculty of Horticulture and Forestry, Faculty of Dairy Technology, Faculty of Agricultural Engineering and the Institute of Biotechnology. SKUAST-J is a multi-campus university with it headquarter located at Chatha, Jammu.

Chatha campus possess 578.00 acres area and R. S. Pura campus has 84.13 acres land holding. The total land holding, including Research Stations/Sub-Stations and KVKs, of the University is 1223 acres. SKUAST-Jammu serves the diverse agro-climatic needs across sub-tropical, semi- temperate and temperate zones of Jammu Province with elevations ranging from 300 to 4200 meters above sea level. Dedicated in improving the livelihood of approximately 800,000 farm families, the university focuses on quality research, extension services, education, and entrepreneurship development.

There are 10 Research Stations/Sub-Stations and nine KVKs in the University which are located in different agro-climatic zones of Jammu region for catering the location-specific needs of the farming community. University pursues research of high standard through projects funded by various central and state agencies. Krishi Vigyan Kendra’s (KVKs)

The admission to the undergraduate and postgraduate courses in the Faculties of Agriculture, Horticulture, Veterinary Science & Animal Husbandry, Dairy Technology, Basic Sciences and Agricultural Engineering, Institute of Biotechnology and Agri Business Management programmes through competitive exams is a regular feature. The university has been actively

involved in the transfer of evolved technologies to the end users through the strong extension system.

Brief about Faculties, Research Stations and KVK network under SKUAST Jammu

Faculties (06)/ Institution (01)

- Faculty of Agriculture - Chatha
- Faculty of Basic Sciences - Chatha
- Faculty of Horticulture & Forestry - Chatha
- Faculty of Agricultural Engineering - Chatha
- Faculty of Veterinary Sciences & Animal Husbandry - R.S. Pura, Jammu
- Faculty of Dairy Technology - Chatha
- Institute of Biotechnology – Chatha

Research Stations and sub stations (08)

- Advanced Center for Rainfed Areas (ACRA) - RakhDhiansar, Jammu
- Advanced Center for Horticultural Research (ACHR) - Udheywalla, Jammu
- Rainfed Research Station for Sub-tropical Fruit Crops (RRSS) - Raya, Samba
- Pulses Research Sub-Station (PRSS) - Samba
- Maize Research Sub-Stations (MRSS) - Udhampur, Poonch
- Regional Horticultural Research Sub-Station (RHRSS) - Bhaderwah, Doda
- Regional Agriculture Research Station (RARS) - Rajouri
- Basmati Rice Research Center - Chakroi, R.S. Pura, Jammu

Extension Network - Krishi Vigyan Kendras (KVKs 09))

- KVK Jammu
- KVK Samba
- KVK Kathua
- KVK Reasi
- KVK Doda
- KVK Kistwar
- KVK Ramban
- KVK Rajouri
- KVK Poonch

Directorate of Research: Advancing Agricultural Innovation and Development

Directorate of research executes and manage research programmes of the University comprising of basic, strategic and applied research activities as per the aspirations of farming community. It also undertakes location specific research in all the Research Stations situated in different parts of Jammu division as well as monitor the location specific activities of these research stations. Research stations/sub-stations (10nos.) are catering the needs of agriculture and allied sector of Jammu Province. Eleven (11 nos.) AICRPs (All India Coordinated Research Projects along with 13 AICRP voluntary centers, 08 advance Center of Excellence including Advanced Centre for Horticulture Research (Indo -Dutch project), Plant Tissue Culture and Bio-control Laboratory, Advanced Center for Rainfed Agriculture (ACRA), RakhDhiansar, Jammu, Gene Bank, Honey Testing Lab, Honey Bee Disease Diagnostic Lab, Quality Control Laboratory, and Advanced Genomics Facility(Next Generation sequencing Unit & Biolistic System) are working in the University for the welfare of farming community through R&D in different crops.

Key Highlights of Major Achievements (2021-24)

Driven by research excellence, it advances studies in agriculture, animal husbandry, and allied fields, focusing on temperate and cold desert agriculture. This commitment has led to the development of total of 50 crop varieties have been released by the university, spanning various categories including cereals, oilseeds, pulses, vegetables and fruits. These varieties aim to enhance crop quality and productivity to cater different agricultural needs in the region. Our work at the forefront of agricultural innovation, benefiting rural communities across Jammu and Kashmir through impactful research and education.

Over recent years, SKUAST-Jammu has executed a growing number of research projects with substantial budgets, *viz* 82 projects in 2021-22 (INR 45.50 crores), 102 (INR 110.31 crores) in 2022-23 and 126 in 2023-24 (INR 199.30 crores), funded by various agencies such as DBT, DST, ICAR, MIDH, NABARD, RKVY-RAFTAAR and HADP (Govt. of J&K), etc.

Infrastructure development during the period includes Center of Excellence for horticulture, bio-control and tissue culture labs, as well as 15 custom machinery prototypes for hill agriculture.

Innovative products, like a Tannin Enriched Multi Nutrient Block and a diagnostic kit for warble fly, have been commercialized, alongside locust protein films for preserving livestock products. Technological advancements in hydroponic and vertical farming for vegetable and saffron cultivation have also been standardized.

University has made substantial strides in intellectual property, with 21 patents filed and 18 granted, alongside significant progress in geographical indications (GI) to protect regional specialties, with 4 GI registrations completed and 12 are under pipe-line. The university's research output has steadily increased, reaching 220 publications in 2021-22, 245 in 2022-23, and 270 in 2023-24, with good number in high-impact NAAS-rated journals. Additionally, University strengthened its collaborative impact through 53 strategic Memoranda of Understanding (MoUs) with national and international research institutions, fostering extensive partnerships to advance agricultural innovation and development.

The University is also providing technical support to the Department of Agriculture, J&K Government & line departments as well as the farmers and supply them improved quality seed and planting material for different agro-climatic conditions of Jammu Province of J&K. The University has developed and implemented comprehensive IPR policy for governing Technology Management and Intellectual Property Rights (TM&IPR). Through Holistic Agriculture Development Plan of J&K UT, the University is undertaking Research& Development in agriculture and allied sectors besides human resource development for technological backstop for sustainable and accelerated transformation of agriculture through scholarships to PG students and strengthening of student research and research infrastructure.

Directorate of Education: Fostering Knowledge and Skills for Future Generations

The Director of Education oversees the coordination and management of inter-faculty and inter-campus instructional programmes, ensuring the quality of teaching across all undergraduate and postgraduate levels. This role involves shaping policies related to resident instruction within the university.

University Examination Cell

University Examination Cell (UEC) established in November 2012 administers the SKUAST-Jammu Common Entrance Test for admission to six undergraduate, 40 postgraduate, and 36 Ph.D. programmes. It is also responsible for conducting end-term examinations for all undergraduate programmes, namely B.Sc. (Hons.) Agriculture; B.Sc. (Hons.) Horticulture; B. Tech. Biotechnology; B.Tech. Agricultural Engineering, and B.Tech. Dairy Technology. Additionally, UEC manages annual board exams (theory and practical) for B.V.Sc & AH, written comprehensive examination for Ph.D. students, recruitment tests for non-teaching positions, and final examination for Diploma in Agricultural and Horticultural Training

Counselling & Placement Cell

The Counseling & Placement Cell focuses on the holistic development of students by creating opportunities for them to engage with field experts and participate in personality development training. Specialized sessions cover resume building, communication skills, and interview preparation. A key mandate of the cell is to establish industry partnerships to facilitate campus placements and provide career guidance to students.

Key Highlights of Major Achievements (2021-24)

- Gross enrolment has risen by 10%, bringing the total student strength to 1,910 including 1,141 undergraduates, 404 master's students, and 298 Ph.D. candidates.
- New faculties have been established, including the Faculty of Horticulture & Forestry, Faculty of Dairy Technology, and Faculty of Agricultural Engineering.
- A dual degree programme with Western Sydney University, Australia, has been introduced for B.Sc. (Hons.) Agriculture and B.Tech (Biotechnology) students.
- Three new postgraduate programmes—M.Sc. Fisheries Sciences, M.Sc. Organic Farming, and M.Sc. Seed Technology—were launched within the last three years.
- The National Education Policy (NEP) 2020 has been implemented at the undergraduate level, following the ICAR 6th Deans' Committee Report.
- In line with NEP 2020, the University formulated the guidelines for Master's and Ph.D. sandwich/bilateral degree programmes.
- The peer review process for a PhD student's research synopsis has been adopted for thorough assessment by independent experts in the field.
- Guidelines for 'Professors of Practice' and 'Adjunct Faculty' have been formulated to enrich academic offerings.
- Under the 'Study in India' initiative, foreign students have been admitted to postgraduate programmes.
- Recommendations from the BSMA Committee have been adopted for PG and Ph.D. programmes.
- A scholarship of ₹5,000 per month has been implemented for all PG and Ph.D. students under HADP.
- Plagiarism detection software, Drill Bit, is now used to uphold academic integrity

in theses and research publications.

- Industry-Academia collaborations have been strengthened through R&D partnerships and the appointment of Professors of Practice. Four Memorandums of Understanding (MoUs) have been signed with industry partners.
- A Career Development Centre has been established to foster students' personality and career development.
- Recruitment tests for non-teaching positions have been held since December 2022, filling 125 positions across 15 posts.

Directorate of Extension: Empowering Farmers Through Research-Driven Extension Initiatives

The Directorate of Extension at SKUAST-Jammu serves farmers across 10 districts encompassing three distinct agro-climatic zones in the Jammu region; Sub-tropical, Intermediate, and Temperate. Technologies developed at research stations and faculties of the university tailored for these zones, are then disseminated directly to field through KVKs. Additionally, various externally funded extension projects are executed to showcase research interventions directly at farmers' fields. The operational framework of the Directorate is strategically aligned to address both traditional and emerging challenges, ensuring the advancement of the agricultural sector along modern lines.

Directorate of extension is working with the mandate of planning, executing and coordinating the extension activities of the university, transferring of latest technologies related to agriculture, animal husbandry, horticulture and other allied areas to the farmers and field functionaries using different extension methodologies and strengthening the linkages between university, line departments and various National International organisations.

Coordination and monitoring of technology application and frontline extension education programmes through a network of 09 Krishi Vigyan Kendra’s with the objective of boosting the socio-economic development of rural families through improved agricultural practices could enhance agricultural productivity and income.

Key Highlights of Major Achievements

- Substituted 40% of coarse rice cultivation with Pusa Basmati varieties in the plains of Jammu region led to a significant increase in profitability, yielding an extra Rs. 16,000 per hectare.
- Transformed maize production over an area of 80% Intermediate hills and Temperate zones by replacing composites with hybrid varieties resulted in enhanced productivity by 28 quintals per hectare.
- Supported the Purple Revolution in 28 villages of Doda district, replacing maize cultivation with Lavender, boosted profitability by Rs. 21,000 per hectare.
- Strengthened over 200 farmers in the Kandi (rainfed) villages of Jammu through Harad cultivation, with each tree yielding an average of 100-120 kgs and generating an average income of Rs. 1800 per tree.
- Contributing to the preservation of traditional Basmati rice in Jammu by producing over 400 quintals of high-quality seed annually.
- Over 500 rural youths in 21 batches secured employment opportunities in the past three years after completing certificate courses (15-days each) on Integrated Nutrient Management since 2021.

- Supported the growth of more than 1000 entrepreneurs in mushroom growing and bee-keeping enterprises.
- Empowering Pashu Sakhis: An alternative community-led livestock extension service mechanism of NDDB has been promoted, led to generation of employment for 312 Pashu Sakhis, from remote villages in 12 batches of the Jammu region in 2023-24.
- Benefitted over 1 lakh farmers and enabled them to have access to information related to Agriculture and allied sectors besides various schemes through Regional Agriculture Fairs and Kisan Melas organized by the Directorate during 2019-2024.
- In the 2023-24 period, the Directorate introduced a recent intervention by demonstrating the utilization of agricultural drones to farmers, covering an extensive area of 300 hectares. This initiative aimed to facilitate the adoption of time and energy-saving technologies in agriculture.
- Developed and uploaded over 200 videos under YouTube channels and Daksh Kisan program to empower farmers and agri-preneurs by providing access to high-quality training and educational resources under Holistic Agriculture Development Plan (HADP).
- Facilitating market linkages for over 1500 farmers through 15 Farmer Producer Organizations (FPOs) promoted by the Directorate since 2021.
- Created employment opportunities for more than 500 farm women in the Reasi district through Self-Help Groups (SHGs), involving value addition and processing, with an average annual income of Rs. 2.49 lakh per group.
- Encouraged marigold cultivation in 36 villages of Doda district, involving over 680 households and generating a collective annual turnover of Rs. 1 crore.
- Providing on-the-spot solutions to farmers' queries under the new initiative 'Vice Chancellor to Village' Programme.
- Delivered capacity building support in Extension Management to 6683 extension functionaries through 222 programs, encompassing participants from both public and private sectors under SAMETI.
- Fifty extension functionaries from various line departments successfully completed the Post Graduate Diploma in Agricultural Extension Management (PGDAEM), while 80 rural youth accomplished the Diploma in Agricultural Extension Services for Input Dealers (DAESI) provided by MANAGE Hyderabad.
- Successfully advocated for the adoption of high egg laying backyard poultry breeds among rural youth and women farmers, resulting in a net annual income of Rs 16000 per 20 birds.
- Enhanced the overall health and productivity of dairy animals by introducing urea mineral molasses blocks in fodder-deficient regions, leading to an increase of 1-1.25 kg in daily milk production per animal.

KVKs under Directorate of Extension

The KVKs operating under the SKUAST, Jammu, serve as vital agricultural technology hubs in their respective districts. It plays a pivotal role in agricultural advancement through assessing and refining technologies to adapt to the unique needs of local farming systems. Currently, India has established 732 KVKs across rural districts, with 19 in J&K and 09 operating under the jurisdiction of the SKUAST Jammu with the vision to become leading resource and knowledge centres for agricultural technology, promoting the progress and well-being of the farming community. Their main activities include on-farm testing of technologies and products to determine location-specific suitability, as well as conducting frontline demonstrations to

showcase the potential of innovative agricultural practices directly on farmers' fields. KVKs also focus on human resource development by providing training to farmers, rural youth, and extension personnel, thereby enhancing skills and knowledge in agricultural practices. Acting as resource and knowledge centers for agricultural technology, KVKs support initiatives from public, private, and voluntary sectors aimed at agricultural improvement

KVK framework aims to leverage agricultural innovations and strengthen the farming community, working closely with stakeholders across sectors are enhancing the agricultural economy of the region.

State Agricultural Management and Extension Training Institute, Jammu

SAMETI-J under the Directorate of Extension is an autonomous institution with greater flexibility in structural and operational aspects. The SAMETI is a state level institute established on the patterns of MANAGE, and mandated to provide support to Extension Reforms. The institute was set up in 2009. The institute has been assigned responsibilities of imparting training to in-service officers of various departments including Agriculture, Horticulture, Animal Husbandry, Sheep Husbandry, Floriculture, Sericulture, Social Forestry, and Fisheries; along with imparting training to extension personnel of ATMA, NGOs, Input Dealers, Deputy Project Directors and Farmer friends with major objective to develop systematic linkage between State, Regional and International Institution of outstanding accomplishment in the field of Agricultural Extension Management It also provides induction training to ATMA functionaries and refresher training to all ATMA functionaries minus BTMs and SMSs. SAMETI–J is conducting contact classes and examination of One Year Post Graduate Diploma in Agricultural Extension Management (PGDAEM) and Diploma in Agricultural Extension Services for Input Dealers (DAESI) in collaboration with MANAGE, Hyderabad, Government of India.

Between 2014 and 2024, the SAMETI organized 222 training programs across various sectors, engaging a total of 6,821 participants. The primary area of focus was Agriculture, which saw the highest number of participants (4,168) over the decade, reflecting consistent engagement. Other significant areas included Sericulture (448 participants), Animal Husbandry (A.H) with 402 participants, and Social Welfare (394 participants), which saw a notable increase due to ICDS-related training in recent years. Horticulture, Floriculture, and Fisheries also saw steady participation, contributing to a diversified training portfolio. Smaller programs, like Command Area Development (17 participants), focused on specific skills, while intermittent training in sectors like ATMA and KVKs/SKUAST targeted specialized needs.

Overall, the SAMETI training initiatives addressed various sectors, promoting skill development across agricultural and social welfare domains.

Establishment of Agri-Business Incubation Centre (ABIC) in 2019 at Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu (SKUAST-Jammu), is an another milestone,serves as the sole R-ABI (Rashtriya Agri-Business Incubator) with the aims to empower agri-entrepreneurs and startups by enhancing their business knowledge and skills through specialized training, focusing on the fundamentals of establishing and managing a successful agri-business. Additionally, it assists in securing grant-in-aid support through the Ministry of Agriculture & Farmers' Welfare, Government of India.ABIC, SKUAST-Jammu currently offers two key training programs: First one is UDGAM (Agripreneurship Orientation Programme/Idea Stage) that targets individuals with innovative ideas in agriculture or allied

sectors, helping them move from concept to incubation. Selected participants may receive a grant-in-aid of up to Rs. 5 lakhs. Second one is PRAGATI (Seed Stage Funding Programme) that geared towards agri-entrepreneurs who have developed a prototype, minimum viable product, or working model, PRAGATI supports these participants in further development, with selected projects eligible for a grant-in-aid of up to Rs. 25 lakhs.

Since its inception, ABIC, SKUAST-Jammu has incubated 78 entrepreneurs across seven training batches through the UDGAM and PRAGATI programs. It has successfully secured grant-in-aid funding totalling Rs. 2.88 crores for 26 of these startups from the Ministry of Agriculture & Farmers' Welfare, Government of India.

Recap

Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu) has made significant strides since its inception in 1999 in advancing agricultural research, education, and extension. The university's strategic approach, which integrates cutting-edge research with practical extension services, has played a crucial role in transforming the agricultural landscape of Jammu and Kashmir. Through its diverse faculties, extensive research stations, and robust extension network, SKUAST-Jammu is empowering farmers, fostering entrepreneurship, and contributing to the overall socio-economic development of rural communities.

Key achievements such as the release of 50 crop varieties, the execution of over 300 research projects, the commercialization of innovative products, and the successful implementation of technology transfer initiatives highlight the university's commitment to addressing region-specific challenges. Its strong focus on infrastructure development, intellectual property, and collaborations with national and international institutions further strengthens its position as a leader in agricultural innovation.

With a growing emphasis on education and the establishment of new programs, SKUAST-Jammu is actively preparing its students to meet the challenges of the modern agricultural industry. The university's extension services, delivered through Krishi Vigyan Kendras (KVKs), have improved agricultural practices, enhanced productivity, and created sustainable livelihoods for farmers.

As SKUAST-Jammu continues to focus on research excellence, infrastructure development, and the holistic empowerment of farmers, it remains at the forefront of agricultural innovation and a beacon of hope for the agricultural community in Jammu and Kashmir. The university's initiatives are paving the way for a prosperous future, ensuring that agricultural transformation in the region is both sustainable and impactful.

WHAT DISTINGUISHES US

- Our university is home to a dedicated team of highly skilled educators and professionals who are committed to academic excellence and the success of our students.
- Our university upholds rigorous academic standards, ensuring that our programs are of the highest quality and effectively prepare our students for successful careers in their respective fields.
- Our university fosters a dynamic and inspiring academic atmosphere that promotes critical thinking, creativity, and innovation, encouraging students to reach their full potential.
- Our university offers a comprehensive learning experience that connects theoretical knowledge with practical, real-world applications.
- Our university is dedicated to cultivating an entrepreneurial mindset among our students, equipping them with the skills and confidence to excel in the business world.
- Our focus is on advancing research in agriculture, animal husbandry, and allied fields—particularly in temperate and cold desert agriculture—positions us as leaders in agricultural innovation.
- Our research efforts are designed to have a direct, positive impact on rural communities in the union territory of Jammu and Kashmir, contributing to local development.
- We strive to shape the next generation of problem-solvers, equipping our students with the knowledge and skills needed to address global challenges and drive innovative solutions.

2. The Directorate of Extension: Bridging the Gap in Agricultural Knowledge and Technology

Amrish Vaid, Hema Tripathi, Pawan Kumar Sharma and Rakesh Sharma

The Directorate of Extension at SKUAST-Jammu is dedicated to enhancing agricultural development in the region by bridging the gap between agricultural research and farming practices. By facilitating the transfer of modern scientific knowledge and technology to rural farmers, the Directorate enables them to adopt more sustainable and profitable agricultural practices. As an extension service provider, the Directorate operates as a vital link between the university's research teams, governmental bodies, and local agricultural stakeholders, ensuring that cutting-edge knowledge reaches those who need it most the farmers.

The core mandate of the Directorate of Extension includes planning, implementing, and coordinating extension activities aimed at disseminating the latest agricultural technologies, providing training to farmers, and promoting sustainable agricultural practices. This involves creating awareness, providing support for innovation adoption, and encouraging farmer participation in government schemes and initiatives. In essence, the Directorate's work is about fostering a dialogue between science and the farm community to improve agricultural productivity, economic resilience, and social well-being.

Mission of the Directorate of Extension

The Directorate of Extension at SKUAST-Jammu operates with the mission to empower farm families in Jammu and Kashmir. It envisions a transformation in rural areas through the adoption of new technologies, innovative farming practices, and improved access to market opportunities. The mission is built on the following principles:

1. **Empowering farmers with knowledge**: One of the key aspects of the Directorate's mission is to provide farmers with the latest technological know-how to improve productivity. Whether it's introducing new crop varieties, sustainable pest management techniques, or water conservation methods, the Directorate ensures that the farmers are equipped with the tools they need to succeed.
2. **Facilitating the adoption of agricultural innovations**: The Directorate works to break down the barriers to adopting new technologies. By organizing training programs, field demonstrations, and awareness campaigns, it makes it easier for farmers to understand and implement new techniques.
3. **Publishing extension literature**: To ensure that farmers stay informed about the latest agricultural trends, the Directorate regularly publishes extension literature. These materials include research findings, guidelines for best practices, and information on new technologies and government schemes.
4. **Supporting Krishi Vigyan Kendras (KVKs)**: The Directorate plays a crucial role in strengthening the outreach and effectiveness of Krishi Vigyan Kendras (KVKs). These rural institutions serve as centers for training and knowledge dissemination. The Directorate works closely with KVKs to improve their capacity to serve farmers effectively.
5. **Improving rural socio-economic conditions**: Ultimately, the goal of the Directorate's mission is to enhance the socio-economic conditions of rural populations. This is achieved by promoting sustainable farming practices that increase income, create jobs, and reduce poverty.

Major extension activities and services

SKUAST-Jammu's Directorate of Extension is instrumental in implementing various farmer-centric services aimed at improving productivity, increasing profitability, and strengthening resilience:

1. **Farmer Advisory Services**
- Advisory services cover crop management, nutrient, water, and weed management, post-harvest techniques, and weather-based guidance.
- The Directorate provides support through phone consultations, SMS alerts, radio, television, and on-field visits, offering tailored solutions to farmers' queries.
- A toll-free Kisan Call Centre assists farmers with immediate solutions, while WhatsApp groups enable quick, real-time problem-solving.

2. **Seed and technology products**
- The university supplies seeds of cereals, pulses, vegetables, and oilseed varieties developed to suit Jammu's climatic zones. These varieties, particularly in basmati rice, have shown great success, empowering farmers to adopt crops with high market demand.

3. **Crop cafeterias and technology parks**
- SKUAST-Jammu has developed crop cafeterias at its main campus and KVKs, where live demonstrations showcase the latest crop varieties and farming techniques. These interactive spaces facilitate knowledge sharing, helping farmers observe and adopt new technologies.

4. **Cluster-Based Business Organizations and Farmer Producer Organizations (FPOs)**
- SKUAST-Jammu has established 15 FPOs to enable smallholder farmers to pool resources, increase bargaining power, and access markets effectively. FPOs receive support for management training, business planning, and market connections.
- Through cluster-based business organizations, SKUAST-Jammu assists these FPOs in developing value chains, conducting baseline surveys, and obtaining Geographical Indication (GI) registration. FPOs such as the Mandi Walnut Farmers' Cooperative and Shiwalik Hills Honey Co-operative have helped boost incomes for small-scale producers.

Major achievements of the Directorate of Extension Over the years, the Directorate of Extension at SKUAST-Jammu has achieved remarkable success in bringing about significant changes in the agricultural landscape of Jammu and Kashmir. Some of the major achievements include:

1. **Crop diversification and increased profitability**: Crop diversification has been one of the key strategies promoted by the Directorate. Traditional crops like maize and wheat, while important, have often failed to yield substantial profits for farmers due to market fluctuations and climatic challenges. The Directorate has been successful in introducing high-yielding varieties such as Pusa Basmati, which has significantly increased farmers' incomes. For instance, by replacing traditional crops with Pusa Basmati, farmers have seen an increase in profitability of Rs. 16,000 per hectare. Such initiatives have not only enhanced income but have also improved food security by promoting diversified and resilient cropping systems.
2. **The "Purple Revolution" and Lavender cultivation**: One of the most innovative initiatives supported by the Directorate is the "Purple Revolution" in the Doda district, which introduced lavender cultivation as an alternative to maize. This shift has proven to be highly beneficial for farmers, as lavender cultivation requires less water and input compared to traditional crops.

The transition has resulted in an increase in income by Rs. 21,000 per hectare, helping farmers to earn better profits while improving the environmental sustainability of farming practices. This initiative has demonstrated the potential of high-value crops in transforming rural economies.

3. **Empowerment programmes for rural youths**: The Directorate of Extension has been a strong advocate for empowering rural youth with skills and knowledge in modern farming techniques. Over 500 rural youths have been trained in integrated nutrient management, a critical aspect of modern farming that optimizes soil fertility while minimizing environmental damage. Additionally, more than 1,000 agripreneurs have benefited from specialized courses in mushroom cultivation and beekeeping, both of which are highly profitable agribusinesses. By providing these youths with entrepreneurial skills, the Directorate has not only improved their livelihoods but has also contributed to local economic development.
4. **Adoption of drones for precision agriculture**: Technological innovation is at the heart of the Directorate's efforts to modernize agriculture. The introduction of agricultural drones is one such advancement. In a recent pilot project, drones were used to cover over 300 hectares, significantly reducing the time and labor required for crop spraying and monitoring. These drones also help to optimize input use, such as pesticides and fertilizers, leading to cost savings and more efficient farming practices. The use of drones in agriculture is a testament to the Directorate's commitment to bringing cutting-edge technologies to the farming community.
5. **Establishment of Farmer Producer Organizations (FPOs)**: The Directorate has played a key role in fostering collective action among farmers by establishing 15 Farmer Producer Organizations (FPOs). These FPOs are groups of small-scale farmers who come together to pool resources, improve bargaining power, and access markets. Over 1,500 farmers have benefited from these initiatives, which have enhanced their market access and helped them secure better prices for their produce. The establishment of FPOs has not only improved income levels but also contributed to building a more resilient and cooperative agricultural community.
6. **Promoting gender empowerment in agriculture**: Gender equality is another area where the Directorate has made significant strides. Through its support for Self-Help Groups (SHGs) for farm women in Reasi, the Directorate has enabled women to generate income and contribute to household finances. These groups have collectively earned Rs. 2.49 lakh annually, demonstrating the potential of empowering women in agriculture. The Directorate's work in this area has played a pivotal role in improving women's economic and social status in rural communities.

Looking ahead, the Directorate of Extension at SKUAST-Jammu plans to continue its efforts to revolutionize agriculture in Jammu and Kashmir, aligning its strategies with India's broader agricultural development goals. Some of the key focus areas for the future include:

1. **Expanding Digital Extension Services**: In line with the digital transformation of agriculture, the Directorate aims to expand the use of digital platforms to deliver timely and relevant information to farmers. These platforms will provide farmers with updates on crop management, pest control, weather patterns, and government schemes, ensuring they have the information they need to make informed decisions. Digital extension services can also facilitate remote consultations and virtual training, especially in hard-to-reach areas.
2. **Promoting Climate-Resilient Agricultural Practices**: Climate change is one of the most significant challenges facing agriculture today. The Directorate of Extension is committed

to promoting climate-resilient practices that help farmers adapt to changing weather patterns. This includes the development and adoption of drought-resistant crop varieties, water-efficient irrigation techniques, and soil conservation practices. By promoting such practices, the Directorate aims to safeguard agricultural productivity and ensure long-term sustainability.

3. **Enhancing Collaboration with Government and Private Sector**: To expand the reach and impact of its extension services, the Directorate plans to strengthen its collaborations with government agencies, private companies, and non-governmental organizations. These partnerships will bring additional resources, knowledge, and technological innovations to rural communities, enabling farmers to access a broader range of support services.

4. **Boosting Agri-Entrepreneurship and Rural Employment**: The Directorate is also focused on creating sustainable income opportunities for rural youth and women through agri-entrepreneurship. By training more youths and women in value-added agriculture and agribusiness, the Directorate aims to empower them to create their own businesses, thereby generating employment and contributing to the rural economy. This will not only help reduce rural unemployment but also stimulate economic growth in the region.

Recap

The Directorate of Extension at SKUAST-Jammu is a cornerstone of agricultural development in the region. Its mission-driven approach to agricultural extension has empowered farmers, improved their livelihoods, and contributed to the overall development of the rural economy. With its focus on technology adoption, capacity building, and market linkages, the Directorate has become an indispensable partner in advancing sustainable and profitable agriculture.

Looking forward, the Directorate's continued efforts to integrate digital technologies, promote climate-resilient farming practices, and foster partnerships will ensure that Jammu and Kashmir's agriculture sector remains competitive, sustainable, and inclusive. Through its innovative extension activities, the Directorate will continue to play a pivotal role in enhancing food security, boosting rural prosperity, and contributing to India's broader agricultural goals.

3. Impact of SKUAST-Jammu Kisan Melas on Farmers and Society

Pawan Kumar Sharma, Amrish Vaid and Hema Tripathi

The impact of the University Kisan mela was assessed by the Directorate of Extension through collection of responses from the participants. The participating farmers in previous two University Kisan Melas were interviewed to assess their views and impact of Kisan melas on their lives and society. The major points of impact are summarized as below:

Impact on farmers

The farmers in large number (>20,000) participated in Kisan melas organized by the University. Some of the major points of impact on farmers are given below:

1. Income generation for farmers

SKUAST-Jammu Kisan mela provides opportunity to farmers, Self Help Groups, FPOs, NGOs and cooperatives to showcase and directly sell their products to the visitors. The stalls have been provided either free of cost or on nominal charges to agripreneurs. The event had been proven to be a great source of income generation for all the farmers who have displayed their products in the mela.

2. Interactions with experts

These events served as platforms for farmers to interact with experts, government officials, and agri-businesses, thereby significantly impacting their practices, productivity, and socio-economic conditions. The farmers had direct access to the officers of all the departments, including agriculture and allied areas during the Kisan mela. Interaction with agricultural scientists, researchers, and technology providers at Kisan Melas facilitated the adoption of advanced agricultural technologies and machinery.

3. Accessibility to improved farm inputs

Kisan melas are the most important source of providing improved agricultural inputs to the farmers. Farmers in large quantity procured farm inputs, including seed, planting material, organic inputs, machinery and implements, animal feed, storage bins etc. The availability of diverse material during the Kisan melas provided farmers one-stop shop for their agricultural practices before the start of Kharif and rabi seasons. Farmers got hands-on experience with new equipment, such as precision farming tools, drones for crop monitoring, and mechanized harvesting machines, leading to efficiency gains and cost reduction.

4. Dissemination of latest information and knowledge

Kisan Melas served as hubs of agricultural information, where farmers gained insights into modern farming techniques, crop varieties, and innovative practices through seminars, demonstrations, and exhibitions. Access to information empowered farmers to make informed decisions regarding crop selection, pest management, irrigation methods, and post-harvest handling, ultimately enhancing agricultural productivity.

5. Development of market linkages

Kisan Melas enabled farmers to connect directly with private agencies, potential buyers, and agri-businesses. While interacting with such stakeholders, farmers understood the market potential and demand for their products for ensuring better price realization and market access. A lot of farmers used Kisan Mela as a platform to launch their products and aware the customers about the benefits associated with them.

6. Policy Advocacy

Farmer gatherings at Kisan Melas served as platforms for collective advocacy on policy issues affecting agriculture. During Kisan ghosties, farmers voiced their concerns and provided suggestions for policy formulation and implementation. They also discussed the effectiveness of government schemes and constraints associated in availing the benefits. Many of their suggestions have been put forth by the university to the government on different occasions.

Impact on society

The farmers expressed their eagerness to participate in the SKUAST-Jammu Kisan mela. The major impact of such melas on the society was discussed with the participants. The Kisan melas seemed to influence beyond the agricultural sector, permeating into the broader fabric of society. The event served as catalysts for social cohesion, economic development, and environmental sustainability, thereby contributing to the overall well-being of society. Some of the important visible points of impact on society are summarized as below:

1. Rural-Urban Linkages

SKUAST-Jammu Kisan Melas served as a valuable platform to bridge the rural-urban divide by bringing together farmers, urban consumers, policymakers, researchers, and entrepreneurs in a shared space. The events of the mela such as Dog show, Lawn competition etc. attracted large number of urban households, whereas other events such as livestock show, vegetable and fruit show etc. attracted rural folks. The events such as rural sports witnessed the participation of both rural as well as urban households. In this way, such interactions during the Kisan Mela promoted mutual understanding, empathy, and collaboration, fostering a more inclusive and interconnected society.

2. Developed the spirit of entrepreneurship and innovation

One of the major activities of SKUAST-Jammu Kisan Mela is organization of entrepreneurs' meet and presentation by progressive farmers. These occasions provided a platform for discussing success stories of entrepreneurs, their products and services etc. This has resulted in nurturing a culture of innovation and enterprise, thereby contributing towards economic growth, job creation, and the emergence of rural entrepreneurship.

3. Cultural Exchange and Celebration

SKUAST-Jammu Kisan Melas incorporated elements of cultural exchange, showcasing diverse traditions, through organization of cultural programmes. These cultural exchanges promoted social cohesion, mutual respect, and appreciation for cultural diversity, fostering a sense of unity and pride in society.

4. Promotion of environmental stewardship

Through exhibits and demonstrations on organic farming, agroforestry, water conservation, and renewable energy, SKUAST-Jammu Kisan Melas promoted environmental stewardship and sustainable resource management. By encouraging adoption of eco-friendly practices and natural farming, the melas have contributed in mitigating environmental degradation and building resilience against climate change.

5. Civic Engagement

SKUAST-Jammu Kisan Melas provided opportunities for farmers and stakeholders to engage in policy advocacy, voicing their concerns, and influencing decision-making processes. By fostering civic engagement and participatory governance, these events strengthen democratic values and promote accountable and inclusive development. In essence, Kisan Melas serve as

dynamic platforms for societal transformation, fostering knowledge exchange, economic empowerment, cultural enrichment, and environmental sustainability. By harnessing the collective wisdom and energy of diverse stakeholders, these fairs contribute to building a more equitable, resilient, and harmonious society.

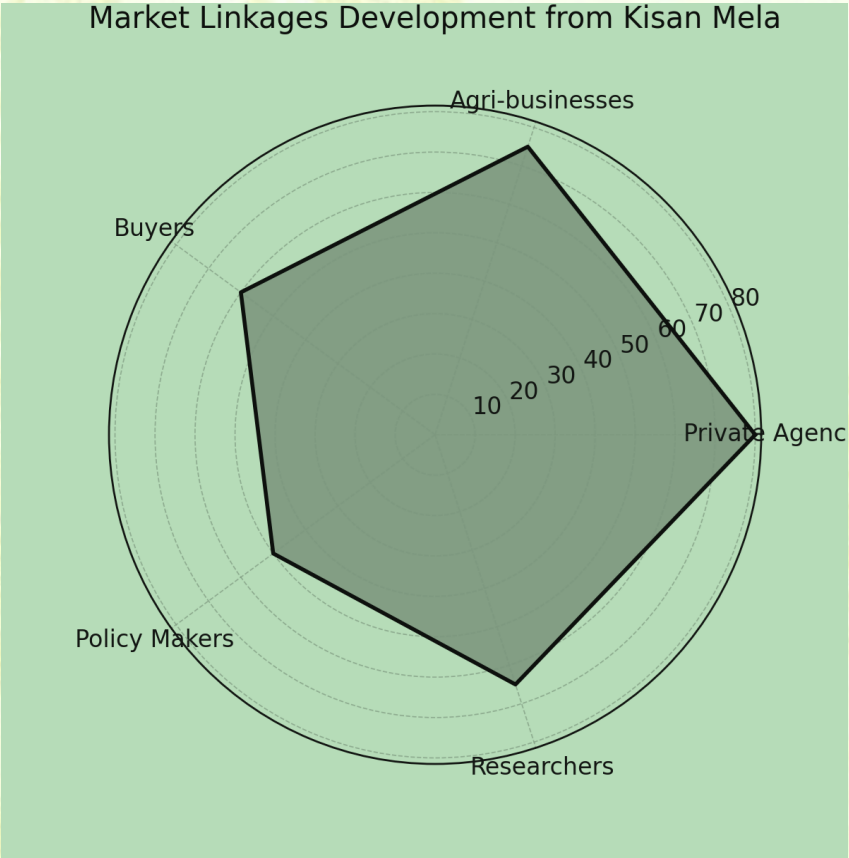
Market Linkages development

The radar chart visualizes the strength of market linkages formed during the SKUAST-J Kisan Mela with different stakeholders. Here's a breakdown of the elements:

Categories

The radar chart has five key stakeholders:

1. **Private Agencies**: Companies or organizations that deal with private sector activities in agriculture.
2. **Agri-businesses**: Firms providing agricultural products or services.
3. **Buyers**: Potential customers interested in purchasing agricultural products directly from farmers.
4. **Policy Makers**: Government officials or authorities involved in shaping agricultural policy.
5. **Researchers**: Scientists or experts involved in agricultural innovation and development.



Values

The values for each category represent the strength of the linkages, on a scale from 0 to 100. For example:

- Private agencies and agri-businesses show high linkage strength (80 and 75, respectively), indicating strong connections formed with these stakeholders during the mela.
- Buyers (60), policymakers (50), and researchers (65) show moderate but important linkages.

Visual Shape

The filled area of the radar chart indicates the distribution of linkages across categories. A larger area in a particular direction (e.g., towards private agencies) suggests stronger connections with that stakeholder.

Conclusion

SKUAST-Jammu Kisan Melas have proven to be a transformative force for both farmers and society at large. These events foster income generation by providing farmers, Self Help Groups, and agripreneurs a platform to showcase and sell products, thus supporting local economies. The melas also facilitate farmer interaction with experts and access to modern technologies, which enhance agricultural productivity and sustainability. Through these interactions, farmers gain crucial insights and tools, empowering them to make informed agricultural decisions. Additionally, the melas strengthen market linkages by connecting farmers with private agencies, agri-businesses, and buyers, ensuring broader market access.

Beyond the agricultural realm, the melas bridge the rural-urban divide, foster social cohesion through cultural exchanges, and promote environmental stewardship by showcasing sustainable farming practices. Events at the mela, including rural sports and livestock shows, draw both rural and urban participants, building empathy and mutual understanding. These Kisan Melas also play a role in policy advocacy, allowing farmers to voice their concerns on agricultural issues. Overall, SKUAST-Jammu Kisan Melas contribute significantly to economic empowerment, cultural unity, and environmental awareness, positioning them as catalysts for holistic societal development.

4. Agripreneurship: Evolving Youth to Entrepreneurs

Jasbir Singh Manhas, Hema Tripathi, Pawan Sharma and Amrish Vaid

Introduction

India is an agrarian economy with abundant availability of land for agricultural activities and a vast population depends on agriculture and its allied activities. In the past, agriculture was seen as a low technology-driven industry dominated by numerous small family firms, whose main focus is on doing things better rather than doing new things. However, due to the economic liberalization and fast-changing economy, this situation has changed drastically.

Agripreneurship

An entrepreneur is someone who organises, starts, operates and in effective control of a business or commercial venture. She/he could also be an innovator in product/ service/ process or design and can maximise profits by adopting new strategies or ventures. Quite similar, *Agripreneur*is an individual who starts, organises and manages a business venture focusing on the agricultural sector. Broadly, *Agri-entrepreneurship* or Agripreneurship provides value addition to agricultural resources typically engaging rural human resources. The finished goods and services coming out of agrientrepreneurial initiatives are generally procured and produced out of resources in rural areas, the consumption of which however may be both urban and rural. Agripreneurship is a concept that is specific to agriculture and drawn from wider entrepreneurship. Agripreneurship has prospective and potential for the social and economic development of the country. Its contribution takes the form of employment creation and economic growth, diversified income and poverty reduction in rural areas, and improvement in nutrition, health and overall food security. Agripreneurship encompasses the transformation of an idea or vision into a “new business or new venture creation, or the expansion of an existing business, by an individual, a team of individuals, or an established business”.

Agripreneurship can be called the development of agriculture into a sustainable, community-oriented and directly-marketed business. Sustainable agriculture denotes a holistic, system-oriented approach to farming that focuses on the interrelationships of social, economic, and environmental processes.

A like most other forms of entrepreneurship, decision making, opportunity identification, resource organisation, risk-taking, coping with failure and profit-making are the characteristics that applies to an agripreneur as well, specifically in the context of farm sector. They will identify opportunities in agri or related industry and launch an enterprise either as a farmer, distributor and sometimes act as an agent in the business-to business-to-consumer model also. Business planning, market analysis, managing equipment, production operation, negotiating and customer relation skills, marketing and sales, financial and developing training programmes, are some of the many key skills essential in running an agribusiness.

The key four of many areas that agripreneurship services are crop advice, agricultural input sales, market linkages and credit facilitation. Agripreneurship can already be seen in Dairy, Sericulture, Goat rearing, Rabbit rearing, Floriculture, Fisheries, Shrimp Farming, Sheep rearing, vegetable cultivation, nursery farming, and also farm forestry. In addition, agripreneurs develop initiatives such as agro-produce processing units (rice and pulses mills), agro-produce manufacturing units (sugar and bakery factories/units), agro- inputs manufacturing units

(fertilizer production units food processing units), agro-service centres (service centers for repairing agri-based tools and equipment), and also other agri enterprises that sets up apiaries, feed and seed processing units, mushroom production units, commercial vermin-compost units, organic vegetable and fruits retail. Newer forms of agripreneurship models link farmers to markets, both rural and urban, and adopts a decentralized approach in order to boost youth entrepreneurship and contribute to developing regional economies. These models also integrate services of credit, market linkages and also high-quality input and crop advisory to the farmers. Agripreneurship is not only an opportunity but also a necessary force for improving the production and profitability in agriculture sector.

Indian agripreneurs could adopt some of the successful tech ventures in agriculture from other neighboring developing countries where their counterparts have integrated remote sensing (that can provide bio geophysical data for agricultural crop monitoring and agromet advisory services), Geographic Information System (GIS), Internet of Things (IoT) based smart farming is a system built for monitoring crop field with the help of sensors that provide data on temperature, soil moisture, light and humidity. This helps to monitor crop health, automating irrigation systems, etc. and applying analytics to improve farm productivity, minimize farm wastage and thereby increasing farmers' income. These technologies can also be used to map the cropping pattern, cropping intensity, draught assessment and better understand the agronomics of crops.

Need for Agripreneurship

(i) **Marketability and value addition of agricultural products**: India is a land of a variety of agricultural and horticultural produce. Value addition to these products can be done to increase the shelf life and convenience of transport. These operations can be managed by inventing new agripreneurship ideas.

(ii) **Employment opportunities:** Agripreneurship plays an important role in providing employment opportunities at a local level. These opportunities at the village level are solutions to eradicate unemployment amongst the rural population and help in the growth and development of the overall economy. This also helps in reducing migration from rural to urban.

(iii) **Marketing of products:** The development of agribusinesses lead to an increase in production due to higher productivity, better processing and packing facilities, logistics support etc. This minimizes the dependence of the farmer on intermediaries and helps provide them with a wider market. This gives better visibility and higher returns to the farmers.

(iv) Standard of living: Agripreneurship helps in checking the migration of rural youth from villages to urban centers and giving them employment at their native place. This helps in getting alternative sources of income and thereby improving their living conditions and happiness quotient.

Scope of Agri-preneurship in India

Bansal (2011) presented a detailed account regarding the scope of agrientrepreneurship in India which is explained below:

(i) India is gifted with a diverse agro-climate, which assists the production of temperate, sub-tropical and tropical agricultural produce. It provides a variety of agricultural materials for all sorts of industries.

(ii) Demand for agricultural inputs like feed and fodder, inorganic fertilizers, and bio-fertilizers has increased.

(iii) Applications of biotechnology in agriculture are a boon for the production of seeds, bio-control agents, and industrial harnessing of microbes for different products. By improving the technique of production, enhancement in domestic consumption and export of mushroom production can be done.

(iv) Economic growth will be enhanced by exporting agricultural produce. According to World Trade Organization (WTO), India has immense potential to recuperate its present position in the World trade of both raw and processed form of agricultural commodities. At present processing is done at primary level only and the rising standard of living expands opportunities for secondary and tertiary processing of agricultural commodities.

(v) The livestock wealth provides vast scope for the production of meat, milk and milk products, poultry products etc.

(vi) The forest resources can be utilized for the production of forestry by products.

(vii) Beekeeping and apiary can be taken up on great extent in India.

(viii) By improving technique of production, enhancement in domestic consumption and export of mushroom production can be done.

(ix) The farmers should be encouraged and educated for organic farming as organic farming has highest potential in India as the pesticide and inorganic fertilizer application are less in India compared to industrial nations of the world.

(x) Huge opportunities for production and promotion of bio-pesticides and bio-control agents for protection of crops.

(xi) Due to plateauing in the productivity of high yielding varieties; seeds, hybrid and genetically modified crops have the highest potential in India in the future.

(xii) Owing to declining groundwater level and labour scarcity for agricultural operations like weeding, transplanting and harvesting, micro-irrigation systems and labour saving farm equipments have potential in coming years.

(xiii) Production of vegetables and flowers under green house conditions can be harnessed for the export.

(xiv) Trained human resources in agriculture and allied sciences will acquire on agricultural extension system due to deteriorating state finance resources and down-sizing the present government agricultural extension staff as consulting services.

(xv) Lastly, employment opportunities have increased in marketing, transport, cold storage and warehousing facilities, credit, insurance and logistic support services because of enhanced agricultural production.

(xvi) Large coastal line and internal water courses should be utilized for production of marine and inland fish. Ornamental fish culture already gaining popularity due to growing aesthetic value among the citizens of India.

Types of Enterprises

(i) **Farm level producers:** Here family is treated as enterprise for augmenting the production by utilizing the high level of technology, possessions and demand in the market.

(ii) **Service providers:** There are varied categories of services indispensable at the village level. These include the input borrowing and distribution, employing of equipment such as tractors, sprayers, seed drills, threshers, harvesters' dryers. It also consists of scientific services for example setting up of irrigation facilities, weed curb, plant security, yielding, threshing, conveyance, warehouse etc. and related opportunities present in the livestock husbandry region

for breeding, immunization, disease diagnostic and treatment services, along with provision of cattle feed, mineral combination, forage grains, etc.

(iii) **Input producers:** There are many booming enterprises which require significant contribution and such inputs can be produced by the home entrepreneurs at the village level are biopesticides, soil amendments, biofertilizers, vermicompost, plants of diverse species of vegetables, fruits, ornamentals, root media for raising plants in pots, production of cattle feed concentrate, agricultural tools, irrigation accessories, mineral mixture and complete feed. Additionally, opportunities are available in fishery, sericulture and poultry as well.

(iv)**Processing and marketing of farm produce**: Highly qualified and skilled persons and higher investment required for well-organized management of post-production processes. Such enterprises can be controlled by people's organizations like cooperatives, service joint stock companies or societies. The most successful illustrations are the dairy cooperatives sugar cooperatives and fruit growers' cooperatives.

Challenges in Agripreneurship

Several challenges of agripreneirship are discussed below:

(i) **Inadequate infrastructural facilities:** Infrastructural facilities in India are not adequate for development of the agripreneurship. The farmers do not have proper storage facilities and hence their produce has to be kept in open space and it gets spoiled often and due to this they incur huge losses which affect them adversely. Secondly, there is lack of transport facilities in the remote areas and due to this their produce does not reach to the market in time. Therefore, there is a need for the availability of a minimum level of prior-built up infrastructural facilities to undertake any economic activity including starting an enterprise.

(ii) **Lack of education and knowledge:** Most of the farmers do not have formal education; they have mostly inherited the knowledge of cultivating. They lack in use of technology for selling their produce. They are forced to use the traditional methods of selling their produce through the middlemen and they have to sell it at very low rate.

(iii) **Lack of entrepreneurial skills:** The agripreneur uses innovative ideas to sell its product in the market and to increase its earnings. Normally the farmers do not sell their produce directly in the market. Hence they were not able to develop qualities of agripreneur among them. Lack of knowledge and awareness is one of the reasons for slow growth of agripreneurship in India.

(iv) **Inadequate knowledge about the market:** One of the obstacles in development of agripreneurship among farmers is lack of knowledge about the price offered for their products in the market. Normally farmers end up in selling their produce in the market at lower prices and hence it reduces their earnings.

(v) **Use of poor technology:** The low-level understanding about the use of technology leads to low level of productivity. Awareness about the use of improved farming equipment will help them to increase their output. Till now many are using same traditional methods of cultivating the land, they are not adopting mechanized farming to improve their productivity. The major challenge is to educate most of them for adopting mechanized farming.

(vi) **Dependence on rainfall:** Inadequate irrigation facilities have led the farmers to under utilize the capacity of the land and hence there is decline in the output.

(vii) **Lack of skilled and managerial manpower:** Rural areas also suffer from rural-urban migration mainly male migration. This results in denudation of educated and skilled manpower

in rural areas. Lack of skilled and managerial manpower in rural areas is mainly due to the absence of suitable educational institutions in rural areas. Moreover, people even otherwise belonging to rural areas do not want to go back to rural areas to work due to various problems the rural areas suffer from.

(viii) **Lack of marketing support:** The lack of promotional and marketing support for the goods produced by the farmers is a great concern. Production has no value unless it is sold. The major marketing problems faced by agri-entrepreneurship are lack of marketing channels and networks, promotional facilities, support system, poor quality of products, and competition with medium and large-scale enterprises.

(ix) **Lack of awareness about career in agripreneurship:** Agrientrepreneurial career has not been considered respectable in the society for one reason or other. Especially, agripreneurship as career has not been taken seriously by the people. The awareness regarding the career opportunity in agriculture should be imparted to them so that there would be many aspirants to take the agriculture as a career.

Way ahead

Agripreneurship is considered a powerful force of economic development. Agripreneurs are considered to inspire economic change by offering new products and services and turning new ideas into agriculture business solutions to local and international needs. At the same time, agripreneurship requires an enabling environment to grow and nourish.

A legal and regulatory framework is needed to reward agri entrepreneurial initiatives, ensure fair competition, and protect private property rights. There is a need on the part of governments to focus on building the legal and institutional foundation for supporting the bottom-up efforts of agripreneurs. The private sector can provide invaluable input into designing policies and reforms and their implementation. Through an open, transparent, and democratic dialogue with the government, business organizations in countries worldwide can become representative voices of business and critical partners in reform.

5. कृषि से समृद्धि तक: जम्मू व् कश्मीर के समग्र कृषि विकास कार्यक्रम की भूमिका

सुशील कुमार गुप्ता, एवं भूपेंद्र नाथ त्रिपाठी

जम्मू और कश्मीर के कृषि उत्पादन विभाग की अगुवाई में समग्र कृषि विकास कार्यक्रम (एच.एडी.पी.) क्षेत्र की कृषि अर्थव्यवस्था को बदलने के उद्देश्य से एक महत्वपूर्ण पहल है। कृषि क्षेत्र के हर पहलू को पुनर्जीवित करने के लिए 29 रणनीतिक परियोजनाएं तैयार की गई हैं जिनमें फसल उत्पादन से लेकर बागवानी, पशुधन और संबद्ध उद्योग शामिल हैं। स्थिरता, वाणिज्यिक व्यवहार्यता एवं सामाजिक-आर्थिक विकास पर विचार करते हुए, एच.एडी.पी. की योजना किसानों, कृषि उद्यमों और जम्मू और कश्मीर की समग्र ग्रामीण आबादी के जीवन पर स्थायी प्रभाव डालने के लिए बनाई गई है। यह लेख क्षेत्र के कृषि परिदृश्य पर एच.ए.डी.पी. के मूल विजन, प्रमुख परियोजनाओं, पांच साल के लक्ष्यों और सामाजिक-आर्थिक प्रभावों को रेखांकित करता है।

एच.ए.डी.पी. का दृष्टिकोण तथा मिशन

समग्र कृषि विकास कार्यक्रम का प्राथमिक **दृष्टिकोण** जम्मू व् कश्मीर में एक प्रतिस्पर्धी, टिकाऊ और आर्थिक रूप से जीवंत कृषि अर्थव्यवस्था का निर्माण करना है। कार्यक्रम का मिशन निम्नलिखित पाँच मुख्य उद्देश्यों से प्रेरित है:

1. **उत्पादकता बढ़ाना**:

आधुनिक कृषि प्रौद्योगिकियों और सर्वोत्तम प्रथाओं को अपनाकर फसल और पशुधन प्रणालियों को बढ़ावा देना।

2. **मूल्य संवर्धन और बाजार तक पहुँच**:

किसानों को बाजारों तक पहुँच प्रदान करके सशक्त बनाना, रसद में सुधार करना और मूल्य वर्धित कृषि को सुविधाजनक बनाना।

3. **सतत विकास**:

दीर्घकालिक कृषि स्थिरता के लिए पर्यावरण के प्रति जिम्मेदार प्रथाओं को बढ़ावा देना।

4. **समावेशी विकास**:

ग्रामीण समुदायों पर ध्यान केंद्रित करते हुए रोज़गार के अवसर पैदा करना और उद्यमिता को बढ़ावा देना।

5. **कौशल विकास**:

आधुनिक कृषि तकनीकों को अपनाने की उनकी क्षमता बढ़ाने के लिए कृषि कार्यबल को प्रशिक्षण प्रदान करना।

एच.ए.डी.पी. को जम्मू और कश्मीर की कृषि क्षमता को उजागर करने, इसकी समृद्ध जैव विविधता, अनुकूल जलवायु और पारंपरिक कृषि प्रणालियों का लाभ उठाने और उन्हें आधुनिक तकनीकी हस्तक्षेपों के साथ जोड़ने के लिए डिज़ाइन किया गया है।

एच.ए.डी.पी. परियोजनाओं का अवलोकन

एच.ए.डी.पी. में 29 अनूठी परियोजनाएँ शामिल हैं, जिनमें से प्रत्येक कृषि अर्थव्यवस्था के विभिन्न क्षेत्रों को लक्षित करती है। इन प्रमुख परियोजनाओं का विवरण नीचे दिया गया है:

1. **पी.पी.पी. मोड में बीज और बीज गुणन श्रृंखला का विकास**:

सार्वजनिक और निजी क्षेत्रों के बीच साझेदारी को बढ़ावा देकर बीज की गुणवत्ता में सुधार करना। इससे उच्च गुणवत्ता वाले बीजों की उपलब्धता बढ़ेगी, जिससे फसल उत्पादकता बढ़ेगी।

2. **जम्मू-कश्मीर में विशिष्ट फसलों को बढ़ावा**:

केसर, लैवेंडर और मसालों जैसी उच्च मूल्य वाली फसलों पर ध्यान केंद्रित करते हुए, यह परियोजना खेती के क्षेत्र को बढ़ाएगी और ब्रांडिंग और प्रमाणन के माध्यम से बाजार संबंधों में सुधार करेगी।

3. **खुली और उच्च तकनीक संरक्षित खेती के तहत सब्जियों/विदेशी सब्जियों को बढ़ावा**:

पॉलीहाउस और ड्रिप सिंचाई जैसी उन्नत खेती विधियों के माध्यम से सब्जियों के साल भर उत्पादन को बढ़ावा देता है, जिससे आय और बाजार पहुंच दोनों में वृद्धि होती है।

4. **जम्मू-कश्मीर में कृषि-विपणन प्रणाली को मजबूत करना**:

इसका उद्देश्य किसानों के बाजारों से जुड़ाव में सुधार करके तथा कटाई के बाद होने वाले नुकसान को कम करने के लिए ग्रेडिंग, पैकेजिंग और भंडारण सुविधाओं को उन्नत करके कृषि विपणन के लिए बेहतर बुनियादी ढाँचा विकसित करना है।

5. **औषधीय और सुगंधित पौधों को बढ़ावा देना**:

लैवेंडर और कैमोमाइल जैसी फसलों की माँग का लाभ उठाकर व्यावसायिक रूप से व्यवहार्य क्षेत्र विकसित करना जो मूल्य संवर्धन और निर्यात के लिए मजबूत संभावनाएँ प्रदान करता है।

6. **मधुमक्खी पालन को बढ़ावा देना**:

पूरक आय स्रोत के रूप में मधुमक्खी पालन का समर्थन करना, शहद उत्पादन और मधुमक्खी आधारित उत्पादों जैसे मोम और रॉयल जेली को बढ़ावा देने पर ध्यान केंद्रित करना।

7. **जम्मू-कश्मीर में रेशम उत्पादन के लिए तकनीकी हस्तक्षेप**:

रेशम उत्पादन की क्षेत्र की समृद्ध परंपरा को पुनर्जीवित करने के लिए उन्नत प्रौद्योगिकी और प्रजनन तकनीकों का परिचय देना, रेशम उत्पादन की गुणवत्ता और मात्रा दोनों में सुधार करना।

8. **पोषक अनाज (बाजरा) को बढ़ावा देना**:

अत्यधिक पौष्टिक बाजरा किस्मों की खेती के माध्यम से पोषण सुरक्षा को संबोधित करना, खाद्य विविधता और स्वास्थ्य परिणामों में योगदान देना।

9. **कृषि मशीनीकरण और स्वचालन**:

छोटे और सीमांत किसानों के लिए श्रम निर्भरता को कम करने, दक्षता को बढ़ावा देने और उत्पादकता में सुधार करने के लिए आधुनिक कृषि मशीनरी के उपयोग को प्रोत्साहित करता है।

10. **मशरूम की खेती को बढ़ावा**:

मशरूम की खेती को साल भर आय पैदा करने वाली गतिविधि के रूप में समर्थन देता है, विशेष रूप से महिला किसानों और ग्रामीण युवाओं को लक्षित करता है।

11. **तिलहन को बढ़ावा**:

सरसों और सूरजमुखी जैसे तिलहनों की घरेलू खेती को प्रोत्साहित करके तिलहन आयात पर निर्भरता कम करता है।

12. 300 **किसान उत्पादक संगठनों (एफपीओ) का गठन**:

एफपीओ की स्थापना करके किसानों को सशक्त बनाता है, जो बेहतर सौदेबाजी शक्ति और बाजार पहुंच के लिए कृषि उपज को एकत्र करने में मदद करते हैं।

13. **एकीकृत कृषि प्रणाली (आईएफएस) को अपनाना और बढ़ावा देना**:

विविधतापूर्ण, एकीकृत कृषि प्रणाली शुरू करता है जो लचीलापन और घरेलू आय में सुधार करने के लिए फसलों, पशुधन और संबद्ध गतिविधियों को जोड़ती है।

14. **वाणिज्यिक पुष्प-कृषि को बढ़ावा देना**:

मैरीगोल्ड और गुलाब जैसे उच्च मूल्य वाले फूलों की खेती पर ध्यान केंद्रित करना, स्थानीय और निर्यात दोनों बाजारों के लिए वाणिज्यिक पुष्प-कृषि को बढ़ावा देना।

15. **जम्मू-कश्मीर में वर्षा आधारित क्षेत्रों का विकास**:

वर्षा आधारित कृषि क्षेत्रों में उत्पादकता बढ़ाने के लिए जल प्रबंधन को बढ़ाता है और फसल विविधीकरण को बढ़ावा देता है।

16. **स्थिरता के लिए वैकल्पिक कृषि प्रणाली**:

पर्यावरण संरक्षण सुनिश्चित करते हुए जैविक खेती, कृषि वानिकी और पर्माकल्चर जैसी स्थायी कृषि पद्धतियों को अपनाने की वकालत करता है।

17. **सेंसर-आधारित स्मार्ट कृषि**:

फसल के स्वास्थ्य की निगरानी, इनपुट को अनुकूलित करने और सटीक कृषि के माध्यम से उत्पादकता में सुधार करने के लिए रिमोट सेंसिंग, ड्रोन और IoT उपकरणों जैसी आधुनिक तकनीकों को पेश करता है।

18. **कृषि में कीटनाशकों के उपयोग को कम करना**:

रासायनिक इनपुट को कम करने, स्वस्थ फसलों और सुरक्षित कृषि पद्धतियों को बढ़ावा देने के लिए एकीकृत कीट प्रबंधन (IPM) और जैविक नियंत्रण के उपयोग को बढ़ावा देता है।

19. **जम्मू-कश्मीर मृदा एवं भूमि संसाधन सूचना प्रणाली**:

वास्तविक समय मृदा स्वास्थ्य डेटा प्रदान करने के लिए एक डिजिटल प्लेटफ़ॉर्म विकसित करता है, जिससे किसान फसल चयन और प्रबंधन प्रथाओं पर सूचित निर्णय लेने में सक्षम होते हैं।

20. **कृषि विस्तार में नवीन दृष्टिकोण**:

कृषि ज्ञान और सर्वोत्तम प्रथाओं के प्रसार को बेहतर बनाने के लिए आईसीटी उपकरण, मोबाइल एप्लिकेशन और किसान फील्ड स्कूलों का उपयोग करता है।

21. **उच्च घनत्व (एच.डी.) रोपण और बाग कायाकल्प के लिए डिज़ाइनर पौधों का उत्पादन**:

फलों के उत्पादन और बाग की लाभप्रदता बढ़ाने के लिए आधुनिक, उच्च घनत्व वाले बागों और मौजूदा बागों के कायाकल्प को बढ़ावा देता है।

22. **विशिष्ट उत्पाद क्लस्टरों के लिए यूटी-स्तरीय खाद्य प्रसंस्करण कार्यक्रम**:

सेब, अखरोट और केसर जैसे प्रमुख उत्पादों के लिए खाद्य प्रसंस्करण क्लस्टरों के विकास का समर्थन करता है, मूल्य जोड़ता है और कटाई के बाद होने वाले नुकसान को कम करता है।

23. **जम्मू-कश्मीर में डेयरी विकास**:

दूध उत्पादन और प्रसंस्करण सुविधाओं में सुधार पर ध्यान केंद्रित करता है, जिससे डेयरी क्षेत्र में आय में वृद्धि होती है।

24. **मटन उत्पादन में आत्मनिर्भरता**:

इसका उद्देश्य प्रजनन और विपणन प्रणालियों में सुधार करके स्थानीय मटन उत्पादन को बढ़ाना है, आयात पर निर्भरता कम करना है।.

25. **पोल्ट्री विकास के लिए रोडमैप**:

बेहतर फ़ीड, प्रबंधन और रोग नियंत्रण प्रथाओं के माध्यम से पोल्ट्री उद्योग के विकास को लक्षित करता है, जिससे रोज़गार पैदा होते हैं और खाद्य सुरक्षा में सुधार होता है।

26. **मछली बीज और ट्राउट उत्पादन के लिए तकनीकी हस्तक्षेप**:

आधुनिक प्रजनन तकनीकों को शुरू करके और ठंडे पानी के जलीय कृषि का विस्तार करके मछली बीज और ट्राउट उत्पादन क्षेत्र को मजबूत करता है।

27. **ऊन/छिलका प्रसंस्करण और विपणन को बढ़ावा देना**:

प्रसंस्करण सुविधाओं का समर्थन करके और बाजार पहुंच में सुधार करके ऊन और खाल के उत्पादन को बढ़ाता है, जिससे भेड़ किसानों की आय में वृद्धि होती है।

28. **चारा संसाधनों का विकास**:

पूरे केंद्र शासित प्रदेश में पशुधन उत्पादकता का समर्थन करने के लिए चारे की उपलब्धता और गुणवत्ता में सुधार पर ध्यान केंद्रित करता है।

29. **सतत कृषि परिवर्तन के लिए मानव संसाधन विकास**:

HADP की पहलों की दीर्घकालिक स्थिरता का समर्थन करने के लिए किसानों, शोधकर्ताओं और कृषि श्रमिकों के लिए क्षमता निर्माण और प्रशिक्षण में निवेश करता है.

एच.ए.डी.पी. के पांच वर्षीय लक्ष्य

एच.ए.डी.पी. ने पांच साल की अवधि में हासिल किए जाने वाले महत्वाकांक्षी लक्ष्य निर्धारित किए हैं। इन लक्ष्यों में शामिल हैं:

1. **रोजगार सृजन**:

एच.ए.डी.पी. का लक्ष्य कृषि और संबद्ध क्षेत्रों में प्रत्यक्ष और अप्रत्यक्ष रोजगार प्रदान करते हुए लगभग 288,000 नौकरियों का सृजन करना है, जिससे ग्रामीण गरीबी उन्मूलन और आर्थिक सशक्तीकरण में योगदान मिलेगा।

2. **उद्यम स्थापना**:

उद्यमिता पर ध्यान केंद्रित करते हुए, कार्यक्रम का लक्ष्य खाद्य प्रसंस्करण, डेयरी फार्मिंग, कृषि-पर्यटन और कृषि-तकनीक में स्टार्ट-अप सहित 18,861 उद्यम स्थापित करना है।

3. **आजीविका सुरक्षित करना**:

कार्यक्रम का उद्देश्य 1.3 मिलियन परिवारों के लिए आजीविका सुरक्षित करना, ग्रामीण परिवारों के लिए आय स्थिरता और जीवन की गुणवत्ता में सुधार करना है।

4. **एसजीडीपी में योगदान**:

एच.ए.डी.पी. से जम्मू और कश्मीर के राज्य सकल घरेलू उत्पाद में सालाना 28,142 करोड़ रुपये जुड़ने का अनुमान है, मुख्य रूप से बढ़े हुए कृषि उत्पादन और मूल्य वर्धित गतिविधियों के माध्यम से।

5. **कौशल विकास करना**:

लक्षित प्रशिक्षण और क्षमता निर्माण कार्यक्रमों के माध्यम से, एच.ए.डी.पी. के अंतगर्त 2.5 लाख व्यक्तियों को आधुनिक कृषि कौशल से लैस किया जाएगा।

6. **उच्च विकास दर प्राप्त करना**

कार्यक्रम की पहल का उद्देश्य कृषि विकास में तेजी लाना है, जिससे इस क्षेत्र में कुल 11% वार्षिक विकास दर हासिल की जा सके।

विभिन्न विभागों और संस्थानों का सहयोगात्मक प्रयास

एच.ए.डी.पी. की सफलता कई विभागों और संस्थानों के बीच सहयोग पर निर्भर करती है, जिनमें से प्रत्येक इसके कार्यान्वयन में महत्वपूर्ण भूमिका निभाता है:

1. **कृषि उत्पादन विभाग**:

एच.ए.डी.पी. के तहत सभी परियोजनाओं के समन्वय, तकनीकी मार्गदर्शन और प्रगति निगरानी की देखरेख करता है।

2. **बागवानी विभाग**:

बागवानी क्षेत्र के लिए उच्च घनत्व वाले रोपण और कटाई के बाद के प्रबंधन को बढ़ावा देने के प्रयासों का नेतृत्व करता है।

3. **पशुधन और पशुपालन विभाग**:

पशुधन उत्पादकता और रोग नियंत्रण में सुधार, डेयरी और मटन उत्पादन का समर्थन करने पर ध्यान केंद्रित करता है।

4. **कृषि विश्वविद्यालय**:

जम्मू व् कश्मीर के दो कृषि विश्वविद्यालय शेरे-ए-कश्मीर कृषि विज्ञान एवं प्रौद्योगिकी विश्वविद्यालय जम्मू तथा कश्मीर आधुनिक कृषि पद्धतियों और जलवायु-लचीली फसल किस्मों को बढ़ावा देने के लिए अनुसंधान, नवाचार और प्रशिक्षण प्रदान करते हैं।

5. **वित्तीय संस्थान**:

इनपुट खरीदने और कृषि-उद्यमों को विकसित करने के लिए किसानों और उद्यमियों को ऋण और वित्तीय सहायता प्रदान करते हैं।

6. **निजी क्षेत्र और कृषि-उद्यमी**:

कोल्ड स्टोरेज, खाद्य प्रसंस्करण और लॉजिस्टिक्स में निवेश के माध्यम से किसानों के लिए बुनियादी ढांचे के विकास, प्रौद्योगिकी अपनाने और बाजार पहुंच में योगदान दें।

एच.ए.डी.पी. का सामाजिक तथा आर्थिक प्रभाव

एच.ए.डी.पी. से जम्मू और कश्मीर की कृषि अर्थव्यवस्था पर परिवर्तनकारी प्रभाव पड़ने की उम्मीद है, इनमे से कुछ महत्वपूर्ण परिणाम निम्नलिखित हैं:

1. **कृषि उत्पादकता में वृद्धि**:

आधुनिक तकनीकों और टिकाऊ कृषि पद्धतियों को अपनाकर, एच.ए.डी.पी. उत्पादकता को महत्वपूर्ण रूप से बढ़ाएगा, जिससे निर्वाह और वाणिज्यिक दोनों तरह के किसानों के लिए उच्च पैदावार सुनिश्चित होगी।

2. **आय विविधीकरण**:

विशिष्ट फसलों, मूल्य संवर्धन और मधुमक्खी पालन, फूलों की खेती और खाद्य प्रसंस्करण जैसे संबद्ध क्षेत्रों को बढ़ावा देने के माध्यम से, एच.ए.डी.पी. किसानों को अपनी आय के स्रोतों में विविधता लाने में सक्षम बनाएगा।

3. **बेहतर बाजार संपर्क**:

परिवहन, भंडारण और विपणन के लिए बेहतर बुनियादी ढांचे के साथ, किसानों को घरेलू और अंतर्राष्ट्रीय बाजारों तक अधिक पहुंच प्राप्त होगी, जिससे फसल कटाई के बाद होने वाले नुकसान में कमी आएगी और लाभ अधिकतम होगा।

4. **बढ़ी हुई खाद्य सुरक्षा**:

अनाज, सब्जियों, डेयरी और मटन के स्थानीय उत्पादन में वृद्धि से क्षेत्र की बढ़ती आबादी के लिए खाद्य उपलब्धता और सामर्थ्य में सुधार होगा।

5. **टिकाऊ कृषि पद्धतियाँ**:

जैविक खेती, कृषि वानिकी और जलवायु-स्मार्ट कृषि को बढ़ावा देने वाले लक्षित हस्तक्षेपों के माध्यम से, एच.ए.डी.पी. पर्यावरणीय स्थिरता और जलवायु परिवर्तन के खिलाफ लचीलापन सुनिश्चित करेगा।.

निष्कर्ष

समग्र कृषि विकास कार्यक्रम (HADP) जम्मू व् कश्मीर के कृषि क्षेत्र के भविष्य के लिए एक महत्वाकांक्षी खाका है। किसानों के सामने आने वाली चुनौतियों का समाधान करके, टिकाऊ प्रथाओं को बढ़ावा देकर और बाजार तक पहुँच को सुविधाजनक बनाकर, HADP में इस क्षेत्र को कृषि क्षेत्र में बदलने की क्षमता है। इसकी सफलता किसानों, सरकारी एजेंसियों, निजी खिलाड़ियों और वित्तीय संस्थानों की सक्रिय भागीदारी पर निर्भर करेगी जो इसके दूरगामी लक्ष्यों को प्राप्त करने के लिए एकजुट होकर काम कर रहे हैं।

6. Diversification Through Horticulture: A Boon for Growers

Vikas Tandon

The Union Territory (UT) of Jammu and Kashmir offers distinctive geographic and climate conditions that are conducive for cultivating a wide variety of fruits, vegetables, floriculture ,medicinal and aromatic plants. Horticulture is the main stay of rural economy of UT of J&K. Horticulture is a source of livelihood for about 35 lakh people and about 8 lakh families are directly or indirectly dependent on the horticulture sector. Horticulture is an important contributor to GDP of the UT, with the share of more than 9 %. The horticulture in J&K has shown a tremendous growth since independence, from a production of only 10,000 metric tonnes in 1950 to 26 lakh metric tonnes of production in 2023. An approximate annual turnover of Rs. 15,000 crores exhibits the importance of this sector not only in UT's economy but also in everyone's lives.

The area and production of fruits and vegetables in UT have significantly increased over the past three decades as a result each year new bench marks are being set. This could only be achieved through scientific cultivation of these lucrative crops and pressing Government interventions that have encouraged growers to adopt horticulture based farming. The UT has been recognised as an export zone for apple and walnut crops and holds the monopoly for being the highest producer of apple, cherry, walnut and almond. In addition, the UT produces high quality honey, kalazeera and saffron, anardaana, pecanut, seasonal vegetable, disease free potato seed etc.

There is enormous scope to grow numerous crops including fruits, vegetables, floriculture and medicinal/aromatic plants in the UT.The current area and production of Major horticulture crops is as under:

Table: 1 Area, production and productivity of different fruits in Jammu and Kashmir.

	2019-20	**2020-21**	**2021-22**	**2022-23**	**2023-24**
Area (in 000 Hec.)	331.149	334.833	337.567	343.748	331.289
Production (in 000 MT)	2549.377	2227.288	2418.770	2721.608	2631.687
Productivity	7.69	6.65	7.16	7.91	7.64

Source: Horticulture Area Production Information System (HAPIS), 2023-24

J&K has limited presence in international markets for horticultural crops. This is due to several challenges: the continuous use of old and traditional orchards with a few varieties that have limited market demand and consumer acceptability; inadequate production of quality planting material, leading to reliance on imports; non-descriptive varieties in crops like walnut and stone fruits, resulting in non-uniformity and high heterogeneity of produce; poor post-harvest handling causing significant losses; lack of marketing strategies such as packaging, branding, labelling, and storage; limited use of modern technology due to high costs; lack of sale and export promotion activities; and insufficient area under cultivation with unclassified regions based on crop suitability.

In the union territory of Jammu and Kashmir during 2022-23, the production of fruit crops was 27.22 lakh MT, from an area of 3.44 lakh hectare and productivity of 7.92 MT/ha. In Jammu Division, 2.67 lakh MT of fruits are produced from an area of 1.28 lakh ha with a meagre productivity of 2.09 MT/ha whereas in Kashmir Division, total fruit production stands at 245.54 lakh MT from an area of 21.56 lakh ha showing productivity of 11.38MT/ha. During 2022-23, 2.29 lakh MT of fruits and 4.38 lakh MT of vegetables were imported and 19.05 lakh MT of fruits were exported. In terms of money value, Jammu division exports fruits worth Rs 240.55 crores whereas Kashmir Division exports 2373.60 crores. However, horticulture in past has been Kashmir Centric as Apple dominates with more than 80 percent of total horticultural produce and which is almost produced in the Valley. Jammu region which is by and large rainfed and has less productive lands, limited climatic options grows only limited horticultural produce. However, with new interventions horticulture in mid and low hills of J&K is bound to make progress in near future.

The favourable agro-climatic conditions in Jammu region enhance the horticulture potential, thereby making it a substantial contributor in the horticulture produce of UT of Jammu and Kashmir. The major fruits grown in the Jammu region are Mango, Citrus, guava, Litchi, aonla, Ber, etc. in lower belts and apple, walnut, pear, apricot, peach, plum etc. in the mid to high hills of Jammu region. However, there is tremendous scope for fruits like strawberry, Dragon fruit, Kiwifruit, prunes, peaches, pecanut, hazelnut and blueberry in the region and the area offers great scope for high density apple orcharding in higher belts with the provision of suitable irrigation facilities. The major vegetables grown in the region are onion, potato, tomato, turnip, peas, radish, carrot, green vegetables and spices like chillies, garlic, turmeric etc. Similarly Jammu region is also good to growing floriculture crops. It offers great scope for cultivation of marigold, Gladiolus, chrysanthemums, tulips, rose, besides numerous annuals with good opportunity of off season cultivation. The Horticulture is a key area where emphasis on number of schemes and programmes has led to income and employment generation for the growers and manpower engaged in the sector. Protected cultivation has added a new horizon to Hi-tech horticulture. Best quality Vegetables, Flowers and other high value crops can be cultivated in these protected structures. The farmers need extensive training to harness potential yields of quality fruits, vegetables and flowers.

