

GREEN FILES

VOLUME-49



THEME: - Agriculture With a Focus on Environment



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Acknowledgement

We thank all the contributors for their immensely valuable contributions and for making this endeavour a success.

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Foreword

In the 49th volume of the “Green Files”, iCED’s quarterly journal, our focus converges on the theme of Agriculture with a focus on Environment. Somewhere, along the middle of each quarter, when the tentative pagination for each issue is finalised, individual articles, features and regular sections begin to metamorphose into the complete picture. Thus we value add to the corpus of knowledge, iCED has already built since the Hon’ble Comptroller and Auditor General of India Shri. Girish Chandra Murmu designated iCED as a Centre of Excellence on the Audit of the Blue Economy in 2023 and in continuation of iCED’s proven decade plus domain knowledge building in environmental audit/SDG issues.



This edition has highlighted multiple sectors and perspectives on Agriculture with a focus on the environment. The article titled “Importance of Coarse Grains in Sustainable Agriculture” sheds light on the importance of significance of Coarse grains in sustainable agricultural practices. It is a detailed and comprehensive edition which focusses on dynamic and cutting-edge issues of sustainable agriculture from a multi-faceted perspective.

The article titled “Crop Insurance Policies” highlights the importance of these schemes and brings out their significant role in fortifying the financial well-being of farmers, propelling the adoption of modern agricultural techniques, and facilitating vital credit flows to the agricultural sector. Through their unified efforts, these policies stand as pillars, ensuring not just income stability but also nurturing food security and encouraging the diversification of crops in the landscape of agriculture

Another article on “Impact of Climate Change on Crop Yield” examines Climate Change's impact on Indian crop yields, highlighting agriculture's importance for the economy and food security. It highlights government efforts for adaptation, predicts yield declines in staple crops, and offers an audit perspective on addressing climate challenges in Indian Agriculture.

Furthermore, the article on “State in Focus” presents a succinct overview of Karnataka. It sheds light on the current state of forestry management within the state, tackling challenges such as water scarcity, particularly urban water issues in Bengaluru. Additionally, they highlight irrigation projects aligned with Sustainable Development Goals (SDGs).

In addition, our publication highlights article on “Importance of Proper Seed Selection for Maximizing Crop yields”. This article highlights the paramount importance of proper seed selection for maximizing crop yields. It emphasizes how selecting the right seeds based on factors like climate, soil type, and disease resistance can significantly impact agricultural productivity. Additionally, it delves into the structural concept of seed quality, the significance of seed germination, and the necessity of resistance to pests and diseases.

Moreover, our publication also includes an article on “Agricultural Markets with a focus on: Equilibrium Moisture Content (EMC), Processing and Minimum Support Price (MSP)”. These insights offer a glimpse into how agricultural markets function, supporting fair and sustainable farming practices.

The Green Files also provides a summary of the training sessions, workshops, and other activities conducted at iCED, as well as recent developments in SAI India, from January to March 2024.

A list of references is included in this journal to provide detailed reading material on the featured themes. We have continued with our publications under the “Occasional Research Paper (ORP) Series”. The links to these articles are available in the “Research” section on the website of the iCED (www.iced.cag.gov.in). The iCED website also has links to all iCED research publications, to act as a repository of knowledge and documentation in an ever-evolving and as inter-connected a domain as environment audit and Sustainable Development issues.

On behalf of the entire team of “Green Files” at iCED, we look forward to your suggestions to make Green Files as informative and user friendly as possible. Your contributions within the broad scope of this quarterly journal will be highly appreciated, including any feedback you may like to share on the featured articles.

(Ms. Sayantani Jafa)

Additional Dy. Comptroller and Auditor General and Director General,
iCED, Jaipur

Message from the Director (Training & Research)

iCED's quarterly journal, "Green Files" offers insights into environmental and sustainable development issues from the perspective of public sector auditing. Additionally, it provides snapshots of the capacity-building and research activities undertaken at iCED during the covered period. The last three volumes have highlighted issues related to Climate Change and the Blue Economy. The current volume now focuses on the theme of Agriculture, with an emphasis on the Environment.

During the last year, our primary focus on the sectors of Climate Change and Blue Economy, has also been evident in our national and international training programmes, research initiatives, and publications.

This 49th volume of "Green Files" brings out, inter alia, articles, news items highlighting multiple dimensions of Agriculture with a focus on Environment, to help understand these dimensions, from the perspectives of Audit. Spanning various facets of agriculture, the 49th Volume covers the critical aspects such as Agricultural Markets, Stubble burning, Eco-friendly pest management techniques, Agri waste management, Carbon Farming, significance of proper seed selection, and the interconnectedness of Agricultural sectors with Climate Change. We have continued to feature a "Biodiversity at iCED, Jaipur", like in the previous editions.

We hope that this edition will prove to be valuable in enhancing comprehension of the diverse facets of the Agriculture Section focused on environment, especially for their relevance to the auditing professionals.

July 2024

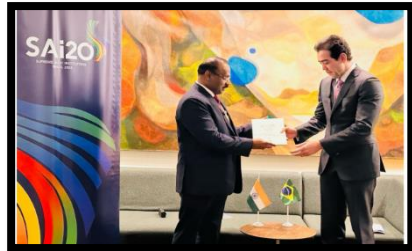
Jaipur



Shri. Mehul Grover

Director (Training & Research),
iCED, Jaipur

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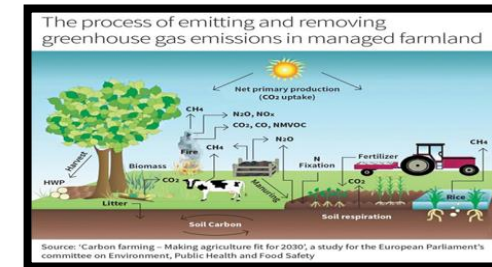
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SAI India News

Climate Financing Key to Move Towards More Resilient and Sustainable Future: Hon'ble Comptroller and Auditor General of India, Shri. Girish Chandra Murmu, addressed a one-day seminar on Climate Financing on March 19, 2024.- In his speech, he emphasized the urgency of robust financial mechanisms to Combat Climate Change, citing WHO's prediction of 250,000 additional deaths annually from 2030 to 2050. He stressed the need for substantial annual Climate Finance, potentially exceeding \$10 trillion by 2050, and highlighted the G20's New Delhi Leaders Declaration and India's initiatives like the National Action Plan on Climate Change and the Delhi Metro's solar energy use. Shri. Murmu underscored the crucial role of Supreme Audit Institutions (SAIs) in ensuring transparency and accountability in Climate Finance. By conducting rigorous audits and developing tailored methodologies, SAIs can enhance the efficiency and impact of Climate Finance initiatives. He concluded by encouraging responsible supervision of Climate Finance to drive sustainable change and protect the planet for future generations. (C&AG of India, 2024)

Data Integrity is Essential for A Fair Audit Assessment of National Climate Action: - During a panel discussion at the "Climate Scanner Global Call: Engaging Supreme Audit Institutions in Assessing National Climate Action" in New York, Shri. Girish Chandra Murmu, Comptroller & Auditor General of India, emphasised the critical need for data integrity in fair audit assessments of national climate action plans. The event, organised by UN



Honourable C&AG, Shri. G C Murmu handing over SAI20 Engagement Group charge to President of the Federal Court of Accounts, Brazil, Minister Bruno Dantas, on 26 March 2024. Image Source: (C&AG of India, 2024)

DESA and Brazil's Federal Court of Accounts (TCU) on March 25-26, focused on the Climate Scanner initiative led by Brazil's Supreme Audit Institution.



Honourable C&AG India speaking at UNDESA joint event on 26 March 2024, Image Source: (C&AG of India, 2024)

Shri. Girish Chandra Murmu, Comptroller & Auditor General of India highlighted challenges faced by Supreme Audit Institutions (SAIs) in assessing national climate actions, including data gaps, incomplete records, limited climate stations, and lack of standardized methodologies. He stressed the importance of capacity building and shared India's climate action progress, such as the National Action Plan on Climate Change (NAPCC) and achieving significant reductions in greenhouse gas emissions.

He also called for collaborative action among SAIs and stressed the importance of comprehensive data banks and green taxonomy for transitioning to a low-carbon economy. He urged SAIs to develop impactful recommendations and embrace eco-efficiency in the fight against Climate Change. (C&AG of India, 2024)

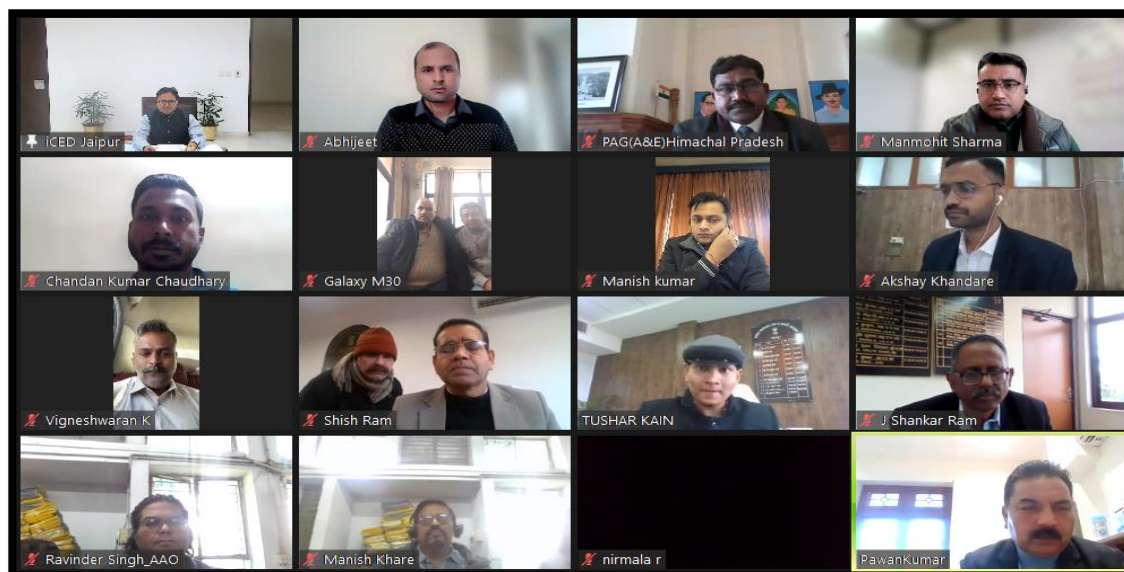
International Training/Workshop/National Training Programmes conducted at iCED Jaipur-

During the period January to March, 2024, International Centre for Environment Audit and Sustainable Development (iCED) organised one International Workshop on “Renewable Energy Development Strategies and Mechanisms with special reference to Solar Energy”, one International Training Programme on “Introduction to Environmental Auditing”, One UN Audit Preparatory Training Programme for Audit of WHO hosted entities and OPCW and two National Training programmes on “Natural Resource Accounting” & “Audit of Ground Water Management, Pollution and Regulation”.

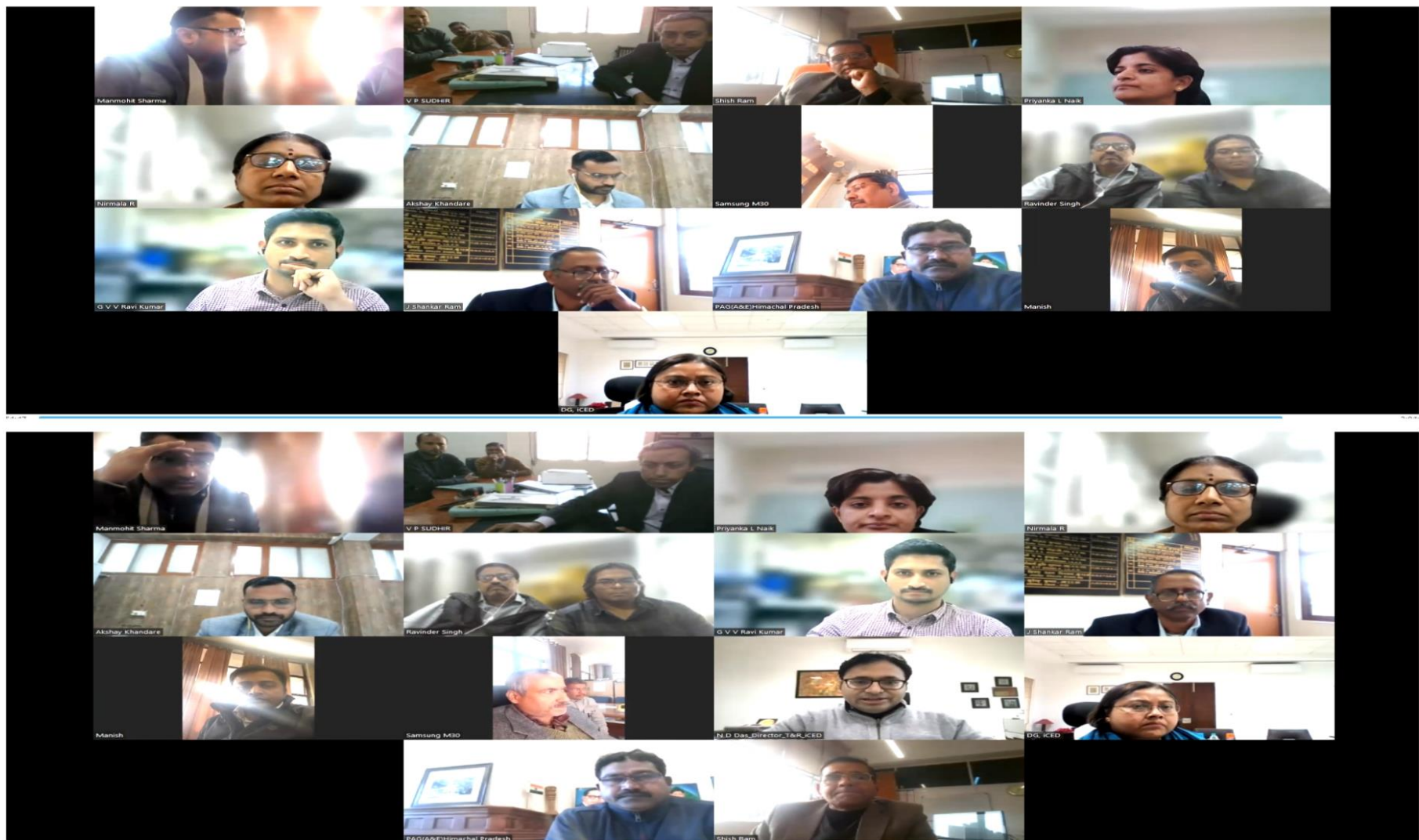
Details of the Training Programmes/Workshop are summarised below in chronological order:

National Training Programme on “Natural Resource Accounting” from 08th to 12th January, 2024 at iCED Jaipur

A five day’ National Training Programme on the said topic was organised from 08th to 12th January, 2024 through virtual mode. A total of 21 participants from 07 field offices including 07 group officers, participated in the training programme.



National Training Programme on “Natural Resource Accounting”



National Training Programme on "Natural Resource Accounting"

During the programme, various sessions were conducted by experts from IA&AD and many other reputed organisations like National Remote Sensing Centre, Hyderabad; Indian Institute of Science, (IISc) Bangalore; Indian Bureau of Mines (IBM), Nagpur; The Energy and Resources Institute (TERI), New Delhi; Oil India Limited, Assam; National Institute of Ocean Technology, Chennai and Madras Institute of Development Studies, Chennai, etc. These sessions had covered topics such as the Concept of Natural Resource Accounting and its linkage with SDGs; GASAB's Endeavour and Recent Developments in respect of Natural Resource Accounting in India; Remote Sensing and Geospatial Technology (Applications to Mineral Resources/Mine mapping/Auditing); Vision for India's Blue Economy and the Role of National Ocean Accounts , etc.

UN Audit Preparatory Training Programme for Audit of the World Health Organisation (WHO) hosted entities and Organisation for the Prohibition of Chemical Weapons (OPCW) from 29th January to 02nd February, 2024 at iCED Jaipur

iCED organized a five day UN Audit preparatory training programme for the audit teams of WHO hosted entities and OPCW, from 29th January to 02nd February 2024. The training brought together a total of 19 participants, including 10 Group Officers. The programme was formally launched by Additional Deputy Comptroller & Auditor General (International Relations, Coordination, &

Legal) Shri. K. S. Subramanian before the training took place.



UN Audit preparatory training for the audit teams of WHO hosted entities and OPCW

International Workshop on “Renewable Energy Development Strategies and Mechanisms with Special Reference to Solar Energy” from 05th to 09th February, 2024

iCED, as the Global Training Facility (GTF) of INTOSAI Working Group on Environmental Auditing (WGEA), organised a 05 day International Workshop on “Renewable Energy Development Strategies and Mechanisms with special reference to Solar Energy” from 05th to 09th February, 2024. The workshop has been conducted in two batches

through virtual mode, with a total of 51 participants (37 in Batch- I & 14 in Batch-II) representing 17 SAIs.

During the inaugural sessions of Batch-I and Batch-II, Dr. Nanda Dulal Das, Director (Training & Research), iCED, welcomed Ms. Sayantani Jafa, Additional Deputy Comptroller and Auditor General & Director General, iCED, participants, and the honourable guest speaker Dr. Vivi Niemenmaa, Secretary General, INTOSAI WGEA and from the National Audit Office, Finland.



Ms. Sayantani Jafa, ADAI & DG, iCED addressing the participants during Inauguration of the International Workshop

Ms. Sayantani Jafa, Additional Deputy Comptroller and Auditor General & Director General, iCED inaugurated the workshop and highlighted that iCED, Jaipur on behalf of SAI India, has played a key role in augmenting and disseminating SAI India's efforts towards environmental auditing and sustainable development at global forums such as the INTOSAI WGEA, ASOSAI WGEA , etc. This Centre is working as the technical focal point for research projects of the INTOSAI WGEA Work Plan 2023-2025, including the “Climate Scanner”, and “Environmental Accounting”, under the “Climate and Biodiversity Hub” and



Faculties delivering Sessions during the International Workshop

“Green Economy Hub”, respectively. Prominent foreign faculties who addressed the International Workshop included Dr Vivi Niemenmaa, SAI, Finland on “An Overview of Renewable Energy Systems with reference to SDGs and role of SAIs”; Ms. Katarzyna Radecka Moroz, European Court of Auditors (ECA) on “Renewable Energy Options: Wind Energy, Tidal Energy, and other options”; Mr. Alar Jürgenson, SAI Estonia on “Audit of Renewable Energy: Experience Sharing on Wind Energy”; Mr. Fery Irawan and Mr. Bagus

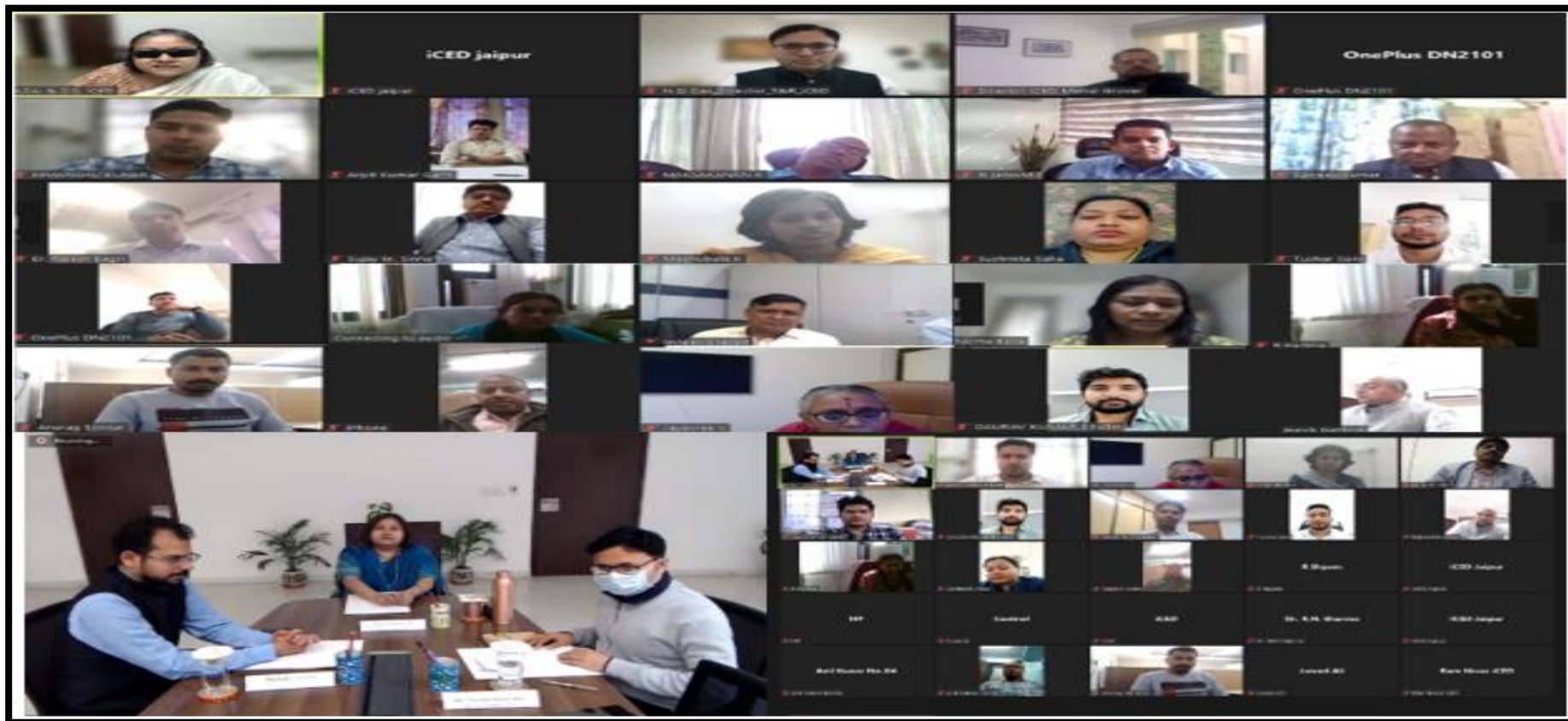
Permadi, SAI Indonesia on “Audit of Renewable Energy: Experience Sharing”; Mr. Denny Wahdini and Mr. Normas Andi Ahmad, SAI Indonesia on “Audit of Renewable Energy: Experience Sharing”; Mr. Andre Delgado de Souza, SAI Brazil on “Audit of Renewable energy with special focus on Solar Energy” while Dr. Nanda Dulal Das from SAI India; Commodore Debesh Lahiri from National Maritime Foundation (NMF), New Delhi; Shri. S.N. Pandey, Deputy Director, National Power Training Institute, Faridabad, Ministry of Power, Govt. of India, New Delhi; Shri.

Dilip Nigam, Scientist G, Ministry of New & Renewable Energy, Govt. of India, New Delhi; Dr Subrahmanyam Pulipaka, Chief Executive Officer, National Solar Energy Federation of India, New Delhi and Ms. Gurveen Sidhu from SAI India were the Indian faculties.

Valediction of the Workshop:

Ms Sayantani Jafa, ADAI and DG, iCED graced the valedictory session and extended heartfelt thanks to all the participants for their enthusiastic involvement throughout the programme, which significantly contributed to its successful execution. She wished that the sharing of experiences and perspectives during the workshop would suitably equip all the participants to take the learning process forward. She thanked all the experts who delivered the sessions during the workshop.

National Training Programme on “Audit of Ground Water Management, Pollution and Regulation” from 19th to 23rd February, 2024



NTP on “Audit of Ground Water Management, Pollution and Regulation”

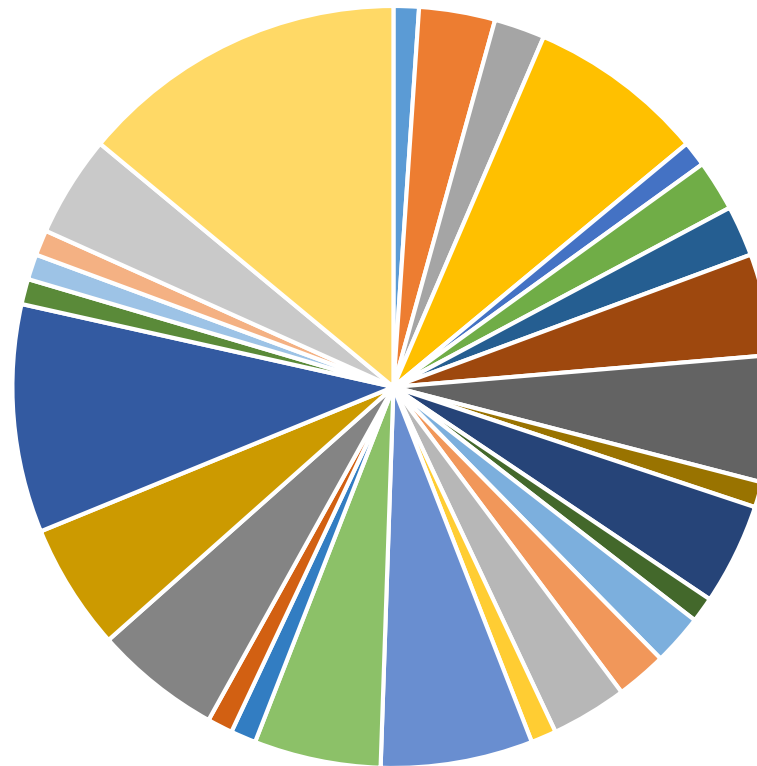
iCED successfully conducted a 05 day National Training Programme on “Audit of Ground Water Management, Pollution and Regulation” from 19th to 23rd February 2024 through virtual mode. The training programme attracted a total of 21 participants from 07 field offices, comprising 07 Group Officers.

During this five days’ National Training Programme, 12 experts from IA&AD and many other reputed organisations like UNICEF India, New Delhi, Forest Research Institute (FRI), Dehradun, Malviya National Institute of Technology, Jaipur, Indian Institute of Science (IISc), Bengaluru, Annamalai University, Tamil Nadu, National Mission for Clean Ganga, International Institute of Waste Management (IIWM) Bengaluru, TERI, New Delhi, and SAC, Ahmedabad, etc. delivered sessions on critical environmental issues. The topics included issues such as the Overview of clean water and sanitation with a focus on Climate Change, Water Resource Management in Arid Regions, Water Pollution in India, Groundwater Pollution and Management of River Basin with Case Studies, Remote Sensing of Ground Water, Remote Sensing and GIS for Ground Water Resource Assessment, etc.

11th International Training Programme on “Introduction to Environmental Auditing” from 11th to 15th March, 2024 and 18th to 22nd March, 2024

iCED, as the Global Training Facility (GTF) of INTOSAI Working Group on Environmental Auditing (WGEA) organised the 11th International Training Programme on “Introduction to Environmental Auditing” in two batches from 11th to 15th March 2024(Batch-I) and 18th to 22nd March 2024(Batch-II) through virtual mode. A total number of 93 participants (63 in Batch- I & 30 in Batch-II) attended the training programme from 28 SAIs.

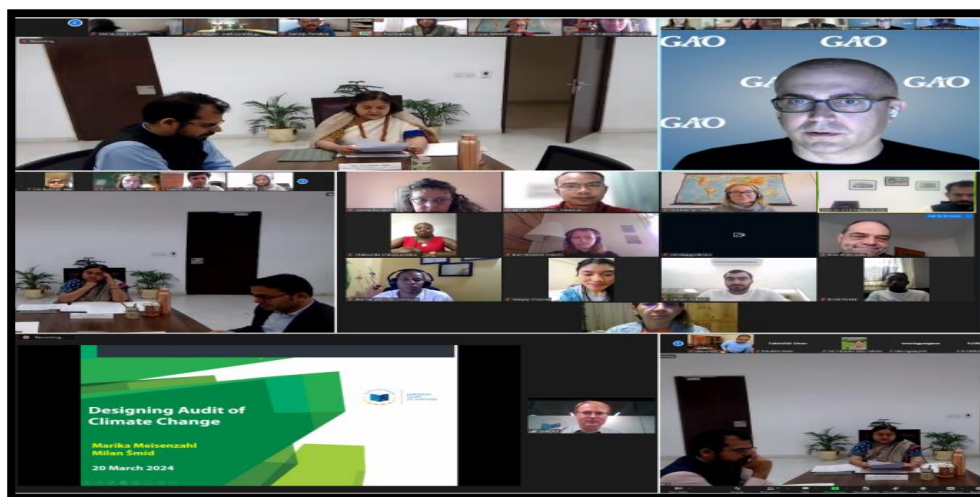
Participants country-wise that participated in the International workshop



- | | | | | | | |
|-------------|---------------|--------------|----------------|----------|------------------------|-----------|
| ■ Australia | ■ Azerbaijan | ■ Bangladesh | ■ Bhutan | ■ Chile | ■ Costa Rica | ■ Ecuador |
| ■ Egypt | ■ Ethiopia | ■ Finland | ■ Greece | ■ Guam | ■ India | ■ Iraq |
| ■ Jamaica | ■ Malawi | ■ Malaysia | ■ Maldives | ■ Malta | ■ Nepal | ■ Oman |
| ■ Pakistan | ■ Philippines | ■ Poland | ■ South Africa | ■ Turkey | ■ United Arab Emirates | ■ Zambia |

Ms. Sayantani Jafa, Additional Deputy Comptroller and Auditor General & Director General, iCED, inaugurated the Training programme and highlighted that the environmental issues know no borders as their effect reaches beyond borders. She emphasised that Environmental Audits are essential not just within nations but globally and beyond, and therefore, it is imperative for the audit community to diligently uphold Environmental Auditing principles worldwide. She reiterated the importance of international cooperation and expertise in ensuring that auditing practices meet regulatory standards.

She expressed gratitude to the Chair of INTOSAI Working Group on Environmental Auditing, Auditor General of the National Audit Office Finland Mr. Sami Yläoutinen, and his team for extending their support in organising this training programme by welcoming all the participants and guest faculties.



11th International Training Programme on “Introduction to Environmental Auditing”

Prominent foreign faculties who addressed the ITP included Dr Vivi Niemenmaa, SAI, Finland on “Basics of Environmental Auditing



Faculties delivering Sessions during the 11th ITP

and Evolution of Environmental Auditing, INTOSAI WGEA”; Mr. Milan Smid and Ms. Marika Meisenzahl, Directorate – Sustainable use of Natural Resources, European Court of Auditors (ECA) on “Designing Audit of Climate Change and Cooperation in Climate Change related Audits”; Ms. Zoe Need, Mr. Joe Thompson , Ms. Adriane Kline, Government Accountability Office(GAO), USA on “Audit of Climate Change Mitigation and Adaptation Efforts: Experience Sharing”; Ms. Paula Hebling Dutra, Specialist, SAI Brazil on “Biodiversity Governance: Global Overview and Auditing Biodiversity” while Mr Souvik Bhattacharjya Associate Director, Resource Efficiency & Governance Division, TERI, New Delhi; Dr. Akhilesh Mishra, Scientist, Department of Science & Technology, Government of India; Dr. Kathiresan Kandasamy, Former Dean and Director, Faculty of Marine Sciences, Annamalai University; Dr. Nanda Dulal Das, SAI India; Mr. Mehul Grover, SAI India; Dr. Sanjay Sood (IFS-1993), Addl. PCCF(Res. & Trg.), Himachal Pradesh Forest Academy; Dr. Nilanjan Ghosh, Director, Centre for New Economic Diplomacy & ORF Kolkata Centre; Shri. G. Rajashekar, Group Director, Forestry & Ecology, RSAA National Remote Sensing Centre (NRSC) Hyderabad; Mr. Pravinjith

and Evolution of Environmental Auditing, INTOSAI WGEA”; Mr. Milan Smid and Ms. Marika Meisenzahl, Directorate – Sustainable use of Natural Resources, European Court of Auditors (ECA) on “Designing Audit of Climate Change and Cooperation in Climate Change related Audits”; Ms. Zoe Need, Mr. Joe Thompson , Ms. Adriane Kline, Government Accountability Office(GAO), USA on “Audit of Climate Change Mitigation and Adaptation Efforts: Experience Sharing”; Ms. Paula Hebling Dutra, Specialist, SAI Brazil on “Biodiversity Governance: Global Overview and Auditing Biodiversity” while Mr Souvik Bhattacharjya Associate Director, Resource Efficiency & Governance Division, TERI, New Delhi; Dr. Akhilesh Mishra, Scientist, Department of Science & Technology, Government of India; Dr. Kathiresan Kandasamy, Former Dean and Director, Faculty of

K.P, Managing Director, Paradigm Environmental Strategies (P) Ltd. Bangalore; Ms. Mannat Jaspal, Associate Fellow, ORF India; Shri. Rajiv Kumar, Group Head, Soil Resources & LUMG, National Remote Sensing Centre (NRSC) Hyderabad were the Indian faculties.

Valediction of the 11th International Programme: Ms Sayantani Jafa, ADAI and DG, iCED graced the valedictory session and extended heartfelt thanks to all the participants for their enthusiastic involvement throughout the programme, which has significantly contributed to its successful execution. She expressed regards to all the SAIs who had nominated resource persons to deliver the sessions during the workshop.

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Intosai News



Image Source- (INTOSAI WGEA, 2024)

By: Shri. Manoj Kumar,AAO

The 22nd INTOSAI WGEA Assembly, Rovaniemi, Finland, 22 – 24 January 2024.

The 22nd INTOSAI WGEA Assembly was held in Rovaniemi, Finland, 22 – 24 January 2024. The main topic of the Assembly was ‘Auditing the Arctic – Environmental Change and Indigenous Knowledge’. Ms Sayantani Jafa, Additional Deputy Comptroller and Auditor General and Director General, iCED and Shri. S. Alok, Director General of Audit, Defence Services, New Delhi represented SAI India in the Assembly meeting. SAI India actively participated in all the sessions held during the INTOSAI WGEA Assembly meeting.

The opening session kicked off the Assembly with broad introductions to the topics of Arctic environmental change and indigenous knowledge. The second session, "Arctic Environmental Change", featured three keynote speakers whose work centres around Climate Change and environmental change in the Arctic region. The third session included a panel discussion on the topic of indigenous knowledge. The last session was on Audit Cases and SAI Practices on Indigenous knowledge



Figure 1 Participants during the 22nd INTOSAI WGEA Assembly meeting in Rovaniemi, Finland.
Image source- <https://www.environmental-auditing.org/media/qvtabjbg/22nd-intosai-wgea-assembly-meeting-minutes-final.pdf>

The second day (23 January 2024) of the Assembly had parallel sessions on Work Plan Projects and Other Workshops including the “Climate and Biodiversity Nexus”, and the “System of Environmental-Economic Accounting”.

On the third day (24 January 2024) of the Assembly Meeting, a presentation was made on the activities of the iCED by SAI India representatives. The presentation highlighted the training courses held at iCED during the INTOSAI WGEA Work Plan 2023-25 including

the International Training Programmes, Workshops and Webinars on Environment Auditing and other environmental themes. The presentation also highlighted the stellar work done by iCED in conducting training courses on the Blue Economy after being declared as a Centre of Excellence on the Audit of the Blue Economy by Hon’ble Comptroller and Auditor General of India, Shri. G.C.Murmu. The presentation further included the various sustainable practices at iCED, and SAI India’s outreach efforts scaling new frontiers of the Blue Economy during the CAG of India’s Presidentship of the SAI 20 in 2023. Mention was made of iCED’s scaling up of knowledge sharing and research through its Occasional Research Paper Series launched in 2022.

ADAI and DG (iCED) requested the member SAIs to send their nominations for the upcoming programmes at iCED and also to lend support to iCED and SAI, India by nominating resource persons/experts for global efforts in iCED’s capacity building initiatives.

This was followed by the WGEI Survey on Energy Transition and a panel discussion on collaborative projects of ClimateScanner (SAI Brazil), Climate Change Adaptation Actions, and P2P initiative and donor funding project (IDI). The Assembly also adopted the Rovaniemi WGEA Assembly Recommendations and presented the WGEA awards for auditing. The Assembly concluded with a formal closing by the Auditor General of Finland. The INTOSAI WGEA Steering Committee additional meeting/ IDI GFU Workshop took place on 25th January 2024.

The key messages from the 22nd Assembly are as follows:

- 1) Environmental issues are global and cross national borders, and regional approaches can be helpful in revealing interdependencies.*
- 2) SAIs are well-positioned to address environmental issues that concern governments by looking at those issues in a holistic manner and breaking down ministerial silos.*
- 3) SAIs can play the long game when it comes to evaluating government performance on environmental issues. They are well positioned to look at issues in a long-term manner in terms of outcomes and future generations even when governments are not looking beyond their electoral term. Auditors can go beyond electoral cycles and should carefully consider the timescale against which they make their assessments and recommendations.*
- 4) Indigenous knowledge and indigenous ways of knowing can be a valuable source of information for auditors, stressing the sustainable use of natural resources and intergenerational perspective, which can complement other sources of information. Many SAIs can assess how their governments are engaging with their indigenous communities and peoples. This acts as an example of “leaving no-one behind”, of taking all perspectives into account, in the spirit of the 2030 Agenda.*
- 5) Various approaches, such as integrating environmental consideration into national budgets, environmental accounting, and sustainability reporting, provide useful points of reference to SAIs. These tools can help highlight the strengths and weaknesses of governments’ actions or inaction on environmental issues as well as improve SAIs audit methodologies and practices.*
- 6) Collaborative projects, such as the ClimateScanner and cooperative audit on Climate Change Adaptation Actions, are opportunities to gain a better understanding of environmental issues that countries are facing and how each government is working to address them. They are also valuable in increasing practical audit skills and knowledge of environmental auditing. In return, this increases the SAIs’ overall capacity to engage with their work and with their government on key environmental issues. SAIs should take all these benefits into consideration when they are thinking about their engagement in collaborative projects (INTOSAI, 2024).*

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Importance of Coarse Grains in Sustainable Agriculture

By: Shri. Kailash Chand Bajya, AAO and Shri. Sonu Dayma, Sr. Ar.

Introduction: - This article on the "Importance of Coarse Grains in Sustainable Agriculture" emphasizes the significance of coarse grains in sustainable agricultural practices. Coarse grains play a crucial role in enhancing food security, nutrition, and environmental sustainability. Since ancient times, coarse cereals have been a part of India's agriculture, culture, and civilization. India aims to shape a global mass movement by creating a better approach towards the use of millet. Coarse grains, such as millet, have been cultivated in India since ancient times. Evidence shows that millets were eaten during the Indus Valley Civilization, indicating they were among the earliest crops cultivated in the region (New India Samachar, 2023).

In the first two decades after India's independence, the area under cultivation was highest for coarse cereals, followed by rice and wheat. Coarse grains like jowar (sorghum), ragi (finger millet), bajra (pearl millet), maize, and barley formed an important part of the dietary composition in the early post-independence period (Oak, 2023). Overall, coarse grains have a long history in India, but their importance and cultivation declined after the Green Revolution, only to see a resurgence in recent times due to their potential benefits for sustainable agriculture and nutrition (Down to Earth, 2001).



Image 1: Snapshot of some Coarse Grains, Image Source: (New India Samachar, 2023)

Why Coarse Grains should be promoted (Ministry of Consumer Affairs, Food & Public Distribution, 2021): -

- They require less water to grow than rice and wheat.
- They are good and better for health than others.
- They are good for the agricultural economy.
- They are cultivated in semi-arid tropics and poor soils.

- They are efficient converters of energy and plant nutrients into biomass.

Nutritional Significance of Coarse Grains: - In India, agriculture is a key primary industry that makes a significant contribution to the wealth and quality of life of rural and urban population. The self-sufficiency in food grain production, brought 45 years ago by achieving the “First Green Revolution”, became the base for claiming “Food for All” and removing poverty. Since then, the farmers were encouraged to adopt improved agricultural practices and to produce targeted food grains, and success was achieved therein (R.C. Gautam, 2024).

Coarse grains like sorghum, millet, and others are rich (B. Dayakar Rao, K. Bhaskarachary, and others from ICAR 2017) in essential nutrients such as protein, minerals, and fat, offering a more cost-effective and nutritionally superior alternative to fine cereals like wheat and rice.

Sorghum is a good source of minerals and vitamins and is mostly located in the aleurone layer and germ. Sorghum is an important source of B vitamins except for vitamin B12. Yellow-coloured sorghum grain is rich in beta-carotene, lutein, and zeaxanthin. Sorghum is an excellent source of polyphenols, flavonoids, and condensed tannins which are antioxidant potent in nature. Sorghum is a very healthy diet for patients with diseases like Celiac, Obesity, Diabetes, Coronary Heart Disease, Cancer, Oxidative Stress, , etc (B. Dayakar Rao, K. Bhaskarachary, and others from ICAR 2017).

Pearl millet is the most widely grown type of millet. It has been grown in Africa and the Indian subcontinent since prehistoric times. Pearl millet, like sorghum, is generally 9 to 13per cent protein, but large variations in protein content, from 6 to 21per cent, have been observed. Pearl Millet is

beneficial in treating stomach ulcers, helpful for Heart health and it reduces the severity of respiratory problems for asthma patients and is also effective in reducing migraine attacks. It helps in bone growth development and repair. It also helps in weight loss, and diabetes issues and has Anti-allergic properties (B. Dayakar Rao, K. Bhaskarachary, and others from ICAR 2017).

Finger Millet (Ragi) is an annual plant, widely grown as a cereal in the arid areas of Africa and Asia. It remains one of the main ingredients of the staple diet in Karnataka. Nutritionally, finger millet is a good source of nutrients, especially calcium, other minerals, and fiber. It is useful for losing weight, helps in slowing the digestion process, and controls blood sugar levels in conditions of diabetes, lowers blood cholesterol. It is a very good source of natural Iron. Ragi consumption helps in the condition of Anemia as well (Praveen, 2022).

Climate Resilience of Coarse Grains: - Coarse grains, particularly millets, contribute significantly to climate resilience in several ways mentioned below.

- **Drought Tolerance:** Coarse grains are more resilient to drought conditions due to their ability to grow in areas with low rainfall and can thrive in water-deficit environments (Ministry of Agriculture, 2014).
- **Heat Tolerance** (researchgate 2020): - Coarse grains exhibit a high degree of heat tolerance, which is profitable in regions facing rising temperatures due to Climate Change.

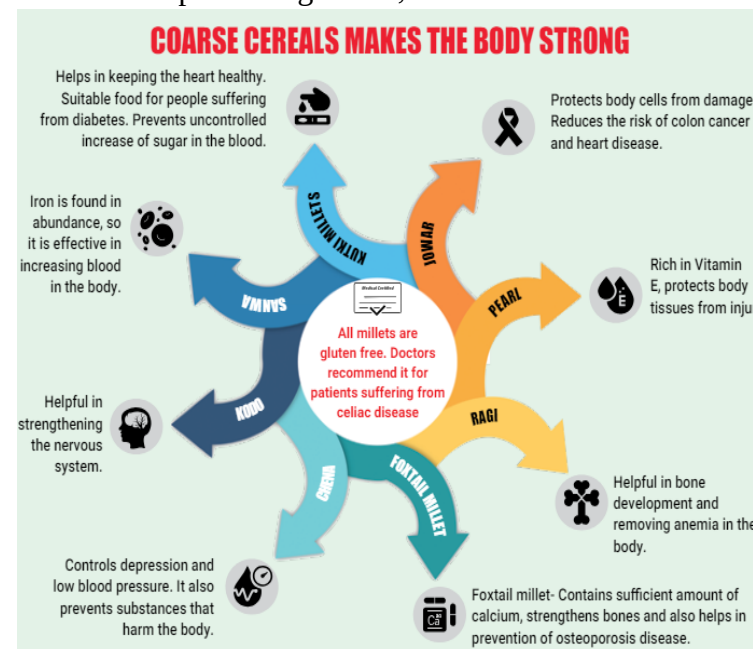


Image 2: Shows how the Coarse Grains play a role in our Body, Image Source (New India Samachar, 2023)

- **Salinity tolerance** is a crucial characteristic for growing coarse grains such as sorghum, pearl millet, and finger millet in regions affected by high salt levels. These crops have evolved diverse strategies to manage salt stress, such as ion exclusion, osmotic adjustment, tissue tolerance, and hormone synthesis, among others (Ministry of Agriculture, 2014).
- **Waterlogging Tolerance:** - Coarse grains are well-adapted to arid and semi-arid agroecosystems and can tolerate waterlogging. In India, about 6.75 mega-hectare lands are either sodic or saline in nature, and 6.41 mega-hectare of land is degraded due to waterlogging. Hence, Coarse Grains are helpful to reduce and control waterlogging (Dagar, 2014).

Water Efficiency in Coarse Grain Production: - Agriculture in our country is facing acute water scarcity and the major reason for this is very low efficiency of use of water. Sorghum ranks 5th among the world's most important crops. More than 70 per cent of the world's total production of Sorghum comes from the developing countries in Asia and Africa, where crop is grown with limited water and nutrients (Ministry of Agriculture, 2014).

Challenges in Coarse Grain Promotion in India (Down To Earth , 2023): -

- The cost of producing millets like ragi is higher in Karnataka compared to crops like paddy, which have lower production costs and higher yields.
- Current MSPs for millets are not sufficiently competitive with high-value crops, making it challenging for farmers to prioritize millet cultivation. It is needed for the government to increase MSP for the farmers.
- In the Pilot Project undertaken by Andhra Pradesh in 2018, there were limited benefits to farmers in past procurement through tendering process. It necessitated a more equitable procurement approach.
- As per a research conducted by MS Swaminathan Research Foundation, it has been observed that 25 percent of households consume millets distributed under PDS, as they show strong preference for rice.

- Establishing decentralized PDS systems for millets is crucial to reduce transport costs, minimize storage losses, and mitigate corruption.
- It is needed to emphasize on Research and Development of processing machinery suitable for energy-constrained rural areas and improving agronomic practices and seed accessibility to boost millet yields.
- Behavioral change campaigns are essential to shift consumer preferences towards millets and improve their acceptance in people's diets. (Down To Earth , 2023)

Coarse Grains:- India's Gift To The World: - India's proposal was supported by 72 countries in March 2021, and the United Nations declared the year 2023 as the International Year of Millets on the initiative of India, which presided over a powerful group like the G-20. Recognizing the importance of coarse cereals and taking the lead in providing nutritious food to the people while also creating indigenous and global demand, India is establishing itself as a world leader during this special year. Millets are a valuable natural gift to humanity, so declaring 2023 the International Year of Millets is nothing short of a gift to the entire humanity (New India Samachar, 2023).

Major Initiatives Taken by The Central Government: - There are some initiatives of the Government of India to promote the use of millet in addition to the significance and awareness programmes.

- **Research-Startups:** The government of India is popularizing Nutritious Millets through R&D support. Startups and entrepreneurs are also getting support to develop recipes and products that promote the consumption of millets (Ministry of Agriculture & Farmers Welfare, 2023).
- **Bio-Fortified Varieties:** Eight bio-fortified varieties/hybrids of millets have been released for cultivation from 2018 to February 2022 (Ministry of Agriculture & Farmers Welfare, 2022).

- **Export Promotion:** The Ministry of Commerce and Industry through its apex agricultural export promotion body, the Agricultural and Processed Food Products Export Development Authority (APEDA) has come up with a comprehensive strategy from December 2022 to promote the export of nutritious food grains worldwide. The cabinet of the Government of India approved a scheme for “Remission of Duties and Taxes on Exported Products (RoDTEP)” to boost the exports Scheme for enhancing Exports to International level (Ministry of Commerce & Industry, 2022).
- **E-Catalogs:** For the promotion of Indian coarse grains and products, the government of India has developed 30 e-catalogs in each of the target countries, covering the range of different Indian coarse grains and products available for export. It contains the list of active exporters, startups, Farmers' Producer Organizations and importer/ retail chain/hypermarkets, , etc. It is to be given to Indian Embassies abroad, importers, exporters, startups, and stakeholders. E-catalogue for export of Indian Millets: SPAIN (Agricultural and Processed Food Products Export Development Authority, 2023).
- **Global Partnership:** NITI Aayog signed a letter of intent with the United Nations World Food Program on 20 December 2021. The partnership focuses on mainstreaming millets and supporting India in sharing knowledge globally in the backdrop of the International Year of Millets 2023 (NITI Aayog, 2021).
- **Request to the Corporate World:** In a webinar organized on February 24, 2022, the Prime Minister of India requested the corporate world to come forward in branding and promotion of Indian coarse grains (PMINDIA, 2022).

Audit Perspective for Coarse grains: - Audit can play a crucial role in assessing and promoting the importance of coarse grains in sustainable agriculture. Here are some ways in which an audit perspective can contribute: The Audit should check the following during audits related to Coarse Grains.

- Ensuring proper implementation of government schemes and initiatives for coarse cereals.
- Checking if the increased Minimum Support Price (MSP) for millets is actually benefiting farmers and providing them with a steady market for their produce.

- Monitoring if the provision of seed kits and inputs to farmers, building value chains through Farmer Producer Organizations, and supporting the marketability of millets is being implemented properly.
- Ensuring that the procurement targets (www.pib.gov.in 2023) for coarse cereals are being met and the procurement period is being extended from the earlier 3 months to 6-10 months as per the new guidelines.
- Verifying if the state governments are promoting the consumption of millets through schemes like PM POSHAN, ICDS and Other Welfare Schemes as per the central government's requests. (www.pib.gov.in 2023).
- Auditing the functioning of the Food Corporation of India (FCI) (Ministry of Consumer affairs, Food & Public Distribution, 2008) and state agencies in procuring coarse grains at MSP to provide a steady market for farmers.

Conclusion

The eminent agricultural scientist, M S Swaminathan, said in his report that millets, often referred to as Climate Smart Nutri-cereals, have not received the attention as much as deserved until recently, as millets were wrongly categorized as coarse grains. He said in his report that the nomenclature should be changed from coarse grains to nutritious grains.

The Indian government has proposed a Millet Mission, for this mission to be successful. It needs to address four key areas comprehensively:

- Production of millet germplasm through community participation thereby stopping genetic erosion
- Processing of millets using organic farming methods
- Pricing of millets in programmes like the school noon-meal programme
- Enlarging the opportunities for Procurement both nationally and internationally.

As stated by M S Swaminathan, the four pillars of the Millet Mission should be conservation, cultivation, consumption, and commerce. He told that by focusing on these areas in an integrated manner, the mission can achieve its goals and promote the widespread adoption of millet as a sustainable and nutritious food source. (M S Swaminathan Research Foundation, 2018)

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Impact of Climate Change on Crop Yield

By: Shri. Rohan Sharma, AAO and Shri. Akesh Kumar Yadav, Sr. Ar.

Agriculture in India

India possesses approximately 160 million hectares of arable land, making it the second-largest after the United States of America. The country experiences all 15 prominent climates and is home to 46 out of the 60 soil types found on Earth. With around 50 per cent of its total geographical area under cultivation, India ranks among the top land users for agriculture. In regions like the Indo-Gangetic Plain (IGP) and the deltas of the eastern coast, the proportion of cultivated land to total geographical area often surpasses 90 per cent. Indian agriculture, renowned as one of the oldest systems globally, is characterized by its diversity, heterogeneity, lack of organization, and susceptibility to uncertainties from seed to market. This sector plays a crucial role in fostering sustainable and inclusive economic growth within the country (ICAR 2023).



Image 1 Agriculture in India , Image Source: ICAR <https://iiab.icar.gov.in/fld/>

Between 1951 and 2021, India's population surged from 35.9 crore to 136.9 crore, while food production escalated from 106 million tonnes to 936 million tonnes during the same period. This signifies that the growth in food production exceeded twice the growth in the

human population over the past seven decades. The income generated from the agriculture sector, adjusted to 2011-12 prices, soared by 7.2 times during this timeframe, reflecting an average annual trend growth rate of 2.83 percent. In contrast, the non-agricultural sector experienced a more rapid expansion than agriculture, leading to a 28.4 fold increase in the overall national income, with an average annual growth rate of 4.83 percent. Despite these advancements, the number of agricultural workers rose from 9.72 crore in 1950-51 to 25 crore in 2021-22 (NITI Aayog 2023).

Effects of Climate Change on Agriculture

While the effects of Climate Change are felt worldwide, nations such as India are particularly vulnerable due to their large population reliant on agriculture (ICAR). Even with the comparatively greater expansion of the non-agricultural sector, agriculture continues to serve as the primary employment provider, engaging 45 percent of the workforce in agricultural and related endeavors (NITI Aayog 2023). During the fiscal year 2021-22, this sector accounted for 18.6 percent of the national income at present prices. The production of food grains, which stood at a modest 51 million tons (Mt) in 1950/51, surged over six fold to exceed 314 Mt in 2022 (ICAR 2023).

In India, significant negative impacts have been implied with medium-term (2010-2039) Climate Change, predicted to reduce yields by 4.5 to 9 percent, depending on the magnitude and distribution of warming. Since agriculture makes up roughly 16 percent of India's GDP, a 4.5 to 9 per cent negative impact on production implies a cost of Climate Change to be roughly up to 1.5 percent of GDP per year (ICAR).

Water Management in Agriculture

Agriculture significantly impacts air, water, and land quality. Most water usage in India is for agriculture, which covers over 40 per cent of the land. Agricultural growth has led to overexploitation of water, with groundwater levels declining in 36 per cent of the country, even in high-rainfall areas. Farmers are drilling deeper, increasing irrigation costs and degrading water quality.

Excessive use of fertilizers and agro-chemicals degrades land, water, and air. Subsidized power encourages water-intensive crops, causing alarming water table declines and future water shortages. **Distorted prices result in the export of water-intensive crops such as rice and sugar, while less water-consuming crops like pulses and edible oil are imported.** This makes India a major exporter of virtual water, despite many lacking adequate water for drinking and other needs.

Agriculture emits about 17 per cent of India's greenhouse gases, matching its GDP share. These emissions come from inputs to soil, biomass decomposition, livestock, manure handling, and crop residue burning. This share could rise if all crop residue burning is accounted for (NITI Aayog 2023).

Involvement of Small-Scale and Marginal Farmers

In India and much of Asia, agriculture is dominated by small land holdings. According to the 2015-16 Agricultural Census, 68 per cent of farms are less than 1 hectare, and 85 per cent are under 2 hectares. Despite their efficiency, small farms often don't generate enough income for a good living. There are two main ways to increase their income:

1. Encourage farmers to grow high-value crops and engage in livestock activities to make better use of family labor.
2. Supplement farm income with non-agricultural sources like wages, salaries, business, and trade.

Smallholders face challenges with scale in both input and output markets, requiring unique institutional support. Non-farm income is increasingly important, making up 47.35 per cent of farm household income in 2019, up from 40 per cent in 2012-13. To boost farm household incomes, both agricultural and non-agricultural sources need to be utilized (NITI Aayog 2023).

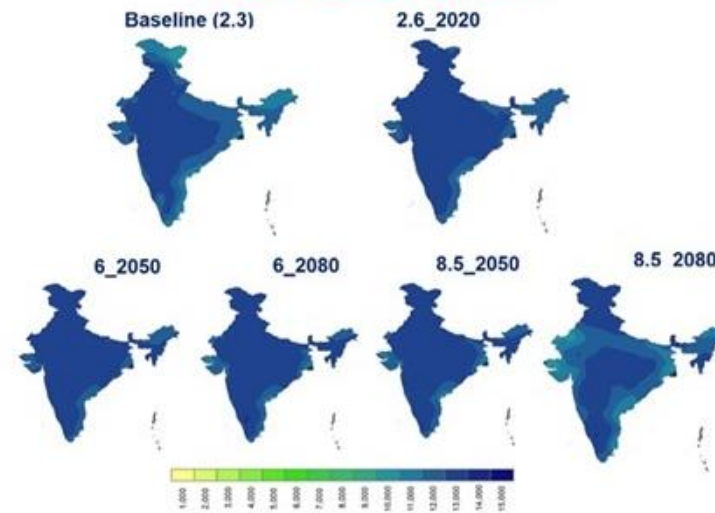
Crop yield impact of Climate Change in India

In India, about two-thirds of farmland depend on rainfall, so climate is the main factor affecting crop growth. Climate Change has a huge impact on agriculture, directly and indirectly. These impacts include:

- Higher global temperatures
- More intense rainfall
- Rising sea levels
- Melting glaciers
- Changes in crop growing seasons
- More frequent extreme weather events like droughts and floods

Agricultural research centres across the country have conducted extensive field research and computer simulations. These simulations looked at the potential impact of Climate Change for the years 2050 and 2080. If no action is taken to adapt, the following effects are expected(Figure 2):

Potential yield of kharif rice is projected to reduce in extreme climate scenario



Potential yield of rice in climate change scenarios

Image 2 Potential yield of Kharif rice is projected to reduce in extreme climate, Image Source: (NICRA n.d.)

1. Rainfed rice yields in India could drop by 20 per cent in 2050 and 47 per cent in 2080. Irrigated rice yields could drop by 3.5 per cent in 2050 and 5 per cent in 2080.
2. Wheat yields could decrease by 19.3 per cent in 2050 and 40 per cent in 2080, with significant differences across regions and times.
3. Kharif maize yields could decrease by 18 per cent in 2050 and 23 per cent in 2080.

4. Climate Change will lower crop yields and reduce the nutritional quality of produce. Extreme events like droughts will affect food availability and impact farmers' livelihoods (Ministry of Agriculture & Farmers Welfare 2023).

Initiatives taken by Government

Government of India has implemented schemes and plans to enhance agriculture's resilience to Climate Change. One such initiative is the National Mission for Sustainable Agriculture (NMSA), operating under the National Action Plan on Climate Change (NAPCC). NMSA focuses on devising and executing strategies to bolster Indian agriculture against shifting climate patterns.

To address the challenge of sustaining domestic food production amidst climatic shifts, the Indian Council of Agricultural Research (ICAR), under the Ministry of Agriculture and Farmers Welfare, initiated the flagship network research project 'National Innovations in Climate Resilient Agriculture' (NICRA) in 2011. NICRA aims to develop and promote climate-resilient agricultural technologies tailored to vulnerable regions, helping them cope with extreme weather events like droughts, floods, and heatwaves. The project encompasses short-term and long-term research programs covering crops, horticulture, livestock, fisheries, and poultry, with a focus on adaptation and mitigation.

Key areas include identifying vulnerable districts, developing crop varieties and management practices for adaptation and mitigation, and assessing Climate Change impacts on livestock, fisheries, and poultry. Since 2014, the project has yielded 1888 climate-resilient varieties and 68 location-specific technologies, facilitating their widespread adoption among farming communities (Ministry of Agriculture & Farmers Welfare 2023).

Audit Perspective

An audit perspective on the impact of Climate Change on crop yields in India involves evaluating the accuracy of yield projections, analyzing the economic consequences for farmers, and assessing the effectiveness of government adaptation policies, particularly for marginal farmers. This includes verifying data sources, examining the financial burden of adaptation, and reviewing the impact of subsidies on crop selection and water usage. Additionally, the audit should assess the implementation of climate-resilient farming practices, disaster preparedness, and the sustainable use of water and soil resources. It also involves investigating the environmental impact of reduced yields, such as groundwater depletion, and evaluating the social consequences for marginal farmers' livelihoods and food security, including potential increases in rural-urban migration.

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State in Focus-Karnataka

Introduction: Karnataka, located in South-Western India, is one of the country's most prosperous states, excelling in education, industry, agriculture, literature, and tourism. Its capital, Bengaluru, known as the Silicon Valley of Asia, is a hub for the Information Technology industry. Karnataka is bordered by Goa and Maharashtra to the north, Telangana to the east, Tamil Nadu to the southeast, Kerala to the south, and the Arabian Sea to the west. Geographically, it lies on a tableland where the Western and Eastern Ghats converge into the Nilgiri hills, between 11.5°N to 18.5°N latitudes and 74°E to 78.5°E longitudes. Spanning 750 km north to south and 400 km east to west, it covers 191,796 sq. km, making it India's 8th largest state, accounting for 5.83 per cent of the country's total area. (Karnataka E. C., 2021)

By:- Shri. Maneesh Mangal ,AAO & Shri. Ashutosh Goyal, Sr.Ar.



Image 1: Important Places in Karnataka, Image Source: (Survey of India, 2018)

Climate:

Karnataka's climate varies widely. Annual rainfall averages 1,151 mm, with 80 per cent during the southwest monsoon. Coastal areas receive more rainfall due to proximity to the Western Ghats, while northern regions have semi-arid climate. Recent studies done by environmental management and policy research institute (EMPRI) published in its report on Karnataka State Action Plan on Climate Change show a declining southwest monsoon trend, contrasting IMD data. Warming trends, especially in northern Karnataka, lead to rising temperatures. Projections indicate further temperature increases by the 2030s, with reduced precipitation, potentially worsening climate challenges. (ENVIS Centre Karnataka, 2021)

Biodiversity: Flora and Fauna

Karnataka's rich biodiversity, reflecting the region's unique ecological heritage, spans diverse ecosystems from the Western Ghats to the plains and coastal regions. The Western Ghats, a global biodiversity hotspot, harbours over 4,500 species of flowering plants, with around 1,500 being endemic to the region. Remarkably, approximately 150 plant species are exclusively endemic to Karnataka, highlighting its distinct botanical heritage.

In terms of faunal diversