



7th AGRIVISION-2023 National Convention

on



"स्वावलंबी कृषि-आत्मनिर्भर भारत"
"Sustainable Agriculture for a Self-Reliant India"

May 05-06, 2023

Organized By



Vidyarthi Kalyan Nyas,
Bhopal (M.P.)

In Collaboration With



कृषि और किसान कल्याण विभाग
Ministry of Agriculture & Farmers Welfare
Government of India



मत्स्यपालन, पशुपालन और डेयरी विभाग
MINISTRY OF FISHERIES,
ANIMAL HUSBANDRY AND DAIRYING



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Venue: A. P. Shinde Auditorium, NASC Complex, ICAR, Pusa, New Delhi-110 012

7th National Convention: AGRIVISION-2023
“Sustainable Agriculture for a Self Reliant India”
May 05-06, 2023

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Citations: Kumar L., Patel S. S., Paradkar V. K., Kumar, C., Tiwari, U., Jain, S., Mehra, P., Nishant, Tiwari, R. K., Kumar, N., Sharma, T. and Goswami, A. K. 2023. “Souvenir and Abstract Book” 7th National Convention: AGRIVISION-2023 “Sustainable Agriculture for a Self Reliant India” May 05-06, 2023 at National Agricultural Science Complex, New Delhi. (pp. 95).

Note: Opinions in this publication are those of authors and not necessarily of the organizers.

Published by:

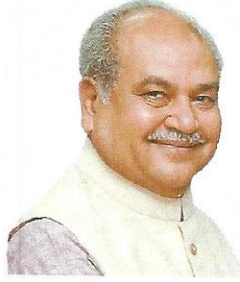
Vidyarthi Kalyan Nyas, Bhopal (M.P.)

Venue: A. P. Shinde Auditorium, NASC Complex, ICAR, Pusa, New Delhi-110012

नरेन्द्र सिंह तोमर
NARENDRA SINGH TOMAR



कृषि एवं किसान कल्याण मंत्री
भारत सरकार
कृषि भवन, नई दिल्ली
MINISTER OF AGRICULTURE & FARMERS WELFARE
GOVERNMENT OF INDIA
KRISHI BHAWAN, NEW DELHI



MESSAGE

I am honored to address this National Convention of Agrivision-2023 with the theme of Sustainable Agriculture for a Self-Reliant India. Agriculture has always been the backbone of our economy and the current government is committed to promoting sustainable agriculture practices to achieve self-reliance. Sustainable agriculture is vital for our country's food security and economic growth. The government is taking steps to promote using natural resources efficiently, improve soil health, conserve water and substantially reduce carbon emissions in agriculture. Promoting sustainable agriculture will lead to better yields, improved rural livelihoods and a more resilient agricultural sector.

The government of India has taken several new initiatives to support sustainable agriculture practices, such as the Pradhan Mantri Fasal Bima Yojana, Soil Health Card Scheme, and the Paramparagat Krishi Vikas Yojana. These schemes aim to provide farmers with the necessary tools and resources to adopt sustainable farming practices.

Sustainable agriculture practices will also contribute to the government's vision of an Aatmanirbhar Bharat or self-reliant India. Focusing on sustainable agriculture can reduce our dependence on imports and promote local production, leading to a more robust, self-reliant economy.

I urge all stakeholders in the agriculture sector to come together to promote sustainable agriculture practices in our country. Let us work towards a future where our agriculture sector is sustainable, productive and self-reliant.

I wish the organizers of this National Convention all success.

Thank you,

(Narendra Singh Tomar)

कैलाश चौधरी
KAILASH CHOUDHARY



कृषि एवं किसान कल्याण
राज्यमंत्री
भारत सरकार
MINISTER OF STATE FOR AGRICULTURE
& FARMERS WELFARE
GOVERNMENT OF INDIA

MESSAGE

It gives me great pleasure to write this message for souvenir of Agrivision-2023, which is held with the focal theme of "Sustainable Agriculture for a Self-Reliant India". Agrivision is a prominent organization of agricultural students, which has potential to modulate and develop thought process among young scholars and students for future and betterment of country.

As we all know, agriculture is a vital sector of our economy and it is essential that we focus on sustainable practices to ensure the health and prosperity of our people and our planet. Sustainability in agriculture involves using resources efficiently, protecting biodiversity, reducing greenhouse gas emissions and promoting food security for all.

The Indian agriculture sector has made significant progress in recent years and we need to continue this momentum towards sustainable development. To achieve this goal, we need to adopt modern techniques and innovative farming practices that minimize environmental impacts and conserve natural resources.

As agricultural students, you have the potential to lead the way in promoting sustainable practices in our agriculture sector. I encourage you to use your knowledge and skills to develop innovative solutions that can help us achieve our sustainability goals.

Let us work together towards a sustainable future for Indian agriculture. I wish you all the best in your efforts towards creating a sustainable and prosperous agriculture ecosystem in our country. I congratulate the organizing team of Agrivision-2023, for organizing this convention and wish them a grand success.

(KAILASH CHOUDHARY)



डॉ. हिमांशु पाठक

DR. HIMANSHU PATHAK

सचिव (डेयर) एवं महानिदेशक (आईसीएआर)

Secretary (DARE) &
Director General (ICAR)

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कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली-110 001

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MESSAGE

I am happy to know that the *National Convention, AGRIVISION-2023* is being organized by Vidyarthi Kalyan Nyas, Bhopal at National Agriculture Science Complex, Pusa campus, New Delhi, on May 05-06, 2023. The focal theme of this convention is "Sustainable Agriculture for a Self-Reliant India".

I extend my warmest greetings and best wishes to all the participants of this National Convention and I am confident that this convention will provide a great platform to discuss various new initiatives for making agriculture more sustainable. ICAR is committed to promoting sustainable agriculture through cutting-edge research, education, and extension activities. We recognize that agriculture is the backbone of our economy, and sustainable agriculture practices are essential for ensuring food security and livelihoods for millions of people.

I urge all participants to actively participate in the discussions and share their ideas and experiences. This convention provides an excellent opportunity to learn from each other and work towards developing sustainable agricultural goals that benefit our farmers and society. Agricultural students are the future of our agricultural sectors and their role in promoting sustainable agriculture practices is very important. This convention will inspire to take up upcoming challenges and contribute to the growth of our nation.

I wish the organizers and participants of AGRIVISION-2023 all success, and I am confident that this convention will be a great learning experience for all.

Thank you,

(Himanshu Pathak)

1st May, 2023
New Delhi

भारतीय कृषि अनुसंधान परिषद
Indian Council of Agricultural Research

Dr. R. C. Agrawal

Deputy Director General (Ag. Education)



Message

I am happy to know that the **AGRIVISION-2023** is scheduled to be held during **May 05–06, 2023** at the ICAR-NASC, New Delhi by Vidyarthi Kalyan Nyas, Bhopal in collaboration with ICAR, New Delhi. The focal theme of the convention is “**Sustainable Agriculture for a Self-Reliant India**”.

It is my pleasure to convey a message for this important event, which is focused on the crucial theme of sustainable agriculture for a self-reliant India. Agriculture is the backbone of our economy, and it plays a vital role in ensuring food security for our growing population. However, with changing climate patterns and limited natural resources, sustainable agricultural practices are essential to ensure that our agricultural sector can continue to meet the needs of our society in the long run.

Agricultural education in India has made significant strides in recent years, but we need to continue to invest in this sector to ensure that we are keeping pace with the evolving needs of our society. This convention provides a platform for stakeholders from across the country to come together and share their experiences, insights, and best practices in sustainable agriculture. I encourage all participants to actively engage in the discussions and collaborate to identify innovative solutions that can help promote sustainable agriculture and make India self-reliant in the long run.

I wish you all a productive and insightful convention.

A handwritten signature in blue ink, appearing to read 'R. C. Agrawal', with a stylized flourish at the end.

(R.C. Agrawal)

PREFACE

It gives me immense pleasure to welcome the delegates, including the policymakers, scientists, academia, farmers and students in the Agrivision 7th Nation Convention on *Sustainable Agriculture for a Self Reliant India* jointly organized by Vidyarthi Kalyan Nyas, Bhopal and ICAR, New Delhi during May 05–06, 2023 at the National Agricultural Science Complex, ICAR, New Delhi.

Agriculture is the backbone of our country's economy since time immemorial, and it continues to play a crucial role in shaping the nation's growth and development. The Indian government has recently emphasized the importance of achieving self-reliance in agriculture, with the aim of ensuring food security and boosting economic growth. Sustainable agriculture practices that focus on increasing crop yields while preserving the environment are crucial in achieving this goal.

This souvenir book is a tribute to the farmers and agricultural experts who have worked tirelessly to develop and promote sustainable agriculture practices in India. It highlights the various initiatives taken by the government, non-profit organizations, and private sector to promote sustainable agriculture and increase farmers' income.

The book contains lead papers and abstracts from various agricultural experts and students from different universities and institutions, showcasing the impact of sustainable agriculture practices on farmers' livelihood and the environment. The aim of this book is to inspire more farmers and policymakers to adopt sustainable agriculture practices and contribute to the growth and development of our country.

I hope that scientific deliberation during the national convention by many scientific experts, policymakers, farmers and students will formulate new ideas and strategies for integration of various forms of sustainable agriculture and its impact on India's self-reliance with modern agriculture production technologies for achieving the production goal and making Indian farming more sustainable.



**Raghuraj Kishore
Tiwari**

LEAD PAPERS

S. N.	Title	Author (s)	Page No.
1.	Digital Transformation for A Sustainable Agricultural Education	Y Ranjana Devi, S. Basanta Singh & Anupam Mishra	1-4
2.	Challenges and Opportunities for Natural Resource Management in India	Dr. A.K. Singh and Dr. A. R. Sharma	5-10
3.	Indian Agriculture Sustainability: Issues & Priorities under different Agro-Ecology	Professor B.R.Kamboj	11-17
4.	Millets for Food Security, Nutrition and Sustainable Future	C Tara Satyavathi and B Venkatesh Bhat	18-26
5.	Vision for Nutritional Security and Sustainable Food Systems in Indian Agriculture by 2047	Prof. Prabha Shankar Shukla	27-29
6.	Building a Self-Reliant India through Sustainable Agriculture: Challenges and Opportunities	Neeraj Kumar, Amit Kumar Goswami, Chavlesh Kumar, C. Bharadwaj, Shubham Singh Patel, Raghuraj Kishore Tiwari, Nishant and Utkarsh Tiwari	30-33

ABSTRACTS

S.N.	Abstract Title	Authors	Page No.
1	Effect of Conservation Agriculture on Weed Species, Soil and Climate	M.P. Sahu, V.K. Choudhary, A.K. Jha, Aarti Sahu, Vikash Singh Badal Verma, Narendra Kumar, Sonali Singh and Alpana Kumhare	35
2	Disease Control and Storage Management Of Cereal and Grains	Deepika Baliyan	35
3	Oat Genotypes Response to Different Nitrogen Levels Under Agro-Climatic Condition of	A. K. Jha and Pushendra Yadav	36

	Kymore Plateau Zone in Madhya Pradesh		
4	Millets: A Smart Choice For Health, Environment, and Sustainability	Sandeep Kumar	36
5	Avian Biodiversity an Wetland Health Indicator of Jabalpur Lakes	Devendra Podhade, Diksha Lade and Yogender Sinha	37
6	Minor Millets for Nutrition Purpose in Present Scenario	Naveena, A. K. Gupta and Shivanjali Sarswat	38
7	Intelligence for Sustainable Agriculture	Satyadeep Pradhan and Adesh Kumar	38
8	Natural Farming with a Pinch of Technology Future for Sustainable Agriculture	Priyanshu Jiwnani and Aman Agrawal	39
9	Natural Farming for Sustainable Agriculture	Shivanshu Bhalwal	40
10	Bridging the Gap for Revolutionizing Apiculture Industry Exploring the Impact of Technology and Digitization	Madhukant Patel and Suhani Patel	40
11	Value Addition of Millets	Kamakshi Sharma, Anju Bhat, Monica Reshi, Mahital Jamwal and GurveenKour	41
12	Ug99- A Big Threat for Wheat Production in India	R. K. Joshi, R. R. Waghunde, J. R. Pandya and D. M. Pathak	42
13	Value Addition in Agriculture Products	Praveen Kumar Patle, Anubha Upadhyay, Alpana Singh	42
14	Towards Sustainable Vegetable Farming Exploring Agroecological Alternatives to Chemical Products in the Marathwada Region of Maharashtra	Swapnali S. Chavan, Dhakne Vaibhav R.	43
15	Urban Agriculture: Way to Feed Cities	Aishwarya R. Ingole, Ekta Rajput, Aniket kumar L. Bijewar, Akshay R. Jagdale Aishwarya R. Ingole, Ekta Rajput and Aniket L. Bijewar	44
16	Chemical Weed Control Measures on Weed Flora and Yield of Wheat	Anamika Pandey and Smita Singh	45
17	Protection of Plant In Agriculture	Garima Yadav, Prabha Siddharth and Vishwa Vijay Raghuvanshi	45
18	Possibilities of Plant Originated Bioenzymes as an Alternative of	Sahaj Nagar, Aman Agrawal, Adesh Kumar	46

	Synthetic Chemicals to Produce Organic Diet: A Review		
19	Modified Polysaccharide-based Coatings for Postharvest Treatment of Fruits and Vegetables	Jyoti Sengar, Pragya Singh	46
20	Shree Anna: Securing Holistic Nutrition	Samiksha Bhagvantrao Misal	47
21	Value Addition in Agriculture	Shivam Rai	47
22	Artificial Intelligence for Sustainable Agriculture	Satyadeep Pradhan	48
23	Compatibility of two Native Entomopathogenic Fungi with Certain Botanicals and their Efficacy against Termite, <i>Odontotermes obesus</i>	Sanjay Hazarika and Sudhansu Bhagawati	49
24	Precision Agriculture: A Perspective Study	Sanjay Hazarika	50
25	Rhizospheric Health Impacts of Mulching and Its Relevance for Natural Farming Practices	Shaik Imran Hussain Choudhary and Arkesh Kedar Shenoy	51
26	Organic Farming and Soil Fertility	Bhumika Sharma	51
27	Adaptation and Mitigation Strategies for Climate Smart Agriculture	Anushruti, Sanjay Kumar and Sudheer Kumar Yadav	52
28	Synergetic Effect of Integrated Agri-Aquaculture System Towards the Green-Blue Revolution: Aquaponics.	Rushirajsinh Jitendrasinh Rana, Mansi Dipakbhai Jungivala,	53
29	Start-Up based on Rhododendron Arboretum Products from Dhauladhar Ranges to Global Level	AbhayVerma, Piyushand Suraj	53
30	Seaweed Cultivation in India – New Livelihood Option for Coastal Communities	Rajesh V. Chudasama and Nilesh H. Joshi	54
31	Recent Advancements in Agriculture Robots: Benefits and Challenges	Ajit A. Ware and Sourabh S. Benake	54
32	Organic Inputs in Floriculture – Trends and Effects	Ekta Rajput, Aishwarya Ingole, Aniket Kumar Bijewar, Akshay Jagdale	55
33	Organic Aquaculture towards Agricultural Sustainability	Kishan V. Sakariya and Dr K. V. Tank	55

34	Study of Weather Parametres Relationship With Performance and Yield of Different Pearl Millet Varieties under Rainfed Conditions of J& K Ut	Vikas Gupta, Permendra Singh, Sanjeev Kumar and A. P. Singh	56
35	Seasonal Abundance and Population Dynamics of Major Phototactic Insect Pests of Paddy in Relation to Weather Parameters	Amit Kumar Sharma, Rameshwar Patil And S. B. Das	57
36	Efficacy of Funnel Diameter in Light Trap Design Against Major Phototactic Insect Pests	Amit Kumar Sharma, Rameshwar Patil and S. B. Das	57
37	National Education Policy 2020: Revamping Agricultural Education System in India	Talib Bashir Bhat, Shah Murtazamushtaq, Akhalq Amin Wani, Asif Ali Gattoo and M.A. Islam	57
38	Cultivating Contracts: Exploring the Landscape of Contract Farming In India	Rohit Kumar, Maninder Singh and Dr. S.P Singh	58
39	The Concerns and Measures for the Management of Food And Agricultural Waste	Deepika Baliyan	59
40	Artificial Intelligence in Crop Improvement	Amarjeet Singh Bhogal, Debojit Sarma and Khanjan Das	60
41	Solar Energy in Indian Farming System: A Step towards Self-Reliance	Kujur, V Sangeetha, Sweety Mukherjee, Amandeep Ranjan, Fatheen Abrar. P. N	60
42	Protocol for the Preservation of Sugarcane Juice	Priyanka Chauhan, Manisha Kaushal, Devina Vaidya, Anil Gupta, Shreya Kashyap	61
43	Climate Change: Adaptation and Mitigation Strategies in Coastal Low Lying Region of Kerala	Fatheen Abrar. P. N, Amandeep Ranjan, Saurabh Tiwari, Seema Kujur, Sweety Mukherjee	62
44	Agritech-Startups: A Key to Supply Chain Revolution in Agriculture	Amandeep Ranjan, Fatheen Abrar P.N, Sweety Mukherjee, Seema Kujur, Saurabh Tiwari	63
45	Climate Resilient Agriculture: Adaptation and Mitigation Strategies High Night Temperature Mediated Carbon Balance Disruption Affects Panicle Yield and Quality Spatially in Contrasting Rice Genotypes	Nitin Sharma and Anjali Anand	63

46	Conservation Agriculture as a Climate Resilient Agriculture Option in Wheat Production	Tarun Sharma, T. K. Das, Rishi Raj and Prabhu Govindasamy	64
47	Application of Artificial Intelligence in Agriculture: Towards a Sustainable Future	Sweety Mukherjee, R.R. Burman, Seema Kujur, Amandeep Ranjan, Saurabh Tiwari	65
48	Scope of Autonomous Tractors in Revolutionizing Agricultural Operations	Rohit Anand	65
49	Nutraceuticals in Vegetables to Combat Covid 19	Shivani and Nishant	66
50	An Ecosystem - Based Approach to Climate Resilient Agriculture	Kratika Nayak	67
51	Carbon Neutral Agriculture: A Move Towards Sustainability	Ayush Mishra and Joginder Singh Malik	67
52	Natural Farming for Sustainable Agriculture	Dr Ashwini C Chandel and H.P. Pardeshi	68
53	Implementation of Artificial Intelligence in Agriculture for Sustainable Agriculture	Badal Verma	69
54	Renewable Energy for Sustainable Agriculture in India	Sourav Singh, K.K. Sood and Talib Bashir Bhat	69
55	Artificial Intelligence in Agriculture	Rashi Mishra	70
56	Climate Resilient Agriculture for Ensuring Food Security	Richa Sharma	70
57	Estimation of Moisture Content of Freshly Harvested Groundnut Pods by Hot Air Oven Drying Followed by Microwave Heating	Akshay Sharma	71
58	Assessment and Prediction of Chill Units Using Different Chilling Models in Kiwifruit Cultivars under Changing Climatic Scenario	Sunny Sharma, Vishal S Rana, Vijay Kumar, Umesh Sharma, Aman Agarwal	72
59	Growth Regulators in Enhancing the Productivity of Vegetables	Rupesh Kumar, Harshit Tomar, Pooja Singh, Yashraj and Vikash Tyagi	72
60	Food Processing Waste and Byproducts as a Source of Nutraceuticals	Shreya Kashyap, Manisha Kaushal, Devina Vaidya, Anil Gupta, Priyanka Chauhan	73
61	Food Printing: From Pixels to Plate	Priyanka Chauhan, Manisha Kaushal, Devina Vaidya, Anil Gupta, Shreya Kashyap	73
62	Development of Flavoured Soy milk from <i>Harit</i> Soya and Its Waste Utilization	Dechen Angmo, Anju K Dhiman	74

63	Pseudo cereals and Red Kidney Bean-Based Gluten Free Bakery Products	Natasha Negi, Kd Sharma	75
64	Sustainable Agriculture for a Self reliant India	Neha Kumawat	75
65	Smart Urban Farming: Potential And Prospects	Joginder Singh Malik and Ayush Mishra	76
66	Impact of Covid-19 Pandemic on Rural Livelihood and Goat Rearing as Alternatives	Ujjwal	76
67	Use of Domestic Oven Toaster Griller for Cashew and Almond Roasting	Amit A. Deogirikar, Yuvraj S. Pethe, and Anagha A. Deogirikar	77
68	Seeds for Natural Farming: Lack of Seeds and Varieties Suited to Natural Farming	Sonali Rajput	78
69	Sensor Based Vertical Farming System Using the Internet of Things (IoT)	Love Kumar, Ram Naresh, Amandeep Singh and Mukesh Kumar	78
70	Shree Anna: A Holistic Approach for Nutrition Security	Vinayak, Yashraj, VikashTyagi	79
71	Battery-Operated Pigeon Pea Stem Cutter for Marginal and Small Farmers	Abhishek Pandey	79
72	Millet, Pre and Post Green Revolution: A Tale of Missing Links	Anirban Das, Swapnil Birunagi, Satyadeep Pradhan, Aman Agrawal, Samaksh Gothi, Adesh Kumar	80
73	Trio-Dynamic Role of Entomocomposting with Black Soldier Fly (<i>Hermetia Illucens L.</i>) Towards Soil Waste Management, Food Security and Soil Sustainability Enhancement	Khanjan Das, Sahidur Rahman, Amarjeet Singh Bhogal and Sanjay Hazarika	81
74	A Critical Discussion on Regenerative Model for Sustainable Livelihood and Balanced Ecology	Anirban Das, Sahaj Nagar, Adesh Kumar and Satya Prakash	81
75	Sustainable Agriculture for A Self - Reliant India	Savaliya Dhaval Paresbhai	82
76	Value Addition in Agriculture	Prafull Patil	82
77	Significance of Value Addition in Agriculture	Mir Muskan Un Nisa, S. A Gangoo, P. A Sofi and Peerzadaihtiyak Ahmad	83
78	Standardization of Skeletonizing Techniques for <i>Ficus Religiosa</i>	Deep Savani, Alka Singh, H P Shah and G D Patel	83
79	Increasing Nitrogen Use Efficiency	Pooja Lr, Manoj Shrivastava, Shiva Dhar, Harshwardhan	84

		Choudhary, Sibananda Darjee, and Renu Singh	
80	Natural Farming for Sustainable Agriculture	Bhadani Samirkumar Rameshbhai	84
81	Zero Energy Cool Chamber: A on Farm Eco-Friendly Storage Unit	Harshvardhan Zala, Sunil S. Solanki, Jenish P. Virani, Yash Trivedi, A.K. Senapati	85
82	Land Use Land Cover Mapping for Identification of Irrigated and Non Irrigated Areas in the Betwa River Basin Using Spatial Data	Vipin Kumar Mishra, Dr. M. K. Awasthi, Dr. Satish K Sharma	86
83	Relative assessment of different okra genotypes against major insect pest.	Roshani Pisda, Yogesh Kumar Nag, Eshant Sukdeve	86
84	Study of biochemical basis of preference of mango leaf hoppers	Mukesh Patel	87
85	Varietal Evaluation of Chrysanthemum for Pot Mums under Raipur region of Chhattisgarh Plains	Akash Chandra	87
86	Compatibility of Two Native Entomopathogenic Fungi with Certain Botanicals and Their Efficacy Against Termite, <i>Odontotermes obesus</i>	Sanjay Hazarika and Sudhansu Bhagawati	88
87	Biofortification in fruit and vegetable crops	Mukesh Shivran	89
88	Application Of Artificial Intelligence (Ai) For Seed Quality Assurance	Bhanu Verma, Rohit singh Chandi and Deepak Rao	89
89	Effect of Natural Inputs Against Root-Knot Nematode (Meloidogyne Incognita) on Potato	Darshkumar R Chaudhari and Dr. Ajaykumar Maru	90
90	An ecological studies of beneficiary insects and soil dwelling organisms in natural and organic farming systems under beans cultivation	Suhasini Chikkalaki, Anand Mastiholi, Maheshwarappa, H. P., Kulapati Hipparagi, Sanjiv Duradundi and Venkatesh Dasar	90
91	Value Addition in Mashroom	Darshkumar R Chaudhari Soham M Thummar and Vansh B Chaudhari	91
92	Biofortification of sulphur in groundnut crop to improve their quality in calcareous soil	R. Vinothini and Anjali Bhadra Vijay	91

93	Importance of Farmer Producer Organization for resolving small farmer problem	Richa Khushwaha	92
94	Artificial Intelligence in Agriculture	Dipesh Ladumor and Shaktiranjana Panigrahy	93
95	Natural Farming for Sustainable Agriculture	Keshav Kashyap	93
96	Subhash Palekar Natural Farming in India.	Bamrotiya Rajesh Hardasbhai	93
97	Urban Permaculture: A Sustainable System for Human Health & Climate.	Varnit Agarwal, Yogesh Prasad, Chetna	94

LEAD PAPERS

Digital Transformation for A Sustainable Agricultural Education

Y Ranjana Devi, S. Basanta Singh & Anupam Mishra

Central Agricultural University

Imphal, Manipur

Digital transformation in the education sector refers to the integration of technology in all aspects of education, from administration to teaching and learning. It is a process of using digital technologies to fundamentally change how education is delivered, consumed, and experienced. The formation of a highly professional teaching staff is the main resource for improving the quality of education and contributes to attracting young people to receive quality agricultural education. Strengthening the research facilities of universities and especially the laboratory fund of scientific laboratories, while the involvement of young scientists in the implementation of research projects and grants is fundamentally important for the development of youth science. In the agricultural sector, the priority is the training of personnel and the testing of their knowledge using digital technologies, as well as the development of the facilities and timely retraining of personnel. The essence of the digital transformation of agricultural education lies in the effective and flexible use of modern technologies for the transition to a personalized and result-oriented educational process. Digital transformation should not be seen as an end in itself, but as a means use to optimize the existing potential in an innovative way. The main goal of agrarian education is to improve the quality of personnel training for the agro-industrial complex that meets modern requirements. There are several technologies that are being used to enable digital transformation in the education sector. These include learning management systems (LMS), virtual reality (VR) and augmented reality (AR), artificial intelligence (AI), online learning platforms, collaboration tools, mobile learning apps etc.

1. Learning management system (LMS) is a software application that is used to create, deliver, and manage online courses. It allows teachers to create and deliver assignments, track student progress, and facilitate communication among students and teachers. Some popular LMS platforms include Blackboard, Moodle, Canvas etc.
2. Virtual reality (VR) and augmented reality (AR) technologies are being used to create immersive and interactive learning experiences that can engage students and enhance their understanding of complex concepts. VR and AR technologies is used to create virtual field trips, simulations, and other interactive learning experiences that can enhance the hands-on experience in low-risk virtual settings.
3. Artificial intelligence (AI) is being used to personalize the learning experience and provide personalized feedback to students. One latest technology that is bringing a major digital transformation is ChatGPT (Generative Pre-trained Transformer) which is an artificial intelligence (AI) chatbot developed by OpenAI which was released in November 2022. It is a program that can realistically write like a human and has garnered attention for its detailed responses and articulate answers across many domains of knowledge. It has become a helpful tool for students for answering questions, problem solving, concept reinforcement, improving writing skills etc. Teachers can use ChatGPT to create and curate educational materials, such as presentations, worksheets, quizzes, and other resources tailored to their students' needs. It also helps to create, organize, and structure course content in a coherent and effective manner. It also supports and streamline the research process for various academic projects, assignments, or personal interests like topic selection, Background information, Organizing research, Citation assistance etc.

4. Online learning platforms, such as Coursera, edX, Udemy etc. offer a wide range of online courses that can be accessed by students from anywhere in the world. These platforms allow students to learn at their own pace and access high-quality educational resources. BYJU's is India's most popular educational website and app that is being used by millions of students to study and learn various topics and courses.
5. Collaboration tools, such as Google Classroom, Microsoft Teams, and Slack, allow students and teachers to communicate and collaborate in real-time. These collaboration tools can facilitate communication, the sharing of resources, and collaboration among students and teachers.
6. Mobile learning apps, such as Udemy, Brainscape, Vedantu, Meritnation etc., allow students to access learning materials and track their progress on their mobile devices. These apps can be used to deliver personalized and interactive learning experiences to students.
7. Another important digital transformation used in education sector in India is the DigiLocker which is a flagship initiative of Ministry of Electronics & IT (MeitY) under Digital India programme aimed at 'Digital Empowerment' of citizen by providing access to authentic digital documents to citizen's digital document wallet. It is a secure cloud based platform for storage, sharing and verification of documents & certificates. Lately, DigiLocker has been focusing a lot on educational documents. Students of present generation are technology savvy and adopt any new technology with ease. These educational documents combined with other documents available on DigiLocker will enable the students to avail various online government/private services such as eDistrict applications, passport application, employment exchange, document verification, background verification etc. from their home itself. It'll not only save time but also ensures that the documents are shared securely with no involvement of any third party. The marksheets/certificates issued through DigiLocker are also digitally signed to ensure highest level of authenticity and is working in the direction wherein students will be able to apply for admissions to higher education across India with their authentic DigiLocker documents.

Digitalization is a rapidly growing trend within agriculture and digital education of the farmers will empower the farmers. Digital agriculture, or "Smart Farming," is characterized by the use of precision and data-driven technologies to assist farmers with real-time and site-specific decision making. It leverages technologies including the Internet of Things (IoT), sensors, drones, robotics, cloud computing, artificial intelligence (AI), decision support software (DSS), and blockchain, for example, to optimize agricultural production processes, value chains, international trade, agricultural systems and governance systems. By and large, digital agriculture is viewed as a promising means for sustainably boosting food production to feed a growing world population. Along with improving agricultural productivity, digitalization could provide a diverse range of benefits to the environment and society. For instance, digital agriculture could help alleviate pressures on scarce resources improve food safety through increased traceability as well as combat climate change. Other potential benefits of agricultural digitalization include the creation of new types of high-skilled job opportunities, fostering global agricultural markets. For digital literacy, farmers require ongoing education to stay aware of fast-moving developments in technology, science, business management, and an array of other skills and fields that affect agricultural operations. However, farmers face unique challenges and require education and training to ensure their success. Training helps farmers to incorporate the latest scientific advances and technology tools into their daily operations. Aidan Connolly, President of AgriTech Capital, a food/farm futurologist in

Forbes Innovation (2022) has listed 10 digital technologies most relevant to food and farming

1. **Robotics:** Those who associate farming with bucolic country living might not realize that the new generation of farmworkers doesn't aspire to pick fruit, pick up animals or do many of the common backbreaking tasks associated with farming. Robots now milk cows, pick strawberries and cut up carcasses in processing plants. Robotics in farming represents a global market of over \$5 billion and is projected to double in the next five years.
2. **IoT And Sensors:** The ability to track produce and live animals, detect health issues and evaluate the environment inside the farm or the uptake of moisture from the soil in real time is of huge value in addressing the major challenges of climate/sustainability, animal welfare and tracking in the food supply chain. The explosion of IoT devices in other industries (46 billion devices are connected) could pale in comparison to the opportunities represented in agriculture, already an \$11.4 billion market.
3. **Artificial Intelligence (AI):** Many careers in food and farming rely upon learning by doing, rather than explicit knowledge transfer. This creates real challenges, such as how to avoid human error, misunderstandings and cognitive bias. AI may sound the death knell for extension agents, farming experts, consultants and professional expertise, but, more likely, it will alter how those professions function. More accurate data will be available faster but will still need interpretation. As an example, consider how AI has changed the healthcare industry: Jobs have been changed but not replaced.
4. **3-D Printers:** The ability of 3-D printers to repair machinery, print food or even make a prosthetic for a valuable animal provides a clear advantage to farms worldwide. It's even clearer in times of disrupted supply chains (e.g., Covid-19) or in regions of the world with their own distribution challenges (e.g., Africa). 3-D printing on the farm and in the food supply chain creates real efficiencies and savings.
5. **Drones:** Already surveying 20 million hectares of China's cotton crop, the ability of drones to go where humans can't and see things not readily observed from the ground creates real insights into pest protection, fertilizer and herbicide application, irrigation and harvest timing.
6. **Extended Reality And The Metaverse:** The potential for extended reality (XR), as human vision is limited to visible light, and XR can let us see a broader spectrum. This can be valuable in managing crops, animals and food production and has the potential for improving health and food safety practices.
7. **Virtual Reality (VR):** The ability of VR to teach students about the inner workings of animals (without vivisection) and how plants grow—or simply to be able to visit farms—is an extraordinary opportunity for students and consumers alike to engage with farming.
8. **Blockchain:** Both the most exciting and the most misunderstood technology (using the same technology as Bitcoin), blockchain can create transparency in a sector that's often failed to capture consumer confidence. Blockchain represents an opportunity for the food industry to regain its high ground. For example, Canadian companies in the beer supply chain, Walmart's global food chain and the FDA see blockchain as a tool to address consumer concerns about provenance and food safety.
9. **Data Analytics:** The world will store 175 zettabytes of data by 2025. Data is often described as the "new oil," which is ironic, as many countries that are rich in oil haven't necessarily become wealthy as a result. It's assumed that the future capturing, controlling (or protecting) and processing of data will justify the high valuations of agtech startups. Believing that data will be the savior of farming is a pipedream, but the power of data analytics can unleash meaningful new insights for farmers and food producers.

10. **Cloud Connectivity:** Cloud-based computing services use real-time connections to the internet to offer more flexible resources and economies of scale than available with conventional server-based or even edge options. The requirement for connectivity—especially 5G—represents a genuine challenge when many farms aren't connected at all yet. Governments understand that if farming is to be revolutionized, addressing connectivity is essential. Without it, the rural-urban divide will be exacerbated.