Indian Himalayan region is known to be a rich repository of medicinal and aromatic plants (MAPs). Due to great altitudinal variation, diverse geological formations and different climatic zones *viz*. subtropical, tropical, temperate, alpine and cold desert, J&K UT have immense wealth of flora (4,439 species (1,220 genera and 189 families of Angiosperms) with about 1123 plant species of medicinal and aromatic value. MAPs growing in J&K have a huge demand in national and international markets, and are source of food, nutrition, medicine, income, and employment generation for more than 50% local population. Jammu division has shown great promise in cultivation of medicinal and aromatic plants such as Lavender (*Lavendulaaugustifolia*), Rosemary (*Rosmarinusofficinalis*), Mushkbala(*Valerianajatamansi*), Pushkermool(*Inularecemosa),* Kuth *(Saussureacostus*), Kutki(*Picrorhizakurrooa*), Wild marigold (*Tagetesminuta*), Harar(*Terminaliachebula*), Lemon grass (*Cymbopogonflexuosus).*

Lavender

Acormuscocasus

To promote horticulture in Jammu, a comprehensive roadmap for horticulture development in the region has to be framed. The roadmap must include the interventions needed to enhance the production and processing potential of niche crops; increase the production and processing of underutilized unique crops of the neglected region on commercial level; reduce post-harvest losses through enhancement of post-harvest handling infrastructure and processing capacity besides facilitating market linkages for horticulture-based crops and products to strengthen the horticultural sector of Jammu which can help to boost the economy of Jammu farmers. SKUAST-Jammu is working hard to promote these commercially important crops among the growers. Government of UT of J&K is running a popular initiative on Holistic Agriculture Development Project (HADP) is promoting entrepreneurship among educated youth and progressive growers. All these initiatives are bound to change the horticulture scenario of the UT.

7. Precision Livestock and Fish Farming: A Pathway to Prosperity

Vijay Kumar Sharma, Amrish Vaid, Hema Tripathi, Pawan Kumar Sharma

The human population is expected to rise by around 9.7 billion over the next 30 years which will result in a sharp rise in the demand for animal products. The biggest challenges for our society will be minimizing environmental impacts, ensuring human health, and ensuring feed the growing population. Global meat production is expected to double by 2050. A combination of higher productivity and a rise in animal population could lead to this production boost, which will be significant in the livestock and fish farming. Intensification involves social considerations that impact customers' perceptions of food security, safety, and sustainability, as well as aspects related to animal welfare and human and animal health. Animal herd sizes have increased in response to the demand for more and better-quality animal products, particularly in developed nations, while at the same time farmer populations have decreased and cropping has limited the amount of farmland available. Farmers are therefore less able to evaluate the demands of each individual animal, and the availability of feed for grazing animals is decreasing. By enhancing waste management, streamlining production procedures, raising feed quality, and advancing animal welfare, livestock farms might cut their greenhouse gas emissions by 14-17%, and there is a need for further improvement in terms of efficiency and sustainability. An important support in achieving all these goals is represented by precision livestock farming (PLF). Precision livestock farming approaches offer a unique chance to transition herd management from manual to automated or semi-automated systems, and they have demonstrated considerable potential for tackling such issues. They may help to improve the state of health and welfare, reduce labor and veterinary expenses on farms, enhance agricultural waste management, and promote both financial and environmental sustainability.

Agriculture is rapidly evolving, with technology playing an essential role in the transformation of traditional farming practices. In recent years, precision farming, particularly in the fields of livestock and fish farming, has gained significant traction. Precision livestock farming (PLF) and precision fish farming (PFF) are innovative approaches that use digital technologies and data analytics to monitor, manage, and enhance animal husbandry. By optimizing resources, improving animal welfare, and boosting productivity, these precision methods contribute to food security, economic growth, and sustainable agriculture. Here we explores the potential of precision livestock and fish farming, the key technologies driving these practices, and the benefits they offer for both farmers and the environment.

What is Precision Livestock and Fish Farming?

Precision farming refers to the application of modern information and communication technologies in agriculture to enhance productivity, efficiency, and sustainability. In livestock and fish farming, precision techniques involve the use of sensors, cameras, and other digital tools to collect real-time data on the health, behavior, and environmental conditions of animals. This data is then analyzed to make informed decisions about feeding, breeding, and overall farm management.

Precision livestock farming (PLF) focuses on cattle, poultry, and other terrestrial animals, while precision fish farming (PFF) applies these principles to aquaculture species like fish and shrimp. Both systems aim to optimize animal care by minimizing waste, reducing costs, and

promoting sustainable practices. The underlying goal is to achieve more output with less input, supporting both farmers' incomes and environmental conservation.

Technologies behind Precision Livestock and Fish Farming

Several cutting-edge technologies drive precision livestock and fish farming, enabling farmers to collect and analyze data for informed decision-making:

1. **Sensors and IoT (Internet of Things) Devices**:

Sensors are integral to precision farming as they monitor various parameters such as temperature, humidity, water quality, and animal health indicators. For instance, wearable sensors on livestock can track heart rates, body temperatures, and movement, helping detect illnesses early. In fish farming, IoT devices are used to monitor water parameters like oxygen levels, pH, and turbidity, ensuring an optimal environment for aquatic life.

2. Machine Learning and Artificial Intelligence (AI):

AI algorithms analyze vast amounts of data to provide actionable insights. For instance, in livestock farming, AI can predict the best time for insemination or detect signs of illness in animals. In fish farming, AI can help detect abnormal swimming patterns or changes in fish feeding behavior, which may indicate health issues or stress.

3.Drones and Remote Sensing:

Drones equipped with cameras and sensors can survey large livestock areas, identifying sick animals, mapping pasture conditions, or assessing feed availability. In aquaculture, drones can monitor water quality over large fish farms, identify algal blooms, and even track fish distribution in open ponds.

4. **Automated Feeding Systems**:

Automated feeders dispense the exact amount of feed based on animal needs, minimizing waste and ensuring optimal growth. This technology is widely used in both livestock and fish farming, where overfeeding can lead to environmental pollution and increased costs.

5. Blockchain Technology:

Blockchain creates transparency in the supply chain, tracking each step from farm to consumer. For example, blockchain can help verify if a fish is sustainably farmed or if meat is antibiotic-free. This transparency builds trust and potentially increases market value for farmers.

6.Underwater Cameras and Sensors:

Cameras and sensors monitor water quality (e.g., oxygen levels, temperature, and pH), fish behavior, and growth. Monitoring water conditions in real-time is crucial for maintaining a healthy environment and preventing disease outbreaks.

7.Automated Feeders:

Smart feeders in fish farms adjust feeding based on fish size, health, and water conditions. This precision minimizes feed waste and optimizes growth rates.

8.Remote Operated Vehicles (ROVs) and Drones:

ROVs and underwater drones are used to inspect underwater structures, monitor fish health, and assess water quality without disturbing the environment.

9.Biometric Data Collection:

Wearable sensors are also being explored in aquaculture to collect biometric data, helping farmers track fish health, stress levels, and growth patterns.

10.Data Analytics and AI:
Machine learning algorithms analyze data on water conditions, feeding patterns, and fish health to predict optimal growth conditions and identify potential health risks.

Benefits of Precision Livestock and Fish Farming

1. **Enhanced Animal Health and Welfare**:
   Precision farming promotes animal welfare by continuously monitoring animals' health and behavior. Early detection of illnesses or stress enables timely intervention, reducing mortality rates and improving productivity. Better animal welfare practices also resonate with consumers, who increasingly prioritize ethically sourced and sustainably produced food.
2. **Increased Productivity and Efficiency**:
   By tailoring feed and care to individual animals or groups, precision farming maximizes growth rates and productivity. For example, automated feeding systems ensure that animals receive the precise amount of nutrients, leading to faster growth and better-quality produce. Similarly, in fish farming, maintaining optimal water conditions and feeding patterns leads to healthier fish, resulting in higher yields.
3. **Cost Reduction**:
   Precision technologies help farmers reduce costs by optimizing resource use. For instance, by monitoring water quality and feed efficiency in fish farms, farmers can minimize feed wastage and reduce water consumption. In livestock farming, wearable sensors and health monitoring reduce veterinary costs, as illnesses can be detected early before they require extensive treatment.
4. **Environmental Sustainability**:
   Precision farming minimizes waste and reduces the environmental footprint of agriculture. By using resources more efficiently, such as feed, water, and energy, farmers can lower greenhouse gas emissions and reduce pollution. In aquaculture, monitoring water quality and managing waste can prevent water contamination, benefiting the surrounding ecosystem.
5. **Data-Driven Decision Making**:
   Precision farming empowers farmers to make data-driven decisions, leading to more consistent and predictable outcomes. Historical data on animal health, feeding, and environmental conditions can be used to improve farm management strategies over time.
6. **Economic Gains**:
   Improved productivity, better animal health, and reduced resource costs translate into higher profits for farmers.

Challenges Facing Precision Livestock and Fish Farming

While precision livestock and fish farming offer substantial benefits, there are also challenges to consider:

1. **High Initial Investment**: The adoption of precision technologies requires significant upfront costs, which can be prohibitive for small-scale farmers. The cost of sensors,

drones, automated feeders, and AI software may limit accessibility in developing regions.

2. **Data Management and Analysis**: Precision farming generates vast amounts of data, necessitating efficient data management and analysis. Small farms may lack the technical expertise to interpret data, while large farms may struggle with data overload.
3. **Infrastructure and Connectivity**: Precision farming relies on stable internet connectivity to transmit data from sensors to management systems. In rural areas with limited internet access, implementing IoT and cloud-based solutions becomes challenging.
4. **Privacy and Data Security**: With the increasing use of data in agriculture, privacy concerns are growing. Farmers must ensure that sensitive farm data is protected from unauthorized access or misuse.
5. **Resistance to Technological Change**: Some farmers may be resistant to adopting new technologies due to a lack of familiarity or concerns over job displacement. Educating farmers on the benefits of precision farming and providing technical support can help overcome these barriers.

Successful interventions in precision farming

1. **Dairy Farming in the Netherlands**: The Netherlands, a leader in precision dairy farming, uses wearable sensors and automated milking systems to optimize milk production. Sensors track each cow's health, behavior, and milk output, allowing farmers to detect illnesses early and improve productivity.
2. **Norwegian Salmon Farming**: In Norway, a country known for its advanced aquaculture industry, precision fish farming has transformed salmon production. Using sensors and AI, Norwegian salmon farms monitor water quality, fish behavior, and feeding patterns, resulting in healthier fish and lower mortality rates.
3. **Smart Poultry Farming in the United States**: In the United States, some poultry farms use automated feeders, environmental sensors, and AI-powered cameras to monitor the health and growth of chickens. These technologies reduce feed costs, improve animal welfare, and increase production efficiency.

Future Prospects of Precision Livestock and Fish Farming

The future of precision livestock and fish farming looks promising, with ongoing advancements in AI, IoT, and data analytics expected to further enhance productivity and sustainability. As these technologies become more affordable, small and medium-sized farms will also have the opportunity to adopt precision farming practices. Furthermore, the increasing global demand for protein-rich foods, coupled with environmental concerns, will drive the adoption of precision farming in both developed and developing countries.

Governments and international organizations can support this transition by providing funding, training, and infrastructure to make precision technologies accessible to all farmers. As the agricultural industry embraces digital transformation, precision livestock and fish farming

could play a pivotal role in ensuring food security, economic growth, and environmental sustainability.

Conclusion

Precision livestock and fish farming represent a significant shift towards smarter, more efficient, and sustainable agriculture. By leveraging modern technologies, farmers can optimize resource use, enhance animal welfare, and increase productivity while reducing environmental impact. Although challenges remain, such as high initial costs and the need for technical expertise, the potential benefits make precision farming a valuable investment. As more farmers adopt these practices, precision livestock and fish farming will pave the way towards a more prosperous and sustainable agricultural future, meeting the demands of a growing global population and contributing to economic development and food security worldwide.

8. Dairy Farming: Source of Livelihood and Sustainability

J.S. Soodan and Mandeep Singh Azad

Introduction:

Dairy farming in the Indian subcontinent has historical roots that go back 8,000 years to the domestication of zebu cattle, which is thought to have originated in India.This is one of the most significant agricultural sectors, playing a pivotal role in the economy of the country. It not only provides nutritious food to millions but also serves as a cornerstone for rural livelihoods. Dairy farming contributes substantially to agricultural GDP and is crucial for the economic well-being of smallholder farmers. This sector is more equitable as 85 % of dairy farmers who are small and marginal own 75 % of milk animals and 47 % of farm land holdings. It also provides gainful employment to the women as 35 % of 2 crore farmers associated with cooperatives are women.Dairying in the recent decades has been considered a vital component in the diversification of Indian agriculture.Where crop farming is beset with stagnating growth and low absorption of unskilled agricultural laborers and income from crop production is seasonal, dairying provides a stable, year-round income, which is an important economic incentive for the small farmer to take to dairying.

The livestock sector in India is characterised by large numbers but little productivity across species. Our milk production is distinctly unique and quite different from rest of the major dairy producing nationswith each farmer managing just about 2-3 animals. It is a low input and low output system where crop residues are fed to the animals - a model that is economically sustainable and more revenue generating to the farmers.

India was milk deficient during early 20thcentury.In 1919, a dairy animal census was conducted for the first time by British colonial officials. In the 1920s, modern milk processing and marketing technologies were introduced in India. The National Dairy Development Board (NDDB) was founded in 1965. It launched Operation Flood in 1969–70, a programme aimed at modernising and developing the dairy sector using co-operatives.In the mid- to late 20th century, Operation Flood transformed the Indian dairy industry into the world's largest milk producer leading to white revolution.. Operation Flood proceeded in three phases.

Phase I (1970–1980) focussed on developing dairy production in areas surrounding New Delhi, Mumbai, Kolkata, and Chennai.

Phase II (1981-1985), a larger phase of the project, expanded investment to 147 urban centres across the country.

Phase III, (1985-1996) expanded investment still further, to a number of smaller towns. In addition to investments by the government of India, several phases of Operation Flood were funded in part by the World Bank and European Economic Community.

During this period, dairy co-operatives emerged as a dominant force.Co-operatives were based on the "Anand model" – a three-tier organisational structure comprising (i) village-level co-operative societies (the primary producers), (ii) district-level co-operative producers' unions which collected the milk and operated processing plants, and (iii) state-level federations for marketing.

Contribution of Dairy sector

India has come a long way from being a milk deficit nation in the pre independence era, to being the largest milk producer in the world today. We have 50 cattle and 19 buffalo breeds, selected over period of 100 years. We have world's largest dairy herd with over 300 million bovines as per the 2019 livestock census, including 192.49 million cattle and 109.85 million buffaloes and presently producing over 232 million tonnes of milk. Dairy sector never attained negative growth in any of the year during the span of 4.5 decades. Dairy sector has provided constant and sustainable growth despite limited investment from public and private sectors.

We are the largest producer of milk in the world contributing 24.64% of global milk production. The milk production of India has registered 58% increase during the last nine years. Milk is the single largest agricultural commodity contributing 5 per cent of the national economy and employing more than 8crore farmers directly. The value of milk is more than the total value of all grains and pulses put together.

The size of dairy industry in India reached INR 16,792.1 billion in 2023 and is expected the market to reach INR 49,953.5 Billion by 2032, exhibiting a growth rate (CAGR) of 13% during 2024-2032. *The industry is experiencing robust growth, propelled by technological innovation, enhanced retail and e-commerce platforms, and improved cold chain infrastructure, meeting rising consumer demand with a diversified and quality-focused product range.*

One of the primary factors propelling the growth in Indian dairy industry is the increasing consumption due to population growth and rising income levels. The other reason is growing health consciousness among consumers. Dairy companies are capitalizing on this trend by launching a range of health-centric products, effectively tapping into consumers' desire for wellness through diet. The third was operational flexibility in business models and supply chain simplification during challenging times in Pandemic. This resilience and adaptability have been crucial in maintaining the industry's integrity and growth.

In Jammu and Kashmir, livestock sector contributes 5.62% to the GDP and 31% to the GDP contribution of Agriculture and allied sectors including forestry. The major contribution of livestock sector is from dairy industry and around 25.94 Lakh MT milk is produced in J&K annually which amounts to a turnover of Rs. 9080 Cr. The annual milk production accounts for 1.23% of total milk produced in country. The average lactation yield per animal in J&K is 2380 Litres against the country avg. of 2199 Litres.

Challenges and opportunities in dairy Farming

The main challenges faced by this sector in J& K UT are poor AI coverage especially in Jammu Division (17.04%) against Srinagar Division (61.71 %) with Overall of 33.09% . There is 41% deficiency in fodder on dry matter basis Only 5% of net sown area under fodder cultivation. The UT is considerably lacking behind in dairy processing sector wherein only 2.8% of the total milk produced is marketed through organized processing sector against the country Avg. of 34%. The Holistic Agriculture Development programme initiated by Govt. Of J &K has kept all these points in consideration for planning Dairy Development Programme in J &K UT.

The other challenges being faced by country and UT are high non-descript population with low productivity, shortage of feed and fodder, Poor health status which include some of economically important disease like Mastitis, FMD, Brucellosis and reproductive disorders ad

infertility. Shortage of diagnostics, antimicrobial residues, pesticides and aflatoxins are other issues need to be addressed.

Rural areas where significant livestock occurs lacks basic infrastructure such as clinics, laboratories, diagnostic facilities hindering timely disease detection and treatment. cutting edge technology like precision medicine, genomics and digital health are revolutionizing veterinary science globally but their adoption in India is limited due to affordability and accessibility issues. strengthening veterinary infrastructure in rural areas coupled with public -private partnership can enhance delivery and disease surveillance.

Livestock sector has got poor research funding and the portfolio of agriculture research funding remained highly biased towards crops (crops 82.9%, livestock: 10.20%, fisheries 3% and natural resources 4%)). It has been observed that every rupee spent on research in animal science pay back Rs. 20.81 compared to Rs. 11.69 on crop research. Thus there is need for funding and incentivizing of research projects focused on addressing local challenges with respect to livestock and dairy sector.

Besides this, climate change and rising costs of milk production have thrown india's dairy industry into deep crises. Fodder deficit varies from 11.24 to 32 % for green fodder and 23% for dry fodder. There is urgent need for increasing land for fodder cultivation and adopting sustainable agriculture practices like hydroponics. policy should be to bring more areas under perennial crops with high biomass for meeting livestock fodder needs.

Technology intervention in promoting growth and development in dairy sector include automation in milk collection, creating cold chains at village levels,refrigerated transport, ensuring food safety and addressing supply chain challenges.

Our share in global dairy export is just 0.25% and looking ahead global dairy landscape is projected to grow by 30% by 2030 and 45 % by 2047. However India's domestic demand is unlikely to absorb this increase and w are expecting surplus of 100 MMT in next 25 years, so we have to explore possibilities for export and develop infrastructure which has high standards that of internationally recognized institutions.

Sustainability in Dairy Farming

Sustainably managed dairy farming contributes to economic stability, environmental conservation, and social well-being. The cyclical nature of income from dairy farming helps reduce poverty and ensures better health and education for rural families. Environmental initiatives, such as efficient resource use, ensure the long-term viability of dairy farming.

Sustainable dairy farming practices not only reduce environmental impacts but also improve community welfare. Practices like balanced ration feeding increase milk yield and reduce costs, directly benefiting farmers.

Sustainable dairy practices such as organic farming, efficient water recycling, renewable energy use, and manure management reduce the environmental footprint. Livestock farming contributes 14.5% to global anthropogenic greenhouse gas emissions. Methane emissions from cattle and the significant use of fresh water are major issues.Technologies like precision feeding, manure management through biogas plants, and the use of solar energy for milk chilling have shown promising results. Additionally, NDDB's efforts in forming organic manure cooperatives and biogas initiatives reduce emissions and enhance sustainability. NDDB's initiatives in water use reduction and balanced ration feeding have decreased methane emissions and improved productivity. Furthermore, integrating crop residues into feed lowers

water consumption and supports a circular economy. Technological advancements, such as automated milk collection systems, refrigerated transportation, and eco-friendly processing methods, are revolutionizing the dairy sector. Digital health and genomics, though underutilized, hold immense potential to improve animal health and productivity sustainably.

Government Policies and Support Programs

The National Dairy Plan (NDP), launched in 2012, is a landmark initiative designed to strengthen India's dairy sector. With a vision to double the country's milk production over a 15-year period, the plan focuses on improving productivity while uplifting the livelihoods of small and marginal dairy farmers. The NDP's goal is to enhance milk production and market access, making it a crucial part of India's agricultural development.

The Rashtriya Gokul Mission, introduced in 2014, is a key program aimed at the conservation and promotion of indigenous cattle breeds. The mission seeks to improve the genetic quality of livestock, ensuring better milk yield and sustainability, while preserving India's rich biodiversity of native cattle.

In 2016, the Government of India launched the National Mission on Bovine Productivity (NMBP) as part of the Rashtriya Gokul Mission. This initiative aims to improve the productivity of dairy animals by focusing on animal nutrition, healthcare, and breeding services. The mission's goal is to ensure long-term improvements in the productivity and health of dairy livestock.

The Dairy Entrepreneurship Development Scheme (DEDS), launched in 2017, plays a vital role in modernizing dairy infrastructure across the country. It provides financial assistance in the form of low-cost loans and grants to dairy cooperatives and private dairy processing units. The scheme aims to enhance milk processing capacity and infrastructure, thus supporting the growth of the dairy sector.

In 2019, the Hon'ble Prime Minister launched the National Animal Disease Control Programme (NADCP) with the goal of controlling Foot and Mouth Disease (FMD) and Brucellosis in livestock. The program has a total outlay of Rs. 13,343 crore for five years (2019-2024), aiming to vaccinate 100% of cattle, buffalo, sheep, goat, and pig populations for FMD, as well as 100% of bovine female calves (aged 4-8 months) for Brucellosis. This initiative is essential for maintaining livestock health and ensuring consistent dairy production.

The Kisan Credit Card (KCC) scheme, introduced in 1998, provides farmers with easy access to credit for agricultural activities. Initially designed to support crop cultivation, the scheme was expanded in 2004 to include allied activities like dairy farming. In the 2018-19 budget, the government extended KCC to fisheries and animal husbandry farmers, offering them the financial support needed for working capital and operational costs.

The Integrated Dairy Development Scheme (IDDS) was introduced by the Animal Husbandry Department of Jammu and Kashmir in the 2020-21 fiscal year. The scheme provides financial incentives and subsidies for several dairy-related activities, including:

- Establishing dairy units with 5 to 10 cows/buffaloes per unit.
- Setting up milk collection, chilling, and processing units.
- Developing market infrastructure, such as milk ATMs.
- Creating a milk transportation system.
- Implementing environmental management practices on dairy farms.

These government initiatives demonstrate a comprehensive approach to enhancing the sustainability, productivity, and economic viability of the dairy sector in India. They aim to modernize infrastructure, improve livestock health, and provide financial support to farmers, ultimately driving the growth and development of the dairy industry.

Holistic Agricultural Development plan by J&K UT covers these initiatives besides upgrading local germplasm through sexed semen, feed and fodder production and upgrading infrastructure for Collection, preservation, processing and marking of milk products.

Conclusion

From being a milk-deficit nation to the world's largest producer, India's dairy sector has achieved remarkable growth, contributing 33% to the national agricultural GDP. It sustains over 8 crore farmers and generates more value than all grains and pulses combined. With a growth rate of over 6% annually, the sector remains resilient, even during economic crises. Strengthening research, adopting sustainable practices, and leveraging technology will be key to ensuring continued growth and global competitiveness.

Dairy farming is not just a source of livelihood; it is a vital component of India's strategy to alleviate poverty, improve nutrition, empower women, and address climate challenges. A sustainable and resilient dairy sector will be essential for the nation's future, contributing significantly to global food security and economic stability.

9. Status of Wool Sector in India

Pranav Kumar, Hema Tripathi ,and Anna Singh

India's textile sector is one of the nation's most ancient industries, with roots extending back centuries. This sector is remarkably diverse, encompassing everything from hand-spun and hand-woven textiles to technologically advanced, capital-intensive mills. A core strength of India's textile industry lies in its extensive production base, encompassing a variety of fibers and yarns. These include natural fibers such as cotton, jute, silk, and wool, as well as synthetic fibers like polyester, viscose, nylon, and acrylic. The sector accounts for approximately 14% of industrial production, 4% of the GDP, and 17% of the nation’s export earnings. It directly employs over 35 million individuals, making the textile industry the second-largest employer after agriculture (Anandhakumar, 2022). The Indian textile and apparel market is projected to be valued at approximately USD 165 billion for the year 2022-23. Of this total, the domestic market is responsible for around 76%, while exports constitute the remaining 24%. Within the domestic segment, apparel is the dominant category, making up roughly 74% of the market, followed by technical textiles, which account for 20% (Annual Report of Indian Textile and Apparel Industry, 2023).

The industry’s unique characteristics stem from its close connection to agriculture, which supplies raw materials such as cotton, and from India's rich cultural heritage in textiles. This relationship between the textile industry and the agricultural sector, along with the country’s longstanding traditions, sets it apart from other industries. India’s textile industry is capable of producing a wide range of products that cater to various market segments both domestically and internationally. Wool, specifically, is among the oldest textile industries in India, with evidence suggesting that Aryans living in the Indus Valley as far back as 5000 B.C. were familiar with its use. Historically, wool textile was quite popular as a cottage industry in India (Ministry of Textiles, 2020-21).

Wool, as a fiber, holds a modest position among various natural fibers, partly due to its seasonal applications. Nevertheless, it remains a vital material for winter clothing, suiting, floor coverings, and specific industrial uses. It stands out as the sole natural fiber derived from various animals, predominantly sourced from rural areas, thus contributing significantly to rural employment. While the woolen textiles and clothing sector is relatively smaller compared to cotton and synthetic fiber industries, it plays a crucial role in bridging the rural economy with manufacturing, represented by a mix of small, medium, and large-scale enterprises. The industry's value in India was Rs. 12444.45 Crores in 2020-21, with a division between organized and decentralized sectors (Ministry of Textiles, 2020-21).

According to Ministry of Textiles Report (2020-21), the organized sector accounts for about 20-25% and unorganized sector makes up about 75-80% of the wool industry. The organized sector includes composite mills, spinning units (both worsted and non-worsted), knitwear and woven garments units, and machine-made carpet manufacturers. Meanwhile, the decentralized sector encompasses hosiery and knitting, power looms, hand-knotted carpets, and independent dyeing and processing units, among others. The wool sector is export-driven, sending handmade carpets, woolen yarn, fabrics, and ready-made garments to international markets.

The woolen industry has significant potential for employment generation, providing jobs to approximately 12 lakh individuals in the organized sector and an additional 20 lakh in sheep rearing and farming. Additionally, there are 3 lakh weavers in the carpet sector (IBEF, 2024). Most woolen mills are located in Uttar Pradesh, Punjab, Rajasthan, Himachal Pradesh, Jammu & Kashmir, and Uttarakhand. Wool production has remained relatively stable in recent years but falls short of meeting the industry's raw material demands. India relies heavily on imports for fine-quality wool required by organized mills and the decentralized hosiery sector.

Sheep Population Dynamics in India

India ranks as the second-largest country in sheep population, with 74.26 million sheep, 6th amongst clean wool producer countries and 9th amongst greasy wool producers. Table 1.2 reveals that Telangana emerged as the state with the largest sheep population, growing from 12.8 million in 2012 to 19.1 million in 2019, marking a substantial increase of 48.51%. Andhra Pradesh, with a population of 17.6 million sheep, follows closely behind, having experienced a growth of 30.00%. Karnataka saw a moderate increase in its sheep population, rising from 9.6 million to 11.1 million (20th Livestock census, 2019).

Conversely, some states witnessed a decline in their sheep populations. Rajasthan, for instance, saw a decrease of 12.95% in sheep population. Similarly, Tamil Nadu and Jammu & Kashmir experienced declines of 5.98% and 4.19%, respectively. Notably, Uttar Pradesh recorded the highest percentage decrease, with its sheep population falling by 27.25% from 1.4 million to 1.0 million. Other states like Maharashtra and Gujarat saw modest increases, with Maharashtra's population rising by 3.87% to 2.7 million and Gujarat's by 4.66% to 1.8 million. Odisha's sheep population, however, declined by 19.10%, reducing from 1.6 million to 1.3 million (20th Livestock census, 2019).

Wool Production scenario in India

The total wool production in the country was estimated as **33.61 million kg** during 2022-23. It registered a negative growth of **16.84%** over the past 5 years as compared to the estimates of 40.42 million kg during 2018-19. However, the production has increased by **2.12%** in 2022-23 over 2021-22. In past the growth rates were -2.51% in 2018-19; -9.05% in 2019-20, - 0.46% in 2020-21and-10.87% in 2021-22 (PIB, 2023). The decline in wool production from 2018-19 to 2021-22, which saw a drop from 40.42 million kg to 33.61 million kg, can be attributed to several factors. Climate change has significantly impacted wool yields, with erratic weather patterns affecting sheep health and wool quality. Disease outbreaks, such as those affecting sheep, have further contributed to decreased production. Economic factors, including market volatility and lower wool prices offered to the producer, may have disincentivized wool production due to market being flooded by affordable synthetic fibers. However, the slight increase of 2.12% in wool production during 2022-23 can be linked to improved animal health and advancements in wool harvesting technology. Enhanced government support and favorable market conditions also contributed to this uptick.

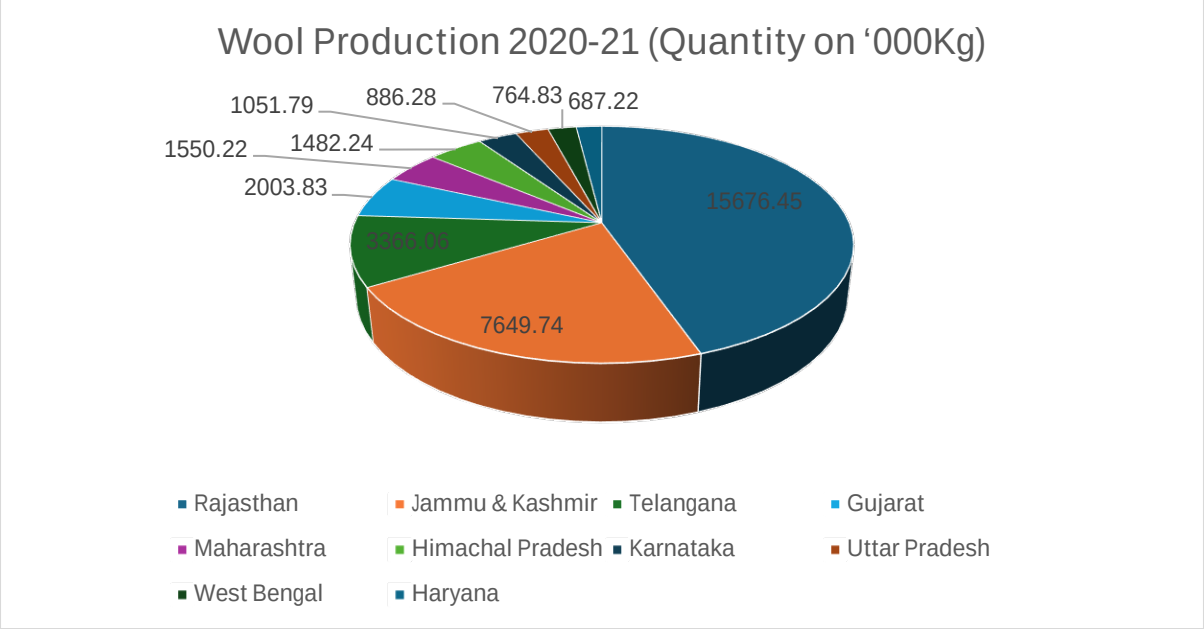


Figure 1: Major Wool Producing States
(Source: Ministry of Fisheries, Animal Husbandry & Dairying)

Why Does India Import Wool?

Indian wool is primarily coarse and suitable for making carpets and rough textiles. However, there is a demand for finer and softer wool, such as Merino wool, which is not produced locally in large quantities. Importing high-quality wool helps in meeting the requirements of the textile and apparel industry for producing fine fabrics (Siddiqui *et al*., 2021).

The domestic production of wool is insufficient to meet the growing demand. The textile industry in India has expanded significantly, leading to a higher requirement for raw wool. Imports bridge the gap between demand and supply, ensuring a steady flow of raw materials for the industry (Verma *et al*., 2019).

Certain types of wool, such as superfine Merino wool and specialty fibers like cashmere and mohair, are required for specific high-end products. These fibers are either not produced in India or are available in limited quantities, necessitating imports to cater to niche markets (Gupta *et al*., 2018).

The import of wool into India is governed by various policies and regulations to ensure quality and compliance with international standards. The Directorate General of Foreign Trade (DGFT) oversees the import regulations, including tariffs, import duties, and quality checks. The government also provides guidelines to ensure that imported wool meets the necessary health and safety standards (Kumar *et al*., 2020).

The import of wool has a significant economic impact on the Indian textile industry. It enables the production of high-value woolen products, contributing to exports and domestic sales. However, the dependency on imports also makes the industry vulnerable to global price fluctuations and supply chain disruptions. Efforts to balance imports with enhanced domestic production are ongoing to reduce this dependency (Kadam *et al*., 2021)

The future of wool imports in India is likely to be influenced by global market trends, domestic production improvements, and policy changes. Enhancing the quality and quantity of domestic wool production can reduce reliance on imports. Additionally, innovations in wool processing

and value addition can improve the competitiveness of Indian wool in the global market (Patel *et al*., 2019).

Major constraints faced by wool sector in India

The wool industry in India, despite its rich heritage and potential, faces several constraints that hinder its growth and development. These challenges span across the entire wool supply chain, from production to processing and marketing.

Low quality and quantity of wool: A significant portion of Indian wool comes from indigenous sheep breeds, which generally produce coarse wool. The lack of focus on breeding programs for high-yield and fine wool-producing sheep has resulted in limited availability of high-quality wool.

Inefficient wool processing infrastructure: Many wool processing units in India still use outdated technology, leading to inefficiencies and lower quality of processed wool. Modernization of processing facilities is essential to improve the quality and competitiveness of Indian wool.

Marketing and Distribution Challenges: The wool market in India is highly fragmented, with numerous small-scale producers and traders. This fragmentation leads to inefficiencies in marketing, lower bargaining power for producers, and price volatility (Rao *et al*., 2018). Many wool producers, particularly those in remote areas, have limited access to markets. Poor infrastructure, including inadequate transportation and storage facilities, exacerbates this problem, resulting in lower returns for producers (Patel *et al*., 2016).

Competition from Synthetic Fibers: Synthetic fibers, such as polyester and acrylic, are often cheaper than wool, making them more attractive to consumers and manufacturers. This price competitiveness poses a significant challenge to the wool industry (Choudhary *et al*., 2019). Changing consumer preferences towards synthetic and blended fibers due to their durability and ease of maintenance have led to a decline in demand for woolen products. Efforts to promote the benefits of wool, such as its sustainability and natural properties, are needed (Nayak *et al*., 2023).

Policy and Regulatory Issues: Inconsistent government policies and lack of coordinated efforts between central and state governments often result in fragmented support for the wool industry. Clear, consistent, and supportive policies are crucial for the industry's development (Jain *et al*., 2018). Limited access to financial resources and credit facilities for wool producers and processors hampers the growth of the industry. Financial support through subsidies, grants, and loans can help in upgrading technology and improving production practices (Kumar *et al*., 2017).

Financial Constraints: Wool producers and processors often face difficulties in accessing credit and financial services. Banks and financial institutions are hesitant to lend to the wool industry due to perceived risks and lack of collateral, hindering investments in quality improvement and modernization (Singh et al., 2018). The cost of production, including feed, veterinary care, and labor, is relatively high compared to the returns from wool sales. This economic imbalance discourages investment in wool production and reduces profitability for farmers (Choudhary *et al*., 2019).

Social and Cultural Barriers: Many wool producers lack awareness of best practices in sheep rearing and wool production. Training and capacity-building programs are essential to improve skills and knowledge, but their reach and effectiveness are currently limited (Rao *et al*., 2019).

Way forward

The wool sector in India holds immense growth potential, driven by significant population of sheep and goats and increasing demand for quality wool in both domestic and international markets. India ranks among the top wool-producing countries, but its share in global wool production is relatively small due to the dominance of coarse wool and the limited production of fine wool. Despite its immense potential to generate employment and provide livelihoods for small-scale farmers, the wool sector remains largely underdeveloped. In the 2021-22 period, India's wool production was around 32.09 million kg, primarily catering to the carpet and coarse wool industries, while fine wool used in apparel is largely imported (Central Wool Development Board, 2022).

At the central level, the Central Wool Development Board (CWDB), under the Ministry of Textiles, has implemented several schemes aimed at improving wool quality and quantity, including the Integrated Wool Development Programme (IWDP) (Ministry of Textiles, 2022). This program focuses on breed improvement, infrastructure support, and skill development. One of its flagship components, the Sheep & Wool Improvement Scheme (SWIS), emphasizes the health and nutrition of sheep while promoting scientific shearing practices to enhance wool quality (Central Wool Development Board, 2021).

Several states, particularly in northern and western India, contribute significantly to wool production. Rajasthan, the leading wool-producing state, has launched programs to support sheep breeders through subsidies, training, and financial assistance. Himachal Pradesh and Jammu and Kashmir have implemented breed improvement and wool promotions programs like Wool Marketing Scheme, Wool Processing Scheme, Revival of Pashmina etc. to promote fine wool production and improve wool quality.

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10. Biotechnological Approaches in Crop Improvement

Manmohan Sharma and Kapil Tiwari

Introduction:

Plant biotechnology is a technology that involves manipulating DNA sequences to create new products, confer new properties to plants, and assist in plant breeding. Given the increasing population and environmental pressures, it is essential to develop crops resilient to environmental stresses and capable of sustained yield and nutrition (Ghag *et al*., 2022). While conventional crop breeding can help develop new varieties with improved traits, it is a slow, labour-intensive, and costly process (Lau *et al*., 2022). The advent of advanced genomic tools and technologies can now enable developing high-yielding, stress-tolerant crop varieties (Pazhamala *et al*., 2021). Modern biotechnology and genome editing technologies could overcome these limitations and accelerate plant breeding beyond what was previously imaginable. Integrating high-throughput omics technologies, reinforced by next-generation sequencing, and the advanced genome editing tools allows for precise manipulation of crop genomes, enabling the development of varieties with desired traits and improved adaptability to changing climates. Additionally, the safe deployment of these technologies in crop improvement may aid in achieving the United Nations' goal of ending global hunger. Great success has been achieved over the years in trait phenotyping, genotyping approaches/methods, and biotechnological approaches, and their use in crop improvement programs (Mir *et al*., 2019). Biotechnological strategies useful in crop improvement include (i) Molecular markers for the assessment of genetic diversity and marker-assisted breeding, ii) Plant tissue culture applications (iii) Genetic engineering for novel trait integration, (iv) Genomics for unravelling gene function and regulation and (v) Genome editing applications

Molecular Markers in Crop Improvement

Marker aided selection is a tool for breeding, wherein genetic marker(s) tightly linked with the desired trait/gene(s) are utilized for indirect selection for that trait in segregating/non-segregating generations. In its simplest form it can be applied to replace evaluation of a trait that is difficult or expensive to evaluate. When a marker is found that co-segregates with a major gene for an important trait, it may be easier and cheaper to screen for the presence of the marker allele linked to the gene, than to evaluate the trait. A variety of different kinds of molecular markers have been developed in almost all important crop plants in the world (Tyagi *et al*., 2019 ; Sagwal *et al*., 2022). More new types of molecular markers have been discovered and used for crop improvement programs. For instance, molecular markers have been used extensively in different activities including the study of genetic diversity of different crop germplasm resources, study of population structure, development of high-density genetic/linkage maps, and mapping genes through traditional quantitative trait loci (QTL) mapping/family mapping and somewhat modern genome-wide association studies (GWAS)/population mapping(Choudhary *et al*., 2021). In addition, these markers have been also used extensively in the development of improved crop varieties through modern breeding approaches like marker-assisted selection (MAS)/marker-assisted gene pyramiding, marker-assisted recurrent selection (MARS), and genomic selection (GS)/genome-wide selection (GWS). Newer emerging molecular markers, also known as next-generation molecular markers

are expected to accelerate crop improvement programs. For instance, new markers including structural variations (SVs) and k-mers are believed to be extremely useful in GWAS and in other gene discovery programs.

Tissue Culture for Crop Improvement

There are several tissue culture techniques that have been developed and utilized to improve crop plants.. Some of the techniques that have found favour are listed below:

- **Embryo Rescue for Wide Hybridization:** Embryo rescue techniques has enabled the introgression of characters such as disease resistance from wild relatives of crops into elite breeding lines. It is now possible to make wide crosses between hexaploid wheat and barley, rye or diploid wheat. The hybrids of such crosses are sometimes sterile due to embryo abortion but can be 'rescued' by culturing or transplanting the embryos.
- **Somatic Embryogenesis**: Somatic embryogenesis refers to the *in vitro* conversion of vegetative cells into viable embryos which are later induced to become complete plantlets. The conversion of callus and cell suspension cultures into somatic embryos was first achieved in 1958 by Reinert and Stewart. In general, the procedure involved pulsing the tissue with a high dosage of an auxin like 2,4-D for a brief period followed by growing on a hormone free medium. Intergeneric hybrids like plumquats, apriots, apriums, and peachquats have been developed by inter-crossing peach, plum and apricot through "embryo rescue" technology which would not be possible otherwise. Most of the genetically transformed varieties of crops, forest trees and several vegetable, fruit and ornamental plants are being multiplied by this technique.
- **Anther Culture and Embryo Rescue**: The pollen grains or anthers, the organ containing these male spores, when successfully cultured on a defined medium and conducive environment, generate into haploid plants that contain only half the normal number of chromosomes. The technique was developed by Guha and Maheshwari (1966) and has since been successfully employed in several plant species. Some improvements like selecting the proper stage of anther development for successful culture, double-layer medium, and determining ploidy levels through flow cytometry in plants further enhanced the reliability and application of this technique.
- **Protoplast Culture and Fusion:** Plant protoplasts were isolated for the first time in 1960 by treating cells with enzymes like cellulase, pectolyase, and hemicelluloses that would dissolve cell wall (Cocking, 1960). These protoplasts coming from diverse cultivars or species could be fused together under specific conditions and grown and regenerated into a new plant. Alternately, a gene of interest could be engineered into a vector like the Ti (tumor inducing) plasmid and either be physically injected into the nucleus of the protoplast by "microinjection," by applying electric current to open up the pores for easy introduction (electroporation) or being briefly co-cultured for incorporation with protoplast nuclear DNA. The resulting fused or transformed protoplast products could be sorted out from the rest of the population by flow cytometry and regenerated into whole plants). New improved citrus cultivars and rootstocks have recently been released that were developed through protoplast fusion at the USDA at Citrus Research and Experiment Station in Florida (Grosser, 2012).

- **Removing Microbes and Viruses from Plant Tissues:** Various studies have confirmed the presence of viruses and other microorganisms in tissue-cultured plants that can withstand surface sterilization and stay in the tissue without showing up until conditions become favorable. This can result in serious losses and the spread of diseases if not controlled in the initial stages of micropropagation. Normally, an apical meristem, less than 0.2 mm tall, excised from the actively growing shoot apex should be relatively free from most of the pathogens. However, some still remain for which the tissues are subjected to high temperatures for a given period that can kill pathogens but not the plant tissue. Some obstinate endophytes, like Badnavirus complex in figs, leaf roll virus in grapes and bushy dwarf virus in raspberry which are tightly embedded within the apical dome of the meristematic tissue still stay and can be eliminated only by combining apical meristem culture and heat therapy with cryotherapy as the last step. This three-step procedure can be very challenging to the
- **Production of Doubled Haploids:** Another important technique that is increasingly used in crop breeding programmes is the production of doubled haploids. The repeated selection of heterozygous materials in a breeding programme can increase uniformity, but many generations are required to reach homozygosity in loci associated with agronomic traits. The artificial production of haploid plants followed by chromosome doubling offers the quickest method for developing homozygous breeding lines from heterozygous parental genotypes in a single generation. Haploid gamete cells from anther or ovary can be diploidized after colchicine treatment, and then regenerated to yield doubled haploid plants. This technique is now widely used for the improvement of many of our most important crops, including all of the major cereals, potatoes, brassicas and even some trees.

Genomics and Crop Improvement

Genomics is now at the core of crop improvement, including the identification of genetic variation underlying differences in phenotypes, identification of additional sources of variation and novel traits, and characterization of molecular pathways involved in biotic and abiotic stress tolerance. Several omics tools and technologies have been used to mine/characterize genes and gene families to facilitate their use in crop improvement. Initial characterization of genes/gene families has been limited to model plants - *Arabidopsis thaliana*, *Brachypodium distachyon*, *Medicago truncatula*, due to their typical features such as small genome size, ease of cultivation, dwarf plant phenotype and responsiveness to genetic transformation.

Next generation sequencing (NGS) has enabled the generation of comprehensive genomic and transcriptomic resources in many crops including model cereal (rice [*Oryza sativa*], wheat [*Triticum aestivum*], maize [*Zea mays*].) and legume (common bean [*Phaseolus vulgaris*], pea [*Pisum sativum*], soybean [*Glycine max*], chickpea [*Cicer arietinum*]) crops. In addition, the availability of these resources has facilitated their use in non-model crops leading to analysis of gene families, gene discovery, differential gene expression of various genes/gene families specific to stress responses, plant growth and development.

The past decade has seen a remarkable rise in throughput and accuracy of genome sequencing technologies. Third generation sequencing technologies facilitated development of contiguous, chromosome-scale genome assemblies in many crops. The increased genome sequence information in crops has improved gene mapping strategies used to discover and map genome-

wide allelic variation. This, in combination with adoption of more efficient family-based linkage designs/large diversity panels, multi-omics assays, and high-throughput phenotyping (HTP) platforms, has contributed to bridging gaps in genome–phenome maps. Resultant acceleration of gene and trait discovery has in turn imparted precision and efficiency to crop breeding programs. At the same time, limitations and challenges began to surface with the acquisition of high-throughput and high-dimensional datasets. The caveats associated with fragmented genome assemblies came to the fore and a pressing need was to construct more genome sequences representative of species (pangenome) or even the entire genus (super-pangenome) in order to capture a comprehensive view of genetic diversity that spans the entire crop gene pool. Genetic improvement of complex traits demanded efficient breeding methods to facilitate identification and subsequent exploitation of hitherto unexplained trait variation attributable to a vast number of small-effect QTLs. Consequently, breeding methods like genomic selection (GS), that exploit genome-wide marker information, became more relevant to continuous population improvement and improving the rate of genetic gain (Crossa *et al*., 2017). Likewise, optimization and adoption of techniques fast-tracking the generation turnover by manipulating the plant growth environment is noteworthy. Advances in genome editing have greatly enhanced our capacity to perform accurate and rapid alterations in plant genomes. New genomics tools are continuously evolving. For instance, whole-genome re-sequencing (WGRS), QTL sequencing (QTL-Seq) and restriction site-associated DNA (RAD) genotyping have emerged and have revolutionized the gene discovery programs and therefore crop improvement programs (Mir *et al*., 2022). The first set of tools for fine mapping of genes/QTLs influencing economically significant quantitative traits, such as biotic/abiotic stressors and agricultural yields, are reference genomes, transcriptomes, and molecular markers (Barmukh *et al*., 2022).

Transgenic Technologies for Crop Improvement

With molecular advances, researchers began to transfer transgenes or gene elements of a known function by random integration, often achieved using *Agrobacterium*-mediated transformation (Que *et al.*, 2010). Recombinase technology and genome engineering have both facilitated precision and targeted genomic changes for crop improvement; however, these technologies have versatile applicability in animal and plant systems (Ryu et al., 2018). Due to public perception, regulation, and complexities associated with GMO animals, GE technologies have been more utilized and rapidly commercialized in plant systems (Caplan *et al*., 2015).

While transgenic crops work to increase the food supply's biosecurity in the face of global change and a growing world population, there has and will be concern about the technologies use in the public forum (Husaini and Tuteja, 2013). One concern is the use of these technologies will forfeit agrobiodiversity and agronomic solutions that promote sustainability through biodiversity in the food supply. It is important to recognize that biodiversity is important; however, the use of transgenic crops and biodiversity solutions are not mutually exclusive (Jacobsen *et al*., 2013). In the search for novel targets for accelerated crop improvement a concerted effort can take place to query genotypes for traits, while working from a conservation genetics standpoint to preserve germplasm for research and conservation purposes.

Another concern is that these crops will hybridize with surrounding cultivars yielding economic, agronomic, or ecological consequences. Factors such as compatibility, flowering time, and spatial proximity can mitigate gene flow from pollen; however, when those factors

align, gene flow is possible (Umurzokov *et al*., 2021). The concern for transgenes to enter native populations of phylogenetically similar plant species could lead to instances of herbicide resistance, monetarily affecting growers. Within the literature the best mode for containment remains physically blocking pollen spread in greenhouse systems, which is unviable for most growers. Biotechnology can work to find some solutions; one example in the *Brassica napus-Brassica rapa* system is placing transgenes on the C chromosome to prevent gene reoccurrence in backcrosses (Sohn *et al*., 2022). Furthermore, research on the mechanisms behind self-incompatibility in plants could provide novel solutions in the future (Zhang *et al*., 2023).

The utilization of transgenic crops, especially those produced using GE technologies, has resulted in economic and environmental benefits. Benefits include increased crop yield, reduced carbon dioxide emission, increased farmer income, and improved consumer health. Herbicide-tolerant crops have gained many agronomic traits other than a general resistance to pests. One example is the ability to increase net yield while maintaining resistance to pests. The introduction of stacked traits, made possible using GE technologies, has advanced the agronomic characteristics of herbicide-tolerant crops and transgenic crops in general revolutionizing the market for both producers and consumers. Insect-resistant crops have introduced beneficial agronomic traits to crops by improving yield gains and providing an alternative to insecticides, which can cause unintended deleterious consequences to the environment (Brookes and Barfoot, 2020).

Genome Editing for Crop Improvement

Genome editing techniques using sequence-specific nucleases (SSNs) have become popular in plant research. They have been used to develop high-yielding crops, improve the adaptability of crops to environmental stresses or enhance their nutrition content (Chen *et al*., 2019). To date, there are four SSNs, namely meganucleases, zinc finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs), and clustered regularly interspaced palindromic repeat (CRISPR)/CRISPR-associated (Cas) protein systems. These technologies allow precise targeting and modifying of specific DNA sequences in three common steps: (1) an exogenous engineered nuclease consisting of a recognition module and nuclease domain recognizes the target DNA sequence, (2) the engineered nuclease binds to the target DNA sequence and induces double-strand breaks (DSBs) at or in the vicinity of the target site and (3) the DSBs will then be repaired by either non-homologous end-joining (NHEJ) or homologous recombination (HR). NHEJ is an error-prone repair mechanism that often results in insertion and deletion (Indel) mutations, whereas HR results in a precise repair of DSBs (Wada *et al*., 2020).

Among the recent genome editing technologies, the clustered regularly interspaced palindromic repeat (CRISPR)/CRISPR-associated (Cas) protein (CRISPR/Cas) is the potent and widely adopted tool for genome editing in plants. The CRISPR/Cas system consists of the Cas endonuclease and a synthetic single-guide RNA (sgRNA) that directs the Cas protein to a targeted genomic DNA (gDNA) sequence, which is then recognized and cleaved by CRISPR/Cas9 (Hamdan *et al*., 2022). There are several Cas endonucleases, such as Cas9, Cas12a, Cas12b, Cas12j (Casϕ), and Cas12f (CasMINI) (Alok *et al*., 2021). The cleavage of DNA can often result in insertions or deletions (InDels), which can lead to frameshift mutations and gene knockouts. CRISPR/Cas9 has been widely used for genome editing in various plant species, including model plants, cereal crops, oil crops, fruits, vegetables, and horticulture

plants (Yao *et al.*, 2022). Hamdan *et al*. (2023) have elaborated in detail role of genome editing technologies for crop improvement.

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11. Farm Mechanization in Hills of Jammu and Kashmir

Sushil Sharma and Vinay Kumar

Introduction

The Union Territory of Jammu and Kashmir features diverse agro-climatic conditions, rich genetic diversity, and abundant natural resources, offering a unique opportunity for farmers to cultivate a variety of crops, including fruits, vegetables, and grains (Kirk and Rais, 2021).This mountainous region has unique ethnic, socio-cultural, and economic traits, with about 70 to 80% of the population relying on agriculture for their livelihoods, highlighting its importance to the local economy. Spanning 42,241 sq kms with a population density of 290 per sq. kms, Jammu and Kashmir consists of 20 districts surrounded by mountains. Despite modern agricultural practices, crop productivity remains low due to diverse geography, challenging terrain, natural disaster risks, inadequate infrastructure, and gender-related issues, resulting in only 30% of the land being cultivated. Agriculture and allied fields are crucial to Jammu and Kashmir's economy, contributing about 65% of its revenue (Kumar, 2018).

Farmers faces challenges like marginal land, irregularly shaped fields, environmental vulnerability, hilly terrain, a shortage of skilled labor, inadequate repair and maintenance facilities, limited manufacturing capabilities for equipment, and the high costs associated with solar technology, necessitating innovative solutions to boost productivity and sustainability (Singh and Verma 2001). The necessity for mechanization in hill agriculture has become increasingly evident as farmers face the challenges posed by the unique topographical and climatic conditions of mountainous regions. Traditional farming methods, which often rely heavily on manual labor, are inefficient and labor-intensive, leading to lower productivity and increased physical strain on farmers of the region. By integrating modern machinery and technology into hill farming practices, agricultural productivity can be significantly enhanced, allowing for more efficient land use and improved crop yields.

Need for Mechanizationin Jammu and Kashmir

Farm mechanization introduces innovative solutions that not only enhance productivity but also promote sustainable agricultural practices. For instance, precision farming techniques enabled by modern machinery can optimize resource use, such as water and fertilizers, thereby minimizing waste and environmental impact. In Jammu and Kashmir, the region lags in farm power availability, achieving between 0.72 to 1.74 kW/ha in different districts of Jammu region as compared to the national average of 2.5 kW/ha. The measurement of farm power per unit area (kW/ha) is recognized as a key indicator for the level of mechanization in agriculture. The utilization of farm machinery is directly influenced by the amount of available farm power for both tractive and stationary tasks in the agriculture and allied activities.

There is significant variation in the availability of unit farm power across different regions within the State due to intensity of agriculture being practiced there; for instance, RS Pura and Bishna report a high of 3.06 kW/ha, while Ramnagar shows a much lower figure of 0.47 kW/ha in the Jammu region (Sharma, 2009; Sharma, 2010). On a gross cropped area basis, the average unit farm power availability stands at 0.78 kW, with 51.2% derived from animate sources, such as human and animal power, and 48.8% from other sources, highlighting the continued

importance of animate power in the overall farm power equation. Tractors are mainly used for initial tillage, sowing, thrashing and transportation in the plains near urban areas, but their application is still limited. The combination of uneven terrain and the economic difficulties faced by farmers leads to a dependence on manual labor, with traditional hand tools and locally made implements being the standard. These tools typically have low output capacity and require considerable physical effort to use. The overall availability of agricultural power in the region is quite low, underscoring a critical need for improved mechanization. This shortfall is largely due to the absence of accessible, farm-suitable equipment and advanced machinery. However, there is a strong demand and ongoing efforts to enhance productivity and reduce labor intensity through the adoption of mechanized solutions.

Farm mechanization plays a crucial role in enhancing agricultural productivity, particularly in hill farming systems. The unique topography and climatic conditions of hilly regions present distinct challenges for traditional farming practices, often leading to labor-intensive methods that can be inefficient. In these areas, the steep slopes, rocky terrain, and variable weather patterns can hinder the effectiveness of conventional farming techniques, making it difficult for farmers to achieve optimal yields. By integrating mechanized tools and equipment, farmers can significantly improve their operational efficiency, reduce the physical strain on laborers, and increase the overall yield of crops. Mechanization not only streamlines various agricultural processes, such as planting, harvesting, and soil preparation, but also enables farmers to manage their land more effectively, even in the face of challenging terrain.

Benefits of Mechanization in Agriculture

The adoption of mechanization in hill agriculture can lead to several benefits, including improved timeliness of operations and enhanced precision in farming practices. For instance, the use of specialized machinery designed for steep slopes can facilitate the cultivation of crops that would otherwise be difficult to grow in such environments. This includes the ability to plant and harvest at optimal times, which is crucial for maximizing crop quality and yield. Mechanization allows farmers to alter their cropping strategies and transition to more lucrative crops by optimizing input usage and benefiting from the flexibility in cropping seasons, resources, and marketing (Alam, 2008). There is a clear correlation between farm power and productivity; a delay of 15 to 20 days can significantly diminish crop yields, particularly in regions where weather constraints restrict the growing season. Therefore, farm mechanization is essential rather than optional.

Additionally, mechanized systems can help in the efficient application of fertilizers and pesticides, ensuring that resources are utilized optimally and reducing waste. This not only contributes to better crop health but also minimizes the environmental impact of agricultural practices. Mechanization allows for better management of water resources, which is particularly vital in hilly areas where water availability can be inconsistent. With the right equipment, farmers can implement more effective irrigation systems, ensuring that crops receive adequate moisture even during dry spells. Overall, mechanized farming can greatly improve efficiency, resulting in a 15-20% reduction in seed usage, a 20-30% decrease in fertilizer consumption, and a 20-30% savings in time. Additionally, it lowers labor needs by 25-35%, encourages a 5-20% increase in cropping intensity, and enhances productivity by 10-15%.

Challenges Associated with the Adoption of Mechanization

However, the transition to mechanized farming in hill regions is not without its challenges. Farmers may face financial constraints when investing in machinery, and there may be a lack of technical knowledge regarding the operation and maintenance of such equipment. The initial costs associated with mechanization can be a barrier for smallholder farmers, who often operate on limited budgets. Additionally, the availability of suitable machinery that can navigate the unique challenges of hilly terrain may be limited, further complicating the adoption process. To address these issues, it is essential to provide access to affordable financing options, training programs, and support services that can help farmers effectively integrate mechanization into their agricultural practices (Dixit et al., 2006).

Governments and agricultural organizations can play a pivotal role in facilitating this transition by offering subsidies or low-interest loans for the purchase of machinery, as well as establishing training workshops that focus on the operation and maintenance of equipment. Collaborations between government agencies, agricultural universities, and local organizations can facilitate knowledge transfer and capacity building, ensuring that farmers are well-prepared to embrace these changes.

Government Initiative and Schemes for Promoting Mechanization

Considering the numerous challenges associated with the adaptation and management of advanced agricultural technologies, the Government of India, in collaboration with the Jammu and Kashmir government, state departments, and the state agricultural university, has launched several initiatives under the Holistic Agriculture Development Program (HADP). These programs, introduced by the Honorable Prime Minister on March 7, 2023, such as "Farm Mechanization and Automation" and "Sensor-Based and Smart Agriculture," are aimed at benefiting the people of Jammu and Kashmir.The Faculty of Agricultural Engineering at SKUAST-J (Chatha) is actively collaborating with both government and private sectors to address the mechanization needs of the region's hilly areas. Additionally, it is spearheading efforts to transform agricultural practices by incorporating cutting-edge technologies, aiming to leverage artificial intelligence, machine learning, agri-robotics, agri-drones, the Internet of Things (IoT), and virtual/augmented reality to elevate agricultural research and practices significantly (Anonymous, 2024).

The government has introduced drone initiatives like Kisan Drones and NAMO Drone Didi. Kisan Drones offers a rental model for farmers, providing 40% financial support (up to Rs. 4 lakhs) for drones purchased by Custom Hiring Centers (CHCs) under Cooperative Societies, Farmer Producer Organizations (FPOs), and rural entrepreneurs. Agriculture graduates establishing CHCs can receive 50% aid (up to Rs. 5 lakhs). Small and marginal farmers, Scheduled Castes/Scheduled Tribes, women, and farmers from the North East can also receive 50% assistance (up to Rs. 5 lakhs), while other farmers are eligible for 40% support (up to Rs. 4 lakhs).

The NAMO Drone Didi initiative, launched by the central government under the DAY-NRLM, aims to integrate drone technology into 15,000 women-led self-help groups (SHGs) in rural areas. This program enables SHGs to offer rental drone services for precise application of fertilizers and pesticides, targeting an additional income of at least Rs. 1 lakh per SHG annually, thereby enhancing financial autonomy for rural women and promoting sustainable agriculture. Furthermost, the Government of India has launched several initiatives, including the National

Mission for Sustainable Agriculture, National Food Security Mission, Rashtriya Krishi Vikas Yojana, Mission for Integrated Development of Horticulture, Pradhan Mantri Krishi Sichayee Yojana, Pradhan Mantri Fasal Bima Yojana, and Paramparagat Krishi Vikas Yojana. The aim of all these schemes is to increase the reach of farm mechanization to small and marginal farmers and to the regions and difficult areas where farm power availability is low with the following objective:

i. Enhance the Farm Mechanization Index to improve agricultural power availability, increasing cropping intensity and ensuring timely operations for optimized productivity.
ii. Minimize physical strain on farm workers through advanced mechanization, improving labor conditions and boosting economic returns for farmers, fostering a sustainable agricultural sector.
iii. Establish 'Custom Hiring Centers' and 'Advanced Technology Hubs' to address economic challenges from small landholdings and high costs of agricultural equipment ownership.
iv. Improve stakeholder engagement and knowledge through demonstration projects and capacity-building initiatives to equip farmers with skills for using advanced machinery.
v. Create a performance evaluation and certification framework for agricultural machinery at testing facilities to ensure equipment meets efficiency and reliability standards.
vi. The implementation of sensor-based Internet of Things (IoT) and automation technologies significantly enhances the efficiency of resource utilization in agricultural practices, leading to optimized input usage and reduced waste.
vii. Advanced farming methodologies, characterized by their responsiveness and accuracy, have the capability to boost crop yields by as much as 300%, thereby maximizing productivity and profitability for farmers.
viii. The adoption of smart farming strategies plays a crucial role in minimizing post-harvest losses throughout the entire value chain, ensuring that more produce reaches the market in optimal condition and reducing overall food waste.

Conclusion and Suggestions

The adoption of farm mechanization in Jammu and Kashmir presents a key opportunity to set a benchmark for other mountainous regions facing similar challenges. This area, with its unique topography and climate, can demonstrate how innovative agricultural practices can be tailored to local needs. By highlighting the benefits of mechanized agriculture, Jammu and Kashmir can inspire neighboring regions to adopt similar strategies, potentially transforming agricultural methods nationwide. Mechanization goes beyond just introducing machinery; it involves a comprehensive approach to improving farming practices. In Jammu and Kashmir, where traditional methods struggle against steep slopes, limited arable land, and unpredictable weather, mechanization can significantly enhance productivity and efficiency. For example, tractors can enable timely planting and harvesting, reduce labor costs, and minimize post-harvest losses, leading to higher crop yields.

Additionally, mechanization promotes sustainable agricultural practices by reducing reliance on manual labor and allowing for more precise application of fertilizers and pesticides, thus minimizing environmental impact. This shift not only conserves resources but also supports

the long-term viability of farming in the region. As farmers become more efficient, they can better adapt to changing climate conditions and market demands, ensuring food security and resilience.To accelerate the advancement of mechanization within the state, several recommendations are outlined below:

i. The creation of a comprehensive agricultural engineering program tailored specifically for hill agriculture is essential to enhance productivity and sustainability in these regions. This initiative will focus on addressing the unique challenges faced by farmers in hilly terrains.

ii. A thorough mechanization assessment across the entire state is necessary to pinpoint existing gaps in agricultural mechanization. This study will help identify areas where technology can be introduced or improved to increase efficiency and yield.

iii. Equipment that has been developed in other regions must undergo rigorous testing and evaluation to ensure its suitability for the specific conditions of both lower and upper hill areas. Modifications may be required to optimize performance and facilitate greater adoption among local farmers.

iv. The introduction of technology that is friendly to women is crucial for promoting socio-economic development within the state. This includes lightweight power sources, such as power tillers, which can significantly ease the physical demands of hill farming.

v. Strengthening research and development efforts in post-harvest and agro-processing sectors is vital. The government should facilitate the establishment of small-scale agro-processing industries by providing necessary support and subsidies, while also promoting cooperative models for farm mechanization and a custom hiring system through state agencies.

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12. Technologies for Drudgery Reduction of Farm Women

Sushmita M. Dadhich, R.K. Srivastava, Akhil Gupta and Rigzen Angmo

Introduction

Women play a crucial role in the agricultural workforce, particularly in rural areas, where they contribute significantly to both agricultural activities and domestic responsibilities. Despite their essential involvement, their efforts are often not financially recognized, and their work is underrepresented in formal agricultural statistics. Farm women are responsible for some of the most physically demanding tasks in agriculture, including sowing, weeding, harvesting, animal husbandry, and post-harvest operations. In fact, women make up about one-third of the agricultural labor force and approximately 48 percent of self-employed farmers, with their participation in farming enterprises rising, especially in more prosperous rural areas (Praveen et al., 2005). However, the physically demanding nature of these tasks, coupled with limited access to suitable tools, exposes farm women to considerable physical strain and health risks. Many rural women experience chronic back pain, joint problems, repetitive strain injuries, and respiratory issues due to prolonged exposure to dust, pesticides, and extreme weather conditions (Singh & Tiwari, 2019). Social and economic barriers, such as limited access to credit, training, and modern agricultural technologies, further complicate their work and hinder their ability to optimize productivity (Patel et al., 2021).

The diversity of agricultural tasks, ranging from highly mechanized operations to the maintenance of subsistence farming plots, presents challenges for healthcare providers and underscores the need for specific technological interventions (Fenske and Simcox, 2000). Agricultural technologies modify for farm women can significantly reduce the physical burden they face. The introduction of women-friendly machinery and ergonomically designed tools can not only empower farm women but also improve productivity and contribute to gender equality in agriculture. While farm machinery has predominantly been designed with male users in mind, the lack of tools suited to women's physical capabilities increases their physical strain. As a result, many farm women often have to adapt tools that are not optimized for their needs, intensifying their workload and contributing to long-term health issues (Sharma et al., 2022)

Furthermore, household responsibilities, which often fall on farm women, compound their workload and reduce the time available for agricultural activities. This makes it even more urgent to develop labor-saving technologies that are both accessible and efficient. Recent advancements in agricultural technology offer a promising solution, providing opportunities to alleviate the drudgery of farm work for women and promote sustainable farming practices. The challenges faced by farm women are multifaceted and interlinked, as shown in Figure 1, which illustrates the various challenges such as physical strain, health risks, lack of resources, social and economic barriers, and the need for gender-sensitive technologies. This article explores various technologies designed to reduce the physical burden on farm women, focusing on those that address specific agricultural tasks and improve their overall well-being.

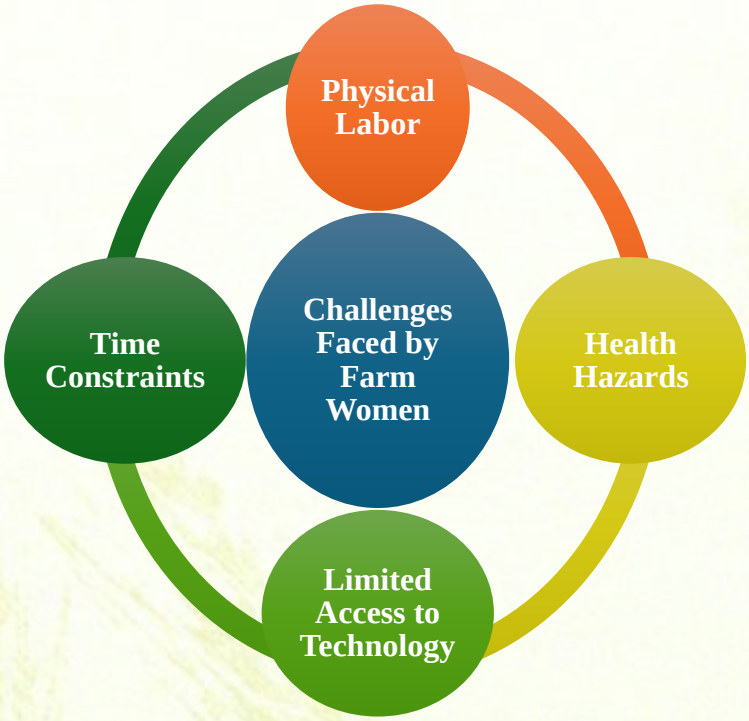

Figure 1: Key Challenges Faced by Farm Women in Agriculture

Drudgery-Reducing Technologies for Farm Women

1. Hand Ridger:

The hand ridger is an essential tool designed to make ridges for sowing vegetables and constructing furrows for irrigation, significantly reducing the physical burden on farm women (Figure 1). It consists of a ridger and a pulling beam with a T-type handle, making it easy to operate manually. For optimal performance, it is necessary to prepare the field properly. This equipment is operated by two workers, one pulling and the other pushing and guiding. The hand ridger can cover an area of up to 330 m^2 per hour and is available at an economical price of ₹1200. The primary benefits of the hand ridger include a 67% reduction in the cardiac cost for workers compared to traditional ridge-making methods. This is crucial as it minimizes the physical strain often associated with manual labor. Additionally, the ridger eliminates the need for workers to bend over while using short-handled tools, which can cause musculoskeletal issues. The design of the hand ridger also doubles the productivity of workers compared to traditional methods, increasing efficiency and reducing the overall workload. This technology was developed at the Central Institute of Agricultural Engineering (CIAE), Bhopal, under the National Research Centre for Women in Agriculture (NRCWA) sub-center.

Figure 2: Hand-operated tool for efficient ridge making in agriculture.

2. Seed Treatment Drum:

The seed treatment drum is designed for uniform mixing of chemicals with seeds before sowing, ensuring effective seed treatment and minimizing the health risks associated with direct chemical contact. This drum consists of a frame, handle, and a cylindrical drum mounted on a tripod angle iron frame. Inside the drum, three mild steel flat plates are welded to facilitate uniform mixing of seeds and chemicals. Prior to use, workers are advised to wear plastic gloves and a nose mask for health protection. After adding the chemicals to the drum, a small amount of water is also added, and the drum is tightly closed. The drum is then rotated for 20 to 25 revolutions. After completing the rotation, the lid is opened, and the treated seeds are transferred to a separate bag or container. The entire process, including filling, treating, and emptying, takes approximately 5 to 6 minutes for a batch of 20 kg seeds. The capacity of the equipment is 200 kg/h, and the cost is ₹3500.

The Seed Treatment Drum offers key benefits: it ensures safety by preventing direct contact with chemicals, promotes uniform mixing for effective seed treatment, and improves posture by eliminating the need for bending or squatting.

Figure 3: Seed Treatment Drum for uniform chemical mixing in seed preparation.

3. Fertilizer Broadcaster

The Fertilizer Broadcaster is designed for the uniform application of granular fertilizers in the field. After receiving feedback from women workers, the broadcaster was refined using

anthropometric data to ensure it is more suitable for their use. The machine consists of a hopper with an agitator, a spreading disk, a gear, a crank with a handle, a rear cushioning pad, and shoulder straps for easy mounting. The broadcaster is cross-mounted and requires the worker to maintain a 2.5 m distance from the bund and 5 m spacing during operation. The transparent lid of the hopper allows the worker to easily monitor fertilizer levels, and it can be refilled when necessary. After each use, the broadcaster should be cleaned thoroughly. With a capacity of 1.15 ha/h, the machine costs Rs. 3000/-. The benefits of the Fertilizer Broadcaster include a 6% reduction in the cardiac cost of workers per hectare compared to traditional methods. It ensures a uniform application of fertilizer, improving the consistency of the operation. Additionally, it protects workers from exposure to urea dust, enhancing their safety. The broadcaster also significantly increases worker productivity, more than tripling the output compared to traditional methods.

Figure 4: Fertilizer Broadcaster in Field Operation

4.CIAE Seed Drill

The CIAE seed drill is designed for row sowing of various crops such as wheat, soybean, maize, gram and pigeon pea. It has been refined specifically for women workers using anthropometric data to ensure ergonomic use. The seed drill consists of a handle, a hopper for seeds and fertilizer, a peg-type ground wheel, a roller with cells, and a hook for pulling the drill. The metering roller is mounted directly on the ground wheel shaft. The equipment needs to be operated in a well-prepared field, and it requires two workers: one to pull and the other to push and guide the drill. The rope tied to the hook at the front of the drill is used for pulling. The machine operates at a capacity of 430 m²/h, with a cost of Rs. 8000/-.

Benefits

- The output is 18 times higher than the traditional method of sowing.
- There is an 87% saving in the cardiac cost of workers per unit of output.
- The seed drill helps avoid the bending posture commonly used in traditional sowing methods.
- Line sowing promotes the use of mechanical weeders, reducing both cost and drudgery during the weeding operation.
- Seed saving is also achieved with the use of this equipment.

Figure 5: CIAE Seed Drill in Field Operation

5. PAU SEED DRILL

The PAU Seed Drill is designed for row sowing of various seeds such as wheat, soybean, maize, gram, and pigeon pea. It has been specifically refined for women workers using anthropometric data to ensure ergonomic operation. The drill consists of a handle, a hopper for seeds, a ground wheel, a fluted roller for seed metering, and a hook for pulling the equipment. The seed metering is done via the fluted roller, and the operation is powered by the ground wheel shaft through a chain and sprocket mechanism. To ensure optimal performance, the drill is used in a well-prepared field. It requires two workers: one for pulling and one for pushing and guiding. The rope is tied to the hook at the front of the seed drill to aid in pulling. The machine has a capacity of 430 m²/h and costs Rs. 10,000/-. The PAU seed drill was developed at PAU Ludhiana and refined at CIAE, Bhopal-NRCWA subcentre. The benefits of using the PAU seed drill are summarized in Figure 7 and the practical demonstration of the seed drill in operation Figure Source of availability CIAE, Nabi Bagh, Berasia Road, Bhopal-462 038.

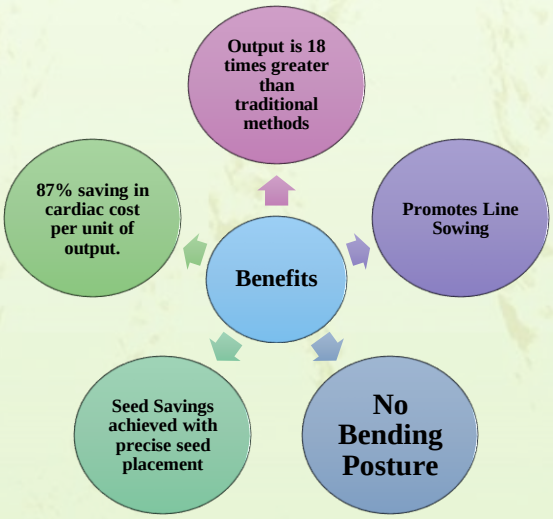

Figure 7: Benefits of the PAU Seed Drill

Figure 8: PAU Seed Drill in Field Operation

6. NAVEEN DIBBLER

The Naveen Dibbler is designed for dibbling bold seeds (such as maize and soybean) or costly/scarce seeds in smaller areas and for gap filling purposes. The machine consists of a jaw-type seed placement device, a cell-type metering mechanism, a lever-type power transmission system for the roller and jaws, and a seed box with a delivery system Figure 9. To operate, the worker fills the seed box with the desired seeds and positions the dibbler at the desired location in the field. By gently pushing the lever at the front of the dibbler, the jaw opens, allowing the seed to drop into the soil. The machine has a capacity of 150 m²/h and is priced at Rs. 3000/-.

Benefits

- ✓ About 13% saving in cardiac cost of workers per unit of output with the dibbler as compared to traditional.
- ✓ It also avoids bending posture, which is generally adopted in traditional method.
- ✓ Line sowing is done with the equipment that promotes use of mechanical weeders thereby reducing drudgery and cost during weeding operation.
- ✓ Seed saving is also achieved.

Figure 9: Naveen Dibbler in Field Operation

7. ROTARY DIBBLER

The Rotary Dibbler is a manually operated push-type equipment designed for dibbling bold or medium-sized seeds, such as maize, soybean, and sorghum, in small areas or for gap filling of seeds in crops like soybean, sorghum, and maize. It allows for uniform seed placement in well-

prepared soil, providing greater planting accuracy compared to traditional methods. The machine has a capacity of 500 m²/h, and the cost is Rs. 5000/-.

Benefits

It is suitable for dibbling bold seeds like maize, soybean and pigeonpea.

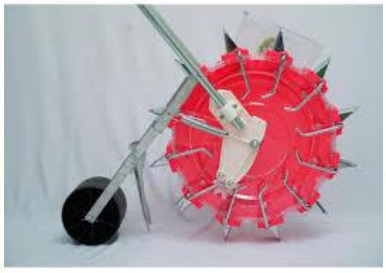

Figure 10: Rotary Dibbler in Field Operation

8. FOUR-ROW PADDY DRUM SEEDER

The Four-Row Paddy Drum Seeder is used for line sowing of sprouted paddy seeds in puddled fields. It consists of drive wheels with lugs, a drive shaft, hyperboloid-shaped drums, and a swinging-type pulling beam. The hyperboloid-shaped drum allows seeds to flow freely toward the metering holes. The machine has 18 holes (10 mm in diameter) for dropping sprouted seeds into the puddled field. The capacity of the machine is 920 m²/h, and it costs Rs. 10,000/-.

Benefits

- ✓ Light in weight, and easy to transport and handle.
- ✓ Uniformity in seed sowing.
- ✓ Hill dropping of seed is achieved and continuous drilling is eliminated.
- ✓ Seed saving is achieved with the equipment as compared to traditional method.
- ✓ Line sowing is done with the equipment that promotes use of mechanical weeders thereby reducing drudgery and cost during weeding operation.

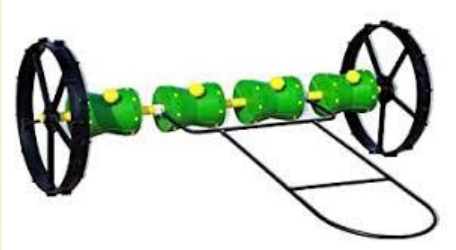

Figure 11: Four-Row Paddy Drum Seeder in Field Operation

9. TWO-ROW RICE TRANSPLANTER

The Two-Row Rice Transplanter is designed to transplant 20-25-day-old mat-type rice seedlings (at the 3-4 leaf stage) in two rows simultaneously under puddled conditions. The machine consists of a frame, floats, seedling tray, operating handle, fingers (pickers), tray drive unit, and depth control mechanism. The seedlings are loaded onto the tray, and the machine transplants them by gently pushing the operating handle. It operates at a speed of 1-1.5 km/h and has a capacity of 61 m²/h, costing Rs. 9000/-.

Benefits

- ✓ Transplanting can be done in two rows simultaneously with the equipment.
- ✓ 16% saving in cardiac cost of workers per unit area.
- ✓ It avoids bending postures which is adopted in traditional method.

- ✓ Line sowing helps in promoting the use of mechanical weeders thereby reducing drudgery

and cost during weeding operation.

- ✓ Productivity of worker is increased by 79% as compared to traditional method.

Figure 12: Two-Row Rice Transplanter in Field Operation

Low-Cost Protected Cultivation: A Sustainable Approach to Enhancing Vegetable Production and Empowering Farmwomen

Low-Cost Protected Cultivation: Empowering Farmwomen and Boosting Vegetable Production

Vegetables play a significant role in India's agricultural landscape, contributing to food security, nutrition, and economic stability. India is the second-largest producer of vegetables globally, and by 2050, the demand for vegetables is expected to rise to 342 million tonnes. To meet this demand, various strategies like expanding cultivated areas, using hybrid seeds, and adopting improved farming techniques are crucial. One effective solution is the promotion of protected high-value vegetable cultivation, especially in regions where hot and humid conditions hinder vegetable production during summer and monsoon seasons. This method not only supports vegetable production but also provides a livelihood option for farmwomen, making horticulture economically viable for small farmers.

At DRWA Bhubaneswar, technologies for protected cultivation of off-season tomatoes and cucumbers have been standardized. The process involves planting 25-day-old seedlings of tomato variety Avinash and cucumber variety Kian with a spacing of 50 x 50 cm. After 45 days, flowering begins, yielding an average of 24 kg/m² for tomatoes and 12 kg/m² for cucumbers. Financial returns from this method range from Rs. 250-300/m² annually. The technology is especially beneficial for rural women, who are trained to operate low-cost polyhouses, enhancing their entrepreneurial skills and income potential Figure 13. Protected cultivation is recognized as a drudgery-free technology that enables more efficient use of land and resources. It provides women with opportunities to improve their income while reducing the physical strain associated with traditional vegetable farming. Through playhouse and net-house units, rural women can significantly enhance their income from vegetable cultivation.

Figure 13: Horticulture section, ICAR- DRWA, Bhubaneswar

Low-cost nutritive guava-lemon-ginger squash

Guava is the sixth most important fruit crop in India, thriving in subtropical and tropical climates. Despite its high nutritional value, especially in vitamin C and antioxidants, the market price of guava fluctuates seasonally, with crops harvested during the rainy season often sold at lower prices compared to winter crops. To address the substantial post-harvest losses during the rainy season, a low-cost, blended guava-lemon-ginger squash was developed to enhance the economic value of this fruit. This product not only adds value to guava but also provides an additional income stream for small farmers. The squash is prepared with 22.5% guava juice, 5.0% lemon juice, and 1.5% ginger juice, and preserved with 200 ppm potassium metabisulphite, allowing for a shelf life of 80-90 days under refrigeration at 4°C. The squash has excellent sensory attributes in terms of appearance, flavor, sweetness, and overall quality. It is rich in vitamin C (212-235 mg/100g) and antioxidants, with a total soluble solids (TSS) of 43.5°Brix, 1.32% acidity, 3.4 pH, and 41.5% total sugar content. The production cost of one liter is ₹62, and it is sold for ₹135, offering a benefit-to-cost ratio of 2.2:1. The technology is especially beneficial for rural women, who are trained in squash-making, enhancing their entrepreneurial skills and providing self-employment opportunities. The availability of raw materials like guava and ginger at the village level makes it easier for women to engage in this value-added activity and improve their economic standing (Singh & Solanki, 2014).

Figure 14: Low-Cost Nutritive Guava-Lemon-Ginger Squash Preparation Process

Fruit based cropping models / SIX F model

Subsistence farmers often face challenging conditions, such as famine, where traditional seasonal crops may fail due to unpredictable weather patterns. To address these issues and ensure livelihood security, fruit-based cropping systems offer a viable solution. These systems can provide significant economic returns, even under unfavorable agro-climatic conditions, which is difficult to achieve with only seasonal crops. Fruit trees are resilient and can remain productive even in adverse conditions. By integrating multiple crop combinations-such as vegetables, short-duration fruit crops, flowers, aromatic plants, fodder crops, and root crops-fruit-based cropping systems maximize the production of nutrient-rich food, fodder, and additional income. These systems are designed to address the six key components of

sustainability: food, fodder, fuel, feed, fiber, and finance, collectively known as the 6Fs. At DRWA, various cropping models have been developed, including guava-based, mango-based, minor fruit-based, coconut-based, and cashew nut-based models. More than 25 intercrops are planted within these systems, providing income opportunities averaging Rs. 150,000-200,000 per hectare per season. These systems are especially beneficial for women, who often have limited involvement in traditional orchards. By growing intercrops, women can actively participate in farm management, improving their livelihoods and ensuring both nutritional and economic security for the family. The models also offer opportunities for off-farm employment through post-harvest handling and value addition, further enhancing women's roles in agriculture and providing them with sustainable income sources (Mehta & Patel, 2021).

Carp Fry Production: an Economic Activity for Rural Women

Freshwater aquaculture in India has emerged as a viable alternative to declining capture fisheries, with the timely availability of quality fish seeds being crucial for success. Carp fry production in backyard ponds offers a unique opportunity for rural women, especially when inputs like fry, feed, and fertilizers are easily accessible. Ponds of 0.02-0.03 ha are ideal for women, with simple preparation processes, including clearing weeds, applying bleaching powder, and fertilizing with organic materials. Supplementary feeding is provided to fry, which are harvested after 20 days, once they reach 25-30 mm in size Figure 15.

This short-duration, low-input activity is ideal for rural women, allowing them to use local resources like backyard ponds, generating additional income and improving local aquaculture. The technology was demonstrated in 11 villages of Odisha, covering 0.858 ha of pond area, producing 7 lakh fry. Women earned a profit of Rs 95,640 per hectare, with an average profit of Rs 2,968 per 0.02 ha pond cycle. This practice offers a sustainable livelihood and enhances both food and income security for rural women.

Figure 15: Carp Fry Production for Rural Women Empowerment

Conclusion

The development and adoption of advanced sowing and planting technologies, such as the PAU Seed Drill, Naveen Dibbler, Rotary Dibbler, Four-Row Paddy Drum Seeder, and Two-Row Rice Transplanter, have significantly improved the efficiency and sustainability of agricultural operations. These innovations help reduce labor drudgery, enhance seed placement accuracy, and promote uniform seed distribution, leading to increased crop productivity and resource savings. Their ergonomic design benefits both male and female farmers by reducing the physical strain associated with traditional methods, with added advantages such as seed saving, reduced cardiac cost, and improved worker productivity.

Implementing gender-equitable policies in agriculture requires a holistic approach, including legal reforms, capacity building, improved market access, and health and safety measures. By integrating gender perspectives, we can empower women in agriculture, boost their contributions, and support sustainable development. Drudgery-reducing technologies play a crucial role in this by enhancing efficiency, reducing physical strain, and enabling women to contribute more effectively to their households and communities. Collaborative efforts among policymakers, researchers, and local organizations are key to scaling these technologies, fostering an inclusive and prosperous agricultural sector that benefits all.

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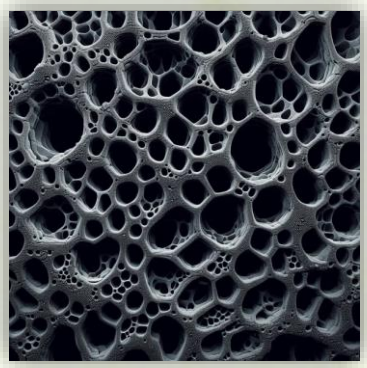
13. Biochar: A Sustainable Solution for Carbon Sequestration and Soil Health Under Climate Change

Vikas Abrol, Peeyush Sharma

Global warming is one of the most significant threats of present times due to high concentrations of greenhouse gases in the atmosphere, rising temperatures, and an increase in the frequency and intensity of extreme weather events. According to the Intergovernmental Panel on Climate Change (IPCC), anthropogenic activities particularly the burning of fossil fuels and deforestation have resulted in unprecedented levels of carbon dioxide (CO_2), reaching 420 ppm. This has contributed to a global temperature rise of approximately 1.1°C and a 151% increase in CO_2 emissions since the pre-industrial era (IPCC, 2023). Among the numerous strategies proposed to combat climate change, carbon sequestration has emerged as a critical focus. Carbon sequestration involves the removal of carbon dioxide from the atmosphere, thereby mitigating the effects of climate change.



Biochar, a carbon-dense solid produced through the pyrolysis of organic materials, has emerged as a promising soil amendment with significant environmental benefits. Biochar improves the chemical, physical, and biological characteristics of soil, leading to increased crop biomass and yield (Glaser et al., 2002). Research indicates that the incorporation of biochar into soil decreases bulk density (Brewer et al., 2014), increases infiltration rates (Abrol et al., 2016), enhances soil water holding capacity (Ouyang et al., 2013), and improves total porosity and mean weight diameter (Omondi et al., 2016), **Biochar** while also aggrading carbon (Abrol et al., 2017). The Intergovernmental Panel on Climate Change (IPCC) has identified biochar as a critical carbon dioxide removal (CDR) technology, highlighting its potential to contribute to a net-zero economy and limit global warming to 2°C (IPCC, 2023). Beyond carbon sequestration, biochar enhances soil fertility, improves water retention, and boosts agricultural productivity, offering multiple environmental and economic benefits. In India, there exists significant potential for valorizing 212 million tons of crop residues into biochar from the crop waste generated annually (Anand et al., 2022).

Mechanisms of carbon sequestration

Carbon sequestration is the process by which plants absorb and store carbon dioxide (CO_2) in long-lasting reservoirs of plant biomass and soil organic carbon. Unlike plant biomass, which releases carbon back into the atmosphere upon decomposition, the carbon trapped in the structure of biochar is stable, making it a more effective contributor to soil carbon storage. By decelerating the decay and mineralization processes within the carbon cycle, biochar establishes a more permanent carbon reservoir thereby acting as a carbon sink (Abrol et al., 2019). Additionally, biochar serves as a habitat for beneficial microorganisms, and its large surface area facilitates the absorption of organic matter, gases, and inorganic nutrients. The application of biochar to soil is increasingly recognized as a promising method for the long-

term storage of carbon. Research indicates that biochar, which contains carbon levels ranging from 50% to 78%, can sequester substantial quantities of carbon in the soil. The optimal application rate of biochar is suggested to be between 10 to 100 megagrams (Mg) per hectare, potentially resulting in the storage of 7 to 110 gigatonnes of carbon (Lehmann et al., 2009; Novak et al., 2009).

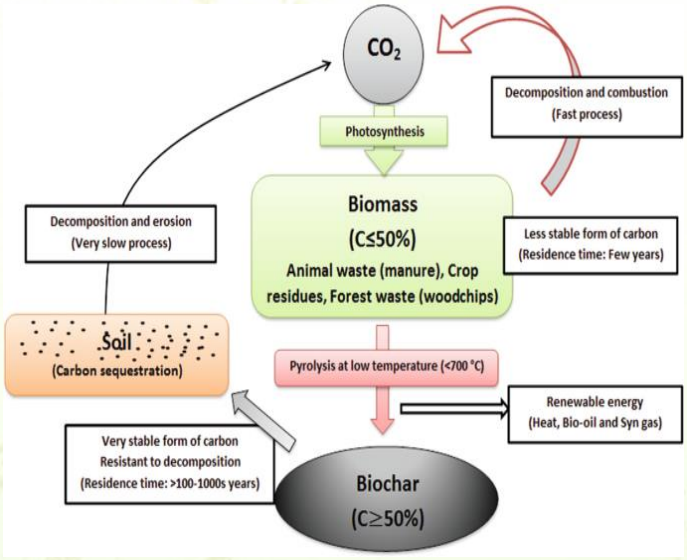


Figure 1 Process of carbon sequestration by biochar (Gupta et al., 2020)

Research indicates that biochar can persist in the soil for up to 1,000 years or longer, effectively functioning as a carbon sink. This remarkable longevity not only enhances its potential for carbon sequestration but also contributes significantly to climate change mitigation efforts while simultaneously improving soil health. By sequestering carbon over extended periods, biochar plays a dual role in fostering sustainable agricultural practices and promoting environmental resilience.

Promotion of Plant Growth: Biochar promotes plant growth by enhancing soil fertility through increased nutrient holding capacity, improved moisture retention, and better soil structure. These improvements create an optimal environment for plant development, leading to increased biomass production. Healthier plants, in turn, have a greater capacity to capture carbon dioxide through photosynthesis, thereby contributing to carbon sequestration and overall ecosystem health.

Reduction of Greenhouse Gas Emissions: The application of biochar has been shown to significantly reduce nitrous oxide (N_2O) emissions from soils, a greenhouse gas with a global warming potential that is substantially higher than that of carbon dioxide. Research indicates that the incorporation of biochar can lead to a reduction in N2O emissions by approximately 30%. This reduction represents a crucial strategy for mitigating the climate change carbon footprint associated with agricultural practices, thereby contributing to more sustainable land management and climate change mitigation.

Soil Microbial Activity: The porous structure of biochar creates an optimal habitat for beneficial soil microorganisms, fostering increased microbial activity that enhances organic matter decomposition and nutrient cycling. This process supports plant growth and, in turn, contributes to carbon sequestration. Research by Lehmann and Joseph (2022) indicates that biochar not only improves soil microbial communities but also facilitates more efficient

nutrient uptake by plants, thereby further enhancing carbon capture in agricultural systems. This interplay between biochar, microbial activity, and plant health underscores the potential of biochar as a valuable tool in sustainable agriculture and climate change mitigation.

Carbon Sequestration and Soil Health Benefits

The primary function of biochar is to sequester carbon; however, its contributions to soil health also plays a significant role in enhancing carbon storage. Research conducted has demonstrated that biochar can improve various soil properties, including soil structure, porosity, and aeration, which in turn promote root growth and water infiltration. Furthermore, biochar enhances nutrient retention and availability, supports microbial activity by providing a habitat for beneficial microorganisms, and helps regulate soil pH, reducing acidity and improving nutrient accessibility for crops. Collectively, these benefits underscore biochar's potential as a sustainable soil amendment that not only facilitates carbon sequestration but also bolsters agricultural productivity.

Improved Nutrient Retention: Research has shown that biochar significantly enhances nutrient retention in soils, increasing the availability of essential nutrients such as nitrogen, phosphorus, and potassium, which are crucial for crop growth. Studies indicate that the application of biochar not only improves nutrient retention but also fosters a more favourable soil environment for plant development. This improved nutrient availability and retention ultimately leads to increased agricultural productivity, highlighting the role of biochar as an effective amendment for enhancing soil fertility and supporting sustainable agricultural practices.

Enhanced Water Retention: Biochar has been shown to significantly enhance the water-holding capacity of soils, which is particularly beneficial for drought-prone regions in India. Research indicates that biochar improves soil structure, increases porosity, and enhances water retention, allowing crops to better withstand periods of dry spells. This capability not only helps in maintaining crop yields but also supports the overall resilience of agricultural systems in areas facing water scarcity. By integrating biochar into farming practices, farmers can enhance their ability to cope with drought conditions, ultimately contributing to food security and economic stability in vulnerable regions.

Soil amelioration: Biochar can effectively neutralize acidic soils, enhancing nutrient availability for plants, which is crucial in regions of India facing soil acidity challenges. Research indicates that biochar application can increase soil pH by 8.48% to 9.25% and significantly reduce exchangeable acidity, aluminum, and hydrogen levels by 56.94% to 94.95%, 34.38% to 95.66%, and 58.72% to 93.27%, respectively (Geng et al., 2022). These findings highlight biochar's potential to improve soil health and enahnce agricultural productivity in acidic environments.

Increased Soil Aeration: Biochar's structural properties improve soil aeration, promoting root growth and microbial activity. This enhancement in soil health leads to better plant growth, allowing plants to sequester more carbon in their roots and rhizospheres. Research shows that biochar application enhances soil structure and boosts carbon sequestration by increasing root biomass and facilitating beneficial microbial interactions (Lehmann et al., 2022).

Agricultural Productivity and Carbon Sequestration Synergy

Agricultural productivity is closely linked to carbon sequestration, and the integration of biochar into farming practices can significantly enhance both. Earlier studies have reported

substantial yield increases following biochar application. For instance, Pietikainen et al. (2000) found that high rates of biochar improved plant responses positively up to 30 t ha^{-1}, after which growth declined for beans. Chan et al. (2008) reported a remarkable 96% increase in radish yields due to biochar from chicken litter, attributing this to improved nitrogen availability. Lehmann and Rondon (2006) found that plant production increases ranging from 20% to 220% based on biochar application rates. Kamara et al. (2015) observed that rice grown in soils amended with rice straw biochar exhibited significantly greater plant height, tiller numbers, and dry weight compared to untreated soils. Abrol et al. (2024) found that a mixture of biochar (10 t ha^{-1}) and synthetic polymer (10 kg ha^{-1}) improved soil properties, enhanced microbial activity, and resulted in better crop growth and economic returns in a rice-wheat system. Additionally, biochar has been shown to mitigate soil erosion and improve infiltration (Abrol et al., 2016). By adopting biochar application, farmers can enhance soil health and productivity, contributing to sustainable agriculture, climate change mitigation, and improved economic resilience.

Economic Implications of Biochar for Carbon Sequestration

For biochar to be widely adopted as a carbon sequestration method, its economic viability is crucial. Utilizing biochar from agricultural waste offers farmers a way to combat climate change while enhancing productivity. Researchers in India recognize biochar's potential in agriculture, and various institutions are focusing on its production and use. The economic feasibility of biochar production relies on investments in pyrolysis technology and infrastructure. State governments and agricultural organizations can support biochar initiatives through financial incentives, grants, or subsidies. Sharma et al. (2024) have outlined various policies and strategies for the sustainable use of biochar in Indian agriculture.

Policy Frameworks

To maximize the carbon sequestration potential of biochar in India, it is imperative to establish robust policies and frameworks that prioritize the development of biochar technology through government investment in research and development. This focus should aim to foster innovation in production methods and applications, while pilot projects funded by the government can demonstrate biochar's effectiveness across diverse agricultural contexts, thereby encouraging broader adoption. Financial barriers faced by farmers can be mitigated through grants or subsidies for biochar production and application, and linking biochar utilization to carbon credit programs can further incentivize its use. Additionally, education and outreach initiatives that raise awareness of biochar's benefits and best practices should be supported by policy measures. Collaborative efforts with countries that have successfully implemented biochar practices can lead to the establishment of standardized methodologies for production and application, ultimately minimizing costs, maximizing benefits, and reducing associated risks. As the Indian government seeks to quantify carbon sequestration in agriculture, integrating biochar into carbon credit programs can provide significant financial incentives, positioning biochar as a crucial component in sustainable agricultural practices and climate change mitigation strategies.

Challenges to Biochar Implementation

Biochar presents numerous benefits for carbon sequestration; however, several challenges must be addressed to ensure its successful implementation. Key challenges include:

Production Consistency: The quality and properties of biochar can vary significantly based on feedstock type and pyrolysis conditions. Establishing standardized production methods is essential to ensure consistent quality and effectiveness for agricultural applications.

Awareness and Education: There is a lack of awareness among farmers and agricultural stakeholders regarding the benefits and best practices for biochar use. Comprehensive education and outreach initiatives are needed to inform and train users on its application.

Market Development: The market for biochar is still developing, and creating demand for biochar products is crucial. This can be achieved through promoting its benefits in soil health, agricultural productivity, and carbon credits.

Long-term Impact Assessment: There is a need for more research on the long-term impacts of biochar application on soil health, crop yields, and carbon sequestration potential. Comprehensive studies can help validate its effectiveness and inform best practices.

Integration with Existing Practices: Biochar must be effectively integrated into existing agricultural practices and systems. This requires collaboration between farmers, researchers, and policymakers to develop strategies that align biochar use with current agricultural methods.

Environmental Concerns: Potential environmental impacts, such as the leaching of harmful substances from biochar, must be thoroughly investigated. Ensuring that biochar production and application are environmentally sustainable is critical for its acceptance.

Addressing these challenges is essential for unlocking the full potential of biochar as a viable solution for carbon sequestration and sustainable agriculture.

Global Perspective on Biochar

Biochar is increasingly recognized globally as an effective strategy for carbon sequestration, and various countries are integrating it into their climate action plans. In Brazil, biochar is incorporated into agroforestry systems, enhancing soil fertility while simultaneously sequestering carbon on degraded lands, thus contributing to both agricultural productivity and environmental restoration. Germany is actively funding research initiatives aimed at developing more efficient biochar production methods and improving its application in agriculture, reflecting a commitment to mitigating climate change through innovation. In the United States, biochar is emerging as a key component of carbon farming strategies, with several states launching programs to promote its production from agricultural residues. These initiatives not only help reduce waste but also serve to sequester carbon, highlighting the multifaceted benefits of biochar in addressing climate challenges. As countries continue to explore and implement biochar solutions, its role in sustainable land management and climate resilience is becoming increasingly prominent on the global stage.

Take away

In conclusion, biochar represents a multi-dimensional solution to the pressing challenges posed by climate change, serving as a crucial amendment to combat global warming. Its capacity to effectively sequester carbon, enhance soil health, and improve agricultural productivity underscores its importance in sustainable farming practices. By integrating biochar into agricultural systems, we can strike a harmonious balance between sustaining ecology and the urgent need for effective carbon management. The time to act is now; investing in biochar research, promoting supportive policies, and educating farmers about its numerous benefits are essential steps toward harnessing biochar as a sustainable and resilient agricultural amendment. Such actions will not only contribute to achieving India’s climate goals but also support

farmers' livelihoods and ensure food security for future generations. Embracing biochar as a vital component of our agricultural landscape will pave the way for a more sustainable and resilient future.

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14. Sweet Profit: Exploring the Uniqueness of Beekeeping In J&K

Devinder Sharma

Abstract

Sweet revolution is an ambitious initiative of the Government of India, which is aimed at promoting apiculture, popularly known as 'beekeeping', for accelerating the production of quality honey and other related products. Beekeeping is a low investment and highly skilled enterprise model, in which technology application has emerged as a great enabler for socio-economic growth. The demand for good quality honey has grown over the years as it is considered a naturally nutritious product. Other apiculture products such as royal jelly, beeswax, pollens, etc., are also used extensively in different sectors like pharmaceuticals, food, beverage, beauty, and others. Scaling up beekeeping will double farmers' income, generate employment, ensure food security and bee conservation, and increase crop productivity and pollination.

Introduction

Bees have been reared by humans since time immemorial and beekeeping is the practise of rearing honey bees in hives for pollination support in crops and production of honey and other hive products like beeswax, pollen, propolis, royal jelly and bee venom, which are commercially marketable and in huge demand for various industrial uses. Beekeeping is an environment friendly activity which can be taken up by people from all walks of life. It involves very little investment and allows time flexibility, but the return is very lucrative and thus is an attractive livelihood option for the unemployed, small scale farmers and can also be taken up as an agro-based activity. Beekeeping offers immense scope for self-employment and indirect employment. It can facilitate the establishment of both small scale cottage industries and large scale commercially viable enterprise. In addition to 4 basic inputs seed, fertilizer & pesticides, water and machinery, honeybees are considered as 5^{th} Input for agriculture which regulates the efficacy of other four inputs. Crop wise yield has been reported to be increased from 2 to 300 times depending upon crop, season and location. Value of additional yield obtained due to bee pollination alone is 15-20 times more than the value of honey & bees wax / hive products put together. In various agricultural and horticultural crops, Honey bee pollination also improves the quality of produce.

Beekeeping industry has quadruple benefits: 1) Producing lakhs of Kg. of honey and beeswax from the nectar of flowers which otherwise dries up and goes waste, 2) Providing employment to forest population, marginal farmers, and landless labourers, 3) Providing employment to rural educated youths in collection, processing and marketing bee-products and finally the most important, 4) Increasing productivity of various crops through bee-pollination. Beekeeping is an ideal eco friendly agro-based subsidized occupation for well to do and margin farmers, farm women, student, In-service and retired personal especially unemployed of the Jammu region with diversified climate and agro climatic condition is one of the most potential area of bee-keeping in the country. This potential has not yet been fully realized this has mainly been due to lack of basic knowledge and skills/trainings and, needed to exploit the honey production potential among the bee-keepers and farmers. Impetus of future growth for the UT of J&K lies with the growth of agriculture and allied sectors. Local self-reliance strategies constitute the

only means of survival for local communities, providing an invaluable basis for reviving local self-reliance and restructuring regional development on more indigenous and self-reliant lines. Beekeeping, it can be argued, is an ecologically and technically appropriate form of income generation for communities in some of the most economically and environmentally poor areas of the state. Its role in promoting economic self-reliance (AtamNirbhar Bharat) and the need to enhance this role has been identified. Although beekeeping can only rarely become the sole source of income and livelihood for people in the state, its role as a source of supplementary earnings, food, and employment should not be underestimated. Integration between Apiculture and Agriculture is essential for mutual benefits and development to pollinate and increase productivity of major crops which are self-sterile and need insect pollination.

Status of apiculture in India

India now has the opportunity to be the 'honey capital' of the world. The fast application of bee products in both traditional and modern medicine has been witnessed in the recent years.India under its fast-pace adoption of Apiculture, has made a mark last year at the global level emerging as a leading (No. 2) honey production country with it production of 133,000 MT after China at 485,960 MT. However, in export, India during 2022 stood at No. 4 with export realize of US$ 229.261 mn (8.7% share) in comparison to China (No. 1 in export, 10.5% share) at US$ 277.671 mn followed by New Zealand (No. 2, 10.1%) at US$ 266.731 mn and Argentina (No. 3, 8.7%) at US$ 229.547 mn. However, in comparison to these three countries, India's net export value in 2022 (US$ 225.5 mn, No. 3) was up by +76.8 per cent compared to 2021 (the highest growth in the world) while China (US$ 206.3 mn, No. 4) was up by +6.8, New Zealand (US$ 265.5 mn, No. 1) by -18.5, and Argentina (US$ 229.4 mn, No. 2) by +7.2 per cent. As per Volza's Export data, honey export shipments from India during the last 10 years stood at 126,742, from 6,027 exporters to 15,393 buyers (USA: 42090, 2343 & 2716, respectively; China: 39782, 4218 & 4858; Argentina: 7763, 135 & 150). As per APEDA, during 2022-23, India exported honey volume of 79,929.17 MT to a total of 76 countries for ₹ 162,277.36 lakh, the maximum export to USA (63,618.63 MT; 79.6%), and about negligible to Europe. The honey market in India was valued at ₹ 23.3 bn in 2022 which is expected to grow at a CAGR of 8.4per cent to ₹ 38.8 bn by 2028.

In context of honey imports in 2022, the USA ranked No. 1, accounting for 31.57 per cent of global honey imports, valued at US$ 794.28 mn with a CAGR of 2 per cent between 2017 and 2021; Germany stood at No. 2 (US$ 314.70 mn, 12.51 % share, CAGR -1%), followed by Japan (US$ 167.67 mn, 6.66 % share, CAGR 5%), France (US$ 140.0 mn, 5.56 % share, CAGR -2%) and UK (US$ 126.57 mn, 5.03 % share, CAGR 0%), in order (China at No. 9). India does import in spite of its high honey production and export, albeit a low volume. In 2022, India imported worth US$ 3.8 mn (US$ 2.1 mn in 2021; up by 80 %) majorly from Spain (for US$ 1.54 mn, 40%), followed by from Bangladesh (US$ 0.705 mn, 18.5 %), USA (*US$ 0.467 mn, 12.2 %)*, UAE (*US$ 0.197 mn, 5.18 %)*, Morocco (*US$ 0.176 mn, 4.69 %*), UK (*US$ 0.126 mn, 3.32 %*), Canada (*US$ 0.117 mn, 3.09 %*), etc. in decreasing order.

Consumption of honey in India, however, has been dismally low as it could not acquire the status of the food item on dining table. It has still been largely known as natural medicine. Per capita annual consumption in India comes to only 37.1 g. The largest honey consumers in terms of total volume are China, USA, Turkey, Iran, Germany, Russia, UK, Japan, France, Spain, Poland, Canada and Italy in decreasing order. Largest per capita per annum consumers are

Turkey (1.3 kg), Canada (1.14 kg), Germany (1.0 kg), Iran (1.0 kg), USA (0.7 kg) and Russia (0.42 kg) in decreasing order. Little knowledge about honey, types, characteristics, standards, etc. and high retail price in India, are inhibitory to the prospective buyers (largely middle class) in the country. The low domestic consumption and the low bulk purchase price available to beekeepers in India (linked to demand, and additionally in particular to the competitive global prices) are attributed to little intervention on research fronts in its value addition, and being linked to export than to domestic market, and further, the export market is a thick cloud, attributed to the lack of research on global honey demand and market, and no open and easy information flow to Indian beekeepers.

Status of apiculture in Jammu and Kashmir

The Union Territory of Jammu and Kashmir having all the agro-climatic zones ranging from low altitude sub tropical, intermediate and temperate offers great potential for both migratory and non-migratory beekeeping. The Union Territory is richly endowed with diverse forest resources which play an important role in preserving the fragile ecosystem of the region and serve as catchments for important Himalayan rivers. Good percentage of forest covers and negligible use of pesticides in cropped land offers the state with vast scope for beekeeping towards producing organic honey and pollen for the world market. Despite its inherent advantages, the JKEDI report reveals that J&K currently imports over Rs. 8.5 million worth of honey annually from other states. This is primarily because the immense potential for beekeeping in the region has not been fully utilized. This supply-demand gap presents a lucrative opportunity for entrepreneurs to tap into the growing market for premium J&K honey, which has a major competitive advantage over other regions due to its high quality and distinct flavor profile.

In Jammu and Kashmir, there are about 4,526 bee keepers having 1,64,955 colonies producing over 23,050.00 of honey worth 5.76 crore every year. The bee pollen is low in calories but rich in proteins, amino acids, vitamins, minerals, enzymes, beneficial fatty acids, carbohydrates, and bioflavonoids which are anti-viral, antibacterial and helpful in lowering cholesterol, stabilising and strengthening capillaries. The average pollen production per hive is between 4-5kg/year costing Rs.750-1000/kg. At a modest estimation, the pollen production potential is more than 825.00 tonnes worth Rs. 11.25 crore. Bee wax is a natural secretion from wax glands on the abdominal sternites of honey bees and is used primarily as a building block for the bees' honeycomb cells in which the young are raised and honey and pollen are stored. The uses of beeswax are found in numerous products, including skin care products, candles, furniture polish, batik-making etc. About 64,000 tons of beeswax were produced in the world, Asia (mainly India) being the major producer with 31,000 tons. The wax yield from beehives is 8-10% of the honey yield. At a modest estimation, the wax production potential of the J&K is more than 200 tonnes worth Rs. 100.00 Lakhs. Royal jelly is the queen bee's extraordinary source of food. It is a blend of secretions from the salivary glands of the worker bee and contains a high concentration of vitamins B5, B6, and amino acids and is believed to be a potent antioxidant a special rejuvenating substance that promotes tissue growth, muscle and cell regeneration. Thepropolis is of vital importance for the survival of the honey bees in the beehive. Because of its antibacterial, antifungal, antiviral, anti-inflammatory and antioxidant effects, propolis has been shown to have outstanding value for a wide variety of illnesses. It is also used as ointments for healing cuts and wounds. Venom is harvested from honey bees for

use in apitherapy, especially for treatment of rheumatism and arthritis. Honey farmers or apiarists have now started extracting the prized "bee venom". In 2023, the global **bee venom extract market** is estimated at US$ 378.0 million. The market is likely to reach nearly US$ 618.6 million by 2033, with a growing CAGR of 5.0% from 2023 to 2033. Protein-rich bee venom, which costs up to Rs 15,000 a gram, is the most sought after resource in the cosmetic and pharmaceutical industry as it is widely used in anti-ageing creams and treatment of severe arthritis. At a meagre rate of 5g bee venom/colony, the J&K has the potential to produce 155kg of bee venom amounting Rs. 232.50 crore.

In a modest rate of 3 Colonies per ha for pollination purpose, the state requires a minimum of 6,45,000 colonies to produce field/ fruits crops. But against this requirement, the state has just 50,000 bee- Colonies -a gap of more than 5-6 times the required numbers. This shows that at present there are just 0.2 colonies / ha against the minimum requirement of 3-5 Colonies/ha. With the appropriate flora, space and demand, the state bee- keeping industry has the potential to flourish and generate employment opportunities easily pursued in the rural settlements.TheDoda, Ramban, Banihal, Kishtwar and Udhampur Districts of Jammu region are the most potential and suitable areas of beekeeping. Though beekeepers are undertaking migration for production, there is a great scope to increase the efficiency and improve honey production. This can be facilitated with knowledge of floral resources and evolving appropriate migration schedules for different beekeeping regions. Important bee-flora of Jammu region include *Plecthranthusrugosus*, *Robiniapseudecica*, *Aesculusindica*, *Dalbergiasisso*, *Acacia modesta*, *Spanidus*spp., *Syzygium*spp., *Toonaciliata*, *R. pseudacacia*, *Eucalyptus* Spp., berseem, Fruit trees and *Brassica* Spp., are the major sources of surplus honey, However, both nectar and pollen are also available from many other species.

Honey and other hive products and their usage

Honey – besides natural sweetener, is an energy elixir and preservative, while in India, it finds its maximum use in Ayurveda and as medicine for cure of common human ailments. It is known for its antioxidants, antibacterial & antifungal and healing properties, in boosting immunity, for digestion, gut health, sore throat and brain benefits. It is also reported as useful in weight management, in nourishing skin and face, boosting memory, natural home remedy for dandruff, and as a natural sleeping aid. Elsewhere in the world, its high consumption has been owing to its usage as a food, including in confectionary, bakery and in wine industry (mead) that makes it a premier hive produce.

Beyond honey, various other hive products, *viz.* bees wax, bee pollen, bee bread, royal jelly, propolis and bee venom greatly widen the scope of Apiculture - the bee and plant origin products elaborated by honey bees find their use in diverse ways in various industries, as food supplements, in pharmaceutical industry, in cosmetic industry, as preservative, disinfectants, etc. and have a great economic value. Depending upon the quality and package size, over the globe, the bees wax price in Indian currency varies between ₹230-1,600/ kg; bee pollen between ₹400-7,000/ kg; royal jelly between ₹2,200-32,000/ kg; propolis between ₹1,300-9,500/ kg and dry bee venom between ₹5,000-22,000/ g.

Government initiatives

The Government of India has a central sector scheme, 'National Beekeeping & Honey Mission (NBHM)' for the overall promotion and development of scientific beekeeping in mission mode to achieve the goal of 'Sweet Revolution'(MithiKranthi) in the country by giving thrust on

capacity building and trainings, specific focus on women, input support for promotion and production, setting up of Integrated Beekeeping Development Centres (IBDCs), other infrastructures, digitization/online registration, etc., processing, value addition, market support, etc.

Jammu and Kashmir government has embarked upon multi-pronged strategies to increase number of bee colonies through cluster formation, encouraging bee-preneurship and bee-startups besides developing infrastructure for post-harvest management, value addition and marketing. Jammu and Kashmir government has launched a Rs 46.65 crore 'Promotion of Beekeeping' project to increase the annual honey production to 6,6100 quintal in the UT. The population of bees will be enhanced by 333 per cent under the 'Promotion of beekeeping' project under HADP will give a big push to honey production in the region. The current system of rearing is less productive with no mechanism for quality improvement. Strengthening and distribution of bee colonies through clusters, Self Help Groups and Farmer Producer Organizations are being focused upon. The after full implementation of the project, the number of bee colonies is expected to increase from 1.43 lakh to 3.085 lakh and the number of beekeepers is also expected to rise from 4,526 to 7,396, and honey production from 23,050 quintals to 66,100 quintals. In addition to honey production, the income from bee by-products such as royal jelly, bee venom, pollen, and wax worth Rs 474 crore per annum will also be realized.

Conclusions

The sweet revolution has created new entrepreneurial avenues and jobs for all farmers and those who are allied with farming. The incentives indeed encourage rural youth to be attached to their roots. This will also lead to women's empowerment. While identifying the colossal demand for unadulterated honey in the market might show that beekeeping and producing honey can be a lucrative business in India now. With increasing demand for honey and honey-based products, both domestically and internationally, Jammu and Kashmir appears to be a fertile ground for a new breed of entrepreneurial beekeepers to establish sustainable apiaries and tap into this sweet and lucrative market opportunity.

15. Mushroom The Farm Profits with Scientific Mushroom Cultivation

Sachin Gupta, Moni Gupta, Upma Dutta, Julie D. Bandral

Mushrooms are regarded as a macro-fungus with a distinctive fruiting body which can be either epigeous or hypogeous and large enough to be seen with the naked eyes and to be picked by hand. Hundreds of identified species of mushrooms, since time immemorial, have made a significant global contribution to human food and medicine. Mushrooms have been a part of the human diet and used as both food and medicine for centuries and their importance is well established in many spheres of human life as well as ecosystem functions. They are known to produce enough amount of protein rich quality food which is of high biological value and appropriate for all age groups. Edible mushrooms are recognized not only as delicacy but also as food in human diet. They are consumed not only for their innate flavour and taste but also for their important nutritional value. Although many myths are associated with consumption of mushrooms, yet they are useful diet for vegetarians because they contain all the essential amino-acid required by an adult. In comparison to animal sources of protein, mushrooms have high protein conversion efficiency per unit of land and per unit time. They are good source of vitamin B, C and D, including niacin, riboflavin, thiamine, and folate.

Mushrooms, being an indoor short season crop and utilizing vertical space, offer a viable solution to a shrinking land base and a limited water supply. The artificial cultivation of mushrooms requires very little expenditure, as numerous cheap and easily available agro wastes can be utilized to grow them. Mushroom cultivation offers a high Benefit:Cost ratio to growers. In India, the total production of mushroom is about 113,315 tonnes, button mushrooms have the majority share (80%), and the remaining share (20%) goes to tropical mushrooms, such as oyster, paddy straw and milky mushrooms.

Mushroom cultivation in India

India, primarily being an agrarian economy, is rich in terms of agro wastes that are not properly utilized by the nation's farmers. Keeping this in view, the availability of abundant agro-wastes and varied agro-climatic conditions are prevalent in the country and mushroom cultivation has great potential as an economic activity and means of societal development with significant remunerative returns. However, mushroom cultivation is yet to be adopted by Indian farmers and mushroom growers on a large scale. The gap in technology knowledge and its adoption needs to be bridged by providing training to farmers regarding various aspects of mushroom cultivation. The enterprise of mushroom cultivation offers employment opportunities for unemployed youth and rural women. The high benefit:cost ratio, the easily obtained and inexpensive agro wastes and congenial weather conditions make adoption of mushroom cultivation a lucrative means of societal development. Initially, mushroom cultivation was restricted to button variety, however situation has changed considerably in the last decade as wide range of mushrooms like Oyster, Milky, Shiitake and other specialty mushrooms like Reishi are also finding favour with the growers. The economic reforms introduced since 1991 and the vastly liberalized foreign trade policy since then, have given a great fillip to this activity. Consequent upon liberalization, the Government of India identified mushroom as a sunrise industry and accorded it 100 percent export-oriented status. Growing domestic and global demand coupled with relatively much higher returns per unit of land than other agricultural

activities has prompted farmers and entrepreneurs to take up this activity. The rapid urbanization, increasing purchasing power and changing dietary habits have also helped in higher demand for mushroom.

Principles of mushroom farming

The commercial production of edible mushrooms represents the unique exploitation of a microbial technology for the bioconversion of agricultural, industrial, forestry and household wastes into nutritious food (mushrooms). Mushrooms have the capacity to breakdown the lignin and utilize it as a food source, thus exposing the underlying cellulose and hemicellulose for food use by other organisms. Thus, mushroom cultivation represents a very basic natural process of fungal decay. Though, different from the conventional farming, basic steps involved in cultivation of any mushrooms follows the similar pattern with little modifications specific to the species chosen for cultivation. The steps involved in mushroom cultivation are as below.

Step -1	Selection of the mushroom species for cultivation
Step-2	Preparation of good quality spawn (mushroom seed)
Step-3	Choosing a suitable growing substrate
Step-4	Substrate preparation either by composting, pasteurization or by sterilization
Step-5	Seeding the substrate with the spawn
Step-6	Maintaining optimal growing conditions such as temperature, moisture, light and CO_2
Step-7	Harvesting, processing and marketing

Selection of mushroom species

Mushrooms which are commonly growing for food and/or medicinal purposes across the India are, white button mushroom (*Agaricus bisporus*), shiitake (*Lentinula edodes*), oyster (*Pleurotus* spp.), paddy straw (*Volvariella volvacea*), milky (*Calocybe indica*) wood ear (*Auricularia polytricha*), winter (*Flammulinavelutipes*) and reishi (*Ganoderma*) mushrooms. Although there has been a considerable research efforts done on cultivation of mushrooms in temperate regions, very few varieties are available that can grow naturally in subtropical and tropical regions of the country. Hence, for choosing a species for commercial cultivation, the grower must consider the following key factors.

i. Availability of waste materials to use as a growth medium – not all the mushrooms can be grown on similar type of substrate. The mushroom species that is able to fruit on the abundantly available agro residues can be chosen.
ii. Environmental conditions - choose a species that fruits at temperatures near your outdoor temperatures. This limits investments in climate control and reduces costs incurred in energy.
iii. Available expertise - some mushrooms are more difficult to grow than others. For beginners it is recommended to select the mushrooms such as oyster or milky which are relatively easy to grow.
iv. Available resources – it is necessary to identify the machinery or growing conditions required for forcing into fruiting stage.
v. Market demand – the product that consumers are willing to buy is the primary driving force for selecting a mushroom species for cultivation

Preparation of good quality spawn

Technically spawn is considered as the mushroom seed. It is prepared from the pure tissue culture obtained from the healthy fruit bodies of mushrooms. This tissue/mycelium is then transferred on a sterilized cereal based substrate such as wheat, jowar, sorgum, paddy, rye etc. to make the mother spawn. Once the grain has been completely colonized by the mushroom mycelium, it can be used to re inoculate the substrate for large scale multiplication which is known as commercial spawn. This grain and mycelium mixture in the form of commercial spawn is used to seed the pasteurized substrate or compost for growing the mushrooms.

Choosing a suitable growing substrate

Substrate is the base material on which mushroom grows and gives the fruiting bodies by utilizing the substrate components. Although some of the mushrooms can be grown on a wide range of materials, for commercial scale production every mushroom species prefers a specific growing medium or substrate. Following is the list of major edible and mushrooms and their substrate suitability.

S.No	Mushroom species	Suitable substrates
1	White button mushroom	Wheat straw, mustard straw, paddy straw, sugar cane bagasse, soya straw
2	Oyster mushroom	Wheat straw, mustard straw, paddy straw, sugar cane bagasse, soya straw, coffee pulp, oilpalm waste, cotton straw
3	Milky mushroom	Paddy straw, wheat straw
4	Paddy straw mushroom	Paddy straw, cotton waste
5	Shiitake mushroom	Sawdust, corncobs, wheat straw
6	Winter mushroom	Sawdust, corn cobs
7	Black ear mushroom	Paddy straw, wheat straw
8	Reishi mushroom	Sawdust, corn cobs
9	Monkey head mushroom	Sawdust, corn cobs
10	Macrocybe mushroom	Paddy straw, wheat straw

Substrate preparation

The substrate selected for growing the specific mushroom species is then composted or pasteruized or sterilized to exclude the other fungi that would compete with the mushroom. The substrate preparation steps helps in avoiding the competition. The method of substrate preparation largely depends on the growth patterns and the enzymatic system of the mushrooms.

Spawning or inoculation

Spawning is a process of addition of freshly prepared grain spawn to the substrate under hygienic conditions. The amount of spawn to be added to the substrate and the methodology to add the spawn (such as through mixing, layer spawning, surface spawning) depends on the mushroom species selected for cultivation. While mixing the spawn it must be ensured that the mycelium grows evenly throughout the substrate.

Maintaining optimal growing conditions

Growing systems should be selected that are best suited to local conditions based on the resources available. The species such as oyster, milky and paddy straw mushrooms can be successfully cultivated on a small-scale, by farmers and other growers who have limited access to resources and vulnerable to risk. It is quite possible for growers to gradually shift from a low-cost system to a higher cost production process, with greater output, when they have gained sufficient skills and income. For cultivation of button mushroom under large-scale commercial methods, it requires significant capital investment to construct the permanent civil structures and to purchase chilling machinery and steam sterilizers.

Marketing of mushrooms:

Annual consumption of mushrooms in India is about 40 grams as against over a kilogram in various countries. There has not been any serious effort to promote the product, to strengthen and expand the market in order to increase its consumption and consequently production. Marketing of mushrooms in India is not yet organised. It is the simple system of producers selling directly to retailer or even to consumer, which has its own limitations. The major quantity of Himachal mushroom is consumed in plains of Punjab, Haryana and Delhi during Oct-Nov and Feb-May or in the local markets catering mainly to the hospitality industry. During Dec-January, the produce from the plain areas also arrives in markets. The middlemen and commission agents collect produce from growers and dispatch to markets/satellite markets or markets outside the state. From consumption trend, it is seen that people of high income group and restaurants catering them are the main buyers of mushrooms. The production of mushrooms, mainly seasonal, has also exacerbated its marketing problems. There have been frequent reports of gluts in North Indian States during the winter months forcing the distress sale of the mushrooms. This reinforces that effort to increase the production without solving its marketing problems, would be counterproductive. The marketing of fresh mushrooms would determine the future of mushroom industry in India. Fresh mushrooms have very short shelf-life, cannot be transported to long distances without refrigerated transport facility and are largely sold in local/ nearby markets in and around production areas. All the problems of marketing is experienced in 2-3 winter months (Dec-Feb) when more than 75% of the annual production comes in market for sale in limited duration and market area. Farmers face the consequences of over-saturated market and are forced to sell their produce at highly un-remunerative prices.

Central Government Initiatives for Mushroom Development

Mission for Integrated Development of Horticulture

Government of India is implementing the Horticulture Mission for North East and Himalayan States (HMNH), as a sub scheme of Mission for Integrated Development of Horticulture (MIDH). As per the approval of GOI, mushroom activity is extended assistance as per the revised cost norms for mushroom production unit, spawn making unit and compost making unit. Both public and private sector are eligible for financial assistance. The cost norms & pattern of assistance under HMNH are briefly given below:-

Production Unit: Rs.20 lakh/unit: The financial assistance to the extent of 100% of the project cost for public sector and 40% for private sector for meeting the expenditure on infrastructure as credit linked back ended subsidy is provided.

Spawn making unit: Rs. 15 lakh/unit: The financial assistance to the extent of 100% of the project cost for public sector and 40% for private sector for meeting the expenditure on infrastructure as credit linked back ended subsidy is provided.

Compost making unit Rs.20 lakh/unit : The financial assistance to the extent of 100% of the project cost for public sector and 40% for private sector for meeting the expenditure on infrastructure as credit linked back ended subsidy is provided.

The other schemes also provides assistance for Post-Harvest Management covering collection, Pre-cooling unit, Cold storage/ CA storage units, Refer vans, Marketing Infrastructure etc., which can be availed for mushroom sector.

National Horticulture Board (NHB)

The scheme relating to establishment of commercial production as well as projects on Post harvest Management and primary processing of products are eligible for assistance as per approved cost norms. The projects for establishment of integrated production unit on Mushroom are extended financial assistance as credit linked backended subsidy @ 50% of project cost limited to Rs.37.50 lakh in Hilly areas. The Board also supports Post Harvest Management projects relating to Pack House, Refer-Van, Retail Outlets, Primary processing etc.,for horticulture produce in project mode as credit linked back-ended subsidy @ 50 % of project cost limited to Rs.72.50 lakh per project in hilly areas.

Agricultural & Processed Food Products Export Development Authority (APEDA)

APEDA was established by the Government of India as a premier organisation assisting in development of export in agricultural and food products in country. A number of schemes have been taken up by APEDA for providing assistance for various beneficiaries/ organizations including R&D, Infrastructure Development, specialised transport units, assistance to exporters / producers, Quality Development etc.

Ministry of Food Processing Industries (MOFPI)

The schemes relating to agriculture, horticulture and food processing are being implemented covering Technology Up-gradation, Establishment/Modernization of Food Processing Industries. In hilly states including NE region, grant–in–aid up to 33.33% of the cost of plant & machinery and technical civil work is provided. The Ministry implements another scheme for construction of Cold Chain, Value Addition and Preservation Infrastructure. The scheme for Mega Food Parks (MFPS) has been launched to provide adequate/excellent infrastructure facilities for food processing along the value chain from the farm to market.

Directorate of Marketing & Intelligence (DMI)

The DMI aims at bringing integrated development of marketing of agricultural and allied produce in the country. Besides other schemes, it implements scheme for development/strengthening of Agricultural Marketing Infrastructure, Grading and Standardization to develop marketing infrastructure in the country to cater to the postharvest requirements of production and marketable surplus of various farm products. The scheme may cover functional infrastructure for collection, drying, cleaning, grading, standardization, SPS (Sanitary &Photo-sanitary) measures and quality certification, labeling, packaging, value addition facilities etc. Mobile infrastructure for post-harvest operations like refrigerated vans used for transporting agricultural produce to maintain cold supply chains are also eligible for assistance under the Scheme.

Small Farmer's Agriculture Consortium (SFAC)

Small Farmer's Agribusiness Consortium (SFAC), a registered society, functioning under Department of Agriculture and Cooperation, Government of India is operating scheme for Agribusiness Development through venture capital assistance and project development facility. The Venture Capital Scheme aims to promote investments in Agri-business projects with the participation of nationalised banks. The venture capital for agribusiness up to 10 % of the total project cost or 26% of the total project equity or Rs. 75 lakh, whichever is lower is made available for the projects in NE & Hilly states. In special cases, higher venture capital can also be considered by SFAC.The Project should provide assured markets to farmers / producer groups.

Rastriya Krishi VikasYojna

An assistance of Rs. 80,000/-for the construction of mushroom house of size 20x12x10 ft, installation of racks in mushroom house, procurement of mushroom kit, tools etc. and pasteurized compost to the registered mushroom growers.

National Bank for Agriculture and Rural Development

NABARD is playing a vital role since its inception in providing credit support to agriculture including production and marketing of horticultural crops. Since 1990s, it has been focusing on horticulture in general and activities like mushroom cultivation in particular with specific objective of providing Off-farm employment opportunities in the rural areas. A number of interventions aimed at augmenting the production of mushrooms have been initiated.

16. Hydroponics and Vertical Farming: The Future is Here

Gurdev Chand, Marvi Sharma

In an era where global challenges such as urbanization, climate change, and food insecurity are increasingly pressing, the agricultural industry faces a pivotal moment. With traditional farming methods straining under the demands of a growing population and environmental pressures, innovations in agricultural technology have become more vital than ever. Enter hydroponics and vertical farming: sustainable, space-efficient, and highly productive solutions that are redefining how we grow our food. The future of agriculture, it seems, has already arrived.

What is Hydroponics?

Hydroponics is a method of growing plants without soil. Instead, plants are cultivated in nutrient-rich water solutions that provide essential minerals directly to the roots. This technique enables plants to grow faster and produce higher yields compared to traditional soil-based farming. It's not new records of hydroponic gardening can be traced back to the ancient Hanging Gardens of Babylon. However, recent advancements have pushed hydroponics to the forefront of sustainable agriculture.

The system works through various setups, including deep water culture, nutrient film technique (NFT), and aeroponics. Each of these has unique advantages tailored to different types of crops. For instance, lettuce and leafy greens thrive in NFT systems, which continuously circulate water and nutrients over the plant roots, ensuring they remain moist and nourished.

The Rise of Vertical Farming

Vertical farming takes the principles of hydroponics and elevates them literally. This innovative agricultural method involves growing crops in stacked layers within controlled environments, often housed in urban settings. By utilizing vertical space, these farms can produce vast quantities of food in compact areas, making them perfect for densely populated cities where traditional farmland is scarce or non-existent. Vertical farms often incorporate cutting-edge technologies such as LED lighting, climate control, and automated watering systems to optimize plant growth. These facilities can precisely regulate temperature, humidity, and nutrient delivery, resulting in consistently high-quality produce. The controlled environment also significantly reduces the risk of pests and diseases, minimizing the need for chemical pesticides and making the food produced safer and more organic.

The Science and Technology behind it

Both hydroponics and vertical farming rely on advances in agricultural science and technology to thrive. Hydroponic systems leverage sensors to monitor water pH levels, temperature, and nutrient concentrations. This data-driven approach allows for real-time adjustments, ensuring optimal growth conditions for plants at all times.LED lighting technology is another game-changer in vertical farming. By tuning the spectrum of light, growers can tailor the intensity and type of light emitted to suit different plant species. Some LED lights are designed to mimic natural sunlight, while others focus on specific wavelengths that boost photosynthesis, accelerating growth rates and improving yields.The integration of artificial intelligence (AI) and automation has also revolutionized these systems. AI algorithms analyze data from sensors to optimize watering schedules, nutrient delivery, and even predict potential problems. Robots

are often used for seeding, harvesting, and packaging, reducing the need for human labor and lowering operational costs.

Benefits of Hydroponics and Vertical Farming

Space Efficiency: One of the most significant benefits of these modern agricultural methods is space efficiency. Vertical farms can produce 10 to 20 times more yield per acre than traditional farms, using only a fraction of the land. This is particularly crucial in urban areas where real estate is at a premium. Hydroponic systems can be set up indoors, on rooftops, or even repurposed warehouses, turning unused spaces into green, productive hubs.

Water Conservation: Agriculture is one of the largest consumers of fresh water globally, accounting for approximately 70% of total use. Hydroponics and vertical farming drastically reduce water consumption by recycling water within closed-loop systems. Unlike soil-based farming, where much water is lost through evaporation and runoff, hydroponics can use up to 90% less water.

Pesticide Reduction: With controlled environments that mitigate the exposure to outdoor pests and diseases, the need for chemical pesticides is minimized. This not only lowers production costs but also results in cleaner, healthier food products that align with the growing consumer demand for organic and pesticide-free produce.

Year-Round Production: Climate change and unpredictable weather patterns are significant challenges for traditional farming. Vertical farms, however, operate independently of the weather, allowing crops to be grown year-round. This constant production cycle can stabilize food supply chains and reduce the impact of seasonal shortages.

Economic and Social Impacts: Hydroponics and vertical farming offer a promising solution for boosting food security, particularly in areas with harsh climates or limited arable land. Countries such as the United Arab Emirates and Singapore have been investing heavily in these technologies to reduce their dependence on food imports.

Job creation is another important aspect. While automated systems reduce the need for manual labor in some areas, new opportunities arise in engineering, programming, and system maintenance. These farms create demand for a workforce skilled in technology and environmental science, which could inspire educational programs and career shifts. However, critics point out the high initial costs of establishing vertical farms and hydroponic systems as a barrier for widespread adoption. The advanced technology required, including LED lights, sensors, and water systems, can be expensive. To tackle this, many start-ups and organizations are working on making this technology more affordable through government subsidies, partnerships, and innovations in cost-effective design.

Hydroponic Structures and Their Operation

Hydroponic system iscustomized and modified according to recycling and reuse of nutrient solution and supporting media. Commonly used systems are wick, drip, ebb-flow, deep water culture and nutrient film technique (NFT) which are described below.

1.1 Wick System

This is simplest hydroponic system requiring no electricity, pump and aerators (Shrestha and Dunn, 2013). Plants are placed in an absorbent medium like coco coir, vermiculite, perlite with a nylon wick running from plant roots into a reservoir of nutrient solution. Water or nutrient solution supplied to plants through capillary action. This system works well for small plants, herbs and spice and doesn’t work effectively that needs lot of water (Fig. 1).

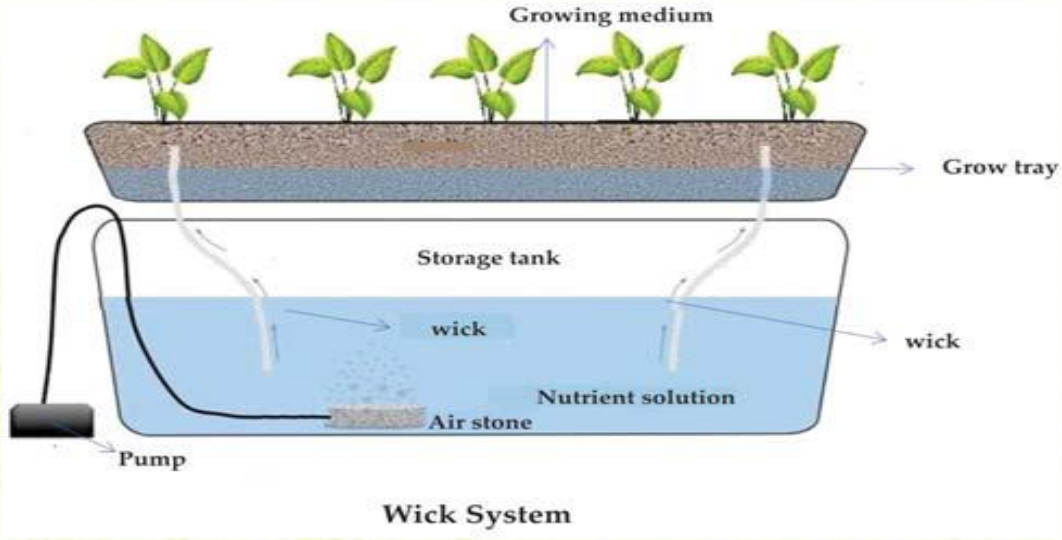

Figure 1: Wick System

1.2 Ebb and Flow system

This is first commercial hydroponic system which works on the principle of flood and drain. Nutrient solution and water from reservoir floodedthrough a water pump to grow bed until it reaches a certain level and stay there for certain period of time so that it provides nutrients and moisture to plants. Besides, it is possible to grow different kinds of crops but the problem of root rot, algae and mould is very common (Nielsen *et al*., 2006) therefore, some modified system with filtration unit is required (Fig. 2).

1.3 Drip system

The drip hydroponic system is widely used method among both home and commercial growers. Water or nutrient solution from the reservoir is provided to individual plant roots in appropriate proportion with the help of pump (Rouphael and Colla, 2005).

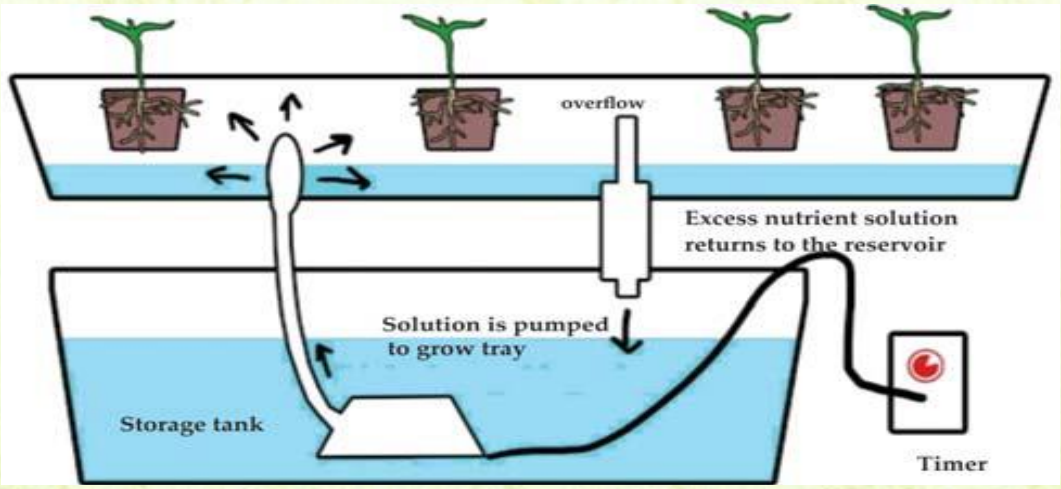

Figure 2: Ebb and Flow System

Plants are usually placed in moderately absorbent growing medium so that the nutrient solution drips slowly. Various crops can be grown systematically with more conservation of water (Fig. 3).

1.4 Deep water culture system

In deep water cultures, roots of plants are suspended in nutrient rich water and air is provideddirectly to the roots by an air stone. Hydroponics buckets system is classical example of this system. Plants are placed in net pots and roots are suspended in nutrient solution where they grow quickly in a large mass. It is mandatory to monitor the oxygen and nutrient concentrations, salinity and pH (Domingues *et al.*, 2012) as algae and moulds can grow rapidly in the reservoir. This system works well for larger plants that produce fruits especially cucumber and tomato, grow well in this system (Figure 4).

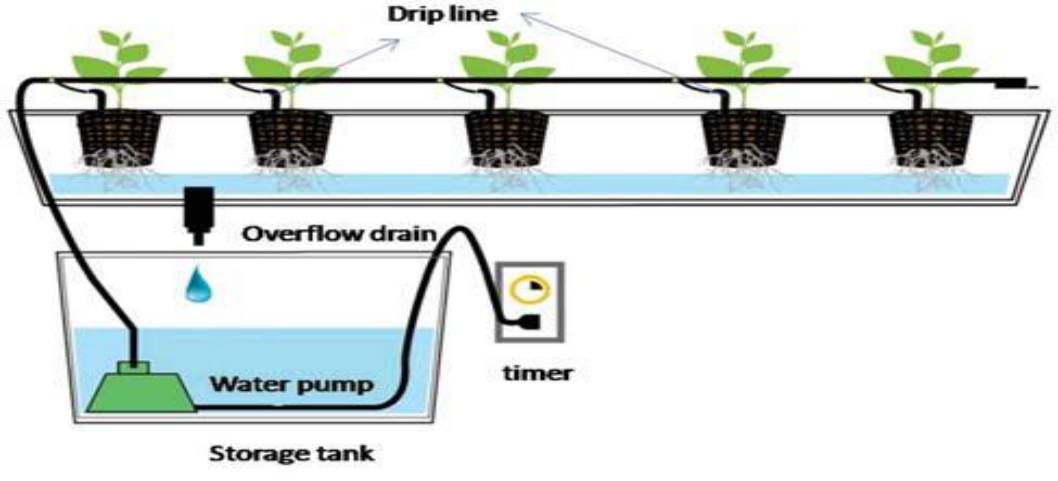

Figure 3: Drip system

1.5 Nutrient Film Technique (NFT) system

NFT was developed in the mid-1960s in England by Dr. Alen Cooper to overcome the shortcomings of ebb and flow system. In this system, water or a nutrient solution circulates throughout the entire system; and enters the growth tray via a water pump without a time control (Domingues *et al.*, 2012). The system is slightly slanted so that nutrient solution runs through roots and down back into a reservoir. Plants are placed in channel or tube with roots dangling in a hydroponic solution. Although, roots are susceptible to fungal infection because they are constantly immersed in water or nutrient. In this system, many leafy green can easily be grown and commercially most widely used for lettuce production (Fig. 5).

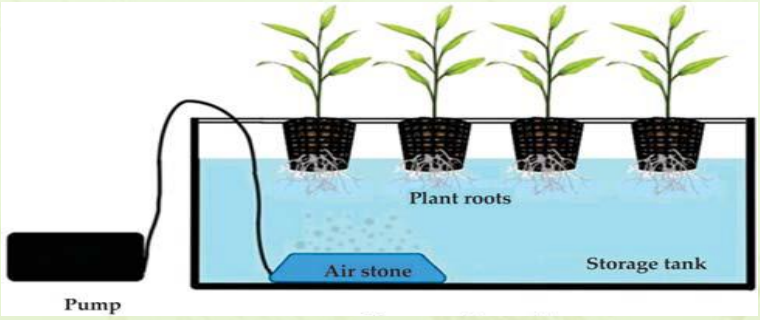

Figure 4: Deep water culture system

Real-Life Examples: Success Stories

Several companies around the world have set impressive benchmarks in the field of hydroponics and vertical farming. AeroFarms in New Jersey, USA, boasts one of the largest vertical farms globally. The company uses aeroponicsa variant of hydroponics where plants are

grown in a mist environmentresulting in up to 390 times more productivity per square foot compared to traditional farming.

Singapore's Sky Greens operates Asia's first commercial vertical farm, using a patented hydraulic system that rotates stacks of vegetable beds to maximize light exposure. This innovation not only conserves water and energy but also produces a high volume of fresh vegetables in a limited space.

In Europe, in-farm has been a leader in deploying small-scale vertical farms directly inside supermarkets and restaurants. This proximity shortens the farm-to-table journey, offering ultra-fresh produce and significantly cutting down on carbon emissions related to transportation. Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST) Jammu has emerged as a significant centre for agricultural research and education in India. One of the standout success stories at SKUAST Jammu is the implementation and advancement of hydroponic farming practices, a game-changer in the region's agricultural landscape. Here's a detailed look into how this innovative approach is reshaping farming in Jammu.

The Hydroponics Initiative at SKUAST Jammu

The agricultural sector in Jammu faces unique challenges due to varying climate conditions, limited fertile land, and water scarcity. Recognizing the potential of hydroponics to address these issues, SKUAST Jammu embarked on developing and promoting this soil-less farming technique. The university established research units dedicated to hydroponics to explore its feasibility and benefits for local farmers. Hydroponics and vertical farming signify a bold leap forward in how humanity can sustainably grow food in the face of mounting challenges. While the technology is still evolving and has hurdles to overcome, its benefits in terms of efficiency, sustainability, and year-round production are undeniable. The future of farming is here, built vertically and flourishing without soil, redefining what it means to cultivate a greener world.

1. **Achievements and Innovations**

SKUAST Jammu's hydroponics program has been a beacon of innovation and success. The University's research and demonstration projects have showcased the following achievements:

2. **Pilot Projects for Local Farmers:** SKUAST initiated pilot hydroponic projects that allowed local farmers to witness first-hand how crops could be grown efficiently without soil. These projects included vegetables like lettuce, spinach, and herbs, which are well-suited to hydroponic systems. The success of these pilot programs has encouraged farmers to adopt this technology in their practices.

3. **Development of Cost-Effective Systems:** One of the significant challenges in hydroponics is the high initial setup cost. SKUAST Jammu focused on developing affordable hydroponic setups that utilize locally available materials. By creating cost-effective models, the University made it easier for small and medium-sized farmers to implement these systems without financial strain.

4. **Training and Workshops:** SKUAST Jammuhas hosted numerous workshops and training sessions to educate farmers and students on the fundamentals of hydroponic farming. These sessions cover aspects such as nutrient management, water recirculation techniques, and plant health monitoring, equipping participants with the knowledge needed to maintain and expand their hydroponic systems.

5. **Collaborations and Funding:** The University has successfully collaborated with various government bodies and private stakeholders to secure funding and technological

support. These partnerships have facilitated the expansion of hydroponic research and provided more comprehensive support for local agricultural development.

Despite its numerous advantages, hydroponics and vertical farming are not without challenges. Energy consumption, particularly from LED lighting, is a major concern. While these farms use less water, they can be energy-intensive, especially in areas with high electricity costs. Renewable energy integration and energy-efficient designs are crucial to making these systems truly sustainable.

The global market for vertical farming and hydroponics is expanding rapidly. According to market research, the industry is expected to grow at a compound annual growth rate (CAGR) of over 20% in the next decade. Governments, investors, and innovators are all taking note. The European Union has launched initiatives supporting urban farming, while cities like Tokyo and New York are seeing a boom in rooftop and community-based hydroponic projects.

Technology continues to evolve, with innovations such as solar-powered farms and nutrient-rich biodegradable growing media poised to push the industry further. Collaborations between tech companies and agricultural experts are expected to yield more efficient systems, making them accessible to smaller-scale farmers and communities around the world.

Benefits and Limitations of Hydroponics

Recently hydroponic technique is becoming popular because this is clean and relatively easy method and there is no chance of soil-borne disease, insect or pest infection to the crops thereby reducing or eliminating use of pesticides and their resulting toxicity. Besides, plants require less growing time as compared to crop grown in field and growth of plant is faster as there is no mechanical hindrance to the roots and the entire nutrient are readily available for plants. This technique is very useful for the area where environmental stress (cold, heat, dessert etc) is a major problem (Polycarpou*et al.*, 2005).

Crops in hydroponic system are not influenced by climate change therefore, can be cultivated year-round and considered as off season (Manzocco*et al*., 2011).Further, commercial hydroponic systems are automatically operated and expected to reduce labour and several traditional agricultural practices can be eliminated, such as weeding, spraying, watering and tilling (Jovicich*et al*., 2003).

Figure 5: NFT system displayed in the Division of plant Physiology, Faculty of Basic Sciences, SKUAST Jammu, Chatha**.**

Ten feet long and 4 inch PVC pipes may be used to create hydroponics system. In this plan, the plants are placed in cups which are arranged in holders drilled into the pipes. The system is watered using a reservoir and pump. This is a closed system, with the water circulating between the pipes and the reservoir. This plan is ideal for growing a lot of small plants within a small area. The basic system can house anywhere from 45 plants of nine pipes. This system can be placed indoors or outdoors. If indoors, grow lights are of course essential. The hydroponics method used in this plant is called NFT. It is an excellent plan for growing plants like tomatoes, brinjal and mostly leafy vegetables.

Table 3. Percentage of water and fertilizer consumption, vegetables yield percentage and the percentage of water productivity for different hydroponic systems as compared with conventional farming system (AlShrouf, 2017) vegetables, nowadays strawberry and different cut flowers are commercially grown under various hydroponic systems.

Parameters	Hydroponic system			
	Media soilless system		Nutrient solution system	
	Open	Closed	Open	Closed
% Irrigation water saving	80	85	85	90
% Fertilizer saving	55	80	68	85
% Productivity increase	100	150	200	250
% Water productivity	1000	1600	2000	3500

Water Conservation Through Hydroponic System

As water becomes scarce and important as a resource, the use of hydroponics and other water saving technologies for crop production is needed now and is poised to popularize in time. Hydroponics uses substantially less water as compared to the soil farming. In soil farming, most of the water that we supply to the plants gets leached deep into the soil and is unavailable to the plants roots, whereas in hydroponics, plant roots are either submerged in water or a film of nutrients mixed in water is constantly encompassing the root zone, keeping it hydrated and nourished. Water is not wasted in this process, as it gets recovered, filtered, replenished and recycled. Waste nutrient solution can be used as an alternate water resource for crop cultivation under hydroponic system (Choi *et al.,* 2012). Savings in irrigation water, fertilizer and increase in vegetable and water productivity under hydroponic system as compared to conventional agriculture is depicted in Table 3. NFT based hydroponics can reduce irrigation water usage by 70% to 90% by recycling the run-off water. It is possible to effectively grow high value, good-quality vegetables under controlled hydroponic conditions using 85 to 90% less water than traditional soil based production. Water sources from groundwater or dam/river water commonly contain factors that can influence plant yield and affect plant condition, including salinity, dissolved solids and pathogens. While some of these factors can be beneficial to crops, others need to be minimized.

Conclusion: Farming Beyond Tomorrow

Hydroponics and vertical farming signify a bold leap forward in how humanity can sustainably grow food in the face of mounting challenges. While the technology is still evolving and has hurdles to overcome, its benefits in terms of efficiency, sustainability, and year-round production are undeniable. The future of farming is here, built vertically and flourishing without soil, redefining what it means to cultivate a greener world. In recent years hydroponics

is seen as a promising strategy for growing different crops. As it is possible to grow short duration crop like vegetables round the year in very limited spaces with low labour, so hydroponics can play a great contribution in areas with limitation of soil and water and for the poorer and landless people. In India, the hydroponic industry is expected to grow exponentially in near future. To encourage commercial hydroponic farm, it is important to develop low-cost hydroponic technologies that reduce dependence on human labour and lower overall startup and operational costs and same low-cost system have been replicated first time in Jammu and Kashmir at SKUAST Jammu, Chatha.

Future Prospectives

As the world population continues to grow, the challenge is to produce more food whilst being more sustainable. To assist with this, more technologies are coming into play. Hydroponic technology, which allows producers to grow plants without soil, will be another option for Indian people for sustainable conditions.

17. Industry-Academia Linkages: The New Education Regime

Sanjay Guleria

The 21st century is marked by swift technological progress, transforming global economies, and a world that is increasingly interconnected. Within this dynamic environment, education systems across the globe are being urged to reconcile academic learning with the needs of industry. The establishment of industry-academia partnerships has become a vital element of the contemporary educational framework, aimed at harmonizing the theoretical foundations of academia with the practical requirements of the business sector. These partnerships not only improve students' employability but also promote research, innovation, and development, thereby enhancing the resilience and preparedness of economies for the future.

As educational policies evolve to address these emerging demands, particularly through initiatives such as India's National Education Policy (NEP) 2020, the integration of industry-academia collaborations is becoming central to higher education. These partnerships align the objectives of educational institutions with the expectations of industry, contributing to the development of a skilled and versatile workforce. This article delves into the various aspects of industry-academia collaborations, the influence of NEP 2020 in promoting these alliances, their advantages, challenges, models, and their significance in fostering a sustainable future.

1. The Foundation of Industry-Academia Linkages

Industry-academia collaborations, often referred to as Industry-Education Collaborations (IEC), involve partnerships between educational institutions and the industrial sector aimed at harmonizing educational objectives with the changing needs of the job market. These collaborations can manifest in various ways, including joint research projects, industry-funded internships, curriculum enhancement, faculty exchange initiatives, and innovation laboratories. By nurturing these partnerships, educational institutions can provide students with essential practical skills, while industries gain access to innovative ideas and a well-prepared workforce.Such collaborations address a significant need in contemporary education: the development of graduates who are not only knowledgeable in theory but also equipped with practical competencies. The disconnect between academic programs and industry expectations often leads to a skills gap, hindering graduates' ability to enter the workforce effectively. Industry-academia collaborations thus play a pivotal role in integrating real-world experiences into academic education and promoting a culture of ongoing learning and innovation.

2. The Role of NEP 2020 in India's Educational Reforms

India's National Education Policy (NEP) 2020 has acknowledged the critical role of fostering industry-academia connections within the higher education framework. This policy advocates for a significant transformation in the delivery of higher education, promoting a multi-disciplinary, adaptable, and skill-focused methodology. It underscores a comprehensive development model aimed at equipping students to tackle future challenges while concentrating on the cultivation of a skilled and employable workforce.

Key Features of NEP 2020 Enhancing Industry-Academia Connections

1.Curriculum Flexibility: NEP 2020 promotes a flexible and multi-disciplinary curriculum that offers various entry and exit points, enabling students to develop a broad range of skills.

2.Skill Enhancement Programs: The policy introduces initiatives aimed at cultivating contemporary skills in high-demand sectors such as Artificial Intelligence (AI), Internet of Things (IoT), data science, robotics, and cybersecurity, ensuring alignment with industry needs.

3. Internship and Apprenticeship Integration: NEP 2020 requires educational institutions to incorporate internships and practical training into their programs, providing students with valuable hands-on experience that enhances their employability.

4. Emphasis on Research and Development (R&D): By establishing the National Research Foundation (NRF) to finance research initiatives, NEP encourages innovation through collaboration between educational institutions and industries on research endeavours that address real-world issues.

5. Inclusion of Vocational Education: The policy integrates vocational education into the academic curriculum, effectively bridging the divide between traditional education and the skill-based training demanded by industries.

6. Credit-based Learning through the Academic Bank of Credits (ABC): NEP introduces a credit-based framework that facilitates learning across institutions and promotes student mobility, allowing for the accumulation and transfer of credits earned through internships and industry-related projects.

The focus of NEP 2020 on strengthening industry-academia connections is pivotal for the future of higher education in India.

3. Benefits of Industry-Academia Linkages

Industry-academia partnerships offer numerous advantages for students, educational institutions, and industries collectively.

3.1 For Students

1. Practical Experience: These collaborations enable students to tackle real-world challenges through internships, projects, and live case studies, thereby providing practical experience and improving their problem-solving skills.

2. Development of Relevant Skills: Such linkages furnish students with skills pertinent to the industry, equipping them to confront workplace challenges and adapt to industry norms upon graduation.

3. Networking and Career Prospects: Internships and industry-related projects afford students significant networking opportunities, facilitating the establishment of professional connections that can be crucial for career progression.

4. Improved Employability: Students who possess industry experience are more likely to obtain employment due to their practical skills and familiarity with professional settings, thereby minimizing the need for extensive training when entering the workforce.

3.2 For Academia

1. Revitalized Curriculum Development: Input from industry stakeholders allows educational institutions to modify and enhance their curricula, ensuring alignment with contemporary market needs and increasing the relevance of the educational experience.

2. Augmented Financial Support and Resources: Collaborations with industry frequently result in additional funding for research initiatives, laboratory enhancements, and infrastructure improvements, thereby elevating the educational and research standards of the institutions.

3. Opportunities for Research and Development: Partnerships with industry stimulate research and development efforts within academic settings, promoting investigations that tackle real-world challenges and contribute to technological progress.

4. Enhanced Prestige and Acknowledgment: Institutions that maintain robust connections with industry typically benefit from an elevated status, as these partnerships highlight the institution's dedication to delivering high-quality education and producing graduates who are well-prepared for employment.

3.3 For Industry

1. Access to New Talent and Innovative Ideas: Collaborating with students and academic professionals allows industries to gain new insights and creative solutions, which can stimulate innovation and potentially lead to the development of novel business concepts or technologies.

2. Decreased Recruitment and Training Expenses: Industries can take advantage of a workforce comprised of well-prepared graduates who are ready for employment, thereby minimizing the costs associated with recruitment and training processes.

3. Research Partnerships: Industries have the opportunity to utilize the research capabilities of academic institutions for exploratory and experimental initiatives that might be prohibitively expensive to pursue on their own.

4. Strengthened Corporate Social Responsibility (CSR): Partnering with educational organizations enables industries to meet their CSR commitments by actively contributing to educational advancement and skill development.

4.Challenges in Establishing Effective Industry-Academia Linkages

While industry-academia collaborations offer numerous benefits, they are accompanied by several challenges.

4.1 Inflexibility of Curriculum

A significant barrier to creating effective linkages is the inflexible nature of academic curricula, which often restricts the incorporation of new courses or technologies aligned with industry needs. The process of updating curricula to keep pace with the rapidly changing demands of the industry can be complicated by institutional procedures and the necessity for regulatory approvals.

4.2 Differences in Culture

The operational frameworks of academia and industry are inherently distinct. Academia tends to emphasize theoretical knowledge, long-term research endeavours, and academic freedom, whereas industry focuses on practical solutions, efficiency, and quick results. Overcoming these cultural disparities necessitates a mutual understanding and a collaborative approach from both parties.

4.3 Resource Limitations

Numerous institutions, particularly in developing countries, encounter financial and infrastructural limitations. They may lack essential facilities, software, or other resources required to equip students with training in advanced technologies such as artificial intelligence, the Internet of Things, and robotics, which impedes effective collaboration.

4.4 Shortage of Faculty in Emerging Fields

There is a notable deficiency of qualified faculty in rapidly evolving domains such as machine learning, big data analytics, and biotechnology. The absence of skilled instructors makes it

challenging for institutions to provide comprehensive programs that align with industry standards.

4.5 Insufficient Industry Engagement

Certain industries may not prioritize collaboration with academic institutions, particularly if they perceive a lack of immediate returns on investment. To foster active and ongoing engagement, it is essential for institutions to illustrate the long-term advantages of such partnerships.

5. Models of Industry-Academia Linkages

Throughout the years, a variety of models have emerged to enhance partnerships between industry and academia, each offering distinct advantages and focal points.

5.1 Collaborative Research and Development Centers

Collaborative research and development centres are formed through alliances between industrial entities and academic institutions, typically concentrating on specific domains such as biotechnology, materials science, or data analytics. These centres merge academic knowledge with industrial resources to stimulate innovation, leading to the creation of new products or processes.

5.2 Corporate-Backed Skill Development Programs

Industries collaborate with academic institutions to create and execute skill development initiatives that correspond with the current and anticipated needs of the workforce. These initiatives encompass training modules, laboratories, and workshops led by industry experts, aimed at closing the skills gap.

5.3 Internship and Apprenticeship Programs

Internships and apprenticeships offer students practical work experience. These programs are frequently integrated into the academic curriculum, with industry partners providing structured, hands-on training that corresponds with the students' areas of study.

5.4 Incubation Centers and Start-Up Ecosystems

Incubation centres located within academic institutions promote entrepreneurship and innovation, often in partnership with industry mentors and investors. These centres enable students and faculty to commercialize their ideas by establishing start-ups, offering resources, networking opportunities, and funding.

5.5 Faculty Exchange Programs

Certain institutions promote faculty engagement in industry environments or invite industry professionals to deliver specialized courses. This exchange enriches academia with practical insights while allowing industry experts to gain exposure to the academic setting.

5.6 Industry-Sponsored Competitions and Hackathons

Competitions and hackathons present students with the chance to tackle industry-specific challenges, fostering creativity and innovation. These events serve as a platform for students to apply their knowledge in real-world scenarios.

Conclusion

In the current fast-changing global environment, the integration of academia and industry is crucial for developing a workforce that is both proficient and versatile. The connections between industry and academia represent a revolutionary strategy in higher education, tackling the growing disparity between theoretical understanding and the practical competencies required in today’s job market. These collaborations not only improve students' employability

but also cultivate a culture of innovation, joint research, and lifelong learning, which are vital for adapting to technological progress and market changes. Initiatives such as NEP 2020 in India, which focuses on adaptable curricula, skill enhancement, and holistic learning, are laying a robust groundwork for industry-academia partnerships. Such policies guarantee that the workforce is prepared for the future, possessing both the technical skills and interpersonal abilities essential for success across various fields.

The advantages of these partnerships are extensive, ranging from hands-on learning and networking prospects for students to enhanced research capabilities and lower recruitment expenses for businesses. Nevertheless, challenges persist, including rigid curricula, cultural disparities, and limited resources. By overcoming these obstacles, educational institutions and industries can forge strong, sustainable alliances that benefit students, educational entities, businesses, and society at large.

Way Forward

To maximize the benefits of collaborations between industry and academia, several proactive measures can be implemented:

1. Curriculum Adaptation and Flexibility: Educational institutions should strive to create a more flexible curriculum framework that allows for the swift incorporation of emerging technologies, industry-specific courses, and skill-oriented training. Regular consultations with industry stakeholders can assist in aligning curricula with both current and anticipated market needs.

2. Enhancing Faculty Expertise in Emerging Domains: Institutions must prioritize the professional development of current faculty and the recruitment of specialists in areas such as artificial intelligence, machine learning, and the Internet of Things.

3. Utilizing Technology for Education and Research: Institutions can leverage digital resources, virtual laboratories, and online platforms to address resource constraints, especially in economically challenged areas.

5. Enhancing Regulatory and Policy Frameworks: Simplifying regulatory procedures to enable faster updates to curricula, approvals for collaborative research centres, and the effective implementation of programs like internships and apprenticeships, ensuring that policies evolve in tandem with industry developments.

6. Fostering an Innovative Culture through Incubators: The establishment or enhancement of incubation centres and entrepreneurship initiatives within educational institutions can motivate students and faculty to transform innovative concepts into practical business solutions. Collaboration with the industry for mentorship, funding, and networking is crucial for the sustainability of these centres.

Through the promotion of mutual understanding, the alignment of objectives, and the establishment of flexible and adaptive frameworks, collaborations between industry and academia have the potential to transform education, bolster economic resilience, and cultivate a skilled and innovative workforce capable of addressing the challenges of a constantly evolving world.

18. Solar Power Revolution in Indian Agriculture: PM-KUSUM Yojana

Prem Kumar and Punit Choudhary

The PM-KUSUM Yojana seeks to achieve multiple objectives:

1. **Enhancing Farmers' Income**: By allowing farmers to generate solar power and sell the surplus to the grid, the scheme provides an additional source of income, thereby improving their financial stability.
2. **Ensuring Energy Security**: The scheme aims to reduce farmers' dependence on grid electricity and diesel for irrigation purposes, ensuring a consistent and reliable energy supply.
3. **Promoting Sustainable Agriculture**: By encouraging the use of clean energy, the scheme supports environmentally sustainable agricultural practices.
4. **Rural Electrification**: The scheme contributes to the broader goal of rural electrification, ensuring that even remote areas have access to reliable power.

Components of PM-KUSUM Yojana

The PM-KUSUM Yojana is divided into three main components:

1. **Component A: Ground-Mounted Solar Power Plants**

   This component aims to install 10,000 MW of decentralized ground-mounted grid-connected renewable power plants. Farmers, cooperatives, panchayats, and Farmer Producer Organizations (FPOs) are encouraged to set up solar power plants on barren or fallow lands. These plants generate electricity, which is fed into the grid. Farmers earn income by selling this power to distribution companies (DISCOMs). This component helps utilize unused land resources, generates clean energy, and provides financial benefits to landowners.
2. **Component B: Standalone Solar Agriculture Pumps**

   The installation of 17.50 lakh standalone solar agriculture pumps to replace existing diesel pumps and grid-connected electric pumps. Farmers receive financial assistance to install solar-powered pumps. These pumps operate independently of the grid, providing reliable and cost-effective water supply for irrigation. This component reduces the dependency on fossil fuels, minimizes operational costs, and ensures consistent water supply for farming activities.
3. **Component C: Solarization of Grid-Connected Agriculture Pumps**

   This component focuses on solarizing 10 lakh grid-connected agriculture pumps. Existing electric pumps are integrated with solar panels, allowing them to function using solar energy. Farmers can use solar power for irrigation and sell any surplus energy to the grid. Enhances energy efficiency, ensures reliable power supply, and promotes the use of renewable energy in agriculture.

Financial Support and Implementation

To encourage widespread adoption, the PM-KUSUM Yojana offers significant financial support to farmers:

- Subsidies: The scheme provides up to 80% subsidy from the central and state governments. Additionally, farmers can avail bank loans to cover the project cost, with the remaining 10% being the farmer's contribution.

- Income Generation: Farmers can earn additional income by selling surplus solar power to the grid. This helps in enhancing their overall financial security.
- Cost Savings: The use of solar pumps reduces dependence on diesel and grid electricity, leading to substantial cost savings in the long run.

Impact on the Agricultural Sector

The PM-KUSUM Yojana has a profound impact on the agricultural sector:

1. Economic Benefits: By providing an additional source of income, the scheme helps in improving the financial stability of farmers. The revenue generated from selling surplus solar power can be reinvested in agricultural activities, thereby boosting productivity.
2. Energy Security: The scheme ensures a reliable and uninterrupted power supply for irrigation, reducing the dependency on erratic grid supply and expensive diesel generators.
3. Environmental Sustainability: By promoting the use of renewable energy, the scheme contributes to reducing greenhouse gas emissions and mitigating climate change. It encourages sustainable farming practices that are less harmful to the environment.
4. Rural Development: The PM-KUSUM Yojana supports rural electrification, ensuring that even remote areas have access to reliable power. This helps in improving the overall quality of life in rural communities.

Challenges and Mitigation Strategies

Despite its numerous benefits, the implementation of the PM-KUSUM Yojana faces several challenges:

1. High Initial Costs: The upfront cost of solar installations can be a significant barrier for many farmers. To mitigate this, the government provides attractive subsidies and financial assistance. Efforts are being made to streamline the application and approval processes to ensure that more farmers can benefit from the scheme.
2. Maintenance and Technical Support: Maintaining solar installations and providing technical support in remote areas can be challenging. To address this, the government is establishing support networks and training programs to ensure that farmers have access to the necessary technical expertise.
3. Awareness and Training: Educating farmers about the benefits and technical aspects of solar energy is crucial for the successful implementation of the scheme. Extensive awareness campaigns and training sessions are being conducted to ensure that farmers are well-informed and capable of managing their solar installations.
4. Policy and Regulatory Challenges: Ensuring seamless coordination between various stakeholders, including government agencies, DISCOMs, and financial institutions, is essential for the smooth implementation of the scheme. Continuous policy updates and regulatory support are necessary to address emerging challenges.

Case Studies and Success Stories

Several success stories have emerged from the implementation of the PM-KUSUM Yojana, highlighting its positive impact on farmers' lives and the environment:

1. Case Study 1: Solar Pumps in Rajasthan
    - In the arid regions of Rajasthan, farmers have benefited immensely from the installation of standalone solar pumps. These pumps have ensured a reliable

water supply for irrigation, even in remote areas, leading to improved crop yields and reduced dependency on diesel pumps.

2. Case Study 2: Ground-Mounted Solar Plants in Maharashtra
    - Farmers in Maharashtra have successfully set up ground-mounted solar power plants on barren lands. By selling the surplus power to the grid, they have generated additional income, which has been reinvested in agricultural activities, leading to overall economic improvement.
3. Case Study 3: Solarization of Grid-Connected Pumps in Punjab
    - In Punjab, the solarization of grid-connected pumps has ensured a consistent and reliable power supply for irrigation. Farmers have benefited from reduced electricity bills and the ability to sell surplus power, enhancing their financial stability.

Future Prospects

The PM-KUSUM Yojana holds immense potential for the future of Indian agriculture. As the adoption of solar energy continues to grow, the scheme is expected to play a pivotal role in transforming the agricultural sector. The government's continuous efforts to address challenges and provide financial and technical support will ensure the successful implementation of the scheme.

Conclusion

The PM-KUSUM Yojana is a visionary step towards integrating renewable energy with agriculture in India that aligns with India's goals of achieving energy independence, promoting sustainable agricultural practices, and improving the livelihood of its farming community. By integrating solar energy with agriculture, the scheme not only enhances farmers' income but also contributes to environmental conservation and rural development. As India moves towards a greener and more sustainable future, the PM-KUSUM Yojana is set to play a pivotal role in transforming Indian agriculture, making it more resilient, profitable, and sustainable.

19. Digital Innovations in Agriculture

Vinod Gupta, Karukumalli Sindhura

Introduction

Agriculture is the backbone of Indian economy, with nearly half of its workforce engaged in agriculture and allied sectors, providing livelihoods for millions of people, especially for small and marginal farmers. The demand for food as well as for other ecosystem services provided by the agricultural sector is increasing (FAO, 2018). At the same time, the agricultural production potential is under strong pressure,due to certain factors like climate change and soil degradation (Borrelli and Finger, 2020).Inspite of these factors, digitalization is rapidly transforming entire societies, including the agri-food sector, and agriculture is now undergoing its 'fourth revolution' (Walter et al., 2017).Digital agriculture encompasses a wide array of technologies and tools aimed at transforming traditional farming by leveraging data to enhance productivity, minimize environmental impact, and create more resilient food systems (Klerkx et al 2019).

Digital innovations in agriculture, also known as "digital agriculture" or "smart farming," refer to the integration of advanced technologies—such as the Internet of Things (IoT), artificial intelligence (AI), machine learning, remote sensing, and data analytics—into agricultural practices to improve efficiency, productivity, and sustainability. These technologies enable real-time data collection, analysis, and decision-making, helping farmers optimize inputs, reduce waste, and adapt to environmental changes.The adoption of these innovations has the potential to address significant challenges in agriculture, such as climate variability, resource scarcity, and food security concerns. This development can potentially contribute to addressing the big challenges of the agricultural sector, i.e., to increase productivity, reduce footprints and conserve natural resources, and thus can contribute to reaching the Sustainable Development Goals (Basso et al, 2020; FAO, 2022; Khanna et al., 2022; Lajoie-O'Malley et al., 2020).

Digital Innovations inIndian agriculture sector

The use of digital technologies is growing exponentially shaping the digital transformation of agricultural production and the agri-food sector at a large scale(MacPherson et al., 2022; Walter et al., 2017; Wolfert et al., 2017). Digital technologies have the potential to be widely used in all fields of agricultural productionranging from arable systems and livestock production to horticultural production and greenhouses (Wolfert et al., 2017).Digital tools, technologies and approaches have become increasingly interconnected, often in real time. The combination of smart sensors, digital technologies and applications at the level of the field, stable, farm and value chains are often also referred to as 'smart farming' (Walter et al., 2017; Wolfert et al., 2017).

The report on doubling farmers' income by 2022 advocates for the adoption of digital technologies in agricultural practices it will help in boosting farmers' income. To achieve the vision of the Self-Reliant India Movement and Sustainable Development Goals (SDGs), the transformation of traditional agriculture into digital agriculture is imperative. Government of India's Digital Agriculture Mission (2021-2025) and consultation paper on Digital Agriculture Ecosystem are the essential steps towards the digitalization of Indian agriculture.

Farmers are the main stakeholders in the food production and supply chain as producers. Thus, it will be challenging to achieve and sustain food security without ensuring farmers' well-being and satisfaction. Policymakers have to focus on the empowerment of the farming community by making farming a more remunerative, easy, secure, respectable, attractive, and less risky profession, ultimately generating food security as a by-product. Digitalization has the potential to make agriculture policy more effective in minimizing the undesired impacts and maximizing the benefits of farming. The digital agricultural policy replaces the technologies used in traditional farm policy. It offers newer alternatives for an agricultural policy: real-time databased or more evidence-based policy interventions for effectively addressing the challenges in the agriculture sector. Thus, digitalization is shifting the agriculture policy from direct intervention to information-based governance, which will increase the policy outcomes and ultimately secure the trust of farming communities and will maximize their satisfaction (Ehlers et al, 2021).

Role of Extension education in Digital innovation in agriculture

Many farmers do not have any authentic source for updated information regarding extreme climate occurrence such as droughts, storms, floods, and other natural calamities (Rajkhowa, 2021). Digital agriculture extension employs digital tools and services that are used to deliver information effectively. Short Message Service (SMS), Interactive Voice Response (IVR), interactive radio, low-cost video is generally used by the extension workers to reach a large number of farmers in a short period for providing extension services like timely reminders and alerts, weather forecasting best practices for enabling farmers to enhance productivity. The traditional way of extension, which includes person-to-person information sharing, is costly and time-consuming, and it may not create value for the farming community. However, with the help of digital technology, the scope of extension can be enhanced (USAID, 2018). It is necessary to provide the correct information to make an informed decision and realize their full potential. At every stage of the cropping cycle, the information provider must be well connected with the farmers. Thus, digital technologies enable the creation of farmers' networks and keep connected with the service/ advisory providers (Yadav et al, 2020).

Digital extension services are helpful for the following reasons:

(i) They can be adapted to the local context,
(ii) Demand-driven and farmer-led,
(iii) Market-oriented,
(iv) Pluralistic (involve multiple actors),
(v) Accountable,
(vi) Sustainable and Scalable.

Digital innovation in agriculture in Jammu and Kashmir

To address the limitations and problems faced by the farmers of Jammu and Kashmir in this digital age due to the digital divide and to diffuse the digital extension services at the grass root level a project entitled "Innovative Extension Approaches for Revitalizing Agriculture in Jammu and Kashmir (Production to Profitability)"was being implemented with an aim to foster smart technology driven seamless innovative, implementable and inclusive agri-extension services for empowering farmers and educated youth to realize the sustainably progressive bio-economy. A dynamic Agri.-extension system using IoT enabled real time big data for farm centric planning and re-orientation of resources to foster sustainable and profitable agriculture

with significant increase in the share of agricultural GDP. The key interventions of the project include

1. **Holistic planning and execution of Production to Profitable agriculture**
    - Area and Commodity Specific Cluster Approach based on agri knowledge system (JK Agri stack platform)
2. **Convergence of functional extension resources and approaches**
    - Establishment of "**KisanKhidmatGhar(KKG)**" at Panchayat level for seamless agricultural extension services
    - Block level Agri Extension Advisory Committee
3. **Krishi Vigyan Kendra as a facilitation centre for developing synergy and convergence of multi stakeholders at district level**
4. **Nurturing agri-business oriented cooperative system of collectivization for strengthening value chain.**
    - Promotion of FPOs, VPOs, CSGs
5. **Synergizing PPP extension system and accreditation of service providers at UT level with outcome linked incentives**
    - Smart, pluralistic seed and plant material chain involving public institutions, farmers and private partners with Buyback system and MSP
    - Contract Farming
6. **Establishing sustainable market linkages for physical and e-market.**
    - Strengthened linkages with micro, small and medium enterprises (MSMEs)
    - Exploring and facilitating Market Expansion & Access
    - Promoting secondary agriculture
7. **Augmentation of Mechanization, Automation and Digital Agriculture**
    - Awareness programmes and demonstrations
    - Farm machinery tailored for local conditions
    - Entrepreneurship in farm machinery services
8. **Promoting biodiversity conservation and ITK**
    - Recognition and scientific validation of locally evolved, viable and sustainable innovations, ITKs and technologies
    - Promoting organic farming
    - Development of Crop cafeteria at KVKs
9. **Reorienting capacity building programmes and promotion of secondary agriculture with post-harvest and non-farm activities as primary focus for harnessing better returns**
    - Trainings in agri-business, marketing, secondary agriculture and non-farm activities.
    - Institution PG diploma and Certificate courses
    - Constituting "Agri-Extension Club" promoting regular online Expert Extension Lecture Series (EELS)

10. **Skilling farmers and youth in mission mode for profitable agriculture, entrepreneurship development, agri-business start-ups, employment generations, and livelihood security.**
    - Augmenting skill development programmes
    - Establishment of Vocational Training Schools
    - Establishment of Para-Vet Training school
    - Training of Master Trainers
    - Promoting start-ups in field laboratories
11. **Multi-level and Multi-mode Agro-Advisory system with outreach Intensification through personal contacts and cyber modules**
    - Creation of Farmers Database
    - Augmentation of Weather based Agro-advisory Services using AWSs and robust, dynamic decision support system (DSS)
    - Cyber Extension Platform (*Kashmir Agriculture information and knowledge management portal - KAIKMP) including Sector /Commodity wise informatics portals, Web based Information, Android Applications, DSS, Expert Systems, and Interactive Tele Service Portal*
    - Augmenting Telecasting and Broadcasting Services
    - Extending Outreach by Students' rural exploration programmes
    - Co-opting and converging public, private and non- profit Extension Services
    - Farmers' Malls, agri-festivals, Kissan melas and Fairs

KisanKhidmatGhar (KKG)

Among all the interventions above there is a unique and innovative Bottom-Top approach being implemented as KissanKhidmatGhar (KKG) a'One Stop Extension ServiceCentre" at panchayat level for agriculture and allied service including recommended agri-inputs using smart technology and facilitated by Panchayat level agripreneur. Envisioned to extend smart technology driven seamless agri-extension services at panchayat level for empowering farmers and educated youth to realize the sustainably progressive bio-economy.

Goals

- To provide seamless agricultural extension services with perfect outreach and dynamic contact across the value chain and real time resource person–client interaction
- To establish KissanKhidmatGhar (KKG) as convergence centre for Extension Functionaries and a common platform for Public-Private Partnership.
- To ensure supply of quality inputs to farmers at their doorsteps.

Key features

- One stop service center for agriculture and allied sectors.
- ICT enabled Information and knowledge center with customized agri kiosk, and conferencing facility.
- One Self-employed technical facilitator at each KKG
- Availability of recommended agri-inputs and implements etc.
- Technology backstopping by Agriculture Universities and KVKs.
- Strong linkage with KVKs, Line Departments and Universities for technical support.
- Farmers: extension worker interaction facility
- Close coordination and cooperation with the Panchayat fostering public-private panchayat partnership.

Infrastructure for KKGs

Placement: Govt. Buildings with basic facilities viz. electricity, water, etc. in the respective Panchayats belonging to any agriculture or allied department (Agriculture/ Horticulture/ Sericulture/ Floriculture/ Animal Husbandry/ Sheep Husbandry/ Fisheries, etc) or administrative department (Panchayat/ Rural Development, etc). The building should provide facilities for:

i. Nodal Cyber extension Platform –cum-Meeting Room
ii. Input store
iii. Outlet window

Note: In case Govt. building is not available at certain place, Facilitator (Panchayat Level Entrepreneur) engaged shall have to provide the same under MOU as a custodian of the

facilities provided (NO OWNERSHIP) which shall be withdrawn as and when the Govt. placement is available or he fails to deliver the services. No rent shall be paid for the same.
The facilitator shall be engaged on franchise- franchise basis. Applications shall be sought from the eligible domicile candidates (Panchayat / area specific) of UT of J&K by notification from Agriculture Production Department.

Job Role:

- Facilitating digital services using agri kiosk
- Providing recommended agri- inputs and implements
- Facilitating liaison between the farmers and development departments
- Facilitating applications for availing different schemes using digital platform
- Facilitating interactive consultancy services.
- Booking of inputs, custom hiring services for advanced farm machinery, processing etc.
- Facilitating B2B and B2C marketing.
- Displaying updates regarding weather, market prices, schemes beneficiaries etc.
- Maintaining inventory of the infrastructure
- Maintaining functional record of KKG and reporting same.

Eligibility:

The candidate must be domicile of UT of J&K. The roles require dynamic person(s) who can be engaged in every aspect of agriculture and allied, to handle digital kiosk, diverse products, to interact with farmers, industry experts & to manage the centre.

Minimum Essential Qualification:

- 10+2 or above with minimum 50% marks or equivalent grade.
- Preference shall be given to Graduate in Agriculture and allied subjects from any institute/ university with minimum 55% marks or equivalent grade.
- Candidates from the local/concerned panchayats shall be preferred

Entitlement of Facilitator:

- The facilitators shall be entitled to acquire input sale certificates after fulfilling the basic requirements.
- For promotion and successful promotion of KKG, APD/ Department of Agriculture shall link KKGs with input companies / agencies by signing MOU with them.
- Facilitators /KKGs shall be eligible for / preferred for establishment of custom hiring services/ centres in private sector under any project / scheme.
- Facilitators shall be provided training for different services and promoted as master trainers.

Expected Earnings:

- Charges for services provided
- Sale of recommended inputs and implements.

Conclusion

India has digitally intervened in the agriculture sector through its policies and project. However, India lags in adopting digital technologies at the farm level as most of the initiatives are limited to governance purposes and provide information to farmers (Confederation of Indian Industry, 2021). The Report on Doubling Farmers Income by 2021 emphasized the introduction of

emerging advanced digital technologies in agriculture. However, any government-led initiative will be successful when it receives maximum public participation. An ecosystem has to be created to digitalize agriculture in India. It is essential to promote digital literacy among youth in rural areas for unleashing the full potential of digital technologies. Institutions play a significant role in assimilating new technologies into society. It is required to upgrade the existing agriculture extension system. Agricultural institutions like State Agricultural Universities or Krishi Vigyan Kendras (KVKs) are essential to disseminate information related to Digital Agriculture technologies. Data acts as a fuel for digital agriculture practices as it is the life source of digital technologies (such as AI, Satellite Image processing). Accurate and updated data on weather conditions, soil type, market, crop variety, crop yield is required to develop and implement innovations and interventions. There is a need to create a trusted and centralized digital data repository to enable efficient data access to different stakeholders, which will help reduce time and cost for digital intervention.

Further there is a need for data sharing, data validation and interoperability and data privacy mechanisms. It is essential to create data-driven solid policies and regulatory agencies for facilitating standardization and interoperability. Finally, digital infrastructure such as internet connectivity, mobile phone network, and the cost of internet and digital devices are crucial for the farming community's extensive adoption and continuous use of digital technologies. People in rural areas still do not have access to basic facilities like all-season roads, regular electricity and clean drinking water. Thus, creating digital infrastructure in a rural area may take time, which may delay the digitalization of the agriculture sector. Policymakers must prioritize the rapid creation of digital infrastructure in rural areas and promote the development of AgriTech startups in each Gram Panchayat (GP) to get benefits of new technologies to farmers and increase their income. The time is apt to transform traditional agriculture into digital agriculture and create "e-Farmers" or "Smart Farmers" in India.

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20. Weather Prediction for Optimize Crop Production

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Weather significantly impacts agricultural production by influencing occurrence of pests and diseases, crop growth, development and yield of different crops. It also affects water requirements and nutrient mobilization under varying moisture conditions and it determines the timing and efficacy of preventive and cultural practices in crop management. The modern farming through rapid technological advancement, as seen in precision agriculture, creates room to empower modern farmers with the requisite skills and technical know-how to turn their farm fortunes around by applying weather forecasting in diverse farming operations. The advantages of weather forecasting are akin to possessing superior intelligence or the ability to circumvent unfavorable situations, as is the case with extreme weather conditions. So, whether you are dealing with the indiscriminate wilting of crops, or any of the many issues smallholder farmers knowledge, you have an unprecedented advantage over the elements and "so called" opposing forces of nature when you can accurately predict the weather. While efforts are made to synchronize agricultural activities with favourable weather conditions, predicting weather patterns accurately every year is challenging. Therefore, forecasts covering different weather parameters are crucial to allow proactive measures to mitigate the effects of unfavourable weather conditions. Weather forecasts also enable farmers to optimize agricultural practices by adjusting cropping patterns, field operations, and input schedules based on expected weather conditions. Although agronomic strategies are available to cope with changing weather, once the cropping season begins, adjustments must rely on early warnings of mid-season weather hazards. The demand for timely and precise weather forecasts among farmers has risen significantly with the advancement and accessibility of information technology in rural areas. Farmers rely on climate patterns and weather forecasting in agriculture to determine which crops to cultivate and when to sow them. The majority of farming techniques depend on favorable meteorological conditions. In case of precision agriculture, the irrigation relies on the amount of rain that falls on a field; soil solarization requires high temperatures, etc.

Weather Forecasting and Precision Agriculture

Weather information is playing an increasingly instrumental role in the evolving field of precision agriculture, a farming practice that emphasizes accuracy and control when it comes to the growing of crops. Weather data, when combined with other technologies like satellite remote sensing, GPS, drones, sensors and data analytics, paves the way for precision agriculture. By utilizing improved weather data to create detailed field maps, farmers can precisely tailor their farming practices to the unique characteristics of their land. This enables targeted application of fertilizers, pesticides and water, reducing input waste and minimizing environmental impact. Precision agriculture not only optimizes resource usage but also improves overall sustainability and profitability.

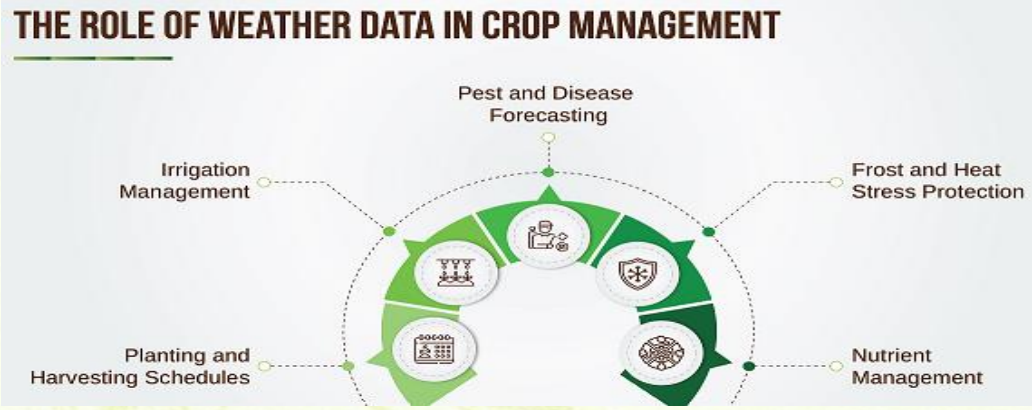
Importance of weather prediction in agriculture

Weather prediction plays an important role in agriculture due to its major impact on crop production, farm management and overall agricultural sustainability. The importance of weather prediction in agriculture can be summarized as follows:

1. ***Optimal Crop Management and planning*:** Accurate weather forecasts enable farmers to make informed decisions about planting, harvesting, irrigation, fertilization, and pest control. By aligning agricultural activities with favorable weather conditions, farmers can optimize crop management practices, minimize risks, and maximize yields. Weather data helps to schedule planting and harvesting more effectively. By understanding seasonal weather patterns, farms can select the best planting times to maximize crop growth and avoid adverse conditions
2. ***Irrigation Planning*:** Weather prediction helps in efficient water management by determining the right timing and amount of irrigation required. Understanding soil moisture levels and evapotranspiration helps farmers determine the optimal amount of water needed for crops, with adjustments made based on current weather conditions. By considering rainfall forecasts and soil moisture conditions, farmers can schedule irrigation activities effectively, avoiding water wastage and reducing the risk of under or over-irrigation.
3. ***Pest and Disease Management*:** Weather conditions influence the prevalence and spread of pests and diseases in crops. By monitoring weather forecasts, farmers can anticipate favorable conditions for pest outbreaks and disease development. This enables them to implement preventive measures and adopt timely pest control strategies, reducing crop losses and minimizing the need for excessive pesticide use.
4. ***Harvesting and Storage*:** Weather conditions impact crop maturation, harvest timing and post-harvest storage. Accurate weather predictions help farmers plan and execute harvest operations during periods of optimal weather, ensuring better crop quality and minimizing post-harvest losses.
5. ***Resource Optimization*:** Weather prediction aids in the efficient utilization of resources such as water, fertilizers, pesticides, and farms energy can reduce input costs while maintaining or even improving crop yields. By aligning resource application with weather patterns, farmers can avoid unnecessary or excessive use, resulting in cost savings, reduced environmental impact and improved sustainability.
6. ***Risk Management*:** Weather variability poses risks to agricultural production. Timely and accurate weather forecasts provide valuable information for risk assessment and management. Farmers can prepare for extreme weather events such as storms, frost, heat waves, droughts by implementing appropriate mitigation strategies and safeguarding their crops and livelihoods. Access to accurate weather forecasts allows one to prepare for extreme weather events. For example, farmers can take measures to protect crops from frost by covering them or using anti-frost irrigation techniques. Similarly, during drought conditions, farmers can implement water-saving practices to sustain crop growth. This data can help reduce crop losses through weather forecasting.
7. ***Crop Selection and Rotation*:** Weather prediction helps farmers make informed decisions regarding crop selection and rotation. By considering long-term weather patterns, farmers can choose crops that are well-suited to the prevailing climatic conditions. Additionally,accurate weather forecasts aid in planning crop rotation schedules, optimizing soil health, and reducing the risk of pest and disease buildup.
8. ***Climate Change Adaptation***: Climate change is affecting agricultural systems globally, leading to altered weather patterns and increased weather variability. Weather prediction

models and forecasts help farmers adapt to changing climatic conditions by adjusting their farming practices, adopting climate-resilient crops and implementing sustainable agricultural techniques.

9. ***Improved Yield Predictions:*** Analyzing historical weather data alongside current conditions helps in making more accurate yield predictions. This information is crucial for planning harvests, managing supply chains, and making informed marketing decisions.
10. ***Cost Savings:*** Effective use of weather data can lead to significant cost savings. By optimizing resource usage such as water, fertilizers, and pesticides, farms can reduce input costs while maintaining or even improving crop yields



Hence, weather prediction is important in agriculture as it empowers farmers with valuable information to make informed decisions, optimize resource allocation, manage risks, and enhance overall crop productivity and sustainability. By using accurate weather forecasts, farmers can improve their resilience, mitigate losses, and contribute to the long-term viability of agricultural systems.

Elements of agricultural weather forecasts

An agricultural weather forecast should mention all weather elements, which immediately affect farm planning or operations. Elements vary from place to place and from seasons to seasons. Normally a weather forecast includes following parameters:

- Cloud cover (amount and types)
- Rainfall and snow
- Temperature (maximum and minimum)
- Wind speed and direction
- Relative humidity (morning and evening)
- Extreme events i.e. heat/cold waves, fog, frost, hail, thunderstorms, wind squalls and gales, low-pressure areas, different intensities of depressions, cyclones, and tornadoes.

There is no aspect of crop operations which is devoid of the impact of weather. However, the weather requirements for optimal growth, development and yield of crops; incidence, multiplication and spread of pests and diseases; and susceptibility to weather-induced stresses and affliction by pests and diseases vary with the variety of a crop, its growth stages and among different crops.

a) Temperature

Forecast of air temperature is important for many agrometeorological applications. Crop species exhibit the phenomenon of Thermo-periodicity, which is the differential response of crop species to daytime, nocturnal and mean air temperatures. It is possible to derive mean day and night time temperatures from data of maximum and minimum temperatures. Forecasts of temperature are generally expressed as range of expected values (e.g.: 30-32°C for maximum and 20-22°C for minimum). A particular attention could be reserved to temperature forecasts at particular stages of crop cycle, taking into account the values of cardinal and critical temperatures for reference crops. Other thermal variables with a specific physiological meaning (e.g.: accumulation of thermal units or chill units) can be the subject of specific forecasts. However, the base temperature above which the accumulations will apply varies with crop types. Therefore, for forecasting dates of attainments of specific phenological stages of crops, time-series data showing actually realized heat or chill accumulationsup to the time of issue of forecasts by various crops have to be maintained. A probabilistic approachcan then be adopted to forecast the probable dates of specific crops reaching particular phonological stages.

b) Precipitation

Precipitation (Type and amount) is probably the most needed and also the most difficult forecasted variables. Quantitative forecasting of rainfall is required for planning agricultural operations. However, for crop operations, it is as important to have the forecast of (i) occurrence/non-occurrence of rains (wet/dry spells) and (ii) type of rain spell that can be expected. Forecasts of rain can be defined adopting some standard classes (light/moderate/heavy etc.) that could depend on the climate and the agricultural context of the selected area.

Fog and dew can contribute significantly to crop water needs. They are beneficial in contributing to water needs of cropsin winter and in helping survival crops during periods of soil moisture stress. Dew is also desirable for using pesticides and fungicides in form of dust. The meteorological conditions required for dew formation are the same as those for fog formation except for the need for absence of air-turbulence in the air layers close to the ground and crop-canopy temperature being lower than the screen temperatures. Dew is an important parameter influencing leaf-wetness duration and hence in facilitating entrance of disease spores into crop tissues.

c) Wind speed and direction

Forecast of wind speed is important for many different agricultural activities. Wind direction could be defined too. It is important to give information on expected variability in wind speed during course of a day.

d) Cloud Cover

Forecasts for the amount cloud cover and the type of clouds. It is also important to give information about the character of prevailing clouds. For example high clouds produce a depletion of global solar radiation quite different from that produced by mid or low clouds. It is also important to give an idea of the expected variability of sky coverage in space and time. A probabilistic approach can be also adopted in order to increase the usefulness of this kind of information.

e) Humidity

Forecast of relative humidity are important in some specific cases such as expected drying power of the air and incidence of pests and diseases. Probability of values critical to a particular crop and its stages (very high or very low) are also important.

Types of weather forecasting and farm operations

There are five types of weather forecasting which are as follows:

1. **Now casting or day forecast**: Such weather forecasting provides predictions typically 2 to 3 hours ahead, benefiting aviation and navigation sectors. Additionally, "nowcasting," which utilizes radar and satellite data, forecasts conditions up to 6 hours in advance. This method is particularly adept at predicting short-term weather phenomena such as lightning.

2. **Short range forecast**: Short-range weather forecasts are daily predictions based on current weather data, focusing primarily on pressure, temperature changes, and cyclonic tendencies. These forecasts are crucial for Irrigation Engineers, Mariners, and aviators as they provide timely alerts and precautions during storms, cyclones, heavy rains, etc. They also aid in preparing pre-emptive measures such as constructing embankments and drains to mitigate potential flood and storm damage. These forecast valid for 24 to 48 hours, these forecasts boast an accuracy ranging from 70% to 80%. It helps in determining irrigation schedules, timing agricultural operations, and safeguarding plants from frost.

3. **Extended forecast or medium range forecast:** This type of forecast focuses on specific weather conditions, including the pattern of rainy days and common agricultural risks such as strong winds, prolonged dry or wet periods. It remains reliable for 5 to 7 days, typically achieving an accuracy level of 60% to 70%. This forecast is particularly valuable for various agricultural activities like sowing and spraying, providing farmers with essential information to plan and execute their operations effectively. These forecasts are instrumental in determining optimal sowing times, assessing the appropriate depth for sowing, scheduling harvesting activities, and determining the ideal timing for spraying pesticides and applying foliar nutrition. They also aid in overall farm management by providing critical information that farmers can use to plan their operations efficiently and maximize crop yields.

4. **Long range forecast or seasonal forecast**: Long-range seasonal forecasts, covering the next 1-2 months, are valuable for anticipating climate trends and adjusting cropping strategies accordingly. They aid in managing soil moisture, selecting appropriate crops, making decisions on irrigation management under water scarcity, and planning cropping patterns effectively. These forecasts provide essential guidance for agricultural planning; ensuring farmers can adapt to expected weather conditions and optimize their crop production strategies.

Extreme weather adaptation

As volatile weather continues to pose challenges for the agricultural sector, accurate weather condition becomes indispensable in adapting to changing conditions. Observational datasets combined with forecasting models help farmers understand long-term trends and anticipate shifts in weather patterns. Armed with this information, farmers can adopt resilient farming techniques, select suitable crop varieties and adjust planting schedules to mitigate the risks associated with extreme weather.

Challenges of unpredictable weather

Agriculture has always been at the mercy of the weather. The unpredictability of weather patterns, worsened by climate change, has made farming increasingly challenging. There are several weather-related challenges, such as:

- **Extended Season:** Changes in climate can lead to longer periods of warm weather, which can disrupt the growth cycle of crops, leading to timing issues in planting and harvesting. This can result in crops maturing at the wrong time, which affects their quality and market value.
- **Extreme Temperatures:** Unseasonal temperature variations can hinder crop development. Frosts can damage sensitive crops, while heat waves can cause heat stress and water scarcity.
- **Uneven Rain:** Uneven distribution of rain, especially during the off-season, can stress plants, reducing their growth and yield potential. Conversely, excessive rainfall can lead to waterlogged fields, which can damage roots, wash away essential nutrients, and create conditions favorable to diseases.
- **Temperature Fluctuations:** Sudden drops in temperature at night can cause frost damage to young plants, while high daytime temperatures can lead to heat stress. These fluctuations can hinder plant growth and development, reduce pollination rates, and increase the likelihood of pests and diseases.

These unpredictable weather events necessitate the need for a reliable system to anticipate and respond to changing weather conditions, thus safeguarding crops and improving farm resilience.

Role of India Meteorological Department (IMD) in weather based Agro Advisory bulletin

The India Meteorological Department (IMD) operates the Gramin Krishi Mausam Sewa (GKMS) scheme to provide essential agrometeorological advisory services to the farming community nationwide. Through this initiative, medium-range weather forecasts are generated for districts and blocks. Based on these forecasts, 130 Agromet Field Units (AMFUs), situated at various State Agricultural Universities, ICAR institutes and IITs, prepare tailored advisories every Tuesday and Friday. These advisories are aimed at assisting farmers in making informed decisions regarding their day-to-day agricultural activities. The IMD's AAS initiative focuses on implementing weather dependent strategies for crop and livestock management, ultimately aiming to boost agricultural productivity, ensure food security, and mitigate losses caused by adverse weather conditions. These units prepare Agrometeorological Advisories for both district and block levels based on respective weather forecasts every Tuesday and Friday. Additionally, they also formulate Impact-based Forecasts (IBFs) tailored for agriculture, utilizing severe weather warnings across various districts, states and Union Territories. Under the GKMS scheme, IMD actively monitors rainfall patterns and weather anomalies, issuing timely alerts and warnings to farmers. These alerts, conveyed via SMS, provide guidance on responding to extreme weather events and include actionable measures. Such information is also shared with State Departments of Agriculture to facilitate effective disaster management. Agrometeorological Advisories are disseminated through various channels such as print and electronic media, Door Darshan, radio, internet, and SMS via the Kisan Portal. Additionally, private companies under Public Private Partnership (PPP) mode aid in distribution. The number of farmers receiving SMS alerts varies based on the farming population and cultivated area.

Farmers can access weather information, alerts, and tailored agrometeorological advisories specific to their districts through the 'Meghdoot' mobile app, launched by the Ministry of Earth Sciences. Another app, 'Kisan Suvidha', launched by the Ministry of Agriculture & Farmers Welfare, also provides access to these details, enhancing accessibility and usability for farmers. Social media platforms are utilized for rapid dissemination of weather forecasts and advisories to farmers. Currently, 16,140 WhatsApp groups cover farmers in 1,19,554 villages across 3,598 Blocks. These groups include officials from State Agriculture Departments at both district and block levels. Efforts are ongoing to expand coverage further, ensuring widespread distribution of Agrometeorological advisories via WhatsApp. Furthermore, Agrometeorological advisories are disseminated through dedicated Facebook pages managed by AMFUs. Collaborative efforts with state governments have facilitated the integration of weather forecasts and advisories into state government mobile apps and websites. This integration has been successfully implemented in Bihar, Chhattisgarh, Gujarat, Haryana, Madhya Pradesh, Nagaland, Rajasthan, Tamil Nadu, and Uttarakhand. Approximately 6 million farmers across these states are benefiting from access to weather forecasts and tailored agrometeorological advisories.IMD continues to actively promote its services among the farming community by organizing Farmers' Awareness Programmes (FAPs) in collaboration with AMFUs across the country. Additionally, IMD and experts from AMFUs participate in agricultural exhibitions like Kisan Melas and Farmers' Days to raise awareness about these services, ensuring more farmers can benefit from them. Under the umbrella Central Sector Scheme ACROSS, IMD is implementing various initiatives to advance forecasting capabilities and enhance Weather & Climate services nationwide, including Agromet Advisory Services. This scheme encompasses four sub-schemes: Atmospheric Observation Network (AON), Upgradation of Forecast System (UFS), Weather & Climate Services (WCS), and Commissioning of Polarimetric Doppler Weather Radars (PDWR). These efforts aim to expand the observational network and improve Weather & Climate services across India (Ministry of Earth Sciences, pib.gov.in).

Current forecasting organization in India

National Weather Forecasting Centre (NWFC) at IMD, New Delhi coordinates IMD’s forecasting activities for the entire country and Weather Central IMD, Pune functions as standby Centre for NWFC (National Weather Forecasting Centre). While Regional Meteorological Centers (RMCs) carry out weather monitoring and forecasting for their respective regions, meteorological centers at state capitals do the same for their respective states. Cyclone related operational activities are being monitored and coordinated by Cyclone Warning Directorate (CWD), IMD, New Delhi at headquarters’ level. This unit also functions as the Regional Specialized Meteorological Centre (RSMC) for tropical cyclones for the WMO region. Area Cyclone Warning Centers (ACWCs) and Cyclone Warning Centers (CWCs) take care of the cyclone warning services of the coastal states as well as marine weather services, as per their area of responsibility. Hydrometeorology Division, IMD, New Delhi coordinates flood forecast related services being carried out through Flood Meteorological Offices (FMOs), collects data and prepares rainfall statistics for the entire country. Agromet forecasting services are coordinated by Agricultural Meteorology Division, IMD Pune whereas liaising work related to Agromet services are carried out by AASD, IMD, New Delhi.

Future Potential of Weather data analytic

The future of weather data analytics in agriculture is promising, with several advancements on the horizon that could further enhance crop management practices.

- **Artificial Intelligence (AI) and Machine Learning (ML):** The integration of AI and ML with weather data analytics can revolutionize predictive models. These technologies can process vast amounts of data, identify complex patterns, and provide highly accurate forecasts and recommendations.
- **Internet of Things (IoT) Integration:** The combination of weather data with IoT devices, such as soil moisture sensors, temperature monitors, and automated irrigation systems that respond to real-time weather conditions for creates a comprehensive and responsive farm management system. This integration enables real-time adjustments to farming practices based on current weather conditions. Smart sprayers that adjust application rates based on weather forecasts. Autonomous farm equipment that plans activities around weather predictions.
- **Blockchain for Data Security:** Blockchain technology can improve the security and transparency of weather data. By ensuring that the data is tamper-proof and reliable, agribusinesses can trust the accuracy of the information they use for decision-making.
- **Climate-Adaptive Crop Varieties:** Weather data analytics can aid in the development of climate-adaptive crop varieties. By understanding how different crops respond to specific weather conditions, researchers can breed new varieties that are more resilient to climate change.
- **Improved Climate Change Adaptation**

As climate change continues to impact agriculture, our hyperlocal weather forecasting will play a crucial role in helping farmers adapt. This includes:

- Long-term climate trend analysis for crop selection and planning
- Improved prediction of extreme weather events
- Recommendations for climate-resilient farming practices

- **Global Collaboration:** The sharing of weather data across regions and countries can lead to a better understanding of global weather patterns and their impact on agriculture. This collaborative approach can drive innovations in crop management with weather data and improve food security worldwide.
- **Enhanced Machine Learning Models**

We are continuously improving our machine learning models to provide even more accurate and tailored predictions. Future developments may include:

- ✓ More sophisticated crop growth models that account for a wider range of variables
- ✓ Improved pest and disease prediction models
- ✓ Personalized recommendations based on individual farm history and practices

Conclusion

Weather is an invaluable asset in modern agriculture, providing critical insights that enhance crop management and reduce losses. By using advanced technologies to collect, analyze and integrate weather information, farms can make informed decisions that optimize resource usage, eliminate risks and improve overall productivity. Farmers obtain the highest output and improve their livelihood within the main limitation i.e. dependence on rainfed agriculture, thus having access to weather forecast information is very important. There is an urgent need for a

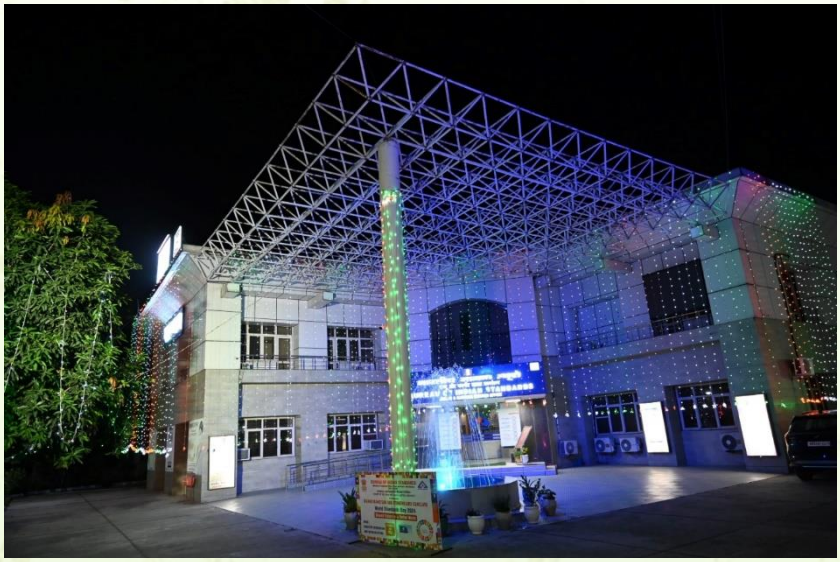
meterological report that is easily accessible and understandable to farmers. The delivery of weather information should be a key factor in all agricultural policies and discussions in enhancing farm risk management. As complexities of agricultural systems and uncertainties of climate forecasts recommended that a coordinated effort is needed, if this technology is to be routinely used in agriculture in future. Weather information should be given by agro-meteorological stations one or two month before the onset of the rainy season that can allow farmers to change critical decisions i.e. sowing schedule, crop varieties, cropping ratio, intensification of production, allocation of labour and capital. Moreover, weather information forecasted by agro-meteorologists can support a smart fertilizer subsidy programme as well as smart improved seed programme.

21. Standards Club-SKUAST- Jammu, Bureau of Indian Standards (BIS), Jammu and Kashmir Branch Office

Sushmita M. Dadhich and Ashish Kumar Dwivedi

The Bureau of Indian Standards (BIS) Jammu and Kashmir Branch Office (JKBO), operating under the Ministry of Consumer Affairs, Food and Public Distribution, Government of India, has emerged as a cornerstone for promoting quality, safety, and standardization in the region. By fostering a culture of conformity assessment and quality assurance, JKBO has been instrumental in driving socio-economic development across diverse sectors.

Strategically located in a region characterized by unique topographical and logistical challenges, JKBO has consistently championed awareness and compliance with Indian Standards, instilling trust and confidence in products and services.



Key Activities and Achievements

Historic MoU Signed Between BIS and SKUAST-Jammu for Standardized Farming Initiatives

A significant milestone was achieved on 29th August 2024 when BIS signed a Memorandum of Understanding (MoU) with the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu). This collaboration envisions the development of a Standardized Agriculture Demonstration Farm (SADF) at SKUAST-Jammu, marking a pioneering step towards integrating standardization into the agricultural sector.

The MoU was formalized in the presence of Dr. B.N. Tripathi, Vice-Chancellor, SKUAST-Jammu, and Smt. Sneh Lata, Deputy Director General (North), BIS. The SADF will serve as a model farm, promoting best agricultural practices aligned with BIS standards, and offering a platform for research, training, and knowledge dissemination to benefit farmers, students, and researchers.

This initiative underscores a shared commitment to modernize farming, foster self-reliance, and align agricultural practices with national and global benchmarks.

Standards Club Movement

JKBO has established 366 Standards Clubs across schools and colleges, inspiring young minds to embrace the principles of quality and standardization. Furthermore, the branch has signed MoUs with esteemed institutions like Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-J), NIT Jalandhar, NIT Srinagar, IIT Jammu, and the Government College of Engineering & Technology Jammu, fostering collaboration in education and research. In SKUAST-Jammu , CLUB has started February, 2022 under guidance of Ex Vice Chancellor Prof. J. P. Sharma and the mentor of the CLUB at SKUAST-J has nominated Dr Sushmita M Dadhich, Associate Prifessor, Division of Soil and Water Engineering (FoAE). Various activities has done under Standard Club-SKUAST-J as follows:

(i) Exposure Visit:

On the 3rd and 4th of March 2022, the SKUAST Jammu Standards Club conducted an exposure visit to the BIS Jammu & Kashmir Branch Office and an industry in Samba. The visit included stops at the BIS Jammu & Kashmir Branch Office located at Lane No. 4, SIDCO Industrial Complex, Bari Brahmana, District Samba (J&K) and an industrial visit to M/S Indogulf Crop Sciences Ltd. Various activities were organized during the visit, including a welcome address, a presentation on “An Overview of BIS Activities,” a demonstration of the e-BIS Portal, and a working visit to the industry at SIDCO Industrial Growth Centre, Phase-1, Samba. A total of 40 students from SKUAST-Jammu participated in this exposure visit.

(ii) Standards writing completions:

The Standards Club at SKUAST-Jammu, in collaboration with the Bureau of Indian Standards Jammu and Kashmir branch office, organized an introductory lecture on standards and a standard writing competition on October 10, 2022, at the Chatha campus. Additionally, a BIS-sponsored orientation program and quiz on Earth Day 2024 were held in April.

(iii) Training and Awareness Programs

The branch conducts regular training programs, such as Learning Science via Standards (LSVS), equipping educators and mentors with practical knowledge of standards to ensure grassroots-level implementation. Training program attended by Mentor, SKUAST-J during 25th-26th April, 2022.In Able guidance of Sh. Tilak Raj, Director & Head, BIS-JKBO, to incorporate and upgradations to industries of JKBO jurisdiction different types training and

awareness program are conducting like as District Level officers and state level officers, Gram Panchyat Sarpanch and Secretary, Capsule Course for Quality Control Personal, Manak Manthan program with stake holders and industries people and Licensee meet for industry and BIS Awareness program for common consumers and academia also.

Standards Club, SKUAST-J members participated in BIS Quality Connect Program organized during 4-8 Jan 2023.

Standards Club, SKUAST-J members participated in Run for Quality organized by BIS, J&K.

Consumer Engagement

Through a series of outreach programs, workshops, and awareness campaigns, JKBO actively engages with local businesses and consumers to promote quality-conscious decisions and the adoption of BIS-certified products.

Support to Industries

JKBO assists industries in achieving BIS certifications, ensuring product conformity to national standards. This initiative strengthens industrial growth and enhances the quality of goods in the region.

Highlights of Recent Accomplishments

World Standards Day (WSD) 2024 Celebrations

Siachen Bike Rally:

A monumental bike rally from Srinagar to the Siachen Base Camp was organized as part of WSD 2024 celebrations. This multi-day event highlighted the importance of BIS standards in promoting quality, safety, and sustainability in challenging terrains. Along the route, BIS officials conducted awareness drives at schools, industrial sites, and military bases.

Manak Mahotsav and Stakeholders Conclave:

Held at the BIS JKBO office in Jammu, this event united industry leaders, stakeholders, and students in celebrating the spirit of standardization.

- Keynote Address: Shri Lalit Mahajan, President of the Bari Brahmana Industrial Association (BBIA), lauded BIS's role in empowering industries through standards and certifications.
- Student Engagement: Creative activities, including poster-making on ISI marks and hallmarking, and skit performances underscored the importance of standards in everyday life.
- Quality Run: A vibrant “Quality Run” engaged the youth in spreading awareness about the critical role of standards in fostering quality.

Commitment to Excellence

BIS JKBO also organizes exposure visits for students to enhance their understanding of standardization processes. Its active involvement in state-level standardization committees further reflects its mission to build a robust quality ecosystem in the region.

With an unwavering commitment to excellence, BIS JKBO continues to integrate Jammu and Kashmir into the national and global quality landscape, reaffirming its mantra: *“Standards have no limit. The sky is no limit. Border is no limit.”*

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Committees for SKUAST-Jammu National Agriculture Summit 2024

I. Core Committee

S. No.	Name	Designation	Responsibility
	Farmers Symposium & Agricultural Fair		
1	Prof. B.N. Tripathi	Vice Chancellor, SKUAST-Jammu	Chairman
2	Dr. Amrish Vaid	Director Extension	Co-Chairman
3	All Statutory Officers	-	Member

II. Farmers Symposium Committees

Session	Name	Designation	Responsibility
I	Post -harvest Management & Agricultural marketing		
	Dr. Vikas Tandon	Dean, FoHF	Coordinator
	Dr. Jagmohan Singh	Professor, PHM	Convener
	Dr Anju Bhat	Professor, PHM	Co-convener
	Dr. Amit Jasrotia	Professor, Horticulture	Member
	Dr Julie D. Bandral	Professor, PHM	Member
	Dr. Neeraj Gupta	Professor, Horticulture	Member
	Dr. Rakesh Kumar	Professor, PHT	Member
	Dr. S.P. Singh	Professor, Agril Econ.	Member
	Dr. Anil Bhat	Assoc. Director Research	Member
2	Natural & organic farming		
	Dr. Anil Kumar	Dean, FoA, Chatha	Coordinator
	Dr. Parshat Bakshi	Prof. & Head, Fruit Science	Convener
	Dr. Meenakshi Gupta	Prof., Agronomy	Co-convener
	Dr. Peeyush Sharma	Prof., Soil Science	Member
	Dr. Renu Gupta	Prof., Soil Science	Member
	Dr. Meenakshi Gupta	Prof., Agroforestry	Member
3	Farmers, Industry & Academia Linkages		
	Dr. SEH Rizvi	Dean, FoBSc., Chatha	Coordinator
	Dr. Sanjay Guleria	Prof. Biochemistry	Convener
	Dr. Sachin Gupta	Prof. Plant Pathology	Co-convener
	Dr. Pawan K Sharma	Prof. Agril. Economics	Member
	Dr. Pranav Kumar	Assoc. Prof. Vety. & AH Ext. Edu.	Member
	Dr. Vinod Kumar	Assoc. Prof. Biochemistry	Member
4	Empowering rural woman in agriculture & beyond		
	Dr. Hema Tripathi	Assoc. Director Extension	Coordinator
	Dr. Moni Gupta	Prof. & Head, Biochemistry	Convener
	Dr. Jasbir Manhas	Prof. Extension Education	Co-convener
	Dr. Kamlesh Bali	Prof. Sericulture	Member
	Dr. Poonam Parihar	Prof., Extension Education	Member
	Dr. Sushmita Dadhich	Prof. Soil & Water Conservation Engineering	Member
	Dr. Sanku Borkataki	Prof., Vety. Parasitology	Member
	Dr.Puja Rattan	Assoc. Prof. Vegetable Sc.	Member

	Dr. Puja Nayyar	Dy. Director, SAMETI-J	Member
5	Hitech agriculture and horticulture		
	Dr. Sushil Sharma	Dean, Faculty of Agril. Engineering	Coordinator
	Dr. A.P. Singh	Prof. & Head Agronomy	Convener
	Dr. Sanjeev Kumar	Prof. PBG	Co-convener
	Dr. Gyanendra Kumar Rai	Prof. Biotechnology	Member
	Dr. Susheel Sharma	Assoc. Prof. Biotechnology	Member
	Dr. Rajan Salalia	Prof., Entomology	Member
	Dr. Arti Sharma	Prof. Fruit Science	Member
6	Precision livestock farming, dairying and fish farming		
	Dr. Rajesh Katoch	Dean, Faculty of Vety. Sciences	Coordinator
	Dr. Anish Yadav	Professor & Head, Vety. Parasitology	Convener
	Dr. Sahar Masood	Prof. Fisheries	Co-convener
	Dr. Rajesh Agrawal	Prof. Vety. Medicine & Epidemiology	Member
	Dr. Anil Kumar Pandey	Prof., Veterinary Gynaecology & Obstetrics	Member
	Dr. Anand Kumar Pathak	Prof. Animal Nutrition	Member
	Dibyendu Chakraborty	Assoc. Prof. & Head	Member
	Dr Ankit Magotra	Deputy Director Research	Member
7	Agri-mechanization, automation and digital agriculture		
	Dr. Sanjay Khar	Director P&M	Coordinator
	Dr. J.P. Singh	Prof. & Head, Farm Machinery & Power Engineering	Convener
	Dr. R K Srivastava	Prof. & Head, Soil & Water Conservation Engineering	Co-convener
	Dr. Akhil Gupta	Prof. Fisheries	Member
	Dr. L.K. Sharma	Prof. Agril. Ext. Education	Member
	Dr. Upma Dutta	Prof., Microbiology	Member
	Dr Ravinder Singh	Asstt. Prof. Biotechnology	Member
8	Agri-startups and Agripreneurship		
	Dr. Sudhakar Dwivedi	Dean Student Welfare	Coordinator
	Dr. Jyoti Kachroo	Prof. Agril Economics	Convener
	Dr. Vinod Gupta	Prof. & Head, Ext. Education	Co-convener
	Dr. Manmohan Sharma	Prof. Biotechnology	Member
	Dr. Neetu Sharma	Prof., Agronomy	Member
	Dr. Narinder Panotra	Prof. Biotechnology	Member
	Dr. Sudhir S Jamwal	Prog. Asstt. DoE	Member
9	Rural youth & students on career opportunities in agriculture		
	Dr. Rajinder Peshin	Director Education	Coordinator
	Dr.Gurdev Chand	Prof. & Head, Plant Physiology	Convener
	Dr. Harsh Sharma	Prof. & Head VPHE	Co- Convener
	Dr. Rakesh Sharma	Prof. Ext. Education	Member
	Dr S.R Upadhayay	Prof. Vety. Medicine	Member
	Dr. Balbir Dotra	Prof. OFRC	Member
	Dr. Shafkat Ahmad Khandi	Assoc. Prof., VAH Ext. Edu.	Member

	Dr. Pranav Kumar	Assoc. Prof., VAH Ext. Education	Member

III. Agricultural Fair Committees

Session	Name	Designation	Responsibility
1	Livestock and Poultry Show		
	Dr. J.S. Soodan	Dean, Faculty of Dairy Technology	Coordinator
	Dr. H.R. Bhardwaj	Professor & Head Vety. Surgery & Radiology	Convener
	Dr. Neelesh Sharma	Prof. & Head, Vety. Medicine	Co-Convener
	Dr. R.K. Bhardwaj	Professor, Vety Medicine	Member
	Dr.Arvind Kumar	Prof. LPT	Member
	Dr. Vijay K Sharma	Deputy Director Extension	Member
	Dr. Parul Gupta	Scientist KVK Rajouri	Member
	Dr Mandeep Singh Azad	Scientist, KVK Reasi	Member
2	Dog Show		
	Dr. Rajesh Katoch	Dean, Faculty of Vety. Sc. & AH	Coordinator
	Dr. J.S. Soodan	Dean, Faculty of Dairy Technology	Convener
	Dr. Ashok Kumar	Professor & Head VCC	Co-Convener
	Dr. Sharad Kumar	Prof. VCC	Member
	Dr. R. B. Kushwaha	Prof. VCC	Member
	Dr. D.K. Dwivedi	Prof. Vety Surgery	Member
3	Flower / Vegetable and Fruit Show		
	Dr. Vikas Tandon	Dean, Faculty of Hort. & Forestry	Coordinator
	Dr. R.K. Pandey	Prof. & Head, Flori & Landscape	Convener Flower Show
	Dr. Sheetal Dogra	Prof. Flori & Landscape	Co-Convener Flower Show
	Dr. Arvinder Singh	Prof. Flori & Landscape	Member Flower Show
	Dr. Nomita Laishram	Prof. Flori & Landscape	Member Flower Show
	Dr. Rakesh Kumar	Assoc. Prof.	Member Flower Show
	Dr. Prashant Bakshi	Head Div. of Fruit Science	Convener Fruit Show
	Dr. Rakesh Sharma	Professor, Fruit Science	Co-Convener Fruit Show
	Dr. Muzaffar Mir	Scientist, KVK Poonch	Member Fruit Show
	Dr. Sandeep Chopra	Professor	Convener Vegetable Show
	Dr. Satish Kumar	Professor	Co-Convener Vegetable Show
	Dr. Anil Bhushan	Professor	Member, Vegetable Show
4	Exhibition & Drone demonstration		
	Dr. S.K. Gupta	Director Research	Coordinator
	Dr. Punit Choudhary	Head KVK Jammu	Convener
	Dr. Sanjay Khajuria	Head KVK Samba	Co-Convener
	Dr. Mahital Jamwal	Assoc. Director Research	Member

	Dr. Vijay Bharti	Prof. & I/c Mega Seed Chatha	Member
	Dr. A.K. Singh	Prof. Div. of Plant Path	Member
	Dr. Susheel Sharma	Assoc. Prof., School of Biotechnology	Member
	Er. K.K. Raina	Asstt. Ex. Engineer, Estates Div.	Member
	Er. Jasmeet Singh	Junior Engineer (Electric) Estates	Member
5	Field Visits		
	Dr. R.K. Salgotra	Director IBT	Coordinator
	Dr. Tuhina Dey	Professor & Head, Div. of PBG	Convener
	Dr. K.K. Sood	Professor, Agroforestry	Co-Convener
	Dr. N.P. Thakur	Chief Scientist/Prof. FSR	Member
	Dr. Vikas Sharma	Prof. & Head Division of Soil Sc.	Member
	Dr. AmitJasrotia	Prof., Div. of Fruit Sc.	Member
	Dr. A.P.Singh	Prof. Div. of Agronomy	Member
	Dr. Satesh Kumar	Prof. Veg. Sc.	Member
	Dr. Devinder Sharma	Prof., Entomology	Member
	Dr. Vijay Khajuria	Sr. Scientist, FSR	Member
6	Sports / Chaff cutting competitions		
	Dr. Akhil Gupta	Prof., Fisheries	Convener
	Dr. Sanjeev Kumar	Prof., Plant Breeding	Co-Convener
	Dr. Balbir Dhotra	Prof., Soil Science	Member
	Sh. Neeraj Gupta	Physical Instructor	Member
	Sh. K.S. Manhas	Physical Instructor	Member

IV. Other Working Committees

1	Registration Committee Farmers		
	Dr. P.S. Salathia	Prof. Div. of Ext. Edu.	Convener
	Dr. S.K. Singh	Prof. Division of Plant Pathology	Co-Convener
	Dr. Abha Tickoo	Prof. Division of Vet. Medicine	Co-Convener
	Dr.Ravneet Kour	Professor, KVK Jammu	Member
	Dr.Brejeshwar Singh	Professor, Microbiology	Member
	Dr.Sheetal Badyal	Prof. KVK Jammu	Member
	Dr.Neerja Sharma	Prof, KVK Samba	Member
	Dr. Anamika Jamwal	Prof. KVK Kathua	Member
	Dr.Sarbdeep Kour	Prof. Division of Soil Science	Member
	Dr.Rakesh Kumar	Assoc. Prof. Division of Agronomy	Member
	Dr.Shalini Khajuria	Prog. Assistant, KVK Samba	Member
	Dr. Arvinder Kumar	Prog. Assistant, KVK Reasi	Member

2	Media & Publicity Committee		
	Dr. Sachin Gupta	Prof. Division of Plant Pathology	Convener
	Dr Anil Bhat	Assoc. Director Research	Co-Convener
	Dr.Pranav Kumar	Associate. Prof. Vety. Extn. DOAEE	Member
	Dr Prem Kumar	Sr. Scientist KVK, Jammu	Member
	Sh. Ajay Sharma	SVC	Member
3	Printing Publication & Banner Committee		
	Dr. Rakesh Sharma	Professor, Extension Education	Convener
	Dr. Magdeshwar Sharma	Prof., Entomology	Co-Convener
	Dr. NarinderPanotra	Sr. Scientist, School of Biotech	Member
	Dr. S.S.Jamwal	Prog Asst. DOE	Member
	Sh.Jagdish Kumar	Programme Assistant Computers	Member
	Sh. Prince Rajan Khajuria	Assistant Programmer, Div. of Ext	Member
4	Transport Committee		
	Dr. Sanjay Khajuria	Head, KVK Samba	Convener
	Dr S.R.Upadhyay	Prof. Vety. Medicine	Co-Convener
	Dr Sanjay Koushal	Scientist Agronomy KVK Reasi	Member
	Dr. Vishal Sharma	Scientist Agronomy KVK Kathua	Member
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	Dr. Rohit Sharma	Tech. Officer, Agromet (Rajouri)	Member
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	Dr. Sanjay Koushal	Scientist Agronomy, KVK Reasi	Member
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	Dr. Shalini Suri	Professor, Vety Anatomy	Co-Convener
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	Sh. Sanjeev Kumar	Medical Assistant	Member
	Sh. Deepak Sharma	Medical Assistant	Member
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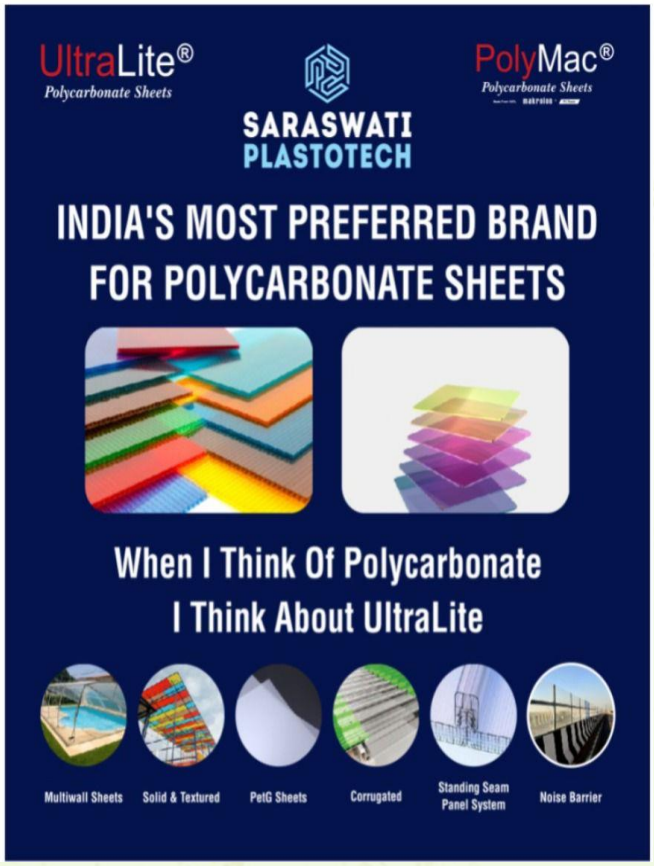
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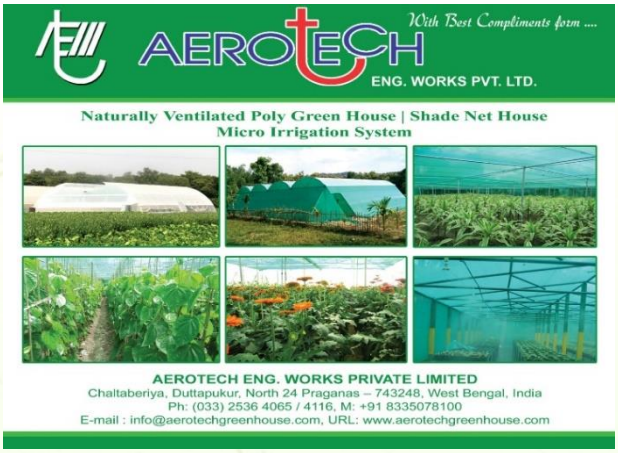
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