Digital agriculture also helps make farming techniques easier, safer and more affordable. Traditional agricultural practices are best combined with technological and digital innovations. This optimizes both productivity and efficiency in terms of cost, labour and resources however there are many adoption barriers of digital agriculture technologies. High investment costs and lack of training and advisory services for farmers are some of the main barriers to adoption, especially for small- and medium-scale farmers. So, there is need for framing policies which can help surmount these barriers through offering financial assistance to farmers and innovators in the form of tax-breaks and/or subsidies. There is also a need for strategic direction for further improving digital technologies in agricultural education with the scientific achievements of educational institutions in partnership with advanced agricultural enterprises. Improving the quality of personnel training is necessary on the basis of integrating agricultural educational institutions, including the further formation of an extensive network of specialized agricultural classes. There is a need for a system of training, retraining and advanced training to have a more effective impact on real transformation of rural areas. Coupling advisory services and training with financial assistance for digital technologies will increase chances that digital agriculture will be leveraged to its fullest potential. Digital agriculture has received considerable attention in policy in recent years, with emphasis mostly placed on the potential of digital agriculture to improve efficiency, productivity and food security. At the same time, they provide solutions to increase social, ecological and financial sustainability. Farmers are gradually becoming techsavvy and agri-digitization is progressively growing with a wider perspective. Digitization has yielded fruitful results to the efforts made so far and has set a benchmark for farmers to utilize such innovations and bring impact on their own life and livelihood. Digital farming is synonymous with smart decision-making, higher productivity, better quality produce and a profitable market using advanced technologies towards shaping a brighter future.

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Challenges and Opportunities for Natural Resource Management in India

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Natural resource management (NRM) refers to the sustainable management of the Earth's natural resources, such as land, water, forests, minerals, and wildlife, among others. It involves the protection, conservation, and sustainable use of natural resources to ensure their availability for present and future generations. India is gifted with various types of natural resources but due to rapid population growth, there is over-exploitation and many valuable resources are rapidly being exhausted. Thus, the agriculture production system faces the daunting task of feeding 17.5% of the global population with only 2.4% of land and 4% of water resources at its disposal.

Adoption of Green Revolution technologies during the 1960s led to increased productivity and elimination of acute foodgrain shortages in India. These technologies primarily involved growing of high-yielding dwarf varieties of rice and wheat, increased use of chemical fertilizers and other agrochemicals, and expansion of irrigation facilities. This was also accompanied by the methods of cultivation such as maximum tilling of land, virtually clean cultivation with complete removal of crop residues and other biomass from the field, fixed crop rotations mostly involving cereals and elimination of fertility-restoring pulses and oilseed crops in the highly productive north-western plain zone of the country. Also, there was greater dependence on chemical fertilizers and reduced application of organic additions like compost, manures and mulches.

Over the last 5 decades, India has achieved not only self-sufficiency in foodgrain production but also the capability to export food commodities. This is cited as one of the greatest accomplishments of Indian agriculture in the post-independence era. However, the transformation from 'traditional animal-based subsistence farming' to 'intensive chemical- and tractor-based modern agriculture' has led to multiplicity of issues associated with sustainability of natural resources.

Conventional agriculture technologies

The invention of the plough for soil inversion and growing crops during the mid-19th century was one of the major milestones in the history of agriculture. For centuries, conventional agricultural systems have been characterized by intensive tillage and soil inversion operations, clean cultivation, extensive use of irrigation water, and chemical fertilisers. These have no doubt brought yield revolutions, but at the cost of over-exploitation of our natural resources. In South Asia, the adoption of intensive tillage practices since the Green Revolution in the mid-1960s has led to a factor productivity decline, deterioration in soil health, depletion of groundwater, increase in the cost of production, lower profitability, and environmental degradation. Therefore, it has been argued that the system of crop production should be suitably modified in accordance with the changing environment and deteriorating natural resources.

Conventional crop production technologies are characterized by: (i) intensive tillage to prepare fine seed- and root-bed for sowing to ensure proper germination and initial vigour, faster absorption of moisture, control of weeds and other pests, mixing of fertilizers and organic manures; (ii) fixed crop rotations mostly involving cereal crops and excluding legumes; (iii) clean cultivation involving removal or burning of all residues after harvesting leading to continuous mining of nutrients and moisture from the soil profile; and bare soil with no cover; (iv) indiscriminate use of pesticides and chemical fertilizers, (v) excessive and imbalanced use of natural resources leading to declining

factor productivity, and increase in pollution of environment, ground water, streams, rivers and oceans; and (v) energy-intensive farming systems.

It is now realized that soils are getting impoverished due to imbalanced use of fertilizers, discontinuation of traditional practices like mulching, intercropping, and inclusion of legumes in cropping systems. Further, the use of organic manures, composts and green manure crops has also decreased considerably due to various reasons. Similarly, water resources are under great stress due to their indiscriminate exploitation and getting polluted due to various human interferences. Burning of fossil fuels and crop residues, and puddling for rice cultivation are leading to emission of greenhouse gases, which are responsible for climate change and global warming.

Depletion of natural resources

It is widely perceived that conventional agricultural practices are not ecologically sustainable as they degrade the land by destroying soil structure and biodiversity, reduce soil organic matter content, cause soil compaction, increase runoff and soil erosion and contaminate water bodies with pollutants and sediments, threatening land productivity, environment and human and animal health. In addition, they produce unacceptable levels of greenhouse gas emissions, speeding up climate change. In this context, the major concerns of natural resource management are low farm productivity and profitability, land degradation, low water productivity, soil health deterioration and low nutrient-use efficiency, abiotic stresses including climatic aberrations, and loss of tree cover and deterioration in ecosystem services.

Natural resource depletion refers to the exhaustion or depletion of natural resources such as minerals, forests, water, and land, due to their overuse or unsustainable management practices. There are several causes of natural resource depletion, including the following:

- *Overuse:* When natural resources are used beyond their capacity to replenish themselves, they become depleted. For example, over-fishing leads to a decline in fish populations, while excessive logging can lead to deforestation and soil erosion.
- *Pollution:* Pollution degrades natural resources such as water, air, and soil, making them unsuitable for human use. For example, the dumping of toxic waste in water bodies leads to water pollution, making it unsafe for human consumption.
- *Climate change:* Climate change, caused by the emission of greenhouse gases, contributes to natural resource depletion. For example, the melting of glaciers due to rising temperatures is leading to water scarcity, while droughts can lead to soil erosion and depletion.
- *Population growth:* The increasing global population puts pressure on natural resources, leading to overuse and depletion. As more people consume natural resources, demand increases, leading to their depletion.
- *Unsustainable management practices:* The practices such as excessive use of pesticides, overgrazing, and deforestation contribute to natural resource depletion. The depletion of natural resources can have severe environmental, social, and economic impacts. It can lead to water scarcity, food insecurity, loss of biodiversity, and soil erosion, among others.

Soil resources

Soil is the basic natural resource that sustains all types of ecosystems on earth. It is the basis of crop production and all life processes on the globe. It is the greatest sink of natural resources and plays an important role in sustaining favourable environment and climate regulation. Intensive agriculture to meet the growing food requirements of ever-increasing population has resulted in severe degradation of soil quality, soil erosion, desertification and salinization, thus compromising on soil health during the last few decades. Decreasing factor productivity and profitability of agricultural systems is posing

serious challenges to meet the future demand for food, feed, fodder and fiber. This has become a major threat of modern agriculture as a consequence of rapid degradation of natural resources, climate change and residue management problems with increased mechanization. Significant impact of these soil degrading factors has started making their influence on productivity of lands, and is estimated to be much more devastating in the next few decades if necessary corrective measures are not initiated.

Water resources

Management of water resources in India has been a challenge and its magnitude has risen manifold over the past 50 years due to a variety of reasons, notably the rising demands and growing environmental degradation. India is likely to face a major challenge in the management of freshwater in view of rapidly rising population and increasing agricultural, industrial and other requirements. India is also highly vulnerable to impacts of climate change on water resources due to its unique climate, geography and topography. As the economy of the country is currently witnessing rapid growth, management of freshwater resources becomes all the more important. Sustainable water management in agriculture aims at matching water availability and needs in quantity and quality, in space and time, at reasonable cost with acceptable environmental impact. Efficient water use not only reduces the production costs, but also increases the profitability by reducing the nutrient losses.

Nutrient resources

It is often said that our soils are not only thirsty but hungry too, and have actually become fertilizer-addicted for producing good crop yields. The net negative nutrient imbalance in Indian soils has been estimated to be about 60 kg NPK/ha annually. Therefore, nutrient management strategy should involve linking soil, crop and weather factors to achieve optimal nutrient use-efficiency, crop yields and economic returns while reducing nutrient losses and negative impacts on the environment. It involves harmonizing the right -source, -rate, -time and -place (commonly known as the 4R nutrient stewardship) of nutrient application with site-specific soil, climate, and crop management conditions. The current fertilizer recommendations are based upon crop response data aggregated across large geographic areas without considering the indigenous nutrient supplying capacity of soils. Such blanket fertilizer application for multi-nutrient deficient soils results in under-fertilization in some cases and over-fertilization in others, and ultimately compromising the soil health and crop productivity. The availability and cost of fertilizers necessitate that every unit of fertilizer should be used effectively. Because of location-specific nutrient needs, fertilizer recommendations based on target yield, fertilizer use-efficiency and inherent soil nutrient supplying capacity provide options to remove the soil fertility constraints.

Plant genetic resources

Plant genetic variations are the backbone for improvement in any plant species. Therefore for development of varieties, sustainable management of variations is must. Monoculture in the form of sole crop and one or two varieties or hybrids has become the order of the day limiting the variability at farmers' fields and maintaining variations for posterity. Intensive and commercial agriculture has ensured food and nutritional security to a large extent but has become a cause of loss of biodiversity, reduced food and crops diversity. This has resulted in failure of crops due to abrupt rise or drop in temperature, and emergence of new diseases and insect-pests. A number of erstwhile minor or introduced crops became major ones and traditional ones diminished from the scene. To meet the future food, feed and fodder demand, there is need to capitalize over huge biodiversity available by searching useful genes from wild and weedy relatives, future crops, climate resilient crops, and transferring these to desirable agronomic backgrounds for bringing

much needed stability in performance and developing new gene(s) combinations for economic yield and quality. Designing future varieties prototypes based on ideotype concept using artificial intelligence may become a reality in near future. Accordingly, the issues related to loss of biodiversity, challenges and strategies need to be addressed so that sufficient quantity of quality food, feed and fodder having maximum diversity can be ensured for future generations.

Forest and wild life

India also has a variety of natural vegetation since the country has a varied relief and climate. These forests are narrowed to the plateaus and hilly mountainous areas. India has a great variety of wildlife. There are many national parks and hundreds of wild life sanctuaries. Around 24.5 percent of the total geographical area include Forests (IFSR 2019). Because India's weather conditions are changing frequently and differences in altitude, different types of Forest are present in India including Tropical, Swamps, Mangrove and Alpine. Variety of forest vegetation is large. Forests are the main source of Fire woods, Paper, Spices, Drugs, Herbs, Gums and more. Forests have great contribution to nation's GDP.

Climate change and its management

Planned adaptation to climate change is essential to increase the resilience of agricultural production. Several improved agricultural practices evolved over time for diverse agro-ecological regions in India have the potential to enhance climate change adaptation, if deployed prudently. Management practices that increase agricultural production under adverse climatic conditions also tend to support climate change adaptation because they increase resilience and reduce yield variability under variable climate and extreme events. Some practices that help adapt to climate change are: soil organic carbon build-up, in-situ moisture conservation, residue recycling instead of burning, water harvesting and recycling for supplemental irrigation, growing drought and flood tolerant varieties, water saving technologies, location-specific agronomic and nutrient management, and improved livestock feed and feeding methods.

India is more vulnerable to climate change in view of the dependence of huge population on agriculture, excessive pressure on natural resources and relatively weak coping mechanisms. The warming trend in India over the past 100 years has indicated an increase of 0.6°C, which is likely to impact many crops, negatively impacting food and livelihood security of millions of farmers dependent on agriculture. Indian agriculture with 80% of farmers being small holders (<0.5 ha) with diverse socio-economic backgrounds, 58% is monsoon dependent rainfed agriculture, about 30% of population undernourished, migration from rural to urban regions, child malnutrition etc. has become more vulnerable with changing climate and variability. During the past decade, frequency of droughts, cyclone and hailstorms increased, with 2002, 2004, 2009, 2012, and 2014 being severe droughts. Reduced foodgrain productivity, loss to vegetable and fruit crops, fodder scarcity, shortage of drinking water to animals during summer, forced migration of animals, severe loss to poultry and fishery sectors were registered, threatening the livelihoods of rural poor.

Climate resilient technologies have been identified in a participatory manner involving farmers in 151 risk prone districts of the country. Promising resilient technologies were identified which can be categorized into the following:

- *Natural resource management* (in-situ moisture conservation, biomass mulching, residue recycling, manure management, soil health card based nutrient application, water harvesting and recycling for supplementary or life saving irrigation, improved drainage in high rainfall/flood prone villages, conservation tillage and water saving irrigation methods.

- *Crop production* consisting of introduction of short duration and drought/heat tolerant varieties, modifications in planting dates for post-rainy season crops to cope with terminal heat stress, watersaving paddy systems (System of Rice Intensification, aerobic, direct seeding), frost management in fruit/vegetables, community nursery in staggered dates to meet delay in onset of monsoon, energy efficient farm machinery through village Custom Hiring Centre (CHC).

- *Technologies for livestock and fisheries*, such as augmentation of fodder production, fodder storage methods, prophylaxis, and improved shelters for reducing heat stress in livestock, management of fish ponds/tanks during water scarcity and excess water, and promotion of livestock as climate adaptation strategy.

Conservation Agriculture (CA) is an approach of managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the natural resource base and the environment. Adoption of CA practices has helped millions of farmers worldwide in increasing productivity and profitability through arresting land degradation, improve input-use efficiency, adapt and mitigate climatic extremes, and improve farm profitability in diverse ecologies across the world. Realizing the potential impacts, significant efforts have been made in the adoption and popularization of CA which covers around 15% of the global cropped area at present. CA involves a total paradigm shift from the conventional agriculture systems, and has the potential not only to improve productivity and profitability but also the sustainability through combating climate change.

Livestock resources

The livestock sector faces a range of challenges including climate change, emerging diseases, competition for natural resources and evolving demand for animal-source foods. Genetic diversity of livestock is a key resource for allowing livestock keepers to address these challenges. Cryo-conservation of genetic resources through gene banking provides one of the most powerful tools to manage the genetic diversity in short- and long-term, and thereby provide future generations with the tools to meet the challenges. Developing technologies such as autonomous livestock monitoring platform enable hands-free method to monitor and recognize the patterns and behaviour of the animals. Automated farming addresses the major challenges such as the growing food demand and worker shortages as well as improves livestock productivity and welfare. Biosafety surveillance is also important to prevent the entry of infectious agents into the farm and mitigate their spread. Drones can solve the problems by enabling remote livestock monitoring. Stem cell technology and biomarkers are among the innovations allowing researchers to demonstrate safety and efficacy while reducing the need for animal testing. Scientific advances offer enormous potential for better health prospects for animals, consumers and greater income opportunities for the farmers.

Fisheries resources

India is bestowed with vast aquatic resources including freshwater, brackish water and marine water having tremendous potential for fish production. These aquatic resources support huge biodiversity and fisheries with an estimated 500 fish species. India has 2.25 million ha of ponds and tanks for freshwater aquaculture and 8118 km of coast line. In recent times, however, most of these resources have been the victim of enhanced man induced perturbations and are in a critical phase of ecological transition. The problems would further be accentuated and likely to be far more serious in the coming years due to accelerated pace of over-exploitation, environmental degradation and climate change. In addition to that, quality fish seed, low cost good quality feed, disease diagnostics and its management, proper fish harvest and post-harvest technology, marketing and value chain are the need of the hour for fish production enhancement. Therefore, there is an urgent

need for sustainable management plan for conservation of fisheries biodiversity and restoration of aquatic ecosystems.

Innovative approaches for natural resource management

There have been many innovations in sustainable natural resource management in recent years, aimed at preserving and protecting our planet's ecosystems for future generations. Some of these innovations include the following:

- *Precision agriculture*: This involves using data and technology to optimize agricultural practices, such as fertilization and irrigation, reducing waste and increasing resource use efficiency.
- *Conservation agriculture*: This involves minimizing soil disturbance, maintaining soil cover, and rotating crops to increase soil fertility and reduce erosion.
- *Water conservation*: This includes using low-flow fixtures, capturing rainwater for irrigation, and implementing water-efficient practices in agriculture and industry.
- *Carbon capture and storage*: This involves capturing carbon dioxide emissions from power plants and other sources and storing them underground or using them for industrial purposes.
- *Renewable energy*: This includes wind, solar, and hydroelectric power, as well as biofuels made from plant materials, reducing reliance on nonrenewable fossil fuels.
- *Sustainable forestry*: This includes using selective cutting techniques, replanting trees, and utilizing wood waste for energy production, to maintain healthy forests and reduce deforestation.
- *Ecotourism*: This involves promoting sustainable travel and tourism practices that minimize environmental impact and support local communities.
- *Sustainable fishing*: This includes using science-based methods to manage fish populations and prevent overfishing, as well as reducing by catch and protecting habitats.
- *Green infrastructure*: This includes using natural systems, such as wetlands and forests, to manage storm water and prevent erosion, as well as implementing green roofs and walls in urban areas to reduce the urban heat island effect and improve air quality.
- *Circular economy*: This involves designing products and systems to minimize waste and promote the reuse and recycling of resources.
- *Information technology*: In the recent times, innovative approaches are being followed for efficient resource management, which include artificial intelligence, IoTs, block chain, agro-drones etc. These technologies are finding rapid acceptance at the field level, and are likely to make a major contribution for sustainable natural resource management in the coming years.

Indian Agriculture Sustainability: Issues & Priorities under different Agro-Ecology

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India's agricultural sector is vital to the country's economy. Climate change threatens agricultural production and leads to an increasing contradiction between food supply and requirement. Solving food security has become a major challenge around the world. As greenhouse-gas emissions in the atmosphere are increasing, the temperature is also rising due to the greenhouse effect. Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate. Climate change also affects all organisms and their activities in various agro-ecosystems. The development of climate-resilient agriculture (CRA) is critical to address for improvement of agricultural quality and efficiency. The highlights of this lecture are to analyze the impacts of climate change on agricultural development, its possible causes, synergy of mitigation and adaptation strategies, their economic impact and sustainable use of water, energy and land.

Keywords: Agriculture, climate change; climate-resilient agriculture; ecosystems; water use

Introduction:

Agriculture represents a core part of the Indian economy and provides food and livelihood activities to much of the Indian population. Humanity faces numerous challenges and most of them are linked to food security of the exploding world population which is expected to cross the nine billion mark by 2050. Populations and demand for food continue to increase worldwide, but growth in agricultural productivity is not accelerating in analogous manner in many countries including India. According to the 2021 report from the Food and Agriculture Organization of the United Nations (FAO), the conflict between rapid global population growth and incompatible food supplies has become more serious. Rapidly growing populations and changing diets will increase the demand for meat and dairy products in developing economies, which will further expand the exploitation of natural resources and increase food production and its security risks (Acevedo *et al.*, 2020).

Indian Agriculture is one of the most significant contributors to the Indian economy. Agriculture is the only means of living for almost 60% of the employed class in India. The agriculture sector of India has occupied almost 43% of India's geographical area. Agriculture is still the only largest contributor to India's GDP (16%) even after a decline in the same in the agriculture share of India. Agriculture also plays a significant role in the growth of socio-economic sector in India.

In the earlier times, India was largely dependent upon food imports, but the successive story of the agriculture sector of Indian economy has made it self-sufficient in grain production. The country also has substantial reserves for the same. India depends heavily on the agriculture sector, especially on the food production unit after the 1960 crisis in food sector. Since then, India has put a lot of effort to be self-sufficient in the food production and this endeavour of India has led to the Green Revolution. We generally compare our contemporary food situation with the situation of food scarcity of mid 1960s

and draw satisfaction from the fact that now we are not facing food scarcity. Our mind set is fixed in comparing agriculture of 2000s or recent years with agriculture of 1965-67 rather than comparing agriculture achievements with the achievements of India's other sectors and other nations. What has been achieved in agriculture is not compared with what is achieved in space, IT, telecom, services, automobiles, medical science, transport etc. Between 1965-67 and 2000s, we are much more different in all sectors and spheres of life than in agriculture but we do not assess achievement of agriculture against the challenging yardsticks. Surely, agricultural achievements are big compared to mid-1960s but they look dwarf compared to other yardsticks. As per the Union Budget 2023, India's agricultural sector is still vital to the country's economy inspite of the fact that the percentage of agriculture in the Indian economy has declined over the past 50 years. In the last few decades, India has made great strides in agricultural productivity, including the introduction of high-yield seed varieties, increased fertiliser use and enhanced water management techniques.

Agriculture Challenges

Agriculture is at the nexus of three major challenges in the future era – sustaining food & nutrition security, adaptation & mitigation of climate change and sustainable use of critical resources such as water, energy and land.

1. **Sustaining food & nutrition security:** Food security in a population means that all people, at all times, have sufficient access to food to meet their dietary needs for a productive and healthy life. The three components of food security—*availability* (having sufficient quantities of appropriate food available), *access* (having adequate income or other resources to access food), and absorption [*utilization / consumption*] (having adequate dietary intake and the ability to absorb and use nutrients in the body)—provide the basis to strengthen food and nutritional security in developing countries. Food security is a crucial aspect of human development, as inadequate access to food can lead to malnutrition, hunger and other health problems. Agriculture is an economic activity that sustains the food and nutrition necessary for human life and plays a pivotal role in socio economic development (Latruffeet *al.*, 2016). India has made significant progress in improving food security over the past few decades, but challenges remain. According to the Global Hunger Index 2022, India's score improved from 38.9 in 2000 to 29.1 in 2022, indicating a reduction in hunger and undernutrition. However, India still ranks 107 out of 121 countries on the index, indicating that there is much room for improvement. During 2021-22, the country recorded US\$ 50.2 billion in total agriculture exports with a 20% increase from US\$ 41.3 billion in 2020-21. It is projected that the Indian agriculture sector will grow by 3.5% in FY23. Security in terms of food and nutrition is one of the top concerns of the Government of India, and as a result, Union Government has hiked the budget to the tune of Rs.1,623 crore during 2023-24.
2. **Adaptation & mitigation of climate change:** Climate resilient agriculture (CRA) is an essential component of food security in India where we rely heavily on agriculture for its economic growth and livelihoods. India's diverse agro-climatic zones, coupled with its monsoon based agriculture, make the country highly vulnerable to the impacts of climate change, including extreme weather. Changing weather introduces a number of issues for farm owners to address, and climate change adaptation strategies in agriculture are objectives of primary importance. The difference between climate change mitigation strategies and climate change adaptation is that mitigation is aimed at tackling the causes and minimising the possible impacts of climate change, whereas adaptation looks at how to reduce the negative effects it has and how to take advantage of any opportunities that arise. Where mitigation strategies fail to reach emissions containment targets, climate

resilience will be key to lessen the impacts of climate change and pave the way for our survival, along with the rest of the Earth's inhabitants.

Agroecosystem is a complex network of plants and their environment that interact to produce food, fiber and other products for the people in a sustainable friendly manner. Climate change is expected to exacerbate these challenges, leading to lower agricultural productivity and food insecurity. Our major concern is why climate resilient agriculture is critical for food security in India, and how it can be achieved through science based solutions. Researchers have confirmed that crop yield falls by 3% to 5% for every 1°F increase in the temperature. Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate (IPCC, 2022). Hence, global warming can be considered as the major affecting parameter in changing the earth's climate. Climate change is a threat to the future of our planet, but there is still time for us to adapt to it and mitigate its effects.

Similarly, changes in temperature and rainfall patterns are expected to alter the distribution of pests and diseases, affecting crop health and productivity. According to a report by the Indian Council of Agricultural Research (ICAR), climate change is projected to adversely affect crop yields in India, leading to a decline in food production by 6-10% by 2050. Increasingly severe climate change raises a series of issues associated with society, economy and life safety (Chausson *et al.*, 2020).

To reduce the risk of climate change, governments and international organizations have developed various countermeasures from both mitigation and adaptation perspectives over the past three decades. The Intergovernmental Panel on Climate Change (IPCC) reported that climate change mitigation action would significantly reduce the severity of impacts that nations, societies, and ecosystems have to face. Climate change adaptation action will reduce the vulnerability of agroecosystems, coastal areas, artificial systems and ultimately enhance the resilience of ecosystems to climate change. Adaptation and mitigation of climate change in agriculture are not all-cure solutions and should be customized in each particular case. Thinking of how to adapt to changing weather conditions, crop producers should consider the climate specifics of their area, farming potential and needs, affordability of applied methods. Agriculture and climate change adaptation are of major concern not only to crop producers but scientists as well. Botanists are working to provide farmers with species that are more tolerant to water deficiency or excess and temperature leaps. Ecologists encourage effective soil management by reducing depletion, promoting carbon sequestration, sparing natural resources, eliminating chemical applications, and harmful emissions.

Extreme weather events, such as droughts, heatwaves and floods, directly threaten food production and security, especially in rural communities with high populations of small-scale producers who are highly dependent on rain-fed agriculture for their livelihoods and food (Acevedo *et al.*, 2020). For instance, the worst drought in the past 40 years affected the southern part of Madagascar in 2021, causing approximately 1.14 million people to face high levels of acute food insecurity, of which nearly 14000 people were in the 'Catastrophe' phase (Phase 5 - the highest on the five-step scale of the Integrated Food Security Phase Classification (IPC)) (FAO, 2021).

To address the challenges posed by climate change while achieving a sustainable transformation of agricultural systems, agricultural operators, governments and related organizations are attempting to transform agriculture into ecologically sustainable climate-resilient agriculture (CRA). CRA is a new model of agricultural management that follows the concept of sustainable development and it aims to address hunger and poverty

under climate change. Following sustainable development conception and using advanced technologies, CRA practices can alter the current situation and sustain agricultural production from the local to the global level, especially in a sustainable manner (Acevedo *et al.*, 2020). For instance, using organic fertilizer and renewable energy instead of chemical fertilizer, pesticide and fossil fuel results in a positive and significant effect on food production and soil health and decrease carbon emission for the long term (Koondharet *et al.*, 2021). Although the new CRA technology has been widely used in agricultural production and management (Ma *et al.*, 2021), few studies have focused on CRA evaluation, comparison and situational analysis among different regions, limiting the potential enhancement and optimization of regional CRA. Therefore, the aim is to design a comprehensive assessment framework to evaluate CRA at the national scale, which will be helpful to formulate, implement and monitor agricultural development policies and to propose reasonable management concepts to ensure the sustainable development of agriculture under climate change.

Conceptualization of Climate resilient agriculture (CRA)

With the current scenario of the climate change phenomenon and the urgency of undertaking adaptation and mitigation strategies, resilience has emerged as the preferred paradigm for addressing potential future climate change risks. The deep construction and application of climate resilience in various natural and artificial ecosystems have recently become important initiatives of international organizations and national governments to address climate change (Chao, 2021).

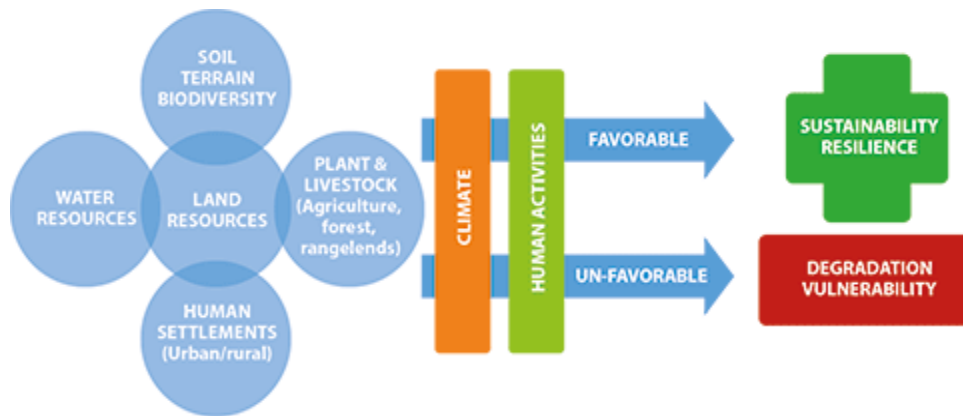
Considering the importance of agriculture in social development, how to sustain the long-term development of agricultural systems under climate change is an urgent issue. Several technologies have been used to improve the climate resilience of agriculture and solve potential climate change risks, such as changes in the planting time (Cui, 2020), supplementary irrigation (Mahatoet *et al.*, 2020), intercropping (Bybee-Finley and Ryan, 2018), establishing short- and long-term crop and seed storage infrastructure (Macholdtet *et al.*, 2020), and changing crop types or planting more climate-resilient crop varieties (Acevedo *et al.*, 2020). Plant productivity is enhanced by having a diversity of crop cultivars, that are able to extract resources from the land, and beneficial insects that help breakdown plant materials. By adopting climate-resilient agriculture, farmers can ensure food security in the face of extreme weather events and climate change. The Indian government has launched several initiatives to promote climate-resilient agriculture, including the flagship programme, National Initiative on Climate Resilient Agriculture (NICRA). The National Mission for Sustainable Agriculture (NMSA) is another such initiative that aims to promote sustainable agriculture practices to enhance productivity, soil health and water use efficiency. The mission also aims to build resilience to climate change by promoting climate-resilient agriculture practices.

3. Sustainable use of water, energy and land:

The twenty-first century is witnessing an explosion in global population, environmental changes, agricultural land disintegration, hunger and geopolitical instabilities. It is difficult to manage these conditions or standardize improvement systems without thinking of the three main elements or subsystems that are necessary for any meaningful development—namely water (W), energy (E) and food (F).

The United Nations defines sustainable land management (SLM) as “the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions”.

Sustainable land use and management (human activities) decide the sustainability/resilience or degradation/vulnerability of land resources



Source: FAO, CLIMATE-SMART AGRICULTURE Sourcebook, Module B.7 Sustainable Soil / Land Management for Climate-Smart Agriculture

It has been recognized for some time that unravelling the synergies and trade-offs between climate, land (or food), energy and water is of fundamental importance to understand the complexity of our planet, and to formulate effective policies for sustainable development Liu *et al.* (2018); Endo *et al.* (2015). The United Nations' Sustainable Development Goals (SDGs), are intrinsically linked to CLEW sectors and involve numerous interdependencies Liu *et al.* (2015); Nilsson *et al.* (2016); McCollum *et al.* (2018); Fader *et al.* (2018).

The world is confronted with significant challenges in the way it manages and consumes its resources. The fact is that energy security, water security and food security are closely intertwined based on the utilization of land. In its simplest form, the relationship can be characterized as follows: food production needs water and energy; water production needs energy; and energy production needs water. Their entanglement likely to become more intimate in the coming decades, as population growth, urbanization, and economic growth combine to exert even greater pressure on resources. At the same juncture, the adequacy of these resources will be impacted as the effects of climate change become more significant. Therefore, to mitigate the challenges, it becomes of utmost importance to adopt Climate resilient practices at village level interventions.

- ✓ Soil health is the key property that determines the resilience of crop production under changing climate. A number of interventions are made to build soil carbon, control soil loss due to erosion and enhance water holding capacity of soils, all of which build resilience in soil. Mandatory soil testing is done in all villages to ensure balanced use of chemical fertilizers. Improved methods of fertilizer application, matching with crop requirement to reduce nitrous oxide emission.
- ✓ Agroforestry involves the cultivation of trees along with crops, which can help to improve soil health, reduce soil erosion, and enhance biodiversity. It also provides multiple benefits such as wood, fodder, and fruit, which can improve farmers' income and livelihoods.
- ✓ Soil and water conservation techniques such as contour bunding, farm ponds, and check dams can help to improve soil moisture retention, reduce soil erosion, and increase groundwater recharge. These practices can also help farmers to cope with droughts and water scarcity, which are becoming more frequent due to climate change.
- ✓ Sustainable agriculture practices such as crop diversification, organic farming and integrated pest management to reduce the use of chemical inputs and improve soil health. These practices also reduce greenhouse gas emissions and improve farmers' income and food security.

- ✓ Community managed custom hiring centres are setup in each village to access farm machinery for timely sowing/planting. This is an important intervention to deal with variable climate like delay in monsoon, inadequate rains needing replanting of crops.
- ✓ Climate Information Services provide farmers with weather forecasts, agro-advisories and other climate-related information. This helps farmers to make informed decisions about their farming practices and manage climate risks more effectively.
- ✓ Livestock management practices such as stall-feeding and mixed cropping can improve the productivity and resilience of livestock systems. These practices also reduce the pressure on natural resources such as grazing lands, which are becoming scarce due to climate change.

Discussion

An increasing population has put a lot of pressure on agriculture to ensure the food and nutritional security of the world, which is further worsening with climate change.

Srinivasa Rao *et al.* (2019) followed the basic concept of CRA and summarized sustainable agricultural evaluation indicators and agricultural vulnerability indicators and then designed a comprehensive evaluation framework of CRA consisting of ecological, economic, societal and infrastructure indicators. Although this framework reflects the three main sustainability pillars that were highly correlated with agricultural development—environmental, economic, and social—it still does not accurately cover all goals of CRA. Therefore, based on the concept and goals of CRA, it is imperative to study the impact of climate change on agroecosystems and related research on the sustainable development of agroecosystems and then design a comprehensive assessment framework of CRA to covers four dimensions *i.e.*, agricultural productivity, farmer income, climate adaptability and the green development level. Compared with other evaluation systems, the resilience of agroecosystems respond to climate change while focusing on the synergy of adaptation and mitigation measures is more consistent with the current strategic goal of achieving productivity amelioration keeping pace with the increasing population.

Conclusion

Agriculture is an important sector of the country. It is one of the market-driven industries that employ a large segment of the country's population. The new changes over the last few years have been enormously helpful to contribute more towards economic growth. Even though there are uncertainties regarding the future climate scenario and its possible impacts, various studies report that climate change will decrease agricultural productivity in the coming years. A number of mitigation and adaptation strategies have been developed to offset the deleterious impact of climate change on agricultural sustainability. Overall, there is a need to build more resilient and sustainable agricultural systems. However, there are also several challenges to promote and implement CRA practices, such as lack of awareness and capacity among farmers, lack of access to finance & markets, policy and institutional barriers. To overcome these challenges, it is important to strengthen partnerships between farmers, researchers, extension agencies & policy makers and to invest in capacity building, research and innovation. By promoting and implementing climate resilient agricultural practices, India can build more resilient and sustainable agricultural systems that can help to mitigate and adapt to the impacts of climate change and to enhance the livelihoods and food security of millions of farmers and rural communities. The future of Indian agriculture seems bright and promising with the advent of new technologies. The government has increased its focus on this sector, implementing various policies and initiatives to boost productivity and growth. India's vast and diverse agricultural landscape, coupled with advancements in technology will provide immense opportunities for farmers to harness their potential and increase yield.

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Millets for Food Security, Nutrition and Sustainable Future

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Millets are group of small grained cereal food crops which are highly nutritious and are grown under marginal/low fertile soils with very low inputs such as fertilizers and pesticides. Most of millet crops are native of India and are popularly known as Nutri-cereals as they provide most of the nutrients required for normal functioning of human body. Millets are rain fed crops and are grown in regions with low rainfall and thus resume greater importance for sustained agriculture and food security. Based on area grown and its grain size the millets are classified as major millet and small millets. The major millets include pearl millet (bajra) and sorghum (jowar). The finger millet (ragi/mandua), foxtail millet (kangni/Italian millet), little millet (kutki), kodo millet, barnyard millet (sawan/jhangora), proso millet (cheena/common millet), and brown top millet (korale) are categorized under small millets. Millet crops also yield good amount of fodder. Grain and fodder yielding 'dual purpose' millets are grown basically to ensure food and fodder security in the rainfed agriculture system. All these millets are nutritionally rich, complete their life cycle in 2 to 4 months, adapting to the shorter cropping windows that facilitated wider adaption, shifting cultivation and withstanding nature's unforeseen vagaries. All millets are essentially kharif season crops that complete their life cycle in the monsoon period. However, most of them give satisfactory to excellent yields in other warmer seasons as well. Millets are especially drought tolerant and can perform well in areas receiving less than 450 mm rainfall.

Millets are grown in kharif season and are an important group of cereals contributing to food and nutritional security in arid and semi-arid regions of India. They contribute to about % of India's food grain basket. These are mainly produced by marginal and small farmers in poor soils with meagre inputs. Nevertheless, most often these are the only food crops that can be grown in that particular piece of land of agro-climate and hence are crucial for the food and nutritional security of the farmers and region. Much of the grains are consumed at house hold levels and the rest goes for industrial uses including for poultry feed, food processing and breweries. Some quantities are also get exported as seed, bird feed and processed food items.

Millets are highly nutritious food grains

Millets possess unique nutritional characteristics specifically have complex carbohydrates, rich in dietary fibre, protein as well as unique in phenolic compounds and phytochemicals having medicinal properties. Millets are natural source of iron, zinc, calcium and other nutrients that are essential for curbing the problem of malnutrition in India (Satyavathi et al., 2021; Devi et al., 2011; Rao et al., 2018). They have higher content of niacin, B6 and folic acid, and calcium, iron, potassium, magnesium and zinc. Finger millet is the richest source of calcium (300-350 mg/100 g) while pearl millet and barnyard millet are good source of iron.

Being staple foods, millets can beneficially replace at least one to two portions of cereal intake of an average adult. Various traditional and modern dishes can be made out of millets. Food market especially in urban areas is selling several modern day foods, ready to cook and ready to eat items, making available an array of options for consumers to embrace millets. Higher protein content of millets provides bulk of the daily recommended dose when consumed as staple food. Higher quantity of minerals in millets is helpful for body building and maintenance functions. Fibre-rich diet ensures easy and normal bowel movement. Comparable (to other cereals) portion of carbohydrates and

their slower release ensures good control of blood sugar levels (Narayanan et al. 2016) and facilitates delaying the next meal.

Nutritional comparison of millets with rice and wheat

(in 100g dry weight of edible grain)

Grain (Millet /Cereal)	Carb o-hydrates (g)	Prot ein (g)	Fat (g)	Ene rgy (Kcal)	Diet ary fibr e (g)	Ca (mg)	<i>P</i> (mg)	M g (mg)	Zn (mg)	Fe (mg)	Thi a-min (mg)	Rib of-lavi n (mg)	Nia cin (mg)	Foli c acid (µg)
Sorghum	67.7	09.9	1.73	334	10.2	27.6	274	133	1.9	3.9	0.35	0.14	2.1	39.4
Pearl Millet	61.8	10.9	5.43	347	11.5	27.4	289	124	2.7	6.4	0.25	0.20	0.9	36.1
Finger millet	66.8	07.2	1.92	320	11.2	364.0	210	146	2.5	4.6	0.37	0.17	1.3	34.7
Kodo millet	66.2	08.9	2.55	331	06.4	15.3	101	122	1.6	2.3	0.29	0.20	1.5	39.5
Proso millet*	70.4	12.5	1.10	341	-	14.0	206	153	1.4	0.8	0.41	0.28	4.5	-
Foxtail millet*	60.1	12.3	4.30	331	-	31.0	188	81	2.4	2.8	0.59	0.11	3.2	15.0
Little millet	65.5	10.1	3.89	346	7.7	16.1	130	91	1.8	1.2	0.26	0.05	1.3	36.2
Barnyard millet*	65.5	06.2	2.20	307	-	20.0	280	82	3.0	5.0	0.33	0.10	4.2	-
Wheat	64.7	10.6	1.47	321	11.2	39.4	315	125	2.8	3.9	0.46	0.15	2.7	30.1
Rice	78.2	07.9	0.52	356	02.8	07.5	96	19	1.2	0.6	0.05	0.05	1.7	9.32

Source: Indian Food Composition Tables (Longvah et al. 2017); *Nutritive value of Indian Foods (Gopalan et al., 2007)

Epidemiological studies have revealed that populations with millets-based diets recorded lesser incidence of esophageal cancer (Chen et al. 1993). The millets are rich in anti-oxidants (Devi et al., 2011) and thus support in managing stresses better and are good for our immunity system. Above all, millet-based diet, characterized by lower glycemic index, is excellent for preventing the incidence of life-style diseases, managing diabetes (Kam et al., 2016) and reducing obesity (Lee et al., 2010).

The niacin content in pearl millet is higher than all other cereals whereas, finger millet proteins are unique because of the sulphur rich amino acid contents. Kodo millet is rich in B vitamins especially niacin, pyridoxine and folic acid as well as the minerals such as calcium, iron, potassium, magnesium and zinc (Sarma et al., 2017). It is also rich in fiber and low in fat content. It contains a high amount of lecithin and is an excellent for strengthening the nervous system. Barnyard millet is the richest source of crude fiber and iron. Barnyard millet grains possess other functional constituents' viz. γ -amino butyric acid (GABA) and β -glucan, used as antioxidants and in reducing blood lipid levels (Pradeep and Sreerama, 2018; Kardada et al., 2018).

Millets are integral food and fodder component of the sustainable dryland systems

Millets are diverse food crops adapted to different climatic conditions and cropping systems, provide a strong case to enrich biodiversity as well as diversify the food grain basket. Since centuries, the millets have provided food and nutritional security to the populations in the disadvantaged geographical regions. Agronomic advantages e.g. highly adapted to low rainfall conditions, able to withstand fairly long dry spells, recover fast after delayed rain, make them good contingent crops.

In spite of the reduced consumption of millets in the country, they are the very

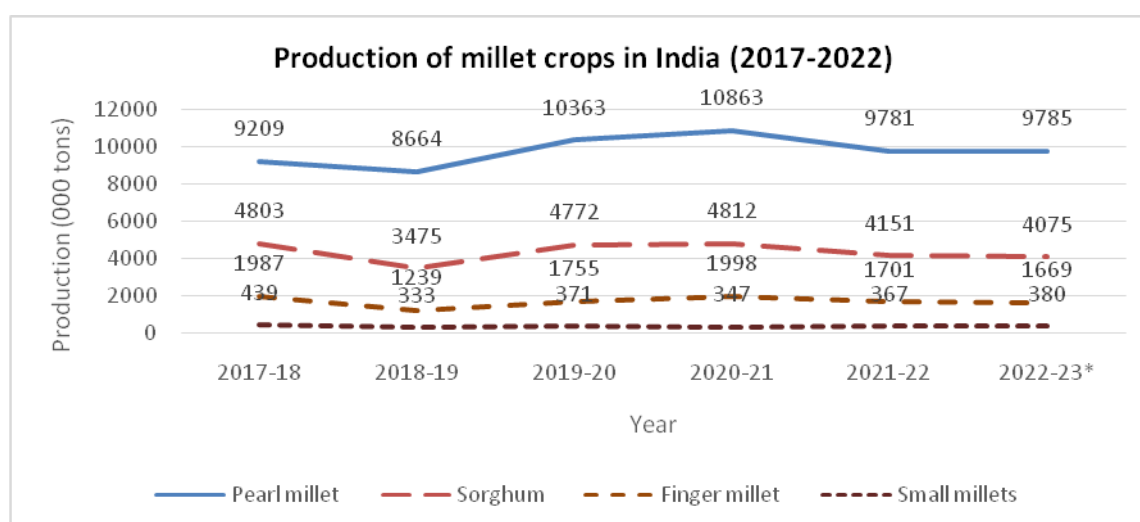
important food crops in niche areas of dry lands and hilly regions, for farming communities including tribal regions. Millets as staple foods also provide nutrient security. Though they presently constitute only about 5.7% of food basket, these are strategically important wherever they are grown and consumed. This is because millets are grown in such areas where no other food crop can grow. Millets form the part of culture in several rural societies and tribal livelihoods. Millets, being climate change resilient, are best suited for Indian agriculture for sustainable production (Seetharam, 2015).

Most smallholder farmers, in India as elsewhere, are net food buyers, which means that increasing their disposable income is a crucial path to better nutrition. Enhancing the use of these neglected crops is thus a powerful way to contribute to nutrition security and at the same time increase the development of vulnerable people. Whereas millet crops grow quickly and complete the life cycle; some millets need 60-65 days to mature against 100-140 days for fine cereals. The small farmers can have large yield increases through improved farm conditions. Millets exhibit good response to sustainable application of fertilizers and water. The basket of millets ensure greater biodiversity on-farm, reduces pests and climate risks, improving farmers' overall resilience.

In India, millets are traditionally consumed as staple foods in the Indian diet. Some typical dishes of millets in India are bajra (pearl millet) *roti* in Punjab, Haryana, parts of Uttar Pradesh, Rajasthan and Tamil Nadu, Jowar (sorghum) *roti orbhakri* in Maharashtra, parts of Karnataka, Madhya Pradesh, Uttar Pradesh and Rajasthan and ragi (finger millet) *mudde* in Karnataka, parts of Tamil Nadu and Andhra Pradesh. Pearl millet is boiled to make an Indian porridge called *KambamChoru* in Tamil Nadu. In Uttarakhand, finger millet is eaten as *roti*, barnyard millet as *paleu* or *chenna*, a savoury porridge cooked in buttermilk. *Zan* is the most popular porridge recipe of Monpa tribes of Arunachal Pradesh made from finger millet and vegetables (Rao et al., 2018).

India is the leading producer of millets

A total of about 16 m tonnes of millets grains were produced in India from nearly 12.3 m ha area during 2021-22, which constituted about 5.7% of national food grain basket.



* 2nd advance estimate

Source: Directorate of Economics and Statistics, Department of Agriculture & Cooperation, Government of India.

Highest production was that of pearl millet (9.78 m tons) followed by sorghum (4.15 m tons), finger millet (1.7 m tons) and small millets (0.37 m tons). These crops are grown

for both grain and fodder purpose.

Among the states, during 2021-22, maximum production was in Rajasthan (4.28m tons), followed by Maharashtra (2.31 m tons), Uttar Pradesh (2.22 m tons), Karnataka (2.05 m tons), Madhya Pradesh (1.18 m tons), Gujarat (1.18 m tons) and Haryana (1.13 m tons). These states produced nearly 90% of all millets during that year (Source: Directorate of Economics and Statistics, Department of Agriculture & Cooperation, Government of India). India and the world have witnessed significant decrease in the area under the millets crops. However, the productivity of these crops has gradually gone up due to adoption of high yielding varieties and improved production technologies (Aruna et. al., 2019).

Top ten States with more production of millets (Average of 5 years- 2017-18 to 2021-22)

State/UT	Area ('000) Hectares	Production ('000 Tonnes)	Yield (Kg./Hectare)
Rajasthan	4747	4586	966
Karnataka	1813	2336	1289
Maharashtra	2790	2194	786
Uttar Pradesh	1080	2136	1977
Madhya Pradesh	556	1084	1951
Gujarat	504	1076	2134
Haryana	519	1036	1998
Tamil Nadu	571	898	1571
Andhra Pradesh	212	434	2045
Uttarakhand	144	198	1377

Source: Directorate of Economics and Statistics, Department of Agriculture & Cooperation, Government of India.

The area, production and consumption of millets in India have come down in the recent decades both due to demand side and supply side factors. There lies significant gap in both the demand and the supply side. On the demand side, the consumption of millets have come down due to increased consumption of other fine cereals, negative perceptions of millets as a food for the poor and policy neglect when compared to other crops. On the supply side, limited productivity of crops and their growing situations and lack of their processing centres in the vicinity which prevents the farmers from realizing additional yield benefits from the improved package of practices and additional income generation (Rao et al., 2018).

Millets are multi-purpose crops

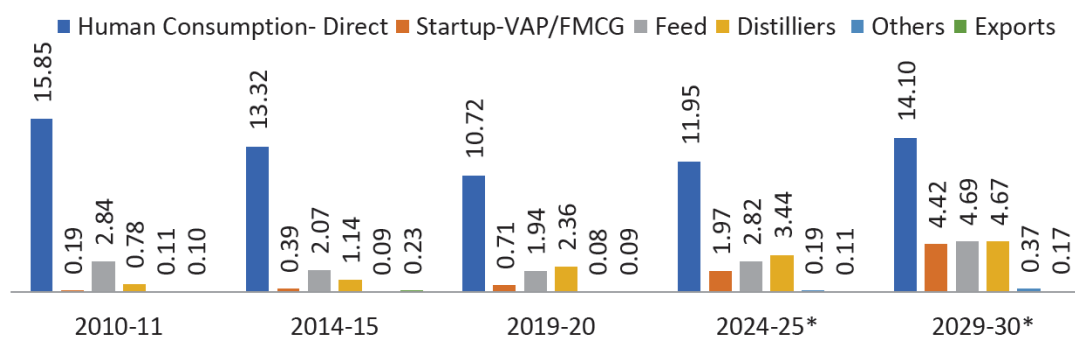
Millet crops have multiple uses other than food. They are also useful as feed, fodder (dry and green), and industrial raw materials (including bioethanol from sweet stalk sorghum). Sorghum and pearl millet also the efficient producers of high biomass. Therefore, millets are "Resource Smart and Climate Smart" crops.

Sweet sorghum is used to a limited extent in producing sorghum syrup and 'jaggery' (raw sugar) in India and has recently gained importance in ethanol production for blending with petrol under national biofuel policy. Sweet stalked sorghum is used to produce bioethanol which can be blended with petrol to reduce the pollution as well as cost. Sorghum straw (stem fibres) can also be made into excellent wallboard for house building, as well as biodegradable packaging. Since it does not accumulate static electricity, it is also used in packaging materials for sensitive electronic equipment.

Utilization of millet grains

Millet grains in India are mainly used for human consumption followed by feed purpose and beverage purpose and in food industry. As per data available, during 2019-20, 67% grains were used for direct human consumption, 14.8% for brewing, 12.2% for feed and 4.5% for value added products manufacture. As per projections, utilization of millets for value addition, feed and brewing purposes are expected to increase by 8-10% by 2029-30.

Combined millets demand break-up (million tons)



* projections

Source: ASSOCHAM (2022) Millets: The Future Super Food of India. 44 pages
[\[https://www.assochem.org/uploads/files/Report_Millets%202022%20\(Print%20Version\)%20\(1\).pdf\]](https://www.assochem.org/uploads/files/Report_Millets%202022%20(Print%20Version)%20(1).pdf)

Millets are climate resilient crops for a sustainable future

Millets are the most dependable food crops the mankind, especially for the resource poor dryland farmers of the world as they are resilient to climate change and assure sustainable grain production in harsh soil and weather conditions (Talwar et al., 2019). These are short duration C4 crops highly adapted to low input conditions. This plasticity exhibited has made them flexible for apparent early as well as delayed planting, very low and medium rainfall areas, various elevations and different soil regimes.

Pearl millet, sorghum, and small millets are primarily dryland crops grown with very less moisture. They can come up in 300-600 mm rainfall areas and are water efficient. Many of the millets are of short duration and hence fit into drought situations arising out of late arrival of monsoon or early withdrawal of monsoon rains. Because of earliness, low water requirement and high drought tolerance, millets fit in contingency crop planning to mitigate drought. When favorable conditions return after alleviation of stress the millets recuperate fast and grow luxuriantly. Millets can withstand all ill effects of climate change except for possible higher ozone concentrations around urban zones.

Millets being C4 crops, are efficient users of water and nutrients for growth. They are highly tolerant to warmer temperatures and to some extent to flooding. Their tolerance to salinity results in germination and seedling stages results in very good plant stand. As millets possess physiological mechanisms for rapid recovery from abiotic stresses like drought and heat (Meena et al., 2021), they are most promising sources for food during climate change.

Millets are nearly organic foods and eco-friendly crops

Millets are extremely resistant to pest attacks. This is a characteristic that comes in very handy when planning a mixed crop farm cultivated using non pesticide management techniques. A few rows of millets separating rows of more susceptible leguminous crops are a common practice in farms in different parts of the world. These are called eco-friendly crops due to their lower requirement of water, chemicals and management interventions for raising the crops (Seetharam, 2015). Besides, some millet can come up in marginal lands and harsh weather conditions where no other crop can grow. In India,

pearl millet comes up well in the hot weather of Rajasthan (Meena et al., 2021). Sorghum yields a valuable crop in the receding moisture regimes of rabi environments of Karnataka and Maharashtra. Little millet, foxtail millet, brown top millet and barnyard millet are known to assure minimum yield even in case of failure of monsoon, thanks to their shorter life cycle. Finger millet farmers realize good yields even with reduced rains and minimum inputs. As these crops are resilient to climate change and provide yield assurance despite environmental risks, they have sustained the onslaught of rice and wheat all these years, despite drastic reduction in cultivation.

High yielding varieties available in millets

Millets are pioneer as far as utilization of hybrid technology is concerned. CSH-1 in sorghum and HB-1 in pearl millet were the first hybrids released during 1964 and 1965. Production technologies have been developed for all small millets. The productivity of finger millet, pearl millet, sorghum and foxtail millet doubled during the past 40 years. Varieties with high yield potential have also been developed in barnyard millet, kodo millet, little millet and proso millet at national and state levels.

Release of > 80 hybrids of sorghum (40) and pearl millet (85) and more than 100 HYVs of millet crops during last 15 years indicates availability of good genetic variability. High yield potential up to 5950 Kg/ha in pearl millet, 7000 Kg/ha in sorghum, 5000 kg in finger millet and 2648 Kg/ha in small millets have been recorded in farmers' production by the adoption of improved technologies. Value added products of millets have started entering the mainstream urban food chain due to demand created by health conscious consumers (Rao et al., 2018).

Millets are amenable to produce RTC and RTE products

Use of 100% millet in ready-to-eat breakfast cereals would be feasible. Puffs can also be made from all millet grains and readily used as breakfast cereals (Rao et al., 2018). Sorghum seeds can be popped in the same manner as popcorn, although the popped kernels are smaller than popcorn. Since several years sorghum has come into increasing use in homemade and commercial breads and cereals made specifically for the gluten-free diet in USA. Sorghum blended with wheat flour has been used over the last two decades to produce baked products, including yeast-leavened pan, hearth and flatbreads, cakes, cookies, and flour tortillas. Millet based malt drinks and malt cocoa-based weaning food and baby foods are popular in Nigeria. Hard endosperm sorghum is used extensively in south-east Asia for noodles.

Modern processing technologies provide more options to develop value added modern foods from millets. Processing interventions in post-harvest processing in millets include cleaning, grading, dehulling, etc, (primary processing) & semolina or suji, flaking, popping, extrusion, baking etc. (secondary) which lead to value-addition (Malleshi, 2007). Because millets are gluten free it does not make good leavened bread when used alone; however, it can be milled and combined with other flours to make delicious breads. To increase the functional aspects of millets, processing such as parboiling, malting (Kimata et al., 1999), flaking, popping, boiling, extrusion (hot and cold) are done (Obadina et al., 2017). Thus resulting in the diversification and shift towards more convenient/ processed products of fine cereals like rice and wheat from the millets. These processing interventions are easily achieved by retrofitting of the processing machinery. Multi-grain millet flour, flakes of sorghum and pearl millet, finger millet malt, sorghum rawa and pasta, millets based breakfast cereals, millets-based regional snacks and fast foods, etc. are the commercially available millets products in India both in retail and online. More extrusion based and bakery products are in the offing from different entrepreneurs. The 'organic' factor of millets is working in favour of uptake of these products in India, where gluten allergy issues are not so much present or

ignored.

Absence of gluten makes millets unsuitable for the preparation of easy-to-handle pure-millet solid food products, particularly bakery or noodle products. Therefore, there is a need for innovative processing technologies to convert millet grains into liquid foods such as drinks of high nutritional quality and safety that can be consumed by large populations in rural and urban areas.

Millets for green forage

Millets are grown for green forage in USA, India, South America, Middle East and Egypt. In India, in regions with assured irrigation, exclusive forage producing sorghum and pearl millet forage varieties and hybrids are grown which produce superior quality fodder for the feeding livestock. Many multi-cut type hybrids are available in these crops which ensure continuous supply of green fodder during kharif and summer seasons. The interspecific Pearl millet × Napier grass hybrids (popular as Napier bajra hybrid in India) are a perennial forage crop and is popular in dairy farms throughout the country. Pearl millet uses less water per unit of forage production, tolerates both lower and higher soil pH and higher aluminum concentration, and is rich in minerals as compared to sorghum. However, sorghum has a wider range of adaptability and is more widely grown. Sorghum forage quality is better than that of other millets and next only to maize. Per day biomass production potential is the highest in pearl millet x Napier hybrids followed by forage sorghum cultivars. They are also more water efficient compared to forage maize. Green fodder from most of these millets can also be made into silage and used during off-season feeding (Bhat, 2015). This helps in conservation and value addition of fodder from millets.

Stover from millet crops

The farm communities in the semi-arid and arid regions of the country are dependent on crop residues as a major form of roughages for cattle since they neither have the luxuries of green fodder from irrigated forage crop nor can afford to sacrifice the farm area for a dedicated one-time green forage. As the millets are the major cereals of dryland crops in arid and semi-arid regions, they form an important source of stover (millet plants left after harvesting the ear head) for the livestock of these regions (Bhat, 2015). Annually, millets account for 11% of the 30 million tones crop residues produced in India. The decision of the farmers to select the crop and variety are greatly influenced by the ability of the crop/variety to meet their fodder requirements from stover, although stovers are poor in nutrition compared to green fodder.

Challenges for millet production and utilization

Low productivity of millets

Compared to wheat, rice and maize, millets have lower productivity in the country. This is attributed to their cultivation in marginal lands in rainfed farming and non-adoption of improved cultivars. The yield gap in millets is largely a reflection of farmers' cultivation technologies that offer ample room for improvement. Seed is usually farm-saved and of poor quality because farmers lack the ability to select seed and store it well. In addition to poor seed stocks, cultivation is not optimal. Higher yields of sorghum, pearl millet, finger millet, foxtail millet and little millet have been realized when they are grown in resource-intensive conditions such as in summer (Rao et al., 2018).

Access to processing machinery of small millets

Easy access to efficient primary processing machinery of small millets for dehulling is a challenge in most production areas. Associated difficulties in primary processing of small millets in particular have caused significant decrease in the production of millets in the country. The available machinery is of moderate efficiency of 65-80 % only. The initiative to fabricate more efficient processing machines and make them available on a large scale

in production areas will surely ensure not only in reduction in consumer cost but also enhances producer share in consumer rupee.

Sustainability of millets in dryland agriculture: Way forward

Millets are our own superfoods as more and more research findings are revealing now. Millets are looked upon as offering greater comparative advantages compared to other food crops owing to their rich nutritional profiles, income augmenting opportunities, and resilience to climate change. Higher calcium and potassium content in finger millet, higher iron and beta carotene in pearl millet, greater energy content in pearl millet and little millet are some of the goodness in the millets besides their ability to provide wholesome nutrition as staple foods. Millets, similar to grain amaranth, are the superfoods of our country. A diet consisting of finger millet and pearl millet would provide richer nutrition than quinoa. Now we are seeing increase in awareness and demand for millets in urban and semi-urban societies. Also, beside the conventional staple foods, "ready to cook" and "ready to eat" processed foods made from millets are entering the market in a big way.

Revitalizing millets into mainstream dryland agriculture and diversifying the food basket is important for sustaining the food, nutritional security of consumers and livelihood security of the rural households. For achieving this, the major challenges are to deliver millet based technologies which are sustainable and market oriented. This can be achieved through reconsideration of millets research in terms of present and future demand, resolving specific production constraints thereby improving productivity, improved agronomic practices, development of value addition and processing technologies, marketing strategies and policy measures that would generate more income and employment generation to the farmers without sacrificing overall goal of attaining sustainable food and nutritional security. Scientific and technological interventions involving convergence of efforts of agricultural and food scientists, policy makers and media is needed to revalorize millets for attaining food and nutritional security.

Policy and incentive support for creating farmer producer organizations, farm-gate warehouse and processing in village clusters, linking farmers to the value chains of both nutri-grains and nutri-fodder and nation-wide marketing platforms can enable better price and incentivize farmers to produce more of millets adopting improved and sustainable technologies. That would enable the nation to ensure cost efficient and environment friendly food and nutritional security in a sustainable way, once all the policy initiatives are fulfilled and comprehensive millets policy is in place.

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Vision for Nutritional Security and Sustainable Food Systems in Indian Agriculture by 2047

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Agriculture continues to be the primary supplier of food and raw materials for a variety of economic activities, as well as the largest employer in the globe. As the world's population continues to rise, much more effort and innovation will be urgently required in order to increase sustainable agricultural production, improve the global supply chain, reduce food losses and waste, and ensure that everyone who suffers from hunger and malnutrition has access to nourishing food.

The 17 Sustainable Development Goals (SDGs), also known as Agenda 2030 and endorsed by 193 nations in 2015, depend on agriculture and related industries to be successful. Agriculture, which includes crops, cattle, aquaculture, fisheries, and forests, has been a source of food and raw materials since the dawn of human civilization. It is the largest employer in the world and the primary provider of money and food, particularly for the extremely poor. In developing nations located in Asia, Africa, and Latin America, the vast majority of people depend on agriculture for their living.

The Sustainable Development Goals could be accomplished with the help of agroecological practices like Natural Farming, which are an economical and environmentally responsible alternative. They can ensure improved economic and financial stability by lowering input costs, which will assist fight poverty, promote gender equality, and maintain sustainable patterns of production and consumption. Through improved yield, crop diversity, year-round access to a variety of dietary sources, and income-generating crops, this method would guarantee food security and eradicate hunger. Natural farming practices that conserve water and protect the environment help make water readily available, manage it sustainably, and reduce CO₂ emissions at various points throughout the agricultural value chain.

Everyone has the fundamental right to be free from hunger and the right to adequate food, which are all consistent with the right to access safe and nourishing food. In order to end hunger and eradicate the worst forms of malnutrition, the UN Secretary-General has already issued the Zero Hunger Challenge at Rio+20, calling for governments, civil society, faith-based organisations, the commercial sector, and academic institutes to collaborate. The Sustainable Development Goal to "End hunger, achieve food security and improved nutrition and promote sustainable agriculture" (SDG2) acknowledges the connections between promoting sustainable agriculture, empowering small farmers, advancing gender equality, eradicating rural poverty, promoting healthy lifestyles, combating climate change, and other issues which are already addressed within the collection of 17 Sustainable Development Goals in the Post-2015 Development Agenda.

Rural areas are the primary location of extreme poverty and hunger, and smallholder farmers and their families make up a sizable share of those who live in these conditions. As a result, increasing food production, agricultural productivity, and rural incomes is essential to ending poverty and hunger. Healthy meals and the availability of micronutrients are two additional aspects of appropriate nutrition that need consideration in addition to an adequate calorie intake. Mothers' and babies' inadequate micronutrient intake may have long-term developmental effects. The increasing prevalence of non-communicable diseases in both industrialised and emerging nations is strongly correlated with unhealthy diets and

lifestyles.

The world's agricultural systems must become more efficient and less wasteful. From a comprehensive and integrated standpoint, sustainable agricultural practices and food systems, encompassing both production and consumption, must be sought.

It is crucial to use and manage land, healthy soils, water, and plant genetic resources sustainably because they are essential components of food production and are becoming increasingly scarce in many regions of the world. Reduced pressure to clear forests for agricultural production would also result from increasing yields on currently used agricultural lands, including the restoration of degraded lands, through sustainable agricultural practices. The productivity of drylands can be maintained by wise management of limited water resources through improved irrigation and storage technology combined with the creation of new drought-resistant crop types.

It is also necessary to stop and reverse land degradation in order to meet future food needs. There are huge potential benefits from land restoration for guaranteeing food security and decreasing climate change, given the current state of global land degradation. However, it is acknowledged that our understanding of the factors that contribute to desertification, land degradation, and drought is still growing.

Traditional farmer knowledge may promote fruitful food systems through the application of sound and sustainable soil, land, water, nutrient, and pest management strategies as well as a larger use of organic fertilisers. This can be achieved by combining this traditional knowledge with the most recent scientific discoveries. To generate synergies and effectively handle trade-offs among agriculture, water, energy, land use, and climate change, there has to be an increase in integrated decision-making procedures at the national and regional levels.

The international community is urged to enhance investment in research, development, and demonstration of technology to improve the sustainability of food systems worldwide in light of anticipated changes in temperatures, precipitation, and pests related to climate change. Building local food system resilience will be essential to preventing future widespread shortages, guaranteeing food security, and promoting healthy eating for all.

Possibly the most influential period in Indian agriculture over the past century was the Green Revolution. India was able to prevent future famines and meet its needs for food security by lowering food imports; thanks to an input-intensive and technology-focused strategy. While the Green Revolution has affected the majority of Indian farmers and ensured India's self-sufficiency for our cereal needs, its long-term effects are now clearly discernible. Whether it is the degradation of soils, dropping groundwater levels, tainted water sources, or decreased biodiversity. Without greater fertilizer use, crop yields cannot support themselves. Numerous smallholders are turning to non-farm economic activities as a result of their fragmented land holdings and low farm incomes. Input-intensive agriculture is both a cause of and a sufferer of climate change, according to developing climate science.

What sustainable agriculture methods, for instance, are used most often in India? Where is the practice taking place? What number of farmers have embraced them? Which organisations are supporting these behaviours? How have these methods affected farm earnings, the environment, and societal outcomes? What gaps exist in our existing understanding if there is no effective evidence?

Examples of resiliency are sprouting from the ground in response to an increase in extreme climate events, such as acute and frequent droughts, floods, and attacks by desert

locusts, emphasising the potential of sustainable agriculture. For instance, in Andhra Pradesh during the 2018 Pethai and Titli cyclones, natural farming crops outperformed conventional crops in terms of wind resistance. Natural resources such as agro-horticultural and forest resources, enormous hydroelectric potential, oil and natural gas, and mineral deposits are abundant in the NER. Over 70% of the population relies on agriculture for a living, making the economy largely agrarian. Two separate forms of agricultural practices have developed as a result of the topography and soil characteristics: settled agriculture in the plains, valleys, and softer slopes, and slash and burn (referred to locally as "jhum") elsewhere. In the hilly states of Arunachal Pradesh, Meghalaya, Mizoram, and Nagaland, jhumming dominates agriculture.

The National Mission for Sustainable Agriculture (NMSA) has been promoting sustainable agriculture in India since 2014–15. It comprises a number of activities that concentrate on agroforestry, rainfed areas, managing water and soil health, addressing the effects of climate change, and adaptation. In addition to NMSA, the Pradhan Mantri Krishi Sinchai Yojana and the Integrated Watershed Management Programme encourage the use of precision agricultural methods like micro-irrigation.

While some Indian states, such as Sikkim and Andhra Pradesh, are setting the bar for sustainable agriculture, overall adoption is still lagging. Similarly, there is little evidence regarding its effects on the economic, social, and environmental fronts. We need to produce more long-term proof at one point. Rainfed areas could be the first to scale up because they currently practise low-resource agriculture, have poor productivity, and have the most to gain from the change. Farmers in irrigated areas will follow suit as soon as the favourable effects on a large scale become apparent.

Funding for sustainable agriculture should be increased significantly at the federal level to enable its expansion across the nation on the basis of scientific data. At the tactical level, special attention must be paid to regional and practice-specific priorities, which range widely: from technical advancements to aid mechanise labour-intensive procedures to farmers' capacity building in knowledge-intensive practises. Finally, the national policies will be widened to include total farm productivity as well as nutrition and yield security.

The administration of current policies and programmes are streamlined by appropriate agencies, and the government is always working to remedy these issues. However, it is acknowledged that food, agricultural, and farm policies need to be reoriented in a more long-term direction. The nation is renowned for the variety of farming techniques it employs. Finding appropriate answers for the future requires engaging varied points of view in a national conversation. . In a world with climate constraints, it would be easier to appreciate the crucial role that sustainable agriculture may play in ensuring India's nutrition security.

Building a Self-Reliant India through Sustainable Agriculture: Challenges and Opportunities

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Introduction

Sustainability and self-reliance are two critical aspects of Indian agriculture that are gaining increasing importance in recent times. The agriculture sector in India is a vital contributor to the country's economy and plays a crucial role in providing food security to its large population. However, the sector faces several challenges, including climate change, water scarcity, soil degradation, and declining crop yields. To ensure sustainability, agriculture needs to adopt practices that promote the efficient use of natural resources, conserve biodiversity, and reduce the use of harmful chemicals. Some of the practices that can help achieve sustainability includes crop diversification, integrated pest management, organic farming, conservation agriculture, and water harvesting.

Self-reliance, on the other hand, means reducing dependence on imports and increasing domestic production of agricultural commodities. It plays a crucial role in the Indian economy, growth, and development. India is an agrarian country, and agriculture is one of the largest contributors to the country's Gross Domestic Product (GDP) and employment. The sector also provides livelihoods to more than 50% of the population. In recent times, there has been a growing emphasis on promoting self-reliant agriculture in India, and the government has launched several initiatives to achieve this goal. These initiatives aim to increase domestic production, reduce dependence on imports, enhance market access for farmers, and provide credit and insurance facilities. The latest data shows that the agriculture sector in India has been performing well, and the growth rate has been consistently increasing over the last few years. According to the Economic Survey 2020-21, the agriculture sector grew by 3.4% in 2020-21, compared to 2.4% in the previous year. The production of food grains, including rice and wheat, has also increased, and India is now the world's largest producer of milk, pulses, and jute.

These initiatives in agriculture sector will be positively impacting growth and development of the Indian economy. The government's efforts to increase domestic production have led to a reduction in imports, which has resulted in a lower trade deficit. The agriculture sector has also been able to generate more employment opportunities, particularly in rural areas, contributing to poverty reduction. Moreover, self-reliant agriculture has led to the development of a robust agri-processing industry in India, which is essential for value addition and export growth. The food processing industry has grown at a CAGR of 9.7% in the last five years, and its contribution to the GDP has increased from 8.8% in 2012-13 to 10.7% in 2020-21. Sustainability in the agriculture sector is crucial to achieving the Sustainable Development Goals (SDGs) set by the United Nations. The agriculture sector is not only essential for food security but also plays a significant role in promoting economic growth, poverty reduction, and environmental sustainability. To achieve sustainable development, the agriculture sector needs to adopt sustainable practices that promote the efficient use of natural resources, conserve biodiversity, and reduce the use of harmful chemicals.

Here are some ways in which sustainability in the agriculture sector can help achieve the SDGs:

1. **Zero Hunger (SDG 2):** Sustainable agriculture practices can help increase food production while conserving natural resources. Sustainable agriculture can also help

improve food security, reduce food waste, and ensure access to healthy and nutritious food.

2. **Decent Work and Economic Growth (SDG 8):** Sustainable agriculture can create more employment opportunities, particularly in rural areas, and promote economic growth. It can also help increase income for small farmers and enhance market access for agricultural products.
3. **Climate Action (SDG 13):** Agriculture is a significant contributor to greenhouse gas emissions. Sustainable agriculture practices such as conservation agriculture, crop diversification, and agroforestry can help reduce emissions, conserve soil moisture, and enhance carbon sequestration.
4. **Life on Land (SDG 15):** Sustainable agriculture can help conserve biodiversity, preserve ecosystems, and prevent land degradation. Sustainable agriculture practices such as organic farming, integrated pest management, and crop rotation can help reduce the use of harmful chemicals and promote biodiversity conservation.
5. **Partnership for the Goals (SDG 17):** Sustainable agriculture requires collaboration between various stakeholders, including farmers, policymakers, researchers, and civil society. Partnerships can help promote sustainable agriculture practices, enhance market access, and provide credit and insurance facilities.

Thus, sustainability in the agriculture sector is essential for achieving the SDGs. Sustainable agriculture practices can help increase food production, promote economic growth, reduce greenhouse gas emissions, conserve biodiversity, and prevent land degradation. By adopting sustainable agriculture practices, the agriculture sector can contribute to a more sustainable and prosperous future.

Opportunities

The recent pandemic has emphasized the importance of building a self-reliant India, and sustainable agriculture can be a major contributor to this goal. Sustainable agriculture not only helps in maintaining the ecological balance but also promotes economic growth, and social development. Here we will discuss the opportunities that sustainable agriculture provides for building a self-reliant India.

- **Safeguarding food security:** One of the primary benefits of sustainable agriculture is the ability to enhance food security. By adopting sustainable farming practices, farmers can improve crop yields, reduce the cost of production, and ensure the availability of nutritious food for all. Additionally, sustainable agriculture helps in conserving soil fertility, reducing soil erosion, and improving water quality, which can contribute to long-term food security.
- **Boost to economic prosperity:** Another opportunity that sustainable agriculture provides is in promoting economic growth in rural areas. By adopting sustainable farming practices, farmers can diversify their income streams, reduce their dependence on a single crop, and increase their profitability. Furthermore, sustainable agriculture can create new job opportunities in areas such as organic farming, value-added processing, and rural tourism. This, in turn, can lead to increased economic growth and reduced poverty in rural areas.
- **Conserving environment:** Sustainable agriculture also provides opportunities for environmental conservation. By reducing the use of chemical fertilizers and pesticides, sustainable agriculture can help in reducing the carbon footprint of the agriculture sector. Additionally, sustainable agriculture can help in conserving

natural resources such as water, land, and biodiversity, which can contribute to environmental sustainability.

- **Catalysing social development:** Furthermore, sustainable agriculture provides opportunities for social development. By adopting sustainable farming practices, farmers can improve their access to credit, information, and technology, which can lead to improved living standards. Additionally, sustainable agriculture can contribute to gender equality by creating opportunities for women in agriculture, promoting their participation in decision-making, and improving their access to resources.

Challenges

While sustainable agriculture offers many opportunities for building a self-reliant India, there are also several challenges that must be overcome to achieve this goal. Here we will discuss some of the challenges that need to be addressed for sustainable agriculture to contribute to India's self-reliance.

- **Lack of effective technological support:** One of the primary challenges is the lack of access to technology and information. Farmers in India often lack access to information about sustainable farming practices, as well as the technology needed to implement these practices. This limits their ability to adopt sustainable agriculture and benefit from its potential. To overcome this challenge, there is a need for investment in research and development, as well as the dissemination of information and technology to farmers.
- **Lack of infrastructure:** Another challenge is the lack of infrastructure to support sustainable agriculture. For example, there is a need for irrigation systems, storage facilities, and transportation networks to support the production and distribution of sustainable agriculture products. Furthermore, there is a need for investment in rural electrification, which can enable farmers to access modern technologies and enhance their productivity.
- **Limited finance:** Another challenge is the limited access to finance. Many farmers in India lack access to credit, which limits their ability to invest in sustainable agriculture practices. To overcome this challenge, there is a need for innovative financing mechanisms that can enable farmers to access credit and invest in sustainable agriculture.
- **Cultural challenges:** Additionally, there are social and cultural challenges that need to be addressed. For example, there is a need to address gender inequality in agriculture by promoting the participation of women in decision-making and increasing their access to resources. Furthermore, there is a need to overcome the cultural biases against sustainable agriculture practices, which are often seen as traditional and outdated.

Conclusion

In conclusion, building a self-reliant India through sustainable agriculture presents both challenges and opportunities. The opportunities include enhancing food security, promoting economic growth in rural areas, conserving natural resources, and promoting social development. However, realizing these opportunities requires overcoming challenges such as the lack of access to technology and information, limited infrastructure, lack of finance, social and cultural biases. To address these challenges and realize the potential benefits of sustainable agriculture, it is essential for the government,

private sector, and civil society to work together. This will require investments in research and development, infrastructure, and policy reforms, as well as the dissemination of information and technology to farmers. Overall, building a self-reliant India through sustainable agriculture is a long-term goal that requires sustained efforts and commitment.

ABSTRACTS

Effect of Conservation Agriculture on Weed Species, Soil and Climate

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ABSTRACT

Agriculture contributes to a number larger of environmental issues that cause environmental degradation including: climate change, deforestation, biodiversity loss, dead zones, genetic engineering, irrigation problems, pollutants, soil degradation, and waste etc. Conservation Agriculture (CA) is a farming system which prevents losses of arable land while regenerating degraded lands. It promotes maintenance of a permanent soil cover, minimum soil disturbance, and diversification of plant species. Objective of CA is to improve agriculture production by adopting economically, ecologically and socially sustainable methods. Conservation Agriculture aims to conserve, improve and make more efficient use of natural resources. Conservation Agriculture reduces labour demands by 20 to 50%. It is less labour intensive and thus contributes to reducing greenhouse gas emissions through lower energy inputs and improved nutrient use efficiency. At the same time, it stabilizes and protects soil from breaking down and releasing carbon to the atmosphere. Minimum tillage minimizes soil organic matter losses and leads to increase soil carbon and nitrogen stocks. Perennial weeds are the major constraint in CA which can control by the use of non selective herbicides. Due to undisturbed land microbial activity is more under conservation agriculture which is responsible to decomposition of crop residues and adding the carbon in soil. Adding of atmospheric carbon in to the soil by carbon sequestration improve carbon in soil carbon and reduce in the atmosphere. More carbon content in the soil makes more fertile land.

Disease Control and Storage Management of Cereal and Grains

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ABSTRACT

For a healthy crop production, its management is necessary before and after harvesting although only a good yield is not enough for a crop also its quality is as much important. Grains are the most used agricultural product by the population of humans as well as animals, so crops must be free from any type of disease. During cropping several fungal and viral diseases attack the crop such as stripe rust, crown rust, powdery mildew, etc. These decrease the quality as well as yield of the crops. Diseases can be managed by following some steps such as crop residue management, nitrogen/balance fertility, variety selection, seed treatment, crop rotation, weed control, etc. After harvesting grain storage management is important till reaches the table of the consumer. Globally over two billion tons of grains are produced annually these grains are stored at different stages of the grain distributor chain in defined use such as bags, silos, warehouses, containers, and even in piles on the ground. Improper storage reduces the quality of grains, cereal grains such as wheat, corn, and oats are a great source of energy, vitamins, and nutrients such as carbohydrates, protein, vitamins A and B, magnesium and zinc, etc, due to these qualities these grains are used as a staple in meal and also use in various food products. Cereal

grains have a moisture content of approximately 10-15% and have an exchange of gases, so techniques like modified atmosphere temperature and controlled atmosphere temperature are used to manage environmental conditions, various drying techniques (sun drying) also use to maintain moisture. Basically, pests (moths, beetles) and fungal molds (aspergillus, penicillium) are found in cereal grains.

Key Words: disease, yield, management, harvest, storage

Oat Genotypes Response to Different Nitrogen Levels Under Agro-Climatic Condition of Kymore Plateau Zone in Madhya Pradesh

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ABSTRACT

Oat (*Avena sativa* L.) is one of the important cereal fodder crop in the temperate climate of the world. Oat is grown in India mainly for its nutritive grain and fodder values especially suited for horses, dairy cows, and buffaloes. A field experiment was conducted under AICRP on Forage Crops, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during Rabi season of 2007-08. The soil of experimental field was clay loam in texture, neutral (7.2) in reaction with low organic carbon(0.44%) and normal electrical conductivity(0.34 dS/m) and analyzing low in available N(228 kg/ha), medium in available P(16.2 kg/ha) and available K(297 kg/ha) contents. Treatments were laid out in split plot design with three replications, keeping four levels of each of N (0, 40, 80 and 120 kg/ha) and varieties (JO 03-91, OS 396, UPO 06- UPO 06-21 and Kent).Sowing was done on November 20, 2007 by using 100 kg/ha of each variety in rows 25 cm apart with uniform dose 40 kg P₂O₅ + 20 kg K₂O /ha .Nitrogen was applied as per treatments. At the harvest, green fodder yield and growth parameters, viz. plant height, tiller number, leaf area index and leaf- stem ratio were recorded. The crude – protein yield was calculated by a factor of 6.25 formula suggested by Mehrez and Zraslox , 1977. The dry matter yield was recorded. The variety JO 03-91with 120 kg N/ ha proved significantly superior in producing maximum green fodder yield (503.9 q/ha), dry matter yield (121.1 q/ha) and crude protein yield (9.6 q/ha) and maximum monetary advantage (Rs 53729) and proved most remunerative with benefit: cost ratio of 2.87.

Millets: A Smart Choice for Health, Environment and Sustainability

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ABSTRACT

Minor millets are small-grain cereal crops that are typically grown in semi-arid regions of the globe. They include several species, such as finger millet, foxtail millet, proso-millet, barnyard millet, and kodo millet. In recent years, minor millets have gained significant attention due to their health, nutritional, economical, and environmental benefits. In addition to a plethora of health benefits, millets are also good for the environment with low water & input requirement. With the aim to create awareness and increase the production & consumption of millets, United Nations, at the behest of the Government of India, declared 2023 the International Year Millets. Minor millets are highly nutritious and contain a range of essential nutrients, including dietary fiber, protein, vitamins, and minerals. They are also rich in antioxidants, which are known to

have a range of health benefits. Studies have shown that consuming minor millet can help to reduce the risk of several chronic diseases, including type-2 diabetes, cardiovascular disease, and certain types of cancer. Minor millets are gluten-free, making them an excellent alternative for people with celiac disease or gluten intolerance. They are also rich in fiber, which can help to promote digestive health and prevent constipation. Minor millets are also a good source of complex carbohydrates, which are absorbed slowly and help to maintain steady blood sugar levels. In addition, these groups of crops are highly adaptable to harsh weather conditions and can be grown in regions where other crops may not thrive. This makes them an ideal crop for smallholder farmers, who often have limited resources and face challenges such as climate change. In addition, minor millets have a low input cost and require less water and fertilizers than other cereal crops, making them a cost-effective option for farmers. Minor millets are known for their environmental benefits, as they have a low carbon footprint and can be grown using sustainable farming practices. They require less water than other cereal crops, making them ideal for regions with water scarcity. In addition, minor millets are also a good crop for crop rotation, which can help to maintain soil health and prevent erosion.

Keywords: Minor millets, nutritional security, food security, sustainability, economics

Avian Biodiversity and Wetland Health Indicator of Jabalpur Lakes

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ABSTRACT

Narmada valley in Jabalpur encompasses number of wetlands in Madhya Pradesh which serve as ideal habitat for dependent species. Therefore, it is necessary to analyze the wetland resource utilization by avian species and their health status and prepare a sustainable management strategy for conservation of wildlife and wetland as well. There were 52 big water bodies "Tals" and 84 small water bodies "Tallaiyas" existed in the Jabalpur in the past but currently only 36 lakes are existing in the city. Many of the water bodies are struggling for their existence which supports several wetland dependent avian species and such losses in habitat have threatened the diversity of wetland ecosystem. Therefore, looking to these facts the study was conducted on the avian biodiversity richness, as an indicator of environmental health in the wetlands viz. Balsagar lake, Gangasagar Lake, Gwarighat (Narmada river bank), Mahanadda lake, Sangram sagar lake and Ranital Lake. 71 species of wetland birds and 178 bird species other than the wetland birds were recorded in these areas. Out of nine hundred respondents maximum 31.88% respondents thought that human disturbance were the major threats to wetland biodiversity followed by 20.22% fishing, 19.33% habitat destruction, 13.66% stray dogs, 8.11% hunting and 6.55% tree cutting. The study revealed that various major threats to wetlands biodiversity were human disturbance 49.33% were maximum at Gwarighat followed by 45.33% at Mahanadda, Ranital 40.67%, Gangasagar 38.00%, Sangramsagar 10.00% and Balsagar 8.00%. Disturbance to ecosystem of the wetland due fishing were noticed higher at Balsagar 30.00% followed by Sangramsagar 28.67%, Gangasagar 21.33%, Ranital 20.67%, Mahanadda 15.33% and Gwarighat 5.33%. Maximum hunting of wetland species were seen in the Balsagar 11.33% followed by Gangasagar 10.00%, Ranital 8.00%, Sangramsagar 8.00%, Mahanadda 6.67% and Gwarighat 4.67%. Problem due to Stray dogs were maximum seen at Gwarighat 19.33% followed by Mahanadda 18.00%, Ranital 17.33%, Gangasagar 16.00%, Balsagar 6.00% and least Sangramsagar 5.33%. Threats to the wetland biodiversity due to habitat destruction were noticed maximum 30.00% people of Balsagar and Sangramsagar thought followed by Gwarighat 18.00%, Mahanadda 13.33%, Gangasagar 12.67% and least seen at Ranital 12.00%.

Maximum 18.00% of the people thought tree cutting were major threat to wetland to Sangramsagar, Balsagar 14.67%, Gwarighat 3.33% Gangasagar 2.00% and least was seen at Ranital 1.33% and Mahanadda 1.33%. For effective and sustainable wetland conservation it is necessary to link wetland conservation with the economy of local public. The measures should be taken to develop and use these areas for bird watching, breeding and development of boating and rainwater harvesting etc. The income thus generated will not only be useful for further conservation and development of wetlands but also provide employment to the local youth and thus motivate them for wetland and wildlife conservation. It is recommended that periodical study should be carried out in future to know status the health status of wetlands and wetlands dependent species in adjoining Narmada Valley.

Minor Millets for Nutrition Purpose in Present Scenario

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ABSTRACT

The second green revolution has to be nutrition oriented, which was neglected in production oriented first green evolution, to have inclusive and equitable growth and development of our country. Minor millets (Nutri cereals) are the groups of small seeded cereals belonging to the family Poaceae. There are upto thirty-five species of grasses from 20 genera are well known as small millets. The most important cultivated species of small millets are finger millet, Foxtail, proso millet, barnyard millet, kodo millet and little millet. Millets are nutritionally comparable or even superior to major cereals such as wheat and rice, owing to their higher levels of protein with more balanced amino acid profile (good source of methionine, cystine and lysine). Millets are staple food source, which are not only providing major nutrients like protein, carbohydrates, fats etc but also provide ample of vitamins and minerals. In developing countries malnutrition and various health problems like obesity, diabetes, cardiovascular diseases, cancer, celiac disease etc are most prominent because of inadequate supply of nutrition. One of the minor millet namely barnyard millet is the richest source of calcium content, about 10 times that of rice or wheat. Minor millets are also full of micronutrients like Mg, Ca, Mn, tryptophan, phosphorous, fibre, B vitamins. These micronutrients act as antioxidants which are essential to human body. Additional specialty of minor millets is, they need very less water for their cultivation and can withstand severe climatic conditions. There is need of new high yielding, promotional strategies and policies are necessary to increase the area under nutri-cereals crops to achieve nutritional security as well as sustain rainfed farming in the country.

Keywords: Millets, nutrition, Cereal crops.

Intelligence for Sustainable Agriculture

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ABSTRACT

In order to sustain the expanding population, this review aims to critically discuss artificial intelligence (AI) to optimize the agricultural production system while preserving soil health and the environment. There is an urgent need to produce more food with limited resources because the world's population is predicted to exceed 9.7 billion by

2050. AI can play a significant role in helping to accomplish this goal. AI can assist farmers in making knowledgeable decisions regarding crop management, reducing crop wastage, and maximising the most efficient use of resources by offering real-time insights and data. AI can also improve food products' quality and safety by keeping track of the manufacturing process from farm to table. Review talks how by using AI pests and diseases are being managed effectively and increases crop output as a whole. Applied methodologies include the use of sensors for weed and crop detection, crop health monitoring for disease and pest identification, the use of agribots for high-volume and quick harvesting, and enhancing the user-friendliness of drone technology. Results indicate that 3D laser scanning and hyperspectral imaging have had a significant positive impact on crop health. AI applications in irrigation have also contributed to a reduction in water use of up to 50%. By tackling important issues like food security and environmental sustainability, the application of AI in sustainable agriculture has the potential to revolutionise the agro-industry. Applying AI to agriculture is a revolutionary strategy that not only boosts productivity but also safeguards biodiversity and makes farms digital. Longterm, it will make it easier to distribute agriculture extension services. A more resilient and sustainable food system that can satisfy the escalating demand of our expanding population must start by implementing AI in agriculture.

Keywords: sustainable agriculture; artificial intelligence; digitalization; food security

Natural Farming with a Pinch of Technology Future for Sustainable Agriculture

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ABSTRACT

The rate of chemical inputs in soil has increased at a growing pace in the last couple of decades making our natural food artificial with time resulting in increased health problems and ecological imbalances in our ecosystem. Further, the deterioration of soil quality and groundwater purity are also significant problems caused due to excessive chemical application and high tillage practices. To overcome this excess inorganic matter in soil and the problems caused due to it, It is important to restore its organic content within this next given decade where there is a risk of an increase in temperature, imbalance in climate and a lot more unpredicted issues. The average organic content in the soil in today's time is merely 0.5% which was as high as 2% during our ancestor's time. To bring back the soil in such a similar state will take years or maybe decades and to do so Natural Farming can be seen as a perfect way. Natural farming along with a few technical advancements is a way of allowing crops to grow on their own without any artificially applied means. It is economically benefiting farmers as well due to the reduction in input costs and it can be referred to as Zero budget natural farming in certain cases. It can significantly reduce production expenses and increase carbon content in the soil. Cultural practices such as mulching, using natural insecticides like neem oil, and natural fertilizers like Jivamrita, Bijamrita, Acchadana (Mulching), and Whapasa are some of the components which can be implemented in natural farming in the coming time. Though Natural Farming assures chemical-free produce it will not help us fulfilling the global food demand and may reduce our food security for a few years which may not be feasible for a population-dense country like India. To make sure improved overall soil ecology while maintaining the current food demands in our country it is essential for us to integrate newer approaches to agriculture like climate-smart farming, resources-

conservative based farming system, vertical farming, and with a practical approach making judicious usage of bio fertilizer and pesticides in the beginning stages to maintain the balance of certain level of production.

Keywords: Natural Farming, Ecology, Organic content in soil, Zero budget farming, Biocontrol, Bio Pesticides, Bio Fertilizers, Jivamrita, Bijamrita

Natural Farming for Sustainable Agriculture

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ABSTRACT

Agriculture and its allied sectors provide largest employment and contribute around 20% in nation's Gross Domestic Production. Alone agriculture sector holds 41.49% of the total work force present in India. Growth in agriculture sector has made a markable achievement but due to over use of fertilizers and chemical base pesticides and insecticides have degraded the quality of food as well as of soil which is of our prior concern. To address all these problems, concept of natural farming again came in the policies of the Government of India and extension department. Natural farming is an ecological farming approach established by Masanobu Fukuoka, a Japanese farmer and philosopher. It is also known as "the natural way of farming" or "do nothing farming". Natural farming encourages the complexity of living organisms including both flora and fauna. In this type of farming the micro environment of soil is less disturbed and hence results in improvement of soil structure and soil texture, in this method the chemical-based insecticides and pesticides are completely eliminated from the field. Natural farming is one of the ways to prevent exploitation of soil and environment. It is a sustainable method of agricultural practices done by farmer which results in high yield and quality produce. By natural farming practices, farmer can increase its income. In natural farming the additional nutrition given in the field is organic and hence encourages farmers to practice dairy farming in the field. It is estimated that a desi cow is sufficient for 3 acres of land. The farmer can also opt for different systems of farming to increase his yield and income. To improve the flow and availability of nutrients in soil farmer should practice crop rotation in the same piece of land like brassica family in winters followed by root crops in spring season then Solanaceae family in summers and then legumes in rainy season.

Keywords: Natural farming, Employment, Gross domestic production,

Bridging the Gap for Revolutionizing Apiculture Industry Exploring the Impact of Technology and Digitization

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ABSTRACT

The apiculture/ beekeeping industry is facing challenges such as climate change, disease outbreaks, and colony collapse disorder, which are affecting the sustainability and profitability of beekeeping operations. Technology and digitization have the potential to mitigate these challenges by providing real time monitoring, precision management, and data driven decision making. One of the primary benefits of IoT technology in apiculture is the ability to monitor hive health and bee behavior. A set of sensors have been used to measure temperature, humidity, bee behavior and other environmental factors that can

affect the bee's health and productivity. Connected hives can also provide data on the amount of bees and its activities in the colony, the amount of honey being produced, and can be equipped with an automated feeding system and pest control mechanism and the presence of pests or diseases. This data can be used to optimize beekeeping practices, reduce the risk of disease outbreaks and pest infestations, and increase the productivity of beekeeping operations. This can save beekeepers time and money, while also reducing the use of chemicals in beekeeping operations. IoT devices are also proposed to be used for monitoring the movement of hives, preventing theft or vandalism. Overall, the use of IoT technology in apiculture has the potential to enhance bee health, increase honey production, and improve the profitability of beekeeping operations. The outcomes of this research paper could provide valuable insights for beekeepers, industry leaders and policy makers to support sustainable growth of the apiculture industry in the digital age. By bridging the gap in technology adoption, the apiculture industry can improve its efficiency, productivity, and profitability, while also contributing to the preservation of bee populations and the environment as a whole.

Keywords: Apiculture, IoT (Internet of Things), Remote monitoring and control, Swarming, Absconding, CCD (Colony Collapse Disorder), AI- ML (Artificial Intelligence, Machine Learning)

Value Addition of Millets

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ABSTRACT

One of the most common cereal grains consumed worldwide, particularly in arid and semi-arid regions is millets. Due to their nutritional content and lower glycemic index value than other major cereals, millets are known as "wonder foods" or "Nutri-cereals." These grains, which are small-seeded, round cereals that are members of the Poaceae family, are the earliest and perhaps the first cereal grain that humans have ever used for domestic purposes. Millets play a significant role in ageing and metabolic illnesses due to the presence of phytates, polyphenols, tannins, anthocyanins, phytosterols, and pinacosanols. These substances also contribute to antioxidant activity. Unlike rice or wheat, millet is constrained by its outer tough seed coat, distinctive flavour, and lack of processed millet products. These are the main explanations for why millet foods are less common among rice and wheat consumers. Farmers receive a much lower price for their unprocessed food than they do for processed produce. Therefore, small millet grains technological features and nutrient compositions present a variety of opportunities for processing and value-adding to use as next-generation foods to meet consumer's needs. Through primary processing techniques, small millet grains can be transformed into a variety of delectable products like rice, flour, sprouts, salted ready-to-eat, flaked, popped, porridge, and fermented products. In addition to these, baking technologies are also developed for the value-added products. It might be said that new techniques for processing and preparing millet are required to increase the micronutrients 'bioavailability' and raise the standard of millet meals. Processing of millet products should be demonstrated to farmers, rural women and another self-help group (SHGs), and urban entrepreneurs so that they can be trained in millet food processing technologies.

Ug99- A Big Threat for Wheat Production in India

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ABSTRACT

Wheat is the world's second most widely grown staple food cereal, which belongs to the genus *Triticum* in the family Poaceae. Wheat is grown on more land area than any other food crop while world trade in wheat is greater than for all other crops combined. In 2021, world production of wheat was 778.6 million tonnes. China, India, and Russia are the three largest individual wheat producers in the world, accounting for about 41% of the world's total wheat production. It is attacked by numerous pathogens, which causes significant crop damage. One of the major disease of wheat is rust diseases. Rust diseases represent the most economically significant fungal diseases in wheat and other cereal crops worldwide, and they are widely distributed across wheat growing regions. With the capacity to form new strains of fungus, rusts can attack even previously resistant varieties. Rust diseases possess the ability to spread and travel long distances by dispersal of windborne spores and can rapidly develop under optimal weather conditions. The three rust diseases affecting wheat are leaf, stem and stripe rust. Stem rust was once the most feared disease of cereal crops. Stem rust remains an important threat to wheat and barley and, thus, to the world food supply. Recently, the resistance of Sr31 was finally overcome. A new race of the wheat stem rust fungus highly virulent to wheat varieties with Sr31 was found in Uganda in 1999. The new race, tentatively designated Ug99, rapidly dominated the fungus population in Uganda and spread to Kenya and Ethiopia where it caused major epidemics. Within a few years, Ug99 was found in South Africa and in Yemen, from which it has spread to the north and east as far as Iran. It seems inevitable that Ug99 will soon invade one of the world's richest wheat producing areas in the Punjab of India. Previous examples of long distance dispersal of rust fungi include spread of a unique race of wheat stem rust from South Africa to Australia. Ug99 lineage of the stem rust fungus has expanded its virulence through mutations that allow it to overcome the resistance of at least two other vertical resistance genes which wheat breeders have relied for protection from stem rust in North America and many other parts of the world, it makes more worse condition as a Plant Breeder and Plant Pathologist. Therefore, it is very much important to spread awareness about wheat rusts.

Value Addition in Agriculture Products

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ABSTRACT

Value addition in each aspect of agricultural produce creates more quality and adequate demand for the products. However, the expanding market demand for quality and reliability in supply necessitates resources and essential technical know-how. The Agri-value addition industry and research and development organizations have weak ties. The lack of technical experts in postharvest and value addition as well as the ineffective knowledge transfer from research stations to extension services are some barriers to the necessary outreach activities. By promoting appropriate post-harvest activities, efficient extension and training play a crucial part in developing capacity along the value chain. Continue losses and waste in the food production industry. Approximately 14% of food is lost before it reaches the markets each year, according to the Food and Agriculture Organisation (FAO), costing \$400 billion. There are many reasons for postharvest food

loss, most notably agricultural pests, mold, natural shrinkage like moisture loss, and climate reducing losses is one of the crucial ways to enhance food security. Even though it might not call for a sizable investment, reducing post-harvest losses will yield high returns when compared to increasing field production to meet rising food demand. The world was attempting to reduce agricultural poverty, particularly in rural areas, by concentrating on two crucial aspects: trade liberalisation and expansion and increase in technology-based activities. Farms can achieve sustainability and food security is through the use of agricultural techniques. The capacity and knowledge development of the workforce are linked to the technology transfer in order to help reduce postharvest losses and boost productivity. In addition, as incomes rise and urbanisation accelerates, there is a growing demand for agricultural products with added value. This can be done by giving agricultural products more value and reducing post-harvest losses, which are crucial to increasing the viability, profitability, and sustainability of agricultural products. In order to better understand how agricultural products are added value through value-adding processes, as well as how institutional capacity building and technology transfer can increase food availability and sustainability.

Keywords- Urbanization, liberalization, Organisation and expansion.

Towards Sustainable Vegetable Farming Exploring Agroecological Alternatives to Chemical Products in the Marathwada Region of Maharashtra

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ABSTRACT

Excessive chemical use in agriculture can harm the environment and human health. Sustainable agricultural methods encourage agroecological practises that limit chemical use while also benefiting the environment and human health. However, data on the status of chemical use and the adoption of agroecological practises in the Marathwada region of Maharashtra, which is a significant national vegetable production area, are lacking. To fill this gap, we performed cross-sectional surveys with 603 farmers to investigate their practises, behaviours, and awareness about the use of chemicals and bio-products, as well as the hazards to crops, health, and the environment. In addition, we wanted to diagnosis the spread of agroecological practises and identify the most significant challenges and reasons for adoption. According to our results, the majority of farmers (95%) utilise chemicals during the production process but have a poor grasp of their use and associated hazards. Alternative practises, such as crop rotation (99.67%), manure (96.35%), drip irrigation (74.46%), and intercropping (69%), are available to farmers. The success of these practises among farmers was a strong motivator for their adoption (50%), with the main impediments to adoption being the difficulty of managing pests and diseases without pesticides (73.2%) and a lack of professional guidance and support (70.8%). Finally, our study emphasises the need for state training and financial incentives to promote healthy and environmentally friendly farming practises. This study provides significant insights into the present scenario of chemical use and the adoption of agroecological practises in the Marathwada region of Maharashtra, which can guide policy decisions and encourage future sustainable agriculture practises.

Urban Agriculture: Way to Feed Cities

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ABSTRACT

Urban agriculture is the practice of growing plants and rearing animals in a city or town and its surrounds primarily for human food and other domestic requirements. Urban agriculture is the term for farming in urban and peri-urban areas. There is certain advantages of urban farming like rain harvested water and waste water use as irrigation and organic waste use as plant nutrition. Some common methods used in urban farming are raised bed farming, container gardening, aquaponics, vertical farming, hydroponics, rooftop plant production, backyard garden, shipping container farm etc., Urban farms may be able to assist many jobless people in obtaining crucial education and training as well as a consistent source of income. A green area is produced. Unused fields and wastelands may be developed as part of urban redevelopment. It reduces pollution while increasing the quantity of accessible green space. Recently harvested vegetables are brought closer to the moment of consumption via urban gardening. Urban farms produce fruit that is considerably more likely to be in-season, ripe, and healthy. Food waste is decreased since individuals only produce what they actually need. As a result, there is significantly less food waste. Farming may be done on wastelands and undeveloped land. Pollutants are reduced while green area is increased. Property values rise in areas with urban farms and communal gardens. Urban farming allows for the production of fresh food closer to the end destination. Food produced in urban locations is considerably more likely to be wholesome, in-season, and perfectly ripe. Low investment due to urban farming's smaller footprint and less expensive setup and infrastructure. The installation expenses are extremely low in comparison to traditional farming. By utilizing methods like hydroponics and aquaponics, they may use less water. According to report by food and agriculture organization (FAO) in 2005, urban agriculture provides food needs of 700 million people around the world. The earliest enterprise in urban agriculture is the traditional marginalized urban farmers who migrated to the city and grew food wherever open space was available, such as farming along the Railway tract in metro cities. There is number of start-ups in urban farming like UrbanKisan, Agritech, Clover, Farmizem etc., Sairam Reddy, Srinivas Chaganti, and Vihari Kanukollu created UrbanKisaan in 2017 with the goal of resolving India's water crisis and introducing chemical-free agriculture to the nation. Agritech greenhouse platform called Clover partners with farmers all throughout India to provide branded, premium vegetables grown in greenhouses. A smart phone company called Farmizen lets city dwellers rent farms to grow organic, locally sourced food. Users of the programmed are given access to a local community's 600 square foot mini-farm. Users may cultivate and harvest chemical-free vegetables at the farm at any time.

Chemical Weed Control Measures on Weed Flora and Yield of Wheat

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ABSTRACT

Wheat (*Triticum aestivum*) is one of the chief staple crops cultivated all over the country in the world. In India after rice second important food crop is wheat. In India year 2021-22 total production and yield of wheat is 109.59 m tonnes and 3519 kg/ha. Field experiment was conducted at college farm, College of Agriculture, Rewa, JNKVV (M.P.) in Rabi season. The experiment was laid out in a randomized block design with three replications and plot size is about 4.5×3.6 m². Seven different herbicides were applied one pre-emergence pendimethalin @ 1 kg/ha and all other as post-emergence sulfosulfuron @ 0.025 kg/ha, clodinafop-propargyl @ 0.06 kg/ha, sulfosulfuron + metsulfuron methyl @ 0.03 + 0.002 kg/ha and clodinafop-propargyl + metsulfuron-methyl @ 0.06 + 0.004 kg/ha at 60 DAS. The average yield loss in wheat due to weeds is about 25-30 %. Chemical herbicides are mainly used for handling these problems. Wheat variety GW-322 was sown as test crop and the herbicides at 60 DAS. The best weed control was achieved by clodinafop-propargyl + metsulfuron-methyl (vesta) as it registered lower weed count and higher weed control efficiency (94.18%). Wheat parameters like plant height (84.18 cm), number of tiller/m² (446.7), number of Spikelets/ear (18.90), and number of grain /ear (56.70) were significantly higher. Based on performance of clodinafop propargyl + metsulfuron-methyl and sulfosulfuron + metsulfuron-methyl were found efficient in controlling both broad leaf and grassy weeds in wheat.

Keywords: Wheat, Pre and post emergence herbicide, Yield

Protection of Plant in Agriculture

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ABSTRACT

Plant quarantine is the legal enforcement of the measures aimed to prevent pests from spreading or multiplying further in case they have already established in new restricted area. First quarantine act came in 1905 whereas India passed it in 1914 entitled "Destructive Insect and Pests Act of 1914" to prevent the attack of any insect, pests and fungus into the country. Cottony cushion scale, San Jose scale, golden cyst nematode of potato, woolly aphid is some exotic pest introduced into India and cause extensive damage before the PQ Order 2003. So, in order to prevent the exotic pests, disease from other countries, legal restrictions are enforced known as Quarantine. The legislative measures in force to prevent the introduction of new pests and weed from the foreign country, to prevent the spread of already existing pests, diseases and weeds from one part of country to another part, to force farmers to apply effective control measures to prevent damage by already established pests, to prevent the misbranding and adulteration of insecticides and determine their permissible residue tolerance levels in food, to regulate the activities of people engaged in pest control operations and application of hazardous insecticides.

KEYWORD:- Plant quarantine, Enforced, Insecticide, Hazardous.

Possibilities of Plant Originated Bioenzymes as an Alternative of Synthetic Chemicals to Produce Organic Diet: A Review

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ABSTRACT

Bioenzymes are proteins that speed up chemical reactions and serve as biological catalysts. Substrates are the molecules that enzymes can interact with, and the enzymes change the substrates into new molecules known as products. Bioenzymes have a significant impact as a result of the organic cleansing products that are made by fermenting various plant wastes, particularly citrus fruit combined with jaggery and water. The organic solution contains beneficial bacteria that encourages the production of digestive enzymes and can be used as a natural cleanser. Bio enzymes are good substitutes for inorganic fertilizers, insecticides, and fungicides because they improve soil health and plant nutrition while completely avoiding contamination. They are also a great tool for promoting organic farming, which will ultimately be beneficial to human health in the form of an organic diet. In this conversation, the use of bio enzymes as a plant protection alternative to chemicals is discussed, along with the effects on human health and potential applications for bioenzyme research in the future.

Keywords: Bioenzymes, proteins, synthetic chemicals, organic diet, byproduct

Modified Polysaccharide-Based Coatings for Postharvest Treatment of Fruits and Vegetables

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ABSTRACT

Polysaccharide-based coatings are used to extend the shelf life of fruits and vegetables. Polysaccharide-based coatings have been regarded safe for consumer and environmental friendly. They have been designated as "Generally Recognized as Safe" by Food and Agriculture Organization. Besides, the effectiveness of edible coating relies on the wettability of the product and is impacted by both the surface qualities of fresh food and the chemical composition and structure of coating-forming polymers. Based on the hydrophobicity, the roughness of the fresh produce surface, and the physical characteristics of each coating property of the edible coatings, including coating emulsion stability, surface tension, viscosity, cost, density, and drying conditions, polysaccharides coatings are chitosen for industrial application but these coatings are not a good barrier for water vapors. Polysaccharide based coatings start losing many volatile active agents after sometime. Such substances typically have distinct smells, which severely restricts their utilization because the foreign aroma is typically undesirable in the coated food. This "escape problem" can be addressed by modifying the structures of the different polysaccharides. The methods which are recently used to modify chemical structures of the polysaccharides and make new edible coatings are reductive amination for

nanocarriers formation, non-specific enzymatic degradation of Carboxymethyl Cellulose to form oligomers of Carboxymethyl Cellulose and covalent linkage approach for developing active edible coatings etc. These modifications have the potential to improve the efficacy of original polysaccharide based coatings and enhance the acceptance for industrial applications of polysaccharide based coatings.

Keyword: Polysaccharide, amination, nanocarriers, coatings, chitosan, & carboxymethyl cellulose.

Shree Anna: Securing Holistic Nutrition

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ABSTRACT

Millets are an integral part of the basic diet for a majority of the population in India. However, their consumption and production grew less in the past few decades. We now are realising the importance of millets in fulfilling nutritional requirements and in fighting many diseases. Millets need less water and labour. They are climate-resilient and thrive in dry regions and conditions of low soil fertility and moisture. Millets can bring prosperity to farmers as well as people. Ragi, Bajra, Porso Millets, KodoMillet, Jowar, Foxtail Millets, Little Millets, and Browntop are top millet varieties that are rich sources of macronutrients and micronutrients. They have higher amounts of iron, zinc, calcium, potassium, protein and essential amino acids. And they are beneficial in checking high blood sugar levels in persons with type-2 diabetes and maintaining blood pressure and cholesterol levels and thus reducing the possibility of cardiovascular diseases. The economic survey 2023, highlighted that India alone was responsible for the production of 80 per cent of Asia's and 20 per cent of the global production of millet. India's average yield of millet is 1239 kg/ha, compared to the global average yield of 1229 kg/ha. India is the largest producer and second-largest exporter of Shree Anna in the world. The year 2018 was declared the National Year of Millets. On India's proposal, the United Nations announced the year 2023 to be the "International Year of Millets". And these efforts seem to be bearing fruits now. In 2022-23, we are likely to see the millets production of 20.5 million tonnes. In a true sense, millets are going to be 'shree anna'.

Key words: Millets, Shree Anna, Climate-resilient, Foxtail

Value Addition in Agriculture

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ABSTRACT

Value addition is the process of increasing the economic value and consumer appeal of an agricultural commodity. It involves the processing, packaging, branding, marketing, and distribution of agricultural products in a way that makes them more appealing to consumers and adds value to them. It is applied in a diverse range from the production of pickles from vegetables to the production of jam from packaging and branding of grains and pulses to the production of bioethanol and biodiesel and from the production of processed dairy products to the production of beverages. According to estimates by the Food and Agriculture Organization of the United Nations (FAO), India loses about 30% of its agricultural produce due to post-harvest losses. A considerable amount of fruits and vegetables produced in India is lost due to improper post-harvest operations; as a result, there is a considerable gap between gross production and net availability. Value addition

can help reduce post-harvest losses by increasing the shelf life of agricultural products and reducing spoilage. With the help of various storage and processing techniques, the shelf life of the harvest can be increased. Value addition in agriculture plays a major role in the creation of employment in rural areas. It leads to the development of agro-processing industries such as the textile industry, dairy industry, and several other industries which help in the creation of employment and promote entrepreneurship in rural areas. Further, this will promote infrastructure development such as warehousing, transportation, and processing plants. Value addition helps in increasing the income of farmers, as the price of processed products in India is generally higher than the price of raw products due to the value-added during the processing, a kilogram of raw tomatoes will cost less, while a kilogram of processed tomato sauce or ketchup will cost three times as much as the unprocessed product.

Keywords: value addition in agriculture; post-harvest operation; shelf life; employment generation; entrepreneurship development.

Artificial Intelligence for Sustainable Agriculture

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ABSTRACT

The aim of this study is to utilize Artificial Intelligence (AI) to optimize the production system in agriculture while conserving soil health and the environment, in order to sustain the growing population. The objectives of the study include the use of AI for effective pest and disease management, making precise use of inputs, and improving overall crop production. Methodologies for application include the use of sensors for harvesting and weed detection, monitoring crop health for disease and pest detection, using agribots for high-volume and faster harvesting, and improving the user-friendly nature of drone technology. Results have shown that hyperspectral imaging and 3D laser scanning have helped tremendously in improving crop health, AI application in irrigation has also helped in reducing water consumption by up to 50 percent. The implementation of AI in sustainable agriculture has the potential to revolutionize the agro-industry by addressing critical challenges such as food security and environmental sustainability. With the world's population expected to reach 9.7 billion by 2050, there is an urgent need to produce more food with limited resources, and AI can play a crucial role in achieving this goal. By providing real-time insights and analytics, AI can help farmers in making informed decisions about crop management, reduce crop waste, and optimize the maximum use of resources. Furthermore, AI can also enhance the quality and safety of food products by monitoring the production process from farm to table. Overall, the use of AI in agriculture is a game-changing approach that not only improves efficiency but also protects biodiversity and enables the digitalization of farms. In the long run, it will facilitate the ease of dissemination of agriculture extension services. The adoption of AI in agriculture is a vital step towards building a more sustainable and resilient food system that can meet the rising demand of our growing population.

Keywords: sustainable; agriculture; artificial intelligence; digitalization; environment

Compatibility of two Native Entomopathogenic Fungi with Certain Botanicals and their Efficacy against Termite, *Odontotermes obesus*

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ABSTRACT

Laboratory experiments were carried out to evaluate the compatibility of two entomopathogenic fungi viz., *Beauveria bassiana* and *Metarhizium anisopliae* with three different botanicals viz., neem oil, pongamia oil and jatropha oil at the Laboratory of Nanotechnology, Department of Plant Pathology, AAU, Jorhat. The potential compatible mixtures were also tested for their efficacy against termites (*Odontotermesobesus*) in the Laboratory of Soil Arthropod Pests, Department of Entomology, AAU, Jorhat. Compatibility testing was done by following poison food technique whereas the bioassay test was done by following the dry film technique. Compatibility testing data were analyzed through 3 factorial Completely Randomized Design (CRD) and bioassay data were analyzed by following CRD with 3 replications. Out of the three different botanicals tested, lowest inhibition was recorded in case of jatropha oil (53.102%) followed by neem oil (53.624%) towards both the entomopathogenic fungi which were recorded to be *at par* with each other. Significantly higher inhibition (67.428%) of the entomopathogenic fungi was recorded in case of pongamia oil. Experimental results further revealed that the per cent inhibition of different botanicals against *B. bassiana* (45.503%) was significantly lower (at P=0.05) as compared to the *M. anisopliae* (70.599%). Out of the six different concentrations used for the study, the lower two concentrations of each botanicals exhibited significantly lower inhibition (41.746 and 42.605%) as compared to rest of the concentrations. From the above study, the four best compatible mixtures i.e. *B.bassiana*+neem oil (0.10%), *B.bassiana*+neem oil (0.20%), *B.bassiana*+jatrophaoil (1.5%) and *B.bassiana* + jatropha oil (2%) were tested for their efficacy against termites along with an untreated control. It was vivid from the results that the combined application of *B.bassiana*+neem oil @ 0.20 per cent concentration recorded highest mortality of termites i.e. 10.00, 23.33, 36.67, 51.8, 81.85 and 100 per cent after 12, 24, 48, 72, 96 and 120 hours, respectively which was significantly superior to the rest of the treatments after 48 hours. *B.bassiana*+jatropha oil @ 2.0 per cent concentration registered 6.67, 20.00, 30.00, 44.44,64.08 and 77.78 per cent mortality after 12, 24, 48, 72, 96 and 120 hours, respectively which was followed by the application of *B.bassiana*+neem oil @ 0.10 per cent (6.67, 16.67, 26.67, 40.74, 60.74 and 70.37 % mortality after 12, 24, 48, 72, 96 and 120 hours, respectively) and *B.bassiana*+jatropha oil @ 1.5 per cent (3.33, 13.33, 20.00, 27.04, 42.59 and 55.56 % mortality after 12, 24, 48, 72, 96 and 120 hours, respectively). The lowest mortality was recorded in case of untreated control (3.33, 6.67 and 10.00% after 72, 96 and 120 hours, respectively). Results obtained from the present investigation could be explored as an efficient alternative to the synthetic chemical insecticides for the effective management of termites in organic cultivation.

Precision Agriculture: A perspective study

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ABSTRACT

Precision agriculture (PA) is the science of improving crop yields and assisting management decisions using high technology sensor and analysis tools. It is a new concept adopted throughout the world to increase production, reduce labor time, and ensure the effective management of fertilizers and irrigation processes. PA is a farming management idea centred on watching, quantifying, and reacting to crop variability both within and between fields. It can assist in ecologically friendly input management for agricultural production. Physical inputs are replaced by knowledge and information. It can target rates of seed, fertilisers, and chemicals for soil and other conditions by applying site-specific knowledge. It has already been demonstrated that more accurate farming can enhance yields simply by increasing plant density. Sustainability is the capacity to consistently support or maintain a process across time. Sustainability aims to stop the depletion of natural or physical resources in business and policy environments so that they will be available for the long term. The intuitive notion that precision agriculture should reduce environmental loading by applying fertilisers and pesticides just where and when they are needed is confirmed by PA's various potential contributions to the long-term sustainability of production agriculture. Environmental advantages of precision agriculture result from more focused input utilisation that lowers losses from excess applications as well as from reductions in losses owing to nutrient imbalances, weed escapes, insect damage, etc. A decrease in the emergence of pesticide resistance is among the additional advantages. One drawback of the publications we analysed is that few of them really investigated environmental parameters directly, like leaching using soil sensors. The majority of them calculated the environmental advantages indirectly by measuring the decreased chemical loading. An example of how site-specific data and variable rate application could be used to maintain profitability while reducing N applications comes from the findings of an on-farm trial conducted in Argentina. The sensitivity analysis's findings indicate that, over a wide range of constraints on N application levels, it is a somewhat more profitable option than whole field management. Producers may benefit from better management tools from precision agriculture for the inputs they must bring to the farm. PA enables farmers to more precisely target applications rather than distributing pesticides or fertiliser at uniform rates over wide areas. It is frequently maintained that PA can replace certain external physical inputs with information and knowledge, potentially bringing the farm closer to the ideal of biological balance. Precision agriculture (PA) and sustainability have a close relationship. The potential for environmental advantages has been explored ever since the first GPS device was installed on farm machinery. According to logic, reducing environmental loading should result from using fertilisers and insecticides only where and when they are required. The realities of PA and sustainability will be explored greatly in the study. The concept of doing the right thing, at the right place, at the right time is known as site-specific management (SSM). With the exception of regions with little geographical variability, nitrogen losses to the environment were lower with variable VRT than with uniform rate application (URA). A field's nutrition and pesticide loading can be changed, offering the chance for efficient input control using PA while boosting production efficiency.

Rhizospheric Health Impacts of Mulching and its Relevance for Natural Farming Practices

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ABSTRACT

Years of research has uncovered the remarkable potential of mulching practices to improve the intricate hydrothermal environment of soils and facilitate the enhancement of rhizospheric health. The rhizosphere represents the zone of soil that immediately surrounds the plant roots, where interactions between roots and soil microorganisms occur. An environment conducive to the establishment of a healthy rhizosphere is pivotal for driving plant growth and productivity. The extent of nutrient uptake, disease resistance, and stress tolerance are influenced by different factors that come to play in this region. Studies have revealed that the type and thickness of mulching material applied play a decisive role in shaping the physicochemical and biological properties of the soil, consequently resulting in changes in the rhizospheric environment. Although the impact of plastic mulching materials has been observed to outweigh that of organic mulching materials, with regards to soil environment and crop yield, organic mulching materials, such as crop residues and composts, have shown to wield a positive influence on soil structure and microbial activity. Natural farming practices, which emphasize the promotion of soil health through the stimulation of biological activity, effectively leverage mulching as a tool to achieve this objective. Such practices bolster the growth of beneficial microorganisms in the rhizosphere, thereby improving soil quality and promoting sustainable and environmentally conscious agricultural practices. In summary, mulching practices can have a profound impact on rhizospheric health and plant productivity. Organic mulching materials are a cost-effective and environmentally friendly option that can promote natural farming practices, while the use of plastic mulching materials can still be an effective strategy for enhancing crop yield. However, the complex interactions between mulching practices and soil microbial communities necessitate further research to optimize rhizospheric health in agriculture.

Keywords: Mulching, Rhizosphere, Microbial activity, Natural farming, Soil health, Crop microclimate.

Organic Farming and Soil Fertility

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ABSTRACT

Organic farming is a production system which avoids, or largely excludes, the use of synthetic fertilizers, pesticides, growth regulators, and livestock feed additives. The objectives of environmental, social, and economic sustainability are the basics of organic farming. The key characteristics include protecting the long-term fertility of soils by maintaining organic matter levels, fostering soil biological activity, careful mechanical intervention, nitrogen self-sufficiency through the use of legumes and biological nitrogen fixation, effective recycling of organic materials including crop residues and livestock wastes and weed, and diseases and pest control relying primarily on crop rotations, natural predators, diversity, organic manuring, and resistant varieties. According to Singh et al., applying 7.5 t FYM ha⁻¹ resulted in significantly higher grain and straw yields than unfertilized fields. With rising rates of FYM, all the rice yield-related characteristics grew. According to Minhas and Sood, the breakdown of organic matter releases macro-

and micronutrients into the soil solution, making them available to plants and increasing absorption. The reserve pool of stored nutrients, organic carbon, soluble phosphorus, exchangeable potassium, pH, and relative stability of the EC level were all reported to increase after 4 years of using organic and low-input farming techniques. Singh and Bohra reported that rice-pea-black gram (*Vigna mungo* L.) cropping system recorded higher population of bacteria, actinomycetes, and fungi than rice-wheat cropping system. According to Bulluck et al. organic fertility amendments increased good soil microbes, decreased pathogen populations, total carbon, and cation exchange capacity, and decreased bulk densities, all of which improved soil quality. Since the entire region cannot afford to switch to organic production at once due to its commitments to ensuring food and nutritional security, it is necessary to identify suitable crops/products on a regional basis for organic production that have international market demands. This will provide ample opportunity for employment, bring prosperity and peace to the region.

Key Words: Organic farming, FYM, Soil Microbes, Organic Carbon, CEC

Adaptation and Mitigation Strategies for Climate Smart Agriculture

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ABSTRACT

Agriculture is particularly vulnerable to the repercussions of climate change, particularly in Asia where increases in temperature, sea level rise, water shortages, and the frequency of severe natural disasters like cyclones and floods. In order to explain the contradiction between raising global agricultural output, boosting the agricultural sector's resiliency in the midst of changing climates, and reducing the release of greenhouse gases from agriculture, a new phrase, climate smart agricultural development, came into existence in year 2009. The term "Climate-Smart Agriculture" (CSA) was first coined in Netherlands and it has been described as agriculture which "sustainably boosts productivity, enhances resilience, minimizes greenhouse gases, and strengthens accomplishment of national food security as well as growth goals." The most effective strategies, policies, and programs must collaborate with coordinated initiatives aimed at reducing poverty, improving food security and water accessibility, preventing erosion of soil and degradation of land, halting the depletion of biodiversity and ecological services, boosting adaptive capacity, and increasing the efficiency of the food production chain to the context of sustainable development. Any planning for adaptation must consider the degree of uncertainty in scenarios for climate change, and the strategies ultimately must be flexible. Effective management of grazing and croplands to boost soil carbon retention; improved rice farming methods; better livestock and waste management to cut minimize CH₄ emission; use of cover crops, conservation tillage, mulching, and biosolids recycled materials, more effective techniques for applying nitrogen fertilizer to decrease N₂O emissions; the regulations and incentives for finance to enhance soil management, preserving carbon content in the soil, and effectively using fertilizers and irrigation are major mitigation strategies for climate smart agriculture.

Keywords: Climate Change, Food Security, Climate Smart Agriculture, Green House Gases

Synergetic Effect of Integrated Agri-Aquaculture System towards the Green-Blue Revolution: Aquaponics

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ABSTRACT

Aquaponics is a promising technology that is part of the broader integrated agri-aquaculture systems discipline. It is also referred to as a sustainable method for raising both fish and vegetable crops. Word Aquaponics refers to the combination of conventional aquaculture (raising aquatic animals like fish, snails, crayfish, prawns, and shrimp) and hydroponics (raising plants in water without soil) in a symbiotic environment. The Aquaponics system is also termed a re-circulating aquaculture system, in which water re-circulates between the components of the system (fish tank, bio-filter, hydroponics system) that incorporate the production of plants without soil. In the aquaponics system, water comes from an aquaculture system which is fed to a hydroponics system, where by-products are breakdown by nitrifying bacteria, and then it is utilized by plants as a nutrient, and then water is re-circulated back to the aqua system. All types of fish either omnivorous or carnivorous, are suitable for the aquaponics culture system. Combining aquaculture and hydroponics, obtaining aquaponics, is a new innovation that adheres to the principles of sustainable agriculture (wastewater biofiltration by plants) and allows us to increase economic efficiency with additional production (organic vegetables) to produce nutrient-rich food. Aquaponics importantly seeks to apply methods that provide technical, biological, chemical, environmental, and economic advantages.

Start-up based on *Rhododendron arboretum* products from Dhauladhar ranges to Global Level

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ABSTRACT

Rhododendron arboreum is a tiny tree that grows predominantly in mountain settings and has pale pink or deep pink blossoms. It is distributed all around the world. It belongs to the Ericaceae family and is well-known for its beautiful blooms. *R. arboreum* species is extensively spread between the latitudes of 80°N and 20°S and is designated as the 'State flower' of Himachal Pradesh (India) and the 'National flower' of Nepal. It is used to cure a variety of ailments, including bacterial infection, diarrhoea, headache, infamy, and fungal infections, because to its many natural phytochemical characteristics. People in the mountains have traditionally used the blooms of this plant to manufacture a range of goods such as juice, squash, jelly, syrup, pickle, and honey. Saponins, flavonoids, and steroids are among the polyphenolic and bioactive substances found in *R. arboreum*. Since its products are difficult to find in other parts of the world, it is beneficial from both the sides by setting up industries at small scale for making products from the local level of Himachal Pradesh (India) mainly area adjoining Dhauladhar mountain range and reaching the global level.

Seaweed Cultivation in India – New Livelihood Option for Coastal Communities

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ABSTRACT

Seaweed cultivation in India has emerged as a new livelihood option for coastal communities. Seaweeds are marine macro algae that can be harvested for a variety of purposes, including food, medicine, and biofuel. India has a vast coastline of over 8129 km, making it ideal for seaweed cultivation. The potential benefits of seaweed cultivation are numerous. It can provide an alternative source of income for coastal communities, promote sustainable aquaculture, and help mitigate climate change by sequestering carbon dioxide. Seaweed cultivation also has the potential to create new jobs in processing and marketing of seaweed products. Several initiatives have been undertaken in India to promote seaweed cultivation, including the establishment of seaweed farms and research centers. The Indian government has also launched a program to promote seaweed cultivation in the country, with the aim of generating employment and promoting sustainable coastal development. Despite the potential benefits, seaweed cultivation in India faces several challenges, including lack of awareness and technical expertise, limited infrastructure, and inadequate financing. To overcome these challenges, it is necessary to create awareness about the benefits of seaweed cultivation, provide training and technical support to farmers, and develop infrastructure for processing and marketing of seaweed products. In conclusion, seaweed cultivation has the potential to provide a new livelihood option for coastal communities in India. However, it requires concerted efforts from government, industry, and civil society to promote and support this emerging sector.

Recent Advancements in Agriculture Robots: Benefits and Challenges

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ABSTRACT

In the development of digital agriculture, agricultural robots play a unique role and confer numerous advantages in farming production. From the invention of the first industrial robots in the 1950s, robots have begun to capture the attention of both research and industry. Thanks to the recent advancements in computer science, sensing, and control approaches, agricultural robots have experienced a rapid evolution, relying on various cutting-edge technologies for different application scenarios. Indeed, significant refinements have been achieved by integrating perception, decision-making, control, and execution techniques. However, most agricultural robots continue to require intelligence solutions, limiting them to small-scale applications without quantity production because of their lack of integration with artificial intelligence. Therefore, to help researchers and engineers grasp the prevalent research status of agricultural robots, in this review we refer to more than 100 pieces of literature according to the category of agricultural robots under discussion.

Organic Inputs in Floriculture –Trends and Effects

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ABSTRACT

Conventionally produced flowers can negatively affect the health of wildlife and people by contaminating groundwater and streams with fertilizer and pesticide discharge. Organic flowers are grown with consideration for surrounding environment, farm workers and ultimately the soil. We like to choose flowers grown using the choose flowers grown using traditional methods because we don't eat flower the same. Since, we don't eat flowers the same way we eat food, we are more laid back and prefer flowers grown using traditional method. However, people are now drawn to a charge that involves choosing organic flowers as they become aware of negative effects caused by conventional farming. Consumers want to buy flowers that are fresh and non-toxic as the idea of localization in floral industry gain acceptance. The demand for chemical-free crops will increase as it does so. Farmers, designers, and florists all work together year-round as the season change, so this will be extremely beneficial to them all Manure, green compost, biogas slurry, FYM, night soil, agricultural wastes, crop residues, biofertilizers etc. are the example of regularly used organic inputs. The primary usage of organic inputs is either as a soil amendment or as fertiliser for crops. A steady level of organic matter in the soil is also made possible by organic inputs, which has numerous advantages. The addition of organic sources supplements the plants' diet with a variety of nutrients that aid in maintaining their health and boost the yield of several flower-related traits. According to research by (Gulser et al., 2011), the availability of chicken dung and barnyard manure increased the macro- and micronutrient contents of *Tagetes erecta*. Due to higher nutrient uptake by plants and greater growth of water conducting tissue, the use of organic manures had an impact on bloom lifetime. Although organic floriculture is still in its early stages, the interest that growers and consumers have shown in organic flowers indicates that the industry has a lot of potential for both farmers and business owners.

Organic Aquaculture towards Agricultural Sustainability

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ABSTRACT

Organic aquaculture originated from the organic agriculture movement. Organic aquaculture is an eco-friendly and sustainable method of producing fish and other aquatic organisms. The principle of organic aquaculture includes maintaining water quality, reducing pollution, and preserving biodiversity in a sustainable manner. It involves using natural feeds, minimal use of chemicals and promoting a healthy aquatic ecosystem. Production from organic aquaculture has grown rapidly over the last few years, although it remains at low volumes worldwide. Farmers can produce high-quality fish/shellfish by practising organic aquaculture with minimizing the environmental impact. Sustainable production through organic aquaculture can provide a reliable and safe source of protein for human consumption while reducing the industry's carbon footprint. However, the transformation from conventional aquaculture to organic aquaculture is a multidimensional, complex, and non-conventional process. Converting to organic aquaculture brings a wide range of environmental and human health advantages.

Aquaculture under organic management intends to produce fish which are economically viable and sustainable. Organic aquaculture can be practised under different systems, including in tanks, ponds, net-pens, cages, raceways, and recirculating aquaculture systems (RAS). Hence, organic aquaculture can open new dimensions for future endeavours.

Study of Weather Parametres Relationship with Performance and Yield of Different Pearl Millet Varieties under Rainfed Conditions of J& K UT

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ABSTRACT

Pearl millet is one of the most important millet crop grown in rainfed areas of the country. It is locally known as Bajra and mainly grown in rainfed and marginal areas of Jammu region by small and marginal farmers for grain and fodder purposes. It is tolerant to smaller and longer duration drought and heat and for that reason it has better adaptability to changing climatic conditions. Field experiments were conducted at Research Farm of Advanced Centre for Rainfed Agriculture (ACRA), Rakh Dhiansar, SKUAST-Jammu during the kharif seasons of 2019, 2020 and 2021. The experiment consisted of pearl millet varieties namely Dhanshakti, ICMV 221, Pusa composite 701, Pusa composite 383, JBV 2, Raj 171 and local variety grown in randomized block design under rainfed conditions. The experiment was mainly conducted to study the growth and yield of different pearl millet varieties and their relationships with weather parametres. Significantly higher grain, stover yield, rain water use efficiency, net returns and B:C ratio of pearl millet varieties were registered in Pusa composite 701 followed by Pusa composite 383 and Dhanshakti. The lowest values of the same were recorded in local variety. The higher grain yield of Pusa composite 701 followed by Pusa composite 383 and Dhanshakti might be due to their well adaptation to the rainfed areas under sub tropical areas of Jammu region. Among the different varieties of pearl millet, days to 50% flowering and physiological maturity were in the range of 49-55 and 73-83 days, respectively. Pearl millet can be a better option for rainfed farmers during late onset (after 15 th July) or even sometimes failure of monsoon due to its short duration and drought resistance. The impact of higher maximum and minimum temperature and stress/drought period during the grain development/reproductive stage had a significant effect (R^2 values ≥ 0.65) on yield of pearl millet varieties. The stress/drought during reproductive stage reduced the duration of reproductive stage that ultimately reduced the grain yield of pearl millet varieties and the findings are depicted in the form of graphs. There was a significant effect of maximum and minimum temperatures during reproductive stage and total crop growing period on grain and biological yields of pearl millet varieties under rainfed conditions of Jammu region.

Keywords: Pearl millet, varieties, yield, weather, relationship

Seasonal Abundance and Population Dynamics of Major Phototactic Insect Pests of Paddy in Relation to Weather Parameters

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ABSTRACT

Field experiment was conducted during *Kharif* 2022 at JNKVV Research Farm. Standard design of Jawahar light trap was used to collect valuable information on seasonal abundance and population dynamics of major insect pest species of paddy in Jabalpur region namely rice leaf folder, army worm & green leaf hopper and to find out their relationship with weather factors and to observe the trend of insect population. Results revealed that major activity period of *Cnaphalocrocis medinalis* (Guene) and *Mythimna separate* (Walker) was confined during warm and humid months from August to November. Three peaks were observed in both these species which indicates completion of two to three generations during the cropping season. *Nephotettix virescens* (Distant) is active during the high rainfall and humid months (July to October) with four peaks.

Key Words: Light trap, Paddy, Seasonal abundance, Weather factors.

Efficacy of Funnel Diameter in Light Trap Design against Major Phototactic Insect Pests

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ABSTRACT

The central region of India in its natural and climatic condition is a zone favourable for the cultivation of paddy in India. Significant damage to paddy was observed since long back due to various insect pests. Monitoring of these insect pests is very essential to plan appropriate management strategy. Use of light trap was very common since 19th century to monitor and manage the insect pests. The present investigation was conducted in paddy crop during *kharif* 2022 at JNKVV Research Farm. Although there are numerous types and designs of insect light traps. Funnel diameter is an important factor collection efficacy of light trap designs. Therefore efficacy of light trap funnel diameter was compared in standard Jawahar light trap models against major insect pests of *kharif* season. Comparative studies of the trap catches revealed that 50 cm funnel diameter light trap has given significantly better response than 40 cm funnel diameter light trap in collecting the major phototactic insect pest species *viz.* green leaf hopper, rice Gandhi bug, green stink bug, red cotton bug, rice butterfly, tiger moth.

National Education Policy 2020: Revamping Agricultural Education System in India

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ABSTRACT

National Agricultural Research, Education and Extension system is the largest system of its kind in world and has paid rich dividends. The NARES needs to be revamped and re-energized to keep pace with modern technology driven teaching-learning systems. The NEP 2020 was formulated based on the Dr. K. Kasturirangan committee's advice to

restructure the traditional educational system. The agricultural education system in India has to be revised in light of National Education Policy-2020 since it improves farmer learning ability and knowledge. Farmers will become more independent and dependent on their own farming-related self-studies as agricultural education levels rise. It is recommended that agricultural higher education needs to be reoriented in light of agribusiness, globalisation, food security, diversification, and ecosystem sustainability. Also the NARES needs to be revamped and re-energized to keep pace with modern technology driven teaching-learning systems. Course curricula need to be upgraded, Outcome Based, made more flexible, with more choices and reorganized to put some vocational courses in first two years. Teachers to be trained in new pedagogy and blended learning. Relook at Land-Grant System for better resource utilization, increase intake and to create MERUS. Avoid establishing mono-disciplinary Universities. Adopt Cluster approach and Group institutions for using best teachers, courses and equipment for a larger number of institutions. More funds to be provided for research in the ratio of salary: AR4D: 60:40. Open doors to talent from anywhere and from any stream for admissions and recruitments, tuned to task. Make regulations to promote and not to prohibit. Strengthen accreditation but rationalize criteria, separate for Programme/College/ University, Link Accreditation and Education to HECI, NHREC, GEC and NAC through DARE to attain statutory status. Establish a National Agricultural Education Commission to examine, prioritize, restructure and recommend corrective course. Be India-Centric but also Include International Education Content to play greater role in Afro-Asian region and the rest of the world. Universities should be UNIVERSAL in Content, Faculty, Students and Relevance: Avoid inbreeding and narrow vision. Through science-based policy options and actions, they are urged to start their own businesses, enhance the security of rural livelihoods, and hasten agricultural transformation. Finally, in order for students to succeed, sufficient emphasis should be placed on developing their entrepreneurial and practical skills. In the near future, it will be necessary to have access to competent human resource in adequate quantities in order to effectively solve the issues that Indian agriculture is currently facing. Because agriculture contributes either directly or indirectly to the country's economic and social development, young graduates have a lot of opportunity to pursue this career. Apart from the opportunities it has also the future challenges Viz., Revise, Upgrade and reorganize course curriculum, install use and teach latest technology in teaching-learning process, use available national and international excellence in teaching to impart focused, inculcate problem solving, effective Utilization of faculty/land/infrastructure/Funds by Universities/ Colleges/Institutes, Institutional partnerships at national and international levels – CLUSTERS, more funds for education and research, stakeholder involvement in training/internships/industry-based course modules/research, emergencies and calamity readiness in teaching and research and need to promote original research not only adoptions and repetitions.

Key words: Agriculture, education, research, economy, university, policy

Cultivating Contracts: Exploring the Landscape of Contract Farming in India

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ABSTRACT

Contract farming, in which farmers enter into contractual arrangements with buyers or

processors, has evolved as a promising agricultural production strategy in India. This arrangement allows small and marginal farmers to have access to new technologies, better seeds, and guaranteed markets, potentially increasing agricultural productivity and farmer revenue. However, contract farming in India confronts a number of obstacles that must be addressed in order for it to be implemented in a sustainable manner. These abstract attempts to provide a brief review of contract farming potential, problems, and future prospects in India. The Model Agricultural Produce and Livestock Marketing Act of 2003 establishes the legal foundation for contract farming in India, laying out the laws and regulations that govern contract farming. This legal framework has permitted the formation of contract farming agreements for a variety of crops and livestock products across India. Access to modern technology is one of the most important benefits of contract farming in India. Farmers are frequently provided with improved seeds, fertilizers, and pesticides, as well as professional advice on optimum agricultural practices, by contracting businesses. Despite the potential benefits, contract farming in India faces several challenges that need to be addressed for sustainable implementation. One of the major challenges is the disparity in negotiating power between farmers and contracting corporations. Small and marginal farmers often have less bargaining power due to their poor socioeconomic status, lack of knowledge about market prices, and reliance on contracting firms for inputs and equipment. To overcome challenges, Farmer-friendly contract farming models that ensure fair and transparent contractual arrangements are needed. Additionally, social and gender issues in contract farming, such as addressing the challenges faced by women farmers, need to be considered and addressed to ensure inclusivity and equality in contract farming arrangements. The future prospects of contract farming in India are promising. With the increasing demand for agricultural products, contract farming can provide small and marginal farmers with access to technology, markets, and financial resources, which can lead to improved livelihoods and rural development. Furthermore, contract farming can facilitate agri-business linkages, where farmers can enter into long-term contracts with agri-businesses, processors, exporters, and retailers, creating a win-win situation for both parties. Various government schemes and initiatives, such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), Rashtriya Krishi Vikas Yojana (RKVY), and the National Agricultural Market (e-NAM) have been launched to promote contract farming and provide farmers with better access to markets, credit, and insurance. In conclusion, while contract farming has significant potential in India, there are challenges that need to be addressed for sustainable implementation. Providing farmers with access to modern technology, markets, and financial resources, and ensuring fair pricing, timely payments, and secure land rights can contribute to the positive impact of contract farming on small and marginal farmers' livelihoods, rural development, and agricultural sustainability.

Keywords: Contract farming, farmers, opportunities, challenges

The Concerns and Measures for the Management of Food and Agricultural Waste

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ABSTRACT

India is one of the largest food-producing countries in the world and the food produced in the country is sufficient for the population. However, due to the fragmented and unorganised supply chain, storage, and logistics, the distribution system has been affected negatively. According to FSSAI, one-third of the food in India is either wasted or goes

stale, before consumption. According to the UNEP, Food Waste Index Report 2021, household food waste in India is estimated to be around 50 kg per person annually or 68.76 million tonnes. In the agricultural sector, India generates about 350 million tonnes of agricultural waste every year. As per the estimate given by the Ministry of New Renewable Energy, this waste can generate more than 18,000 MW of power every year apart from generating green fertilizer for use in agriculture; cropping systems, livestock systems, irrigation and drainage system, pest control system, reduce conservation system are some steps that can successfully help to reduce agricultural waste. Even the harvest of expensive fruit and vegetable in India, which also it's globally the second large producer but is wasted as a consequence of inappropriate management such as poor infrastructure of storage, not sufficient cold chains, not proper processing, and lack of appropriate plans. Both food and agriculture waste can be managed by employing some of the necessary and sustainable steps, including proper production strategies, collection and transport, storage, treatment of unhealthy raw material, and proper strategies for distribution and consumption. The produced waste is a downside for both humans and the environment, hence there is an urgent need to address fix this problem.

Key words: food waste, problem, harvest, appropriate plans.

Artificial Intelligence in Crop Improvement

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ABSTRACT

Today's science is tomorrow's technology. Adaptive inventions for reducing the human work and bright future were invented which is called Artificial Intelligence. With the invention of various technologies and machines, the work load of human being has been decreasing day by day. From reducing the human error to increasing the working efficiency, artificial intelligence is playing a crucial role in the development of various sectors in today's world. Agriculture is one of the most important sectors in the world. Climate change and increasing population has become a challenging task for the scientists. In the next 50 years, conventional breeding technologies will not be able to fulfill the requirements of food, fodder and fiber for the next generation. The sector faces numerous challenges in order to maximize its yield including improper soil treatment, disease and pest infestation, big data requirements, low output, and knowledge gap between farmers and technology. Artificial Intelligence is seen more and more as a solution to these challenges. The main concept of AI in agriculture is its flexibility, high performance, accuracy, and cost-effectiveness. For example Artificial Neural Networks (ANN), a branch of A.I. has played a crucial role in selection of an ideal genotype of cotton and soybean for a specific location in Brazil.

Keywords: artificial intelligence, climate change, genotype, crop improvement

Solar Energy in Indian Farming System: A Step towards Self-reliance

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ABSTRACT

India is the world's third largest consumer of energy. The Indian power sector

employs a variety of fuel sources, including both conventional and environmentally sustainable resources such as coal, oil, gas, solar, wind, biomass, industrial waste, and both large and small hydro plants. To fulfil the needs of a growing population and an expanding need for food, the energy consumption in the agriculture sector has greatly expanded. This demand along with the need for powering agricultural equipment like pumps, generators, motors, tillers, etc. calls for an alternative energy source that can decrease the dependency on fossil fuels and conventional energy. Solar energy is one of the most versatile kinds of energy, with limitless potential, and it has the potential to be a game changer for the agricultural sector in India, preserving vital water resources, reducing reliance on the grid, and even creating an additional cash stream for farmers. Solar energy in agriculture has the potential to address not only the global energy issue, climate change, and renewables, but also rising hunger and malnutrition. Solar energy may be used in a variety of agricultural operations and benefits farmers by lowering agricultural expenses, boosting land use efficiency, increasing crop yields, soil health, and enhancing sustainability, as well as aiding in the fight against climate change. However, there are various challenges in scaling up solar energy in the Indian farming system including land scarcity, lack of proper knowledge about installation of solar power, higher per unit production costs, environmental issues, slow pace of growth, reliance on imports for solar equipment and the absence of solar waste management policy. In this regard, government has implemented many schemes to attain renewable energy driven Indian farming system. Even though, Indian farming system is still dependent on conventional energy. To use solar energy at large scale in Indian farming system, government should bring more structured strategies, interventions and policy to address these ground level issues and also to provide assistance for the same. Extension measures like training, technology dissemination, extension advisory services and provision of subsidies can motivate the farmers for adopting solar energy for farming activities. These steps may help India to become self-reliance in energy consumption.

Key Words: Solar Energy, Agriculture, Farming System, Benefits, Challenges

Protocol for the Preservation of Sugarcane Juice

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ABSTRACT

Sugarcane (*Saccharum officinarum*L.) a perennial long duration crop which belongs to family Poaceae, is widely cultivated as a major crop in tropical and subtropical regions of the world. A total of 116 sugarcane varieties have been identified under All India Coordinated Research Project on sugarcane, out of which 55 varieties have been registered and notified for cultivation in different parts of the country. Among the varieties grown in India, CoP 92226 variety is extremely preferred because of its high juice yield and sensory characteristics. In India, sugarcane juice is available throughout the country but juice composition varies according to cane variety, geographical location, cultural practices, maturity at harvest and mechanical treatment during harvesting and transportation. Sugarcane juice is high in nutritional value as it is rich in sugars, organic acid, vitamins, phenolic compounds, minerals etc. and possess excellent health benefits, but its processing and marketing are limited due to its rapid deterioration. The chemical, physical, sensory and nutritional attributes of sugarcane juice are affected by several factors that can be physical (light, heat), chemical (oxygen), biochemical (enzymes) and biological (microorganisms). The time lag between the extraction and consumption of

sugarcane juice has marked deteriorating effect on its quality characteristics and particularly due to the presence of simple sugars where the endogenous invertase enzyme gets activated and act as a cause of deterioration soon after the harvest of sugarcane. These enzymes lead to inversion of sucrose and split into two monosaccharides, glucose and fructose leading to rapid fermentation. Similarly, Polyphenol oxidase has been implicated as a leading enzyme that acts upon the phenolic compounds resulting in enzymatic browning of sugarcane juice. Thus, study conducted to develop the processing techniques for the shelf life extension of sugarcane juice. Study indicated optimization of pH of sugarcane juice upto 4.00 was standardized by adding different acidulants where orthophosphoric acid was found highly acceptable on the basis of organoleptic characteristics. The standardized pH adjusted sugarcane juice was then heated at different temperature (50°C, 60°C, 70°C, 80°C and 90°C) and results indicated that heating of juice at 90°C caused reduction in PPO activity (13.40 U/ml) as compared to control (51.60 U/ml). Time for pasteurization was optimized at 90°C for 15 minutes on the basis of PPO activity and microbial growth. The standardized protocol for the preservation of sugarcane juice involves pH adjusted juice (with orthophosphoric acid) preheated to 60°C followed by hot filling in pre-sterilized glass bottles and pasteurized at 90°C for 15 minutes was able to maintain the quality and storage stability of sugarcane juice up to six months under both the storage conditions.

Climate Change: Adaptation and Mitigation Strategies in Coastal Low Lying Region of Kerala

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ABSTRACT

The present study was all about assessing the adaptation and mitigation strategies adopted by farmers of Kuttanad region in Kerala, to cope with the adverse effects of changing climate. Two adopted villages of KVK-Alappuzha, Muttar and Thalavady, under the NICRA-project, were selected purposively for this study. Exploratory and descriptive research designs were used to identify and list out the indigenous and improved adaptation strategies adopted by the farmers to cope with the adverse effects of climate change. Focused group discussion was conducted to get an insight into the existing indigenous adaptation strategies, and secondary data was collected from KVK-officials to obtain the improved strategies implemented under NICRA-project. The study revealed that, the increased flood and unexpected rain during harvesting season forced the farmers to shift their paddy mono-cropping system into paddy cum fish cultivation and to adopt short duration paddy varieties. To counteract the adverse effects of climate change on crop production, KVK-Alappuzha introduced the following climate resilient agricultural technologies such as site specific acidity-nutrient management, integrated pest and disease management, crop field mechanization, intercropping short duration cassava in coconut gardens, mushroom production, establishment of seed bank etc. So as to improve the livestock production, they introduced the climate resilient agricultural technologies such as integrated duck and fish farming, model dairy unit, local breed up-gradation, Enerfat production, animal nutrition and fodder enrichment, improved shelter, establishment of fodder bank etc.

Key Words: NICRA, Climate change, Adaptation strategies, Climate resilient

agricultural technologies

Agri-tech-Startups: A Key to Supply Chain Revolution in Agriculture

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ABSTRACT

Agriculture being the backbone of the Indian economy is the biggest employer in the country and contributed around 55.33% of India's total gross value added (GVA) in financial year 2022. Due to outdated farming techniques and a lack of improved price discovery tools, the farmers struggle to make ends meet and remain in poverty. Agri-tech startups have helped open new avenues for farming community, from restructuring market linkages to enabling tenants to sell their produce at better prices. This has resulted in the growth of a thriving market and the quick appearance of numerous participants for the improvement of the agrarian situation. Agri startups are aiming to innovate, develop, or upgrade goods, processes, or services that have a significant potential to create money or jobs. The increasing demand for innovation in agriculture and the declining last-mile delivery to farmers have introduced new terminology to the Indian agriculture ecosystem which will revolutionize the supply chain as well as the Indian farming scenario. Agri-tech businesses are the sector's up-and-coming pioneers, working hard to modernize conventional farming practices by fusing them with technology. India presently has more than 450 startups in the AgriTech industry operating at every stage of the value chain, growing at a rate of 25% per year. Technology today impacts every aspect of agricultural value chain ranging from very basic of supplying inputs to providing markets. Currently, home to more than 2,000 AgriTech startups, the government aims to scale this number to 10,000 in the coming future which will help to earn round-the-year income, improve productivity and profitability and adopt sustainable farming systems.

Keywords: Agri-tech-Startups, Farming community, Market linkages, Sustainable farming system

Climate Resilient Agriculture: Adaptation and Mitigation Strategies High Night Temperature Mediated Carbon Balance Disruption Affects Panicle Yield and Quality Spatially in Contrasting Rice Genotypes

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ABSTRACT

Nighttime temperatures are increasing three times faster than daytime temperatures, resulting in a 10% reduction in rice yield for every 1°C increase in seasonal nighttime temperatures. Vandana (high night temperature susceptible) and Nagina 22 (high night temperature tolerant) rice cultivars were subjected to a 4°C increase in mean seasonal night temperature (HNT 28 °C vs Ambient 24°C) from anthesis to physiological maturity. The ratio of photosynthetic to nocturnal respiration rate (Pn/Rn) on leaf area basis at 10 DAA (Days after anthesis) showed a significant reduction by 58% in Vandana and reduced total biomass, indicating carbon limitation, while it increased significantly in Nagina 22, indicating the existence of a compensatory mechanism in tolerant genotype to compensate for the respiratory loss of transitory starch by flag leaf. Furthermore, during the early and middle phase of grain filling period (5-15 days), inferior grains of Vandana recorded a significant reduction in grain filling rate, while

superior and inferior grains of Nagina 22 recorded a higher grain filling rate at 5 and 10 DAA. This is further confirmed by ¹⁴C When 6:00 AM ¹⁴C DPM g⁻¹ dry weight (disintegration per minute per gram dry weight) were compared with DPM g⁻¹ dry weight at 11:00 PM and 4:00 PM, in Nagina 22, DPM g⁻¹ dry weight at 11:00 PM and 4:00 PM, DPM g⁻¹ dry weight in superior grains was found to be 437% and 37% more, respectively, and inferior grains were found to be 667% and 97% more. Even lower panicle temperature depression in Vandana confirms that high night temperatures are detrimental to grains of Vandana. This has resulted in increased spikelet sterility, reduction in test weight, increased chalkiness and reduced apparent amylose content in both types of grains in Vandana. Furthermore, inferior grains of both genotypes had similar patterns of various pasting properties, whereas superior grains showed the opposite trend with significant difference. In conclusion, lower carbohydrate availability, increased respiratory consumption was partitioned more towards maintenance respiration than growth respiration in HNT susceptible genotype, as evidenced by reduced grain filling rate and test weight. Tolerance in Nagina 22 can be attributed to ability to compensate nocturnal respiratory losses that resulted in higher percentage of filled grains with higher test weight in inferior spikelets of the panicle.

Conservation Agriculture as a Climate Resilient Agriculture Option in Wheat Production

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ABSTRACT

Wheat is the major food grain crop cultivated widely over 31.1 million hectares in India. Wheat in sequence to rice constitutes Rice-wheat system (RWS) that covers 13.5 M ha area in South Asia and is the backbone of food security of millions of people. However, challenges pertaining to sustainable wheat production under declining resource-use efficiency in the existing RWS have led to its diversification with a pigeon pea-wheat system (PWS) in the Indo Gangetic Plains of India. Growing wheat under conservation agriculture (CA) (i.e., by adopting minimum mechanical soil disturbance, permanent organic soil cover with crop residue or cover crops, and diversified crop rotations including a legume) offers a more sustainable system with higher resource use efficiency, carbon sequestration and adaptation led mitigation to climate change. Therefore, we studied a long-term (~12 years) conservation agriculture (CA)-based PWS. Treatments were conventional till flatbed (CT), ZT permanent narrow beds (PNBR & PNB), broad beds (PBBR & PBB), and flat beds (PFBR & PFB) with and without residue (R) retention and residue retention treatments have different N levels (75% and 100% of the recommended N). Results indicated that CA based systems conserved soil moisture that led to savings in total water use by 8.0-15.6%. Also, yield at either of N levels (75% and 100%N) was found non-significant, indicating the saving in N application without compromising yield besides mitigating the greenhouse gas (GHG) emission, particularly N₂O. Therefore, for wheat production under CA based PWS adoption of PBBR100N practice in initial years and 75%N in later years can be recommended considering better resource use-efficiency and mitigation of GHG emission.

Application of Artificial Intelligence in Agriculture: Towards a Sustainable Future

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ABSTRACT

Indian agriculture grapples with many challenges, *viz.* climate change, extreme weather vagariessuch as floods and droughts, lack of adequate groundwater resources, etc. At the same time, factors like expanding global population, urbanisation, increased disposable income, and changing consumption patterns require farmers to develop a strategy to increase productivity since they are under a lot of pressure to meet the escalating demand. Thirty years from now, the number of people to feed will be more. Additionally, since there is a limited supply of fertile soil, traditional farming methods will need to be modified. Thus, we need methods to lessen or at the very least control the risks faced by farmers. One of the most promising possibilities is the application of artificial intelligence in agriculture on a global scale, which can be defined as a branch of science dealing with developing intelligent machines which think and behave like humans. The use of modern technologies, like artificial intelligence and machine learning, offers various advantages like yield prediction, risk management, food safety and spoilage prevention, operation/equipment management, analysing market demand etc., thereby facilitating to achieve higher productivity by engaging very limited people in farm-related activities, which can transform agriculture, ultimately transforming the Indian economy. Different models employed under these technologies, which include Artificial Neural Networks, Deep Learning, Decision Trees, Support Vector Machines, Dimensionality Reduction, etc., can also strengthen the decision-making capacity of various stakeholders, resulting in efficient farm management. Despite the advantages provided by these technologies, India, is still long, long way from reaching that stage because of lengthy technology adoption process, lack of experience with emerging technologies, and also, most of the data collected from Indian agriculture is highly unstructured and difficult to analyse to find patterns. Thus, it is imperative to understand how applying AI can solve farming problems, and challenges faced by farmers in adopting AI, which will help in encouraging the farming community to accelerate the adoption of new technologies, thereby creating a more sustainable and inclusive agricultural ecosystem.

Keywords: Artificial intelligence, Farming community, Machine learning, Sustainable agriculture.

Scope of Autonomous Tractors in revolutionizing agricultural operations

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ABSTRACT

The concept of autonomous tractors involves the use of advanced technology to automate agricultural operations. This paper discusses the potential scope of autonomous tractors in revolutionizing agricultural operations. Autonomous tractors use GPS, sensors, and machine learning algorithms to carry out a range of tasks, including plowing, planting, and harvesting. The benefits of adopting this technology include reduced labor costs,

increased efficiency, and 24/7 operation, leading to higher overall yields. However, challenges associated with autonomous tractors include high initial investment costs, the need for infrastructure upgrades, and potential job displacement. Despite these challenges, the scope of autonomous tractors in agriculture is vast. Autonomous tractors are already being used in various parts of the world, and their adoption is expected to increase in the coming years. This technology has the potential to revolutionize the way farmers carry out their operations, making them more efficient and cost-effective. Additionally, autonomous tractors can improve the accuracy and precision of operations, leading to better crop yields and higher-quality produce. However, farmers need to carefully weigh the benefits and challenges associated with this technology before making a decision to adopt it. Overall, the scope of autonomous tractors in agriculture is significant, and their adoption is expected to transform the agricultural sector in the coming years.

Nutraceuticals in vegetables to combat COVID 19

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ABSTRACT

Despite substantial improvement in health and well-being since the country's independence in 1947, malnutrition remains a silent emergency in India. India still has one of the worst rates of child malnutrition in the world, despite decades of investment to address this problem. Vegetables are the rich source of carbohydrates, proteins, vitamins and minerals, hence known as protective foods. Vegetables are the essential part of balanced diet since they are good source of phytonutrients and nutraceuticals which can serve as the cheapest sources to combat COVID-19 and human malnutrition and are the means of assuring nutritional security in India. Coloured vegetables produce certain biologically active plant substances to protect themselves against stress and they are also beneficial for human health. Nutraceuticals have been advertised under the claim of being safe, effective and being a drug substitute. Additionally, it has been claimed that these products can be used in preventing and treating many health problems without any side effects. Approximately 80% of global population preferred using dietary supplements and nutraceuticals. Nearly 2/3rd of world population (6.1 billion) believe in healing power of plant based material (NATIONAL GEOGRAPHIC MAGAZINE, 10 JULY 2020). Nutraceuticals have come to light as potential treatments for COVID-19 problems. Loss of appetite during COVID is due to the leptin hormone and garlic is known to recover the appetite by decreasing the leptin concentrations in the body. Curcumin could be a beneficial nutraceutical supplement to combat inflammatory diseases due to "cytokine storm" during a COVID-19 infection. COVID-19 infection also poses a high risk of patients being malnourished. As powder curcumin form has very low bioavailability, researchers/pharmaceutical industries are designing various highly bioavailable forms of curcumin to increase cellular uptake and efficacy. There is a need to emphasize on nutritional security through vegetable due to their easily affordable, available, safe nature and because of traditional cures. Therefore, awareness among the people for the beneficial effect of nutraceuticals in day to day life is needed. Vegetables are commonly used by us can serve as important prophylactic and therapeutic role ingredient of food in our day to day life.

An Ecosystem - Based Approach to Climate Resilient Agriculture

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ABSTRACT

Agriculture is more resilient when aligned with a specific agro-ecological zone by choosing crops that suit the climate, soil type, and rainfall conditions. An ecosystem-based approach to agriculture includes soil and water management, the use of eco-friendly pesticides and organic manure, the promotion of agro-biodiversity, agro-forestry, and reforestation, as well as multi-layer farming with locally adapted crops to climate variation. Several soil and water management interventions are also involved through resilience, like rainwater harvesting and its judicious utilization through farm ponds and community tanks in rainfed areas. Another water-saving intervention is direct-seeded rice. A modified system of rice intensification and alternate wetting and drying (AWD) of rice were implemented in a cluster approach and enhanced water productivity. Integrated watershed management has also played an essential role in intervention through resilience; its adaptation within a river basin perspective provides a framework for climate change adaptation through reduced runoff, increased groundwater recharge, improved productivity, and increased carbon sequestration. Secondly, extended cropping intensity and a change in cropping practices for vegetable cultivation with a micro-irrigation system Temporary check dams (*boribandhan*) should be constructed in high rainfall areas. The various research institutions of the Indian Council of Agricultural Research (ICAR), the Indian Meteorological Department (IMD), as well as numerous NGOs and innovative farmers are demonstrating a range of tested methodologies for improving agricultural productivity while adopting more environmentally friendly practices. Overall, we conclude that the success of land and water management interventions implemented has demonstrated the ability of such low-cost interventions to enhance resilience to climate change for sustainable agriculture in India.

Keywords: Ecosystem, Climate Resilient , Sustainable Agriculture, Agro-biodiversity ,Ecological zone, Rainfed Area

Carbon Neutral Agriculture: A Move towards Sustainability

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ABSTRACT

Carbon Neutral Agriculture is all about practicing a scientifically proven methodology that arrests carbon emissions without affecting agricultural output. Proper farm management techniques can result in healthy crop yields, without endangering the planet (FAO,2019). It is concerned with achieving net zero emissions for the sustainability of the agriculture sector in specific and the economy as a whole. In the era of climate change where all major discussions revolve around the issue of climate change and sustainable agriculture carbon neutral agriculture, also referred to as carbon farming holds the key. Carbon farming does not advocate new methods or systems of farming but instead relies on changes within the existing system to achieve net zero emissions, also called carbon neutrality. It advocates carbon footprinting of sectors and enterprises to develop mitigation measures and promote carbon sequestration through the adoption of different

agronomic and technological measures. India is committed to reducing GHG emissions as a part of the 2030 agenda for sustainable development. This calls for reducing carbon footprints across all sectors of the economy. While there has always been a great focus on reducing emissions from industrial production, the emissions from agricultural sectors are often ignored for various political and social reasons. It is high time that a sound and effective strategy for countering carbon emissions from agriculture sector is developed and implemented. Incentivizing farmers through monetary support and carbon credits can prove to be an effective measure to address this issue.

Keywords: Carbon farming, Carbon footprinting, Carbon sequestration, Sustainable development goals (SDGs), Green Economy

Natural Farming for Sustainable Agriculture

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ABSTRACT

Natural farming is an agricultural approach that emphasizes sustainable and eco-friendly practices to cultivate crops and raise livestock. Natural farming is an ecological farming approach established by Masanobu Fukuoka (1913–2008), a Japanese farmer and philosopher, introduced in his 1975 book. It promotes a harmonious relationship between nature and agriculture, aiming to preserve and enhance the health of the soil, water, and ecosystems while producing nutritious food for human consumption. The foundation of natural farming lies in the understanding that healthy soil is crucial for robust plant growth and overall ecosystem health. By avoiding synthetic chemical inputs such as pesticides, herbicides, and fertilizers, natural farmers maintain the natural balance of soil microorganisms and promote biodiversity. Instead, they employ techniques such as composting, mulching, and crop rotation to nourish the soil, enhance its structure, and retain moisture. It also prioritizes the use of organic materials readily available on the farm. This approach reduces environmental pollution, conserves energy, and supports self-sufficiency within the farming system. In addition to soil health, natural farming places great importance on the holistic management of pests and diseases. Rather than resorting to chemical interventions, farmers focus on preventing pest and disease outbreaks through techniques such as intercropping, companion planting, and natural predators. By creating diverse and resilient ecosystems, natural farmers can maintain a balance between pests and beneficial organisms, minimizing the need for harmful chemical treatments. Natural farming systems also integrate traditional knowledge and local practices, taking into account the unique characteristics of the land and climate. The benefits of natural farming extend beyond environmental sustainability. It promotes food security by enhancing the resilience of agricultural systems to climate change, pests, and diseases. Natural farming methods also result in higher-quality produce, with improved nutritional content and flavor. Moreover, by avoiding the use of synthetic chemicals, natural farming safeguards the health of farmers, consumers, and ecosystems. In conclusion, natural farming offers a holistic and sustainable approach to agriculture, prioritizing the health of the soil, biodiversity, and ecosystem integrity. By embracing organic practices, optimizing resource utilization, and minimizing chemical inputs, natural farming contributes to a more resilient and environmentally friendly food production system. As the global demand for sustainable and nutritious food continues to grow, the principles and techniques of natural farming hold great promise in shaping the future of agriculture.

Implementation of Artificial Intelligence in Agriculture for Sustainable Agriculture

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ABSTRACT

Agriculture has a massive impact on the economy of a country. The high stress on the agricultural sector has increased day by day due to the population increment accompanied by the high demand for food which threatens food safety. The next generation is very keen on agriculture and is looking forward to high yield productivity by using the latest technologies. Artificial intelligence tops the list as it creates an eco-system that is favourable to all stakeholders involved. The sector of artificial intelligence with its rigorous getting-to-know capabilities has emerged as a key approach for fixing unique agriculture related problems. The utility of artificial intelligence has been extensively taken into consideration as one of the maximum possible solutions to cope with food inadequacy and to evolve to the need of a growing population. This overview gives an outline of AI's application in agronomic areas and progress in research labs. Technology should produce a framework that helps the farmers in every aspect of cultivation, starting from land preparation to selecting seeds to fertilize. AI has been seen to solve agricultural problems like crop disease, pest infestation, improper soil treatment, the need for irrigation, weed control, inadequate drainage and irrigation and so on. Hence, Artificial intelligence and its allied fields are tuned to 'agro computer' in tomorrow's world for sustainable agriculture.

Keywords: Artificial intelligence, Food security, Growing population, Sustainable agriculture

Renewable energy for sustainable agriculture in India

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ABSTRACT

Human food is only produced via agriculture. The majority of farm equipment is powered by fossil fuels, which increase greenhouse gas emissions and hasten climate change. The development of renewable resources like solar, wind, biomass, tidal, geo-thermal, small-scale hydro, biofuels, and wave-generated power can reduce such environmental harm. The agricultural sector has a lot of promise with these renewable resources. Subsidies should be used to encourage farmers to use renewable energy sources. The idea of sustainable agriculture revolves around striking a delicate balance between increasing agricultural output and preserving economic stability, while minimising the use of limited natural resources and unfavourable environmental effects. Sustainable agriculture also depends on replenishing the soil while minimising the use of non-renewable resources like mineral ores, such as phosphate, or fossil fuel used in diesel generators for water pumping for irrigation. These resources include natural gas, which is used to convert

atmospheric nitrogen into synthetic fertiliser. In order to support sustainable agriculture, it is necessary to promote the use of renewable energy systems, such as solar hot water heaters, greenhouse technologies, solar dryers for post-harvest processing, and solar photovoltaic water pumps and electricity. An environmentally friendly alternative to a diesel generator set in isolated agricultural areas is an underground submersible solar photovoltaic water pump. In order to maintain the ideal plant ambient temperature conditions for the growth of plants and vegetables, renewable energy technology such as greenhouses are required when there are unfavourable climatic circumstances for the growth of specific plants in cold climate zones. In order to reduce CO₂ emissions at the lowest possible cost, clean development gives industrialised countries an incentive to fund emission reduction initiatives in developing nations.

Keyword: Green energy, agriculture, renewable, Sustainable agriculture, solar

Artificial Intelligence in Agriculture

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ABSTRACT

Artificial Intelligence Principle :-Human intelligence is define in such a way , which is machine can mimic and perform the task in simpler form.How AI can be beneficial in case of agriculture [challenges and solution through AI Challenges faced by farmers in farming ,Increasing Deforestation, Increasing pollution, Climate change-climate factor like-rainfall, temperature, humidity Solution through Artificial intelligence ,WEATHER FORECASTING -this provide the idea about which type of crop and where a crop can be grown in a particular area Analysis of crop health by drones :- Drones capture data – transfer into computer through UBS drive – Analyzed by expert ,Monitoring system for crop and field :- Machine can detect the crop specific fertilizer dose according to area specificity, Precision farming :- Controlled farming by providing proper guidance to farmer about water management ,crop rotation timely harvesting ,Agriculture Robotics :- robots are trained to perform farming activities eg;- control weeds and harvesting of crop.

Climate Resilient Agriculture for Ensuring Food Security

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ABSTRACT

Agriculture as an arena is amalgamated with wider range of biotic and abiotic components, which affects its functioning and dynamics to a greater extent. Climate is one such integral component that plays a major role in its sustainability and clock dominated functioning. With the upsurge of global warming, the situation has created a question mark in front of the agriculture scientists about how to adjust and mitigate with the changing climatic parameters and develop some strategies that should support sustainability and also maintains the productivity of agricultural produce. Hence the concept of 'climate resilient agriculture' came into light. Climate Resilient Agriculture for Ensuring Food Security comprehensively deals with important aspects of climate resilient agriculture for food security using adaptation and mitigation measures. Climatic changes and increasing climatic variability are likely to aggravate the problem of future food security by exerting pressure on agriculture.To cope with climate change, farmers need to

modify production and farm management practices, such as adjusting planting time, supplementing irrigation (when possible), intercropping, adopting conservation agriculture, accessing short- and long-term crop and seed storage infrastructure, and changing crops or planting more climate-resilient crop varieties. Prioritizing the reduction of greenhouse gas emissions from both agricultural and non-agricultural sources is necessary, and systematic training is needed to instill trust in stakeholders and make them aware of the effects of climate change. To improve skills in agriculture and related industries, it is also necessary to develop flagship farmer-oriented activities. Farmers, research institutions, funding organizations, governments, non-governmental organizations, and the private sector can work together to promote CRA.

Keywords: Climatic change, Climate Resilient Agriculture, Food Security, Greenhouse gas emissions, Sustainability.

Estimation of Moisture Content of Freshly Harvested Groundnut Pods by Hot Air Oven Drying Followed by Microwave Heating

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ABSTRACT

Despite the multiple research efforts being made to improvise the food processing sector and endeavours in meeting the food requirements as well as demands of the people, there remains a huge untapped area for research to be focused upon. This research work focuses on the comparative practices that can be adopted for improvements in increasing energy efficiency and shortening of time period for effectively carrying out the moisture reduction operations in peanut (*Arachis hypogea*) also known as 'groundnut', a legume crop grown mainly for edible seeds. In India, groundnut is considered as "the king of oilseeds", also called "Poor man's almond". In India, it is available throughout the year, because of two crop cycles, harvested in March and October. A source of all the nutrients, particularly with protein content of 24-30%, it is also a low-priced commodity. Being an oilseed crop it contains 40 to 53% oil. Its protein rich residues (de-oiled cake) are used as animal feed. It is a primary ingredient of many finished products such as peanut butter, confections, nutritional bars, and is used in numerous dishes as well. A microwave treatment followed by hot air oven treatment (HAOT) of sample of freshly harvested peanut pods was conducted at different time periods of microwave heating (MWH). With a comparative study of the drying kinetics, subsequent changes in moisture content, nutritional change and quality characteristics of the testing sample, it was observed that a pre treatment with microwaves improves the energy efficiency by 60 % and saves much process time for obtaining the similar results of lower safe moisture content. Results and methodology when applied at industrial level bear the potential to highly improvise the energy demands of the processing flows in a much bigger ways.

Assessment and Prediction of Chill Units Using Different Chilling Models in Kiwifruit Cultivars under Changing Climatic Scenario

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ABSTRACT

Kiwifruit is the only crop that has garnered traction in recent years due to the changing climate. In temperate perennial fruit crops, the winter cold period is essential for regulating crop cycle events such as the timing of bud break, and insufficient chilling units can drastically reduce yield potential. To evaluate future cultivation options for kiwifruit cultivars in India, we estimated winter chill using multiple models, including the Chill hour model, the Utah model, the Positive Utah model, and the Dynamic model, for two commercial kiwifruit cultivars, Hayward and Allison. At lower elevations, the maximum average temperature was recorded. However, superior accumulations of chilling units were observed at higher elevations, such as Phagli, which provided sufficient chilling units for cultivar Hayward. The Positive Utah model was determined to be the most appropriate chill prediction model among those available. The experimental year 2019–20 was colder than 2020–21, resulting in a greater accumulation of chill units during 2019–20. The Hayward cultivar is more suited to high altitudes than lower elevations, whereas the Allison cultivar is better suited to lower elevations.

Keywords: *Actinidia deliciosa* (A. Chev), Bud initiation, Chilling Model, Allison and Hayward

Growth Regulators in Enhancing the Productivity of Vegetables

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ABSTRACT

Application of growth regulators is an old way yet most effective to increase the production of vegetable crops. It's the easiest and most convenient method to supply nutrients directly to plant and help them to grow. Agriculture makes a vast improvement in mechanisation and science. Plant growth regulators are the synthetic chemical which make an immediate impact on vegetables growth and make them harvestable on a large count. There are mainly five types of growth regulators and they are very specific in their action. They are less time consuming and more beneficial to farmers. Various physiological processes and development in plants are regulated by the activity of these regulators and some naturally occurring inhibitors. Growth regulators are also environmental safe.

Keywords: regulators, process, environment

Food Processing Waste and Byproducts as a Source of Nutraceuticals

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ABSTRACT

Food processing waste is a significant concern in the food industry, as it generates large amounts of byproducts that can cause environmental and health risks if not properly managed. Almost 30-40 per cent of fruits and vegetables and 10 per cent of the total agricultural produce goes waste annually in India. Up to 42 per cent of food waste is produced by household activities, 39 per cent losses occur in the food manufacturing industries and 14 per cent in food service sector, while 5 per cent is lost during distribution. The huge wastage of the food materials is due to lack of control on agri-economy practices. The utilization of waste for the production of value-added products is very important in the management of food processing waste. Different types of wastes are fermentation industry waste, fruit and vegetable industry waste, dairy industry waste, palm oil industry waste, fish and meat processing industry waste. Nutraceuticals are medicinal foods that play a role in enhancing health, maintaining well being, improving immunity and preventing as well as treating specific diseases. Numerous researchers have worked on the waste products which can be a potential source of nutraceuticals and bioactive compounds. Fruit and vegetable processing waste contains high levels of phenolic compounds such as flavonoids, anthocyanins, and tannins. These compounds have antioxidant, anti-inflammatory, and anti-carcinogenic properties and thus have potential as functional food ingredients. The byproducts generated from dairy processing, such as whey and casein are rich in bioactive peptides, which have various health benefits, including blood pressure regulation, cholesterol reduction, and immune system modulation. Seafood processing waste is also a potential source of nutraceuticals, particularly omega-3 fatty acids which have numerous health benefits, including reducing the risk of heart disease, inflammation, and cognitive decline. The use of food processing waste as a source of nutraceuticals not only provides a solution for managing waste but also offers economic benefits to the food industry by creating new value-added products. Food processing waste can serve as a valuable source of nutraceuticals, offering both health and economic benefits. While there are challenges to overcome, advancements in extraction and purification methods, as well as regulatory frameworks, which can enable the development of new nutraceutical products from food processing waste, promoting a sustainable and circular food system.

Food Printing: From Pixels to Plate

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ABSTRACT

The growing consumer interest in specific food composition, food structure, and food properties in general has resulted in the emerging trend of personalized foods and personalized nutrition. 3D printing gives the opportunity to fabricate 3D food structures using layer-by-layer deposition of the food material. 3D food printing technology has been used to develop foods with different shapes or textures and further different food materials can be printed in different layers for creating functional foods with a complete nutritional balance. The food materials such as sugar, chocolate, and cheese are used to create designed shape based on layer-by-layer. Currently there are four types of 3D

printing techniques viz., extrusion, inkjet, binder jetting and selective sintering. These techniques permits to create personalized food product based with specific properties related to nutritional needs, calorie intake, specific shape, texture, colour and flavour. Moreover, 3D food printing has a great potential to reduce food waste by making use of discarded food parts such as meat scraps, damaged fruits and vegetables. Three types of printing materials i.e., natively printable materials, non-printable traditional food materials, and alternative ingredients have been used for customized food fabrication. However, there are some obstacles regarding the printing accuracy, layer-by-layer printing speed and surface finishes. To overcome this challenge, four-dimensional (4D) printing which defined as fabricating a complex spontaneous structure that changes with time respond in an intended manner to external stimuli such as pH, humidity and temperature. Although 4D printing is mainly based on 3D printing and become an branch of additive manufacturing, the fabricated objects are no longer static and can be transformed into complex structures by changing the size, shape, property and functionality under external stimuli, which makes 3D printing alive. The existence of smart materials promotes the application of 4D printing technology in various fields like biomedicine, automobile, soft robot, food and aerospace. Food printers, though advantageous, are still an emerging technology that must overcome several challenges, including cost, speed, and ease-of-use. However, Food printers are getting better every year, and the price is falling owing to the increasing adoption and technological developments. The future of food printing is bright, as there is no limit to the scope and the future of the food printing industry.

Development of Flavoured Soymilk from *Harit* Soya and Its Waste Utilization

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ABSTRACT

Soybean (*Glycine max* (L.) Merrill), an important oilseed crop belongs to family *Leguminosae* and sub family *papilionaceae*. It is a legume and also called as golden bean or miracle crop. It is highly nutritious legume seed. It comprises of 7.46-8.40 per cent moisture, 35.70-45.30 per cent protein, 18.20-25.40 per cent oil, 4.84-5.59 per cent ash, 13.91-35 per cent carbohydrates of which 17 per cent is the dietary fiber, vitamins and minerals. A number of nutraceutical compounds such as isoflavones, tocopherol, lecithin, bioactive peptides and phenolic compounds such as chlorogenic acid, caffeic acid, ferulic acid and p-coumaric acid present in soybean seeds possess numerous health benefits. The availability of these components in soybean have been claimed to act as anticancer, cholesterol lowering, antioxidant and chelating agent and also play an important role in prevention of bone loss in menopausal women and type 2 diabetes mellitus. Utilization of soybeans is generally considered to be one of the most promising means of alleviating the shortage of good quality protein in developing countries. The high interest of the nutritional value in soybean has encouraged consumers to develop specialized foods by combining functional ingredients to existing standard food products. Advancement in technology has modified the soybean consumption and commercialized it as the primary ingredient in many dairy product substitutes like soy milk, soy-based infant formula, margarine, soy ice cream, soy yogurt, soy cheese and soy cream cheese, meat alternatives, etc. Recently, the utilization of by-products from the food industry has been increasing tremendously. Soya residue (okara) is a by-product produced during the production of soymilk. Nearly 1/3 of the isoflavones found in soybeans are retained in

okara protein, indicating that okara protein is of extremely high quality by-product used in food material and thus a good, low-cost source of nutrients for human nutrition. Therefore, okara can act as a potential source for the development of various functional foods.

Pseudocereals and Red Kidney Bean-Based Gluten Free Bakery Products

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ABSTRACT

Pseudocereals are defined as seeds or fruits of non-grass species that are consumed in a same manner as that of traditional cereals and are successful supplements to these cereals. The well-known pseudocereals are amaranth (*Amaranthus caudatus*), quinoa (*Chenopodium quinoa*) and buckwheat (*Fagopyrum esculentum*). The grains of these pseudocereals are rich in different compounds like flavonoids, phenolic acids, trace elements, fatty acids and vitamins with known consequences for human wellbeing like counteraction and decrease of numerous degenerative illnesses like malignancy, cardiovascular disease, hypertension and diabetes. Pseudocereals are underutilized crops, they are gluten free, profoundly proteinaceous and contains wide range of essential nutrients, saponins which are having numerous agro-pharmacological and modern applications. On the other hand, the dried beans have added health benefits related with plant-based diets. Red kidney beans (*Phaseolus vulgaris*) are predominantly grown in the higher slopes of Himachal Pradesh. These beans are rich in dietary fibre, starch, nutrients, minerals, phytochemicals and have a protein content which is 2-3 times more than that of cereal grains, making them nutritionally essential. It contains moisture (12%), protein (22.9%), fat (1.3%) and 3.2% minerals. They being a healthy source of dietary fibre helps to reduce cholesterol levels. The red kidney bean comprises of a lot of polyphenols incorporating tannins, anthocyanins and flavonols which are considered to have significant antioxidant, antimutagenic and antigenotoxic effect. Gluten-free bakery items currently available in the market delivers lower protein, fibre and mineral content, as well as a higher glycaemic index than gluten-containing items. As a result, the production of gluten-free bakery items that are high in protein, fibre and minerals are of major concern, therefore pseudocereals and bean-based flours offers a great potential to enhance the nutritional and sensory properties of gluten-free bakery items.

Sustainable Agriculture for A Self reliant India

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ABSTRACT

Sustainable agriculture focuses on environmental health, economic viability, and social equity. In different terms, sustainable agriculture lies on the principle of fulfill the need of present without compromising the needs of future generations. It incorporate all the agricultural practices which are safe to the soil and ecosystem like Mixed farming, organic farming, crop rotation, permaculture etc. Since 2014-15 India has had a National mission for sustainable agriculture (NMSA) to making the agriculture more productive, climate resilient, composite farming systems. Rather than NMSA, the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) promote adoption of micro-irrigation. Increased nutrient status of soil, ecological balance, economic sustainability are some of the impacts of sustainable

agriculture. Sustainable agriculture would have a great potential to increase the India's nutritional security and climate stability.

Key words – Sustainable agriculture, Environment, Ecological balance, Ecosystem, Nutritional security, Climate, Micro irrigation, Economy, Adoption.

Smart Urban Farming: Potential and Prospects

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ABSTRACT

Smart urban farming refers to the practice of growing plants such as herbs, vegetables and fruits in urban areas, which may include kitchen gardens, backyard farming, or terrace farming. Smart urban farming gained popularity in post covid era as it allowed growers to grow safe and high-value nutrient-rich crops, around the year for self consumption as well as for sale in nearby areas. Smart urban farming has several advantages due to which it has been called as the future of farming. It allows the cultivator to grow off-season crops using protected technologies, makes better use of costly inputs such as seeds, fertilizers, and water, leads to a healthy and environment-friendly atmosphere, and serves the aesthetic purpose. Sustainable management of urban farms using artificial intelligence (AI) and the internet of things (IoT) not just helps in obtaining safe and chemical-free production of high-value crops and reducing the overall cost of inputs but also enables the grower to keep better control of quality and quantity of produce. Moreover, smart urban farming also helps in making cities green and clean. Rooftop farms and gardens dispel the heat and cool the buildings, plant and food waste can be used to make composts and bottles and containers can be recycled for making pots and planters thereby reducing municipal waste. Policy support and technological incentives to the growers would go a long way in increasing the adoption of smart urban farming, which holds the key to achieving a green environment and good health.

Keywords: Green environment, IoT, Sustainable agriculture, Terrace farming, Urban farming

Impact of Covid-19 Pandemic on Rural Livelihood and Goat Rearing as Alternatives

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ABSTRACT

India ranked first in total livestock production as per livestock production statistics of india-2022. Subsequently ranked second in goat population as it is having significant role in meat (111.32 million Number of Animals Slaughtered for Meat Production in 2021-22) and milk production (0.47 kg/day) which increase agricultural economy and GDP. By this data estimation can be done for importance of goat population. The poor man's cow has always worked as a cash crop to the poor farmers of rural India. It helped those who lost their jobs and immigrated back to their villages during Covid-19 pandemic. Study was carried on 600 respondents divided in 2 phases were given goat units in year 2020 and 2021. A cross-sectional study was conducted on 12 states and 200 districts in India from 3 to 15 May 2020 which include 1437 farmers completed the survey. About 11% of growers failed to harvest in the previous month due to unfavourable weather (37%) and

lockdown-related factors (24%). 63% of farmers harvested their crops in the previous month, but just 44% had sold them and 39% had stored them, with more than half (55%) citing lockdown-related problems as their rationale. 79 % of households with wage-workers witnessed a decline in wages in the past month and 49% of households with incomes from livestock witnessed a decline. Department of animal husbandry and dairying under a scheme for establishment of sheep and goat breeding unit with minimum 500 females and 25 males, (under National Livestock Mission) gave 50% subsidy up to the subsidy limit of Rs. 50 lakhs directly to the beneficiary account through SIDBI in two equal installments. After one year of distribution observed that maximum was continuing goat farming. Areas like hilly region of Uttarakhand have quite high number of migratory populations which leave for better avenues. Such programmes are needed to help people continue with agriculture and allied activities. Ultimately, we discovered that the COVID-19 shutdown in India mostly affected farmers ability to market their livestock and found goat rearing as alternate.

Keywords: Covid-19, India, Livelihood improvement, Mitigation

Use of Domestic Oven Toaster Griller for Cashew and Almond Roasting

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ABSTRACT

The domestic Oven-Toaster-Griller (OTG) is commonly used for pizza, cake baking and grilling chicken. This OTG is used for the roasting the cashew nut, almonds or similar nuts. For this, an innovative attachment of the stainless steel perforated drum that can be used with the domestic OTG is designed and fabricated (Patent filed: No. 201921041121). The innovative drum can be mounted on the square rod of the commercially available OTG. Two lids are provided to the drum. One of them is fixed while the other is removable with twist open/lock arrangement. The lids are provided with square hole so that it can accommodate and fixed with the square rod of the OTG. The drum is provided with four baffles along its length distributed equally throughout its circumference for mixing and shuffling of nuts in drum while it is rotating. The innovative attachment can make it able to use the commercial OTG for the roasting of cashew nuts, almonds or similar nuts. The drum adds to the existing functionality of the OTG. The procedure for the salting and roasting of the cashew nuts and the almonds to prepare salty crispy cashew nuts or almonds respectively is also standardized. The developed roaster is a portable, low cost and compact unit that can be used in the processing industry and for the domestic purpose. It can add to the income of small cashew nut or almond processing industries as well as it gives an opportunity to prepare roasted cashew nuts or almonds at domestic level. The OTG with innovative attachment can be a better option for the agro-tourism centres to serve hot crispy and salty roasted nut to the tourists. It can add to the income source to the local public involved in the similar business. The developed unit has a capacity of 10 kg per day in about 14 batches of 45 min each. Considering the expenses on labour and electricity, the net income to the owner is around Rs 300 per day.

Seeds for Natural Farming: Lack of Seeds and Varieties Suited to Natural Farming

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ABSTRACT

The scarcity of seeds and varieties appropriate for natural farming is a long-standing issue. Traditional breeding methods do not meet the needs of natural farming. In natural farming, indigenous or locally adapted seeds are often recommended. These seeds are well-suited to the local environment and are often more resilient and better adapted to local growing conditions than imported or hybrid seeds. Natural farming also emphasizes the use of open-pollinated and heirloom varieties, which have been saved and selected by farmers over generations for their desirable traits, such as flavour, nutrition, and disease resistance. These seeds are often more diverse and genetically stable than hybrid varieties, which can be prone to genetic instability and may require synthetic inputs such as fertilizers and pesticides to grow successfully. In addition to using locally adapted and open-pollinated seeds, natural farming emphasizes the use of sustainable farming practices, such as soil conservation, composting, crop rotation, and intercropping, to promote soil health and biodiversity, reduce the use of synthetic inputs, and improve crop yields and quality. The use of chemically treated seeds is generally not allowed in natural farming, even if organic seeds are not available. If organic seeds are not available, organic farmers may use untreated conventional seeds, provided that the seeds have not been genetically modified or treated with synthetic pesticides or fertilizers. However, the use of untreated conventional seeds is only allowed as a last resort, and farmers are expected to make every effort to source organic seeds whenever possible.

Sensor Based Vertical Farming System Using the Internet of Things (IoT)

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ABSTRACT

The growth of world population and tremendous urbanization initiatives has posed an important challenge to sustainable agriculture. To efficiently utilize the land to yield maximum produce, IoT based Vertical farming monitoring systems are an absolute necessity today. Vertical farming had become a hot topic among peak development countries. However, vertical farming is hard to practice because minor changes on the surrounding would leave big impact to the productivity and quality of farming activity. Thus, the aim of this project is to provide a vertical farming monitoring system to help keeping track on the physical conditions of crops. In this system, varieties of sensors will be used to detect current physical conditions, and send the data to microcontroller either in analog or digital input. Then, the data will be processed by microcontroller and upload to the Thing speak Cloud. Furthermore, the system will record the position of equipment in used, which make it easier for maintenance when there is equipment broken down. The system also provides basic remote function where users could turn on/off the watering system, and the LED light via web-based application. The web-based application will also be designed to analyze and display data gathered in the form of graphs, charts or figures, for better understanding. With the improvement implemented on the vertical farming, In this chapter, an overview of such vertical farming systems is presented along with

important research challenges, architectures and case studies. Open research problems in this field are also discussed to motivate researchers in this field.

Keywords: Sensors, vertical farming, Thing speak Cloud and LED

Shree Anna: A holistic approach for nutrition security

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ABSTRACT

Shree Anna is a comprehensive nutrition program designed to promote holistic health and wellbeing. It focuses on providing individuals with a balanced and nutritious diet that supports physical, mental, and emotional health. This abstract outlines the key features of the Shree Anna program and the benefits it offers to individuals who follow it. The program emphasizes the use of whole, natural foods, and incorporates a range of foods from all food groups to ensure adequate nutrient intake. It also emphasizes the importance of mindful eating and encourages individuals to tune into their hunger and fullness cues. The Shree Anna program has been shown to promote weight loss, improve blood sugar control, and reduce the risk of chronic diseases such as heart disease and diabetes. In addition to its physical benefits, the program also focuses on mental and emotional wellbeing, incorporating meditation and other mindfulness practices into its approach. Overall, the Shree Anna program offers a comprehensive and holistic approach to nutrition that can support individuals in achieving optimal health and wellbeing.

Battery-Operated Pigeon Pea Stem Cutter for Marginal and Small Farmers

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ABSTRACT

In India, the pigeon pea (*Cajanus cajan* L. Millsp.) is the second most significant pulse crop, after chickpea. Harvesting with an engine-powered self-propelled reaper results in a lot of vibration and noise, which can be harmful to the operator. Additionally, fragmented land holdings make it difficult for a large combine harvester to operate effectively as possible which makes it the least economically viable option. In light of the foregoing, a study was planned to develop a battery-powered pigeon pea stem cutter that would cut the stem using a rotating circular blade connected to a motor and driven by 24-volt lithium-ion batteries. Performance evaluation and testing of the developed pigeon pea stem cutter was performed at Sagdividi research station, Junagadh Agricultural University, Junagadh, in March 2022. The performance of the machine was evaluated based on field capacity, field efficiency, cutting efficiency, uncut and damage percentage, with two different levels of forward speeds and three types of cutting blade. The field data were analysed using analysis of variance (ANOVA) for the Factorial-complete randomized design (FCRD) with three replications. After evaluation, 0.131 ha/h, 85.85%, 86.09%, and 13.90%, respectively, were the effective field capacity, field efficiency, cutting efficiency, and uncut percentage. The operational time of the developed cutter was determined to be 18.20 man-hours per hectare, which was considerably less than the traditional manual harvesting of 78.12 man-h/ha. The overall cost of harvesting for the manual method was ₹3000 /ha while the total cost for the developed pigeon pea stem cutter was ₹993.79/ha.

When comparing the stem cutter harvesting method to manual pigeon pea harvesting, there was a 76.70% time reduction and a 66.87% cost reduction. In conclusion, the developed pigeon pea stem cutter was found to be a cost-effective and time-saving alternative to traditional manual harvesting methods, with the potential to improve the efficiency and productivity of pigeon pea cultivation in India.

Millets, pre and post green revolution: A tale of missing links

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ABSTRACT

The first crops to be domesticated were millets, which are many types of cereals in the Poaceae family include pearl millet, sorghum, as major millets and finger millet, barnyard millet, kodo, foxtail, proso, little millet etc. as minor millets. The oldest reference to millet is found in the Yajurveda, which names Priyangava (Foxtail millet), Aanava (Barnyard millet) and Shyaamaka (Black finger millet). Millets were consumed in Indus-Sarasvati civilization from 3,300 to 1,300 BCE proves that millet cultivation has been a long-standing and traditional agricultural practice in India since 1200 BCE. Millets are referred to as 'poor people's crops; in Asia and Africa mostly poor or tribal people traditionally cultivating and consuming these super foods since 7000 years ago. Millets are the ideal food because they are a rich source of protein and carbohydrates and allow for a gluten-free diet. Additionally, it contains vitamin B3, which lowers oxidative stress and prevents type 2 diabetes and heart disease. Millets' alkaline composition helps to keep the body's pH balanced. The United States started producing more wheat in the 1940s, and by the 1950s, using Public Law 480, began to supply wheat to India under the concept of 'Green Revolution'; that was an attempt to take over our food system. In order to become self-sufficient in agriculture, India imported 18000 tonnes of high yielding variety (HYV) wheat seeds in the 1960s; this completely damaged the country's food and nutrient systems by lessening the contribution of millets below 20% of grains. Millets can withstand adverse environmental conditions; hence millets cultivation seems to address unpredictable weather conditions and declining groundwater levels. In comparison to rice and wheat, millets are the best and healthiest options for the expanding population because they are simple to grow in a shorter crop time.

Keywords: Millets; history; public law 480 of United States; green revolution; political interventions; nutritional value; geographical distribution; periodical degradation; call of the hour

Trio-Dynamic Role of Entomocomposting with Black Soldier Fly (*Hermetia illucens* L.) towards Soild Waste Management, Food Security and Soil Sustainability Enhancement

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ABSTRACT

Advancement of science and technology has led us into a new era where there is a solution for everything. Nowadays, the application of fertilizers in the soil for the enhancement of growth and development of crops or plants is a common practice. In agricultural activities, organic fertilizers are used in many different ways. The process of composting is one of the most important ways to produce organic fertilizers. In addition to providing nutrients to the crops, the organically composted materials can also help improve soil quality and fertility. Entomocompost refers to the process by which organic waste is converted into a nutrient-rich soil amendment through the use of insects. The main focus of this chapter is to highlight the role of insects in the conversion of large amounts of food waste into a beneficial product. These beneficial products may be supplementary feed for the animals, industrialbased secondary compounds, and most importantly, organic matter and soil amendments that are rich in nutrients. Black soldier fly (*Hermetia illucens* L) larval rearing is an emerging technology that converts decomposing waste into stable, environmentally-friendly residues (similar to compost) and larval biomass. This insect's larvae are a critical component in the process of producing entomocompost. The larvae are produced in large quantities for the purpose of inoculating the organic part of municipal wastes, which will then be converted to organic compost. But the larvae of the Black Soldier Fly must be generated in large quantities scientifically in order to meet the demands of it for efficient utilization in organic compost. It is still necessary to popularize the benefits of the Black Soldier Fly among farmers. In this 21st century, when sustainable agriculture is being promoted all across the globe, the production of "Entomocompost" can be of great help. Key words: beneficial, composting, emerging, organic waste, supplementary, larva.

A Critical Discussion on Regenerative Model for Sustainable Livelihood and Balanced Ecology

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ABSTRACT

Ecosystems are maintained through a cyclical process; but, in the modern era, human actions for heedless industrial development—which include excessive exploitation of natural resources, deforestation, and adoption of artificial lifestyles—have shattered this natural cycle, leading to an imbalance of ecological limits. More than 80% of people's food and daily necessities were sourced from forests before the industrial revolution, and they relied on regional and seasonal crops. Currently, we have only chosen a method for

maintaining our way of life that is mostly located downstream of huge industrial operations; monoculturing brought about by industrialization caused the ecological system to collapse, but a deliberate change may help us move towards a sustainable way of life. The term "regeneration" itself refers to the process by which we define or recreate the planetary boundaries that allow us to exist in peace and safety. Biodiversity is restored as a result of regeneration, contrary to the limited large-scale industrial possibilities, regenerative livelihood provides certainty to all members of our social structure proportionately and in a way that is always sustainable. All of the fundamental necessities required by any human being are present in our immediate environment, either in usable form or in raw form, thanks to the land that surrounds us, in its fertile state, and in its potential to support and maintain the necessary biodiversity load. Our alterations to nature's existence and way of life are the primary forces behind a regenerative livelihood system that operates independently within an ecological limit.

Keywords: Regenerative model, habitat, phylogenetics, ecological components, sustainability

Sustainable Agriculture for a Self - reliant India

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ABSTRACT

India has a rich agricultural heritage, with the agriculture sector contributing significantly to the country's GDP and employing over half of the workforce. However, the sector is facing several challenges that threaten food security and self-reliance. Sustainable agriculture practices such as organic farming, conservation agriculture, and precision farming can address these challenges and ensure a sustainable future for India's agriculture sector. Organic farming involves the use of natural fertilizers and pest control methods, reducing the use of synthetic chemicals that harm the environment. Conservation agriculture involves the use of minimum tillage, crop rotation, and cover crops to improve soil health and reduce erosion. Precision farming involves the use of technology to optimize crop yields and reduce inputs such as water and fertilizers. The benefits of sustainable agriculture are numerous, including increased yields, improved soil health, reduced greenhouse gas emissions, water conservation, and biodiversity promotion. Government policies such as the Pradhan Mantri Fasal Bima Yojana (PMFBY) and the Soil Health Card Scheme promote sustainable agriculture practices. Private sector initiatives such as contract farming and farmer producer organizations (FPOs) also play a significant role in promoting sustainable agriculture practices. In conclusion, sustainable agriculture is crucial for ensuring food security and self-reliance in India's agriculture sector. It is essential to continue investing in sustainable agriculture practices to ensure a sustainable future for India's agriculture sector.

Value addition in Agriculture

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ABSTRACT

India is a country of farmers and farming. Indian farmers toil hard in fields to ensure our food and nutritional security but the income of our farmers is quite uncertain. Hence, the Government has made a strong commitment to double farmers' income by 2022. Value-addition of agro-produce is one such most effective methodology to enhance profitability and income of the farmers. The wide range of topography and climatic conditions make

India advantageous for producing a large variety of crops. The possibilities of processing some of these crops into value-added items are profuse, but the potential remains untapped mainly due to the limited technology base and awareness among farmers. We undertook a journey to explore the science and technology-based value-addition in various popular crops, such as orange, star fruit, soybean, tamarind and pineapple.

Significance of Value Addition in Agriculture

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ABSTRACT

The cornerstone of the Indian economy is agriculture. The agriculture industry has made value addition and crop diversity its mantra. In India, agriculture contributes 14% of the country's overall GDP and employs 65% of the people. Rural workers are now moving to non-agricultural jobs, which has tightened the labour market for agriculture and boosted pressure for higher farm salaries relative to rising production costs. The major issue confronting worldwide today is how to attain food security while taking long-term sustainability into account. Many agricultural products can be given added value to boost their quality, increase farmer income, reduce waste, and address sustainability-related concerns regarding food safety. Value addition in agriculture and green businesses is converting raw materials into more valuable things. For instance, grinding maize into flour and packaging it, drying herbs, pasteurising milk, drying and packaging items, smoking, marinating, and sun-drying seafood. Furniture, purses, and ornaments can all be created using crafts and trees. Various other products made from various raw materials are also possible, such as perfume made from flowers, and herbal medicines. A number of incentive programmes have also been implemented, along with the concepts of food parks, agri-export zones, cold chains, and human resource development. According to the Income Tax Act, new agro-processing businesses are created to prepare, preserve, and package fruits and vegetables. It is believed that the state plays a crucial contribution. Value addition prevents economic and post-harvest losses of food and environmentally friendly products. Without this, economies would collapse and people who depend only on agriculture for their subsistence would perish. The ensuing wealth can significantly raise income and standard of living. People who work in these industries and factories, such as industrial chemists, food processors, and factory labourers, have employment opportunities.

Keywords: India, agriculture, value addition, sustainability, economy

Standardization of skeletonizing techniques for *Ficus religiosa*

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ABSTRACT

The research endeavour entitled 'Standardization of skeletonising techniques for *Ficus religiosa*.' was conducted at Value Addition Laboratory, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari

Agricultural University, Navsari. Research was conducted in *Ficus religiosa* with seven treatments replicated thrice. The investigation was performed to study the effect of different skeletonising agents viz. water, sodium carbonate 10%, sodium carbonate 20%, sodium carbonate 30%, potassium hydroxide 10%, potassium hydroxide 20% and potassium hydroxide 30% by following separate completely randomized design (CRD) for each tree species. The result revealed that maximum skeletonising percentage (98.01%) with superior grade, minimum retention of green tissue (1.98%), highest intactness of secondary (92.29%) and tertiary veins (98.66%), better colour (4.80) and texture (4.87) with higher loss in fresh weight (92.90%) was recorded in leaves of *Ficus religiosa* when skeletonised using 20% sodium carbonate.

Increasing Nitrogen Use Efficiency

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ABSTRACT

The agricultural sector is one of the major contributors to global greenhouse gas (GHG) emissions, primarily through the use of synthetic fertilizers. Nitrogen (N) fertilizers, in particular, contribute significantly to GHG emissions through the production of nitrous oxide (N₂O). Additionally, the low nitrogen use efficiency (NUE) of conventional fertilizers also contributes to the problem. Zeolites are naturally occurring minerals that have a unique structure characterized by a three-dimensional framework of interconnected channels and cages. These pores can trap and store molecules such as nitrogen, which can then be slowly released to the plant roots over time. The controlled-release mechanism of zeolite-based nitrogen nanofertilizers ensures that nitrogen is available to the plant over an extended period, reducing the risk of nutrient leaching into the soil and groundwater. The high surface area and pore size of zeolites provide an optimal environment for the conversion of nitrate to ammonium, which is more readily available to plants than nitrate and which is less likely to be converted to N₂O. This results in increased plant growth and yield. The unique structure of zeolites enables the encapsulation of N within the pores, preventing leaching and providing a slow-release mechanism. Moreover, the use of zeolite-based nitrogen nanofertilizers has been shown to reduce GHG emissions by minimizing the production of N₂O. Overall; the use of zeolite-based nitrogen nanofertilizers represents a promising approach to reducing GHG emissions, improving NUE in agriculture, and reducing environmental impacts.

Natural Farming for Sustainable Agriculture

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ABSTRACT

Natural farming is a sustainable agriculture practice that relies on the use of natural inputs, such as compost, cow dung, and urine, instead of synthetic fertilizers and pesticides. It is based on the principles of ecological balance, conservation of biodiversity, and preservation of natural resources. Natural farming promotes a holistic

approach to agriculture, where the farmer works with nature, rather than against it, to produce high-quality crops while minimizing the impact on the environment. One of the main benefits of natural farming is that it helps to maintain soil health. By using natural inputs, such as compost and manure, natural farming can improve soil structure, enhance soil fertility, and promote the growth of beneficial microorganisms. This, in turn, can increase the yields of crops, reduce soil erosion, and improve water retention in the soil. Natural farming also promotes biodiversity by creating a diverse ecosystem that supports a wide range of plant and animal species. This can help to reduce the risk of pest and disease outbreaks, as well as promote the natural pollination of crops. Additionally, natural farming can reduce greenhouse gas emissions, as it avoids the use of synthetic fertilizers and pesticides that are energy-intensive to produce. Another important aspect of natural farming is that it promotes the use of local resources and traditional knowledge. By using local inputs and traditional knowledge, natural farming can promote self-reliance among farmers and reduce their dependence on external inputs. This can help to create a more sustainable and resilient agricultural system, especially in rural areas. In conclusion, natural farming is a sustainable agriculture practice that can help to improve soil health, promote biodiversity, and reduce greenhouse gas emissions. By promoting a holistic approach to agriculture and using local resources and traditional knowledge, natural farming can contribute to a more self-reliant and sustainable agricultural system in India.

Zero Energy Cool Chamber: On Farm Eco-Friendly Storage Unit

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ABSTRACT

Fruits and vegetables are highly perishable in nature and storage of them is one of the most pressing problems. Post harvest losses in fruits and vegetables are very high (20-40%). About 10-15% fresh fruits and vegetables shrivel, stale lowering their market value and consumer acceptability. Moreover, they are living entities and carry out the vital activities such as respiration, transpiration and ripening even after harvest. The spoilage of fruits and vegetables can be controlled by reducing the storage temperature in refrigerated cold storage. It is not only energy intensive, expensive and pollutant but also capital intensive. But in this direction, zero energy cool chambers can play very important role for the rural farmers to sell their produce after harvest in better price because it is an on-farm and a low cost, environmental friendly rural oriented storage structure which operates on the principle of evaporative cooling i.e. cooling effect due to evaporation of water. This can be constructed easily anywhere with locally available raw materials such as bricks, sand, bamboo, dry grass, jute, cloth etc. The rise in relative humidity (90% or more) and fall in temperature (10-15°C) from the ambient condition could be achieved by watering the chamber twice a day. The major advantage of cool chamber storage is the maintenance of fruit firmness by lowering the physiological loss in weight (PLW) and other metabolic processes. The result of the study revealed that the shelf life of various fruits and vegetables under zero energy cool chamber can be extended from 3 to 50 days of storage such as leaf vegetable (3 days in summer condition), potatoes (97 days in summer condition), orange (30 days in winter condition), okra and bitter gourd (6 days in summer condition) and tomatoes (15 days in summer condition) etc.

Land use land cover mapping for identification of irrigated and non-irrigated areas in the Betwa river basin using spatial data

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ABSTRACT

This study aimed to map the land use/land cover (LU/LC) and irrigated areas of the Betwa river basin in Madhya Pradesh and Uttar Pradesh, India, which is a tributary of the Yamuna River. To achieve this, a digital elevation map, slope map, LU/LC map, soil map, and irrigated area map were created using spatial data such as SRTM DEM, Sentinel-2B satellite data, and MODIS NDVI data. The study identified six LU/LC types, including water bodies, agricultural land, forest, habitation, wasteland, and grassland, and found that 44.25% of the total area of the basin was irrigated, 53.50% was non-irrigated or rainfed, and 2.30% was covered by water bodies. The study utilized ground truth data, Google Earth imagery, and state-level census data to test and verify the accuracy of the mapping results, which showed a fuzzy classification accuracy of around 77.56% for most classes, with mixing primarily across irrigated classes. The study also developed a remote sensing-based vegetation phenological strategy to distinguish between ground water and surface water irrigated areas, and found that temporal fluctuations in NDVI patterns were more consistent in areas irrigated with ground water. Overall, this study provides valuable insights into optimizing land use in the Betwa river basin to meet the demands of a growing population while minimizing losses

Relative assessment of different okra genotypes against major insect pest

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ABSTRACT

The screening of sucking insect pest incidence at 3 levels of the leaf whorl of five random plants showed that the minimum mean jassid population recorded in germplasm 2018/OKYVRES-1 (6.19) whereas, the maximum mean jassid population was recorded in germplasm 2018/OKHYVRES-2 (10.07) which was found significantly higher than that to rest of the germplasm. In case of Bemisiatabaci, the minimum mean population recorded in germplasm 2017/OKYVRES-8 (5.45) while, maximum mean was recorded in germplasm 2018/OKHYVRES-2 (9.09). However, the minimum mean aphids was recorded in germplasm 2017/OKYVRES-8 (4.10) while, the maximum mean aphid population was recorded in germplasm 2018/OKHYVRES-6 (9.85). The mean larval population of Eariasvitella was found minimum in the germplasm 2018/OKYVRES-1 (4.22) and the maximum population was found in the germplasm 2018/OKHYVRES-2 (7.29). But the larval damaged fruits ranged between 13.02 to 22.16 which was recorded from germplasm 2018/OKYVRES-1 and 2017/OKYVRES-6, respectively. In relation to yield, germplasm 2018/OKYVRES-6 had shown its inferiority and contributed the minimum yield of (690.75 kg /ha) while the maximum yield was recorded from the germplasm 2018/OKHYVRES-5 (2490.23 kg/ ha).

Study of biochemical basis of preference of mango leaf hoppers

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ABSTRACT

Present investigations entitled "Varietal preference of mango leaf hoppers and its management through biopesticides" was conducted at the Horticultural mango orchard, B.T.C. College of agriculture and research station, Sarkanda, Bilaspur, Chhattisgarh during November-2020 to May-2021. Five varieties of mango viz. Langra, Amrapali, Himsagar, Sunderja and Alphonso were tested for biochemical preference to mango leaf hoppers. Overall average minimum moisture percentage was recorded in leaf of varieties Sunderja (49.18 %) followed by Himsagar(50.21%) and Langra (51.28%). The maximum moisture percentage was recorded in leaf of varieties Alphonso(53.82%) followed by Amrapali (52.47%). Overall average minimum total chlorophyll was recorded in leaf of varieties Sunderja(2.38 mg) followed by Himsagar(2.51 mg) and Langra(2.61 mg). The maximum total chlorophyll was recorded in leaf of varieties Alphonso(2.91 mg) followed by Amrapali(2.79 mg). Similarly, Overall average minimum chlorophyll-a was recorded in leaf of varieties Sunderja(1.69 mg) followed by Himsagar(1.75 mg) and Langra(1.81 mg). The maximum chlorophyll-a was recorded in leaf of varieties Alphonso(1.94 mg) followed by Amrapali(1.89 mg). and Overall average minimum chlorophyll-b was recorded in leaf of varieties Sunderja(0.69 mg) followed by Himsagar(0.76 mg) and Langra(0.81 mg). The maximum chlorophyll-b was recorded in leaf of varieties Alphonso(0.95 mg) followed by Amrapali(0.90 mg). In case of wax content in leaf average minimum wax content was recorded in leaf of varieties Alphonso(2.42 mg) followed by Amrapali(2.53 mg) and Langra(2.57 mg) and maximum wax content was found in leaf of varieties Sunderja (2.81 mg) followed by Himsagar(2.62 mg). In correlation with important biochemical parameter, moisture percentage is significantly positive correlated with leaf hopper population with r value 0.945, similarly Total Chlorophyll, chlorophyll-a and chlorophyll-b had significantly positive correlated with leaf hopper population with r value 0.944, 0.960, 0.952. respectively. Whereas wax content of leaf had significantly negative correlation with leaf hopper population with r value -0.907.

Keywords- Mango leaf hopper, Biochemical, Wax, Moisture, Chlorophyll, Correlation.

Varietal Evaluation of Chrysanthemum for Pot Mums under Raipur region of Chhattisgarh Plains

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ABSTRACT

This research on the Varietal Evaluation of Chrysanthemum for Pot Mums under Raipur region of Chhattisgarh Plains. The research was conducted at IGKV Raipur using a Completely Randomized Design (CRD) with nine chrysanthemum varieties (Aub pink, Aub burgundy, Tourmalet, Mount Kenya, Aub purple, Mount Pleasant, Aub apricot, Mount Juno, Savita). The main objective of the research was to evaluate the performance of these varieties for their suitability as pot mums in the Raipur region. The research covered different parameters such as growth parameters, flower yield and vase life of

flower. The research revealed that Aub Pink and Mount Juno were the best performers in terms of growth, yield, and quality of flowers, while Savita was found to be the least performing variety. The study concludes that the use of Aub Pink and Mount Juno varieties can be recommended for commercial pot mum cultivation in the Raipur region. This research provides valuable insights for the floriculture industry, especially for growers and breeders of chrysanthemum, in the selection of suitable varieties for pot mum cultivation in the region.

Compatibility of two native entomopathogenic fungi with certain botanicals and their efficacy against termite, *Odontotermesobesus*

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ABSTRACT

Laboratory experiments were carried out to evaluate the compatibility of two entomopathogenic fungi viz., *Beauveria bassiana* and *Metarhizium anisopliae* with three different botanicals viz., neem oil, pongamia oil and jatropha oil at the Laboratory of Nanotechnology, Department of Plant Pathology, AAU, Jorhat. The potential compatible mixtures were also tested for their efficacy against termites (*Odontotermesobesus*) in the Laboratory of Soil Arthropod Pests, Department of Entomology, AAU, Jorhat. Compatibility testing was done by following poison food technique whereas the bioassay test was done by following the dry film technique. Compatibility testing data were analyzed through 3 factorial Completely Randomized Design (CRD) and bioassay data were analyzed by following CRD with 3 replications. Out of the three different botanicals tested, lowest inhibition was recorded in case of jatropha oil (53.102%) followed by neem oil (53.624%) towards both the entomopathogenic fungi which were recorded to be *at par* with each other. Significantly higher inhibition (67.428%) of the entomopathogenic fungi was recorded in case of pongamia oil. Experimental results further revealed that the per cent inhibition of different botanicals against *B. bassiana* (45.503%) was significantly lower (at P=0.05) as compared to the *M. anisopliae* (70.599%). Out of the six different concentrations used for the study, the lower two concentrations of each botanicals exhibited significantly lower inhibition (41.746 and 42.605%) as compared to rest of the concentrations. From the above study, the four best compatible mixtures i.e. *B.bassiana*+neem oil (0.10%), *B.bassiana*+neem oil (0.20%), *B.bassiana*+jatrophaoil (1.5%) and *B.bassiana* + jatropha oil (2%) were tested for their efficacy against termites along with an untreated control. It was vivid from the results that the combined application of *B.bassiana*+neem oil @ 0.20 per cent concentration recorded highest mortality of termites i.e. 10.00, 23.33, 36.67, 51.8, 81.85 and 100 per cent after 12, 24, 48, 72, 96 and 120 hours, respectively which was significantly superior to the rest of the treatments after 48 hours. *B.bassiana*+jatropha oil @ 2.0 per cent concentration registered 6.67, 20.00, 30.00, 44.44,64.08 and 77.78 per cent mortality after 12, 24, 48, 72, 96 and 120 hours, respectively which was followed by the application of *B.bassiana*+neem oil @ 0.10 per cent (6.67, 16.67, 26.67, 40.74, 60.74 and 70.37 % mortality after 12, 24, 48, 72, 96 and 120 hours, respectively) and *B.bassiana*+jatropha oil @ 1.5 per cent (3.33, 13.33, 20.00, 27.04, 42.59 and 55.56 % mortality after 12, 24, 48, 72, 96 and 120 hours, respectively). The lowest mortality was recorded in case of untreated control (3.33, 6.67 and 10.00% after 72, 96 and 120 hours, respectively). Results obtained from the present investigation could be explored as an efficient alternative to the synthetic chemical insecticides for the effective management of termites in organic cultivation.

Biofortification in fruit and vegetable crops

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ABSTRACT

One of the most significant challenges faced by nations across the globe is the increasing population, which is compounded by issues such as inadequate food and nutrition, hunger, and malnourishment of essential vitamins and micronutrients. Biofortification is an emerging approach that involves enhancing the nutritional quality of crops using conventional techniques, plant breeding and biotechnology techniques. In fruit and vegetables, biofortification has the potential to address malnutrition and promote better health outcomes by increasing the concentration of essential micronutrients such as vitamins and minerals. The major objective of biofortification is development of horticultural crops containing highly available micronutrients such as iron, zinc, and vitamin A for preventing global deficiency of these nutrients. The focus on fruit and vegetables particularly cassava, sweet potato, and banana, as they are rich in provitamin A carotenoids. Other crops such as potato and common bean are also emphasized due to their high iron and zinc content, while cowpeas are known for their high iron content. Additionally, vegetables like spinach, onion, broccoli, cabbage, lettuce, and tomato are notable for their high iron levels. Many institutes developed orange-fleshed sweet potato varieties with higher levels of beta-carotene, a precursor of vitamin A, which is crucial for vision and immune function. Similarly, researchers have developed tomatoes with higher levels of lycopene, a powerful antioxidant that has been linked to reduced risks of cancer and heart disease. Biofortification of fruit and vegetables is a promising approach for improving the nutritional quality of the human diet. Continued research and development in this area will be essential to optimize biofortification techniques and ensure their safety and efficacy.

Application Of Artificial Intelligence (Ai) For Seed Quality Assurance

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ABSTRACT

Agricultural production system has witnessed a paradigm shift in last few decades with advancements in precision agricultural technologies. The growing global population and shrinking land holdings have prompted researchers to focus on the application of technology, such as artificial intelligence, machine learning, and robotics, for economically viable, environmentally safe, and sustainable agriculture. AI can be applied at mainly three stages i.e; seed production, seed processing, seed quality. Recently, imaging techniques are gaining great attention in the seed industry for quality assessment and monitoring. Due to its ability to combine the merits of spectroscopy and imaging, spectral imaging techniques have been invented to extensively investigate several aspects of seed quality determination. Various applications in seed quality assessment using spectral imaging are reported, such as quality grading, disease and infestation detection, variety identification, classification, and prediction of chemical composition. Varietal identification for iRSVPred: a web server for artificial intelligence-based prediction of basmati paddy seed varieties. For seed processing AI powered seed sorter, sample evaluation of image analysis through seed vision, QR code for tracing using for

distribution to farmers. Seed testing for Deep learning models based on convolutional neural networks (CNN) for monitoring the quality of seeds using X-ray images. Integrating Optical Imaging Tools for Rapid and Non-invasive Characterization Chlorophyll fluorescence images of the seeds were captured and analyzed using two instruments: SeedReporter™ and VideometerLab4™. So, by careful consideration of all limitations and challenges faced by this technology, seed quality assessment is anticipated that the AI can be moved from laboratories to practical applications in the form of real-time seed monitoring systems that meet the requirements of the modern industrial control and sorting systems. The decreasing cost, increasing speed, capability of computer hardware and artificial intelligence makes this technology more attractive for prospective usages in quality.

Effect of Natural Inputs Against Root-Knot Nematode (*Meloidogyne Incognita*) on Potato

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ABSTRACT

The efficacy of natural inputs against root-knot nematode (*M. incognita*) on potato was studied in pot conditions at the Department of Nematology, B. A. College of Agriculture, AAU, Anand. The toxicity of the plant-derived natural inputs neemastra, agniastra, brahmastra were evaluated based on the root-knot index, fresh shoot weight, fresh root weight. Agniastra @ 800 ml, 600ml, 400 ml per 10 l water was found most effective for reduction of root-knot index of *M. incognita* followed by Neemastra @ 400 l, 300 l, 200 l per acre. Maximum fresh shoot weight and fresh root weight were recorded with the treatment of Agniastra @ 800 ml, 600ml, 400 ml per 10 l water followed by Neemastra @ 400 l, 300 l, 200 l per acre. Whereas, Brahmastra @ 800 ml, 600ml, 400 ml per 10 l was found least effective for reduction of root-knot index of *M. incognita* as well as increasing the fresh shoot weight and fresh root weight.

An ecological studies of beneficiary insects and soil dwelling organisms in natural and organic farming systems under beans cultivation

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ABSTRACT

Modern intensification of industrial agriculture has significantly modified terrestrial landscapes and is one of the biggest drivers of biodiversity loss, habitat fragmentation and pollution. Thus, the use of pesticides and the reduction of landscape heterogeneity in agricultural areas lead to the loss of biodiversity. Field experiment was conducted in Block-I of The Regional Horticulture Research and Extension Center, Kumbapur, Dharwad which is situated at 15° 29' Northern latitude, 74° 57' Eastern longitude and at an altitude of 678 m above the mean sea level. Experiment was conducted during *Kharif* seasons of 2019, 2020 and 2021. Among the four different farming practices, population of natural enemies were recorded higher in natural farming

in cluster bean (2.19) and dolichos bean (1.75 @ 30 DAS & 3.11 @ 60 DAS). Which was on par/followed by organic farming in cluster bean (2.07) and dolichos bean (1.49 @ 30 DAS & 2.57 @ 60 DAS). As concern to floral visitors in both the crops, significantly the higher number of floral visitors in cluster bean (3.15 @ 60 DAS & 2.96 @ Harvest) and dolichos bean (3.26 @ 60 DAS & 2.34 @ harvest) were observed in natural farming. On pooled basis significantly higher arthropod population were recorded in natural farming in cluster and dolichos bean (5.16/m² & 6.36/m²), which was on par/followed by organic farming (4.03/ m² & 5.82/m²). Similarly, earthworm population in soil were found significantly higher in natural farming in cluster and dolichos bean (2.32/m² & 2.73/m²).
Key words: Natural enemies, floral visitors, natural farming, organic farming, soil arthropods and earthworms

Value Addition in Mashroom

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ABSTRACT

Value addition is the process of changing or transforming a product from its original state to a more valuable state. Value addition to agricultural products is the process of increasing the economic value and consumer appeal of an agricultural commodity. Various value-adding technologies such as processing and preservation techniques, dehydration and drying technology, freezing technology, packing, labelling, *etc.* can be applied to agricultural produce to increase its value. Total value of any agricultural produce is increased by performing certain post-harvest processing operations rather than selling it as such after harvest. Every year optimum amount of mashroom is produced in India. Out of this a significant portion goes to waste due mainly to its perishable nature and seasonal glut. Value addition is important to utilize the surplus available during the season as well to improve the livelihood of the farmers by producing value added products. There are various value-added products like pickle, soup powder, biscuit, ketch-up, chips, candy *etc.* can be prepared from mashroom. Mashroom being rich in nutritional, medicinal and processing qualities can play a very significant role in the livelihood security of the rural communities through enhanced household income, employment generation and environmental protection.

Biofortification of sulphur in groundnut crop to improve their quality in calcareous soil

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ABSTRACT

Groundnut covers 295 million hectares worldwide, producing 487 million tonnes with a productivity of 1647 kg per hectare (FAO., 2019). India dominates the world in area under groundnut and would be the world's second largest groundnut producer. Groundnut accounts for 19.1% of total oilseeds area and 21.3 percent of total production in India. It is valued for its high-oil edible seeds, making it the world's fourth-largest

source of edible oil and third-most source of vegetable protein. Calcium and sulphur, in addition to the essential minerals, play an important role in increasing groundnut production and productivity. Adequate S is much crucial for the oil yield production and quality of pulse. Information on application of S for biofortification in groundnut seeds is meagre. Biofortification is considered to be a potential strategy for tackling malnutrition. Agronomic biofortification focusses on soil and foliar fertilization Shivay *et al.* (2014) and Ram *et al.* (2016). Most studies on S fertilization of crops are generally restricted to yield, quality of the crop produce and S uptake. Scanty information on the effect of S fertilization on bio accumulation of S in kernels of groundnut hence the present study was conducted for sorting out the efficient S utilizing genotypes of groundnut that aid in biofortification of S. The objectives were to optimize the groundnut genotypes and sulphur sources to improve the sulphur use efficiency. Field experiments were conducted with groundnut (variety CO7 & VRI 8) as test crops using SSP and FeSO₄ as sulphur sources at 40 kg S ha⁻¹. From this research investigation it was concluded that application of 40 kg S ha⁻¹ as FeSO₄ along with the recommended dose of fertilizers (100 % RDF) in calcareous soil enhanced biofortification of sulphur in groundnut. Among the sources FeSO₄ recorded the highest plant height, 100 grain weight, grain yield, S uptake. Comparing groundnut genotype CO 7 were observed to be efficient sulphur utilizing genotypes.

Key words: SSP, FeSO₄, genotypes, groundnut, CO 7.

Importance of Farmer Producer Organization for resolving small farmer problem

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ABSTRACT

Farmer Producer Organisation (FPO) is a farmer-led group that aims to help farmers become self-sufficient. FPO members benefit from a variety of services, including input supply procurement, packaging, marketing, custom recruiting service centre, insurance facility, technical, and networking services, among others. On the recommendation of Dr Y.K. ALAGH Farmer producer organization (FPOs) was introduced in India due to certain shortcomings in co-operatives. FPOs has gained attention of Central and State government announcing Formation and Promotion of 10,000 FPOs in the year 2021. In 2014 government announced "Year of FPOs". FPOs is ray of hope for small and marginal farmers as 85% of the agrarian population is small and marginal farmer. Collectivization in agriculture has the ability to reduce post-harvest losses, increases marketable surplus, increasing bargaining power of farmers, reduces number of middlemen, increases employment in rural area. Farmer and rural communities need time and technical assistance for mobilizing the resources in order to respond to the pressure of competitive market. Trained organizers are needed for encouraging producers and rural communities to develop group decision making and self-reliance skills. The high vulnerability of small and marginal households is largely attributed to lower scale of operation, lack of information, poor access to cheaper credit, weak participation in the consumers' markets and consequently, exploitation by intermediaries in procuring inputs and marketing of their produce.

Artificial Intelligence in Agriculture

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ABSTRACT

One of the most practical ways to manage food insufficiency and adjust to the needs of a rising population is the application of AI in agriculture. An overview of AI's use in agronomic fields and its development in research laboratories is given in this paper. The analysis begins by highlighting two industries soil management and weed management where AI may have a significant impact. Next, the Internet of Things (IoT), a technology with enormous potential for the future, is discussed. Uneven mechanisation distribution, algorithms' capacity to swiftly and accurately handle huge amounts of data, and data security and privacy are the three issues that must be resolved for AI-based technology to become widely accepted in the market. The review emphasises an already successful development and a promising prospect of application, despite pointing out the difficulty of applying machines and algorithms tested in experimental environments to real environments. Agricultural robots targeted at various aspects of the agricultural industry have been developed and improved greatly in the past years.

Natural Farming for Sustainable Agriculture

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ABSTRACT

Natural farming is an agricultural practice that involves working in harmony with nature to produce food sustainably. It is a holistic approach that promotes biodiversity, soil health, and the use of natural inputs instead of chemical fertilizers and pesticides. Natural farming methods have been used for centuries, and their popularity is growing due to their potential to reduce environmental impacts and improve food security. Natural farming techniques involve practices such as crop rotation, intercropping, cover cropping, and the use of compost and other organic materials. These methods help to maintain soil fertility, reduce pest and disease pressure, and increase crop yields over the long term. Natural farming also emphasizes the importance of using locally adapted plant varieties and preserving traditional knowledge. The benefits of natural farming extend beyond the farm itself. By reducing the use of synthetic inputs, natural farming can help to reduce greenhouse gas emissions and improve water quality. It also promotes food sovereignty and strengthens local food systems, which can contribute to improved health and social well-being. While natural farming has many advantages, it is not without its challenges. Farmers may need to invest more time and effort into maintaining soil health and managing pests and diseases using natural methods. Additionally, there may be a learning curve for farmers transitioning from conventional farming practices to natural farming. Overall, natural farming has the potential to support sustainable agriculture and contribute to a more equitable and resilient food system.

Subhash Palekar Natural Farming in India.

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ABSTRACT

Subhash Palekar is an Indian agriculturist and natural farming advocate who has

developed a farming system called "Zero Budget Natural Farming" (ZBNF). The ZBNF method aims to create a sustainable and self-sufficient farming system that does not rely on any external inputs such as chemical fertilizers or pesticides. The ZBNF method emphasizes the use of locally available resources, such as cow dung, cow urine, jaggery, and gram flour, to reduce inputs such as fertilizers and pesticides. It also emphasizes the importance of maintaining soil health through practices such as mulching, crop rotation, and intercropping. Palekar's natural farming approach has gained popularity in India and has been adopted by many farmers. The government of India has also promoted ZBNF as a model for sustainable agriculture and has provided support and training to farmers to adopt this method. The ZBNF method is considered to be environmentally sustainable and economically viable, as it reduces the input costs for farmers and promotes the use of locally available resources. It has also been shown to improve soil health, increase crop yields, and reduce the use of water. However, there have been some criticisms of the ZBNF method, including concerns about its scalability and the potential for reduced yields in some cases. Despite these criticisms, Palekar's natural farming approach has inspired a growing movement of farmers in India who are seeking to create a more sustainable and self-sufficient agricultural system.

Urban Permaculture: A Sustainable System for Human Health & Climate.

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ABSTRACT

Permaculture is a holistic approach to design and manage a sustainable system with component like farms, gardens, forestry and communities that are interdependently weaved as a single unit. The concept of permaculture is to create human settlements and agricultural systems that mimic the patterns and relationships found in natural ecosystems. Urban permaculture is the concept based on the same approach and deals with the designing and building sustainable cities, with the changing climate and proves to be a boon for ameliorating human health. One of the key principles of urban permaculture is harbouring multi-functionality in a multi-layered system. A concept like companion planting can be used to create food forests. In this, fruit and nut trees are planted at the top, followed by smaller fruit and berry bushes, and then by perennial and annual vegetables and herbs and flowering perennials at the bottom. This creates a diverse ecosystem that provides a variety of foods, medicine and flowers throughout the growing season and provides habitat for beneficial insects, birds, and other wildlife. This not only helps to create a more diverse and resilient ecosystem, but it also makes the most efficient use of space and resources. Urban Permaculture has the potential to make a significant impact on the climate. One of its main principles is the use of natural systems to manage waste and resources. For example, composting can be used to turn food scraps, yard waste, and other organic matter into nutrient-rich soil. This can be used to fertilize the garden, reducing the need for synthetic fertilizers. Additionally, rainwater harvesting can be used to collect and store rainwater for use in the garden and household, reducing the demand on the municipal water supply which are often powered by fossil fuels.

Carbon sequestration through permaculture is an important factor that makes it a viable system in urban planning. The trees can sequester the carbon from the atmosphere and fix them as soil organic carbon (SOC) which improves soil structure, growth of microbial fauna and healthy flora. This can help to reduce the carbon footprint of human settlements

and agricultural systems. There are many examples of urban permaculture projects around the world: 'The P-Patch Community Garden Program in Seattle, USA' and 'The Beddington Zero Energy Development (BedZED) in London, UK' are networks of community gardens that use permaculture principles to grow food and build community. These gardens include a wide variety of fruits, vegetables, herbs, and flowers, and also include elements such as rainwater harvesting and composting systems, community gardens, green roofs, solar panels, as well as a district heating system that uses biomass as a fuel.



Society for Community Mobilization for Sustainable Development (Mobilization)

Headquarter: ICAR-Indian Agricultural Research Institute, New Delhi-110012

ABOUT THE SOCIETY

MOBILIZATION Society was established in 2003 as a non-profit professional society aimed at sensitizing and mobilizing development partners and community for sustainable development. The Society has successfully mobilized researchers, academicians, planners, grass-root mobilizers, students to create conducive intellectual atmosphere for introspective deliberations. Nine national seminars organized in collaboration with renowned institutions like IIT-Delhi, ICAR-IVRI, Bareilly, GBPAU&T, Pantnagar etc., to address the emerging problems experienced by the agrarian mass. The Society remained collaborator of two International Conference organized at Andaman in December 2016 and New Delhi in February 2017. The recognition of the society in the efforts for strengthening the forum for scientific communication is growing among the related professionals and concerned agricultural stakeholders rapidly and presently has more than 1800 Life Members.



JOURNAL

Society publishes Quarterly Journal of Community Mobilization and Sustainable Development (print ISSN 2230– 9047; online ISSN 2231–6736) having NAAS rating of 5.67 (Journal ID J158). The Mobilization journal is available on the website www.mobilization.org.in and has been registered with www.indianjournals.com for national and global abstracting and indexing.



AWARDS & HONOURS

MOBILIZATION envisages reorienting the young professionals and researchers for imbibing the values of community participation in research, training and extension endeavours. The society instituted awards for researchers, educationalists, teachers, trainers, extension professionals, students, innovative farmers and NGOs in recognition of their contributions for the society.

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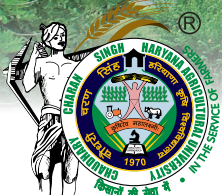
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Inspiring Agripreneurs

A Premier Institution for

Carrier Opportunities in

AGRICULTURE and ALLIED SECTORS

The University offers (Degree Programmes)

6 Under Graduate

44 Masters

38 Ph.D.

Prestigious Academic Establishment of High Repute

- Full Fledged University Since 1970
- Quality Research, Teaching and Extension
- State of the Art Infrastructure
- High-tech laboratories
- World Class Sports Facilities
- Wi-Fi connected campus
- One of the most beautiful campuses in India with a lot of biodiversity both in terms of flora and fauna.
- Research on Natural farming
- All the hostels have solar water system
- 7 Community Radio Stations in various districts

- Twice Recipient of ICAR Best Institution Award
- First Stop for International Students
- First Recipient of Haryana Kisan Ratna Award
- Among the Top Ranked Agricultural Universities of the Country
- Best ABIC of the country Award 2021
- All India Champion of Agriculture Sports Meet 2017 and 2023

Constituent Colleges

- ✓ College of Agriculture, Hisar
- ✓ College of Agriculture, Bawal
- ✓ College of Agriculture, Kaul
- ✓ College of Basic Sciences and Humanities
- ✓ College of Biotechnology
- ✓ Indira Chakravorty College of Home Sciences
- ✓ College of Agricultural Engineering & Technology
- ✓ College of Fisheries Science
- ✓ Institute of Business Management and Agripreneurship, Gurugram

The faculty of this university have served on various coveted positions such as Director General (ICAR), Chairman (ASRB), Advisor (Planning Commission), Vice-Chancellors, Deputy Director General (ICRISAT), Deputy Director Generals (ICAR), Directors of National Institutes etc. Alumni of this university are working all over the world and are holding important positions in administration of various sectors.

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Rani Lakshmi Bai Central Agricultural University, Jhansi-284003, UP (India)

(Established on 5th March, 2014 by the act of Parliament as Institution of National Importance)

Steps towards Rainbow Revolution & Bright Future in Agriculture.....

IN THE SERVICE OF THE NATION THROUGH PURSUE A CAREER IN

- The University has two colleges located at the headquarter in Jhansi, Uttar Pradesh namely College of Agriculture and College of Horticulture & Forestry and two upcoming colleges namely College of Veterinary & Animal Sciences and College of Fisheries located at Datia campus, Madhya Pradesh.
- B.Sc. (Hons) Agriculture, B.Sc. (Hons) Horticulture and B.Sc. (Hons) Forestry: 4-years undergraduate programmes at Jhansi campus. B.V.Sc. & AH Veterinary & Animal Science, B.F.Sc. Fisheries at upcoming Datia campus.
- M.Sc. (Agriculture) in eleven disciplines, namely; Genetics & Plant Breeding, Plant Pathology, Agronomy, Soil Sciences, Entomology and Agricultural Extension Education: 2-Years degree programmes and two upcoming Inter-institutional and Inter-disciplinary Master's Programmes in Agricultural Biotechnology & Seed Science & Technology. M.Sc. (Horticulture) in three disciplines, namely; Fruit Science, Vegetable Science and Floriculture & Landscaping: 2-Years degree programmes. M.Sc. (Forestry) in two disciplines, namely; Silviculture & Agroforestry and Forest Product and Utilization: 2-Years degree programmes.
- Doctoral Programme in Ph.D. Genetics & Plant Breeding, Ph.D. Agronomy, Ph.D. Plant Pathology, Ph.D. (Horticulture) Fruit Science, Ph.D. Forestry (Silviculture & Agroforestry)

JOIN THE INSTITUTION OF NATIONAL IMPORTANCE

ADMISSION THROUGH ALL INDIA COMMON UNIVERSITY ENTRANCE TEST (CUET) CONDUCTED BY ICAR, NEW DELHI

Research activities

- Three well developed research farms in Jhansi, Datia and Niwari along with modern implements.
- Well equipped Central Research laboratory facilities, with high end equipments.
- Augmentation of agricultural productivity in Bundelkhand through basic and strategic research with focus on pulses, oilseeds, millets, fruits, vegetables, flowers, value addition, natural resource management and social science.
- Developed technologies have potential to increase agricultural productivity and income of small and marginal farmers in the region.

Extension Education Activities

- FLDs, training and ICT tools for transfer of technologies in 14 districts of Bundelkhand region in UP and MP
- Dissemination of knowledge, agri-practices and technology for crop protection and soil fertility management through Mobile Plant Health Clinic at the doorsteps of farmers, Promotion of science based Natural farming in the Bundelkhand
- Drone technology for enhancing efficiency of Agri-inputs, less labor intensive and cost effective manner
- Promotion and diversification of industrialized agriculture through development of technical skills.

Others Features

- Well furnished library, e-library and classrooms to nurture the students for their all round development.
- Establishment of state-of-art infrastructure facilities in academic and administrative blocks, laboratories, instructional units/ blocks for enhanced learning.
- Emphasis on Experiential Learning, Student READY and NSS to discover new passion.
- Green & Clean campus fulfilling green building norms, Placement cell, Media cell, Smart Classrooms, Sports & Gym, 24*7 Wi-Fi, Hygienic Mess, CCTV camera surveillance in the whole campus, Geysers, Air, Water coolers and proper waste disposal system.

Inspiring Academic community for Innovations & Inventions for the development of Emerging technology, Employability and Enterprise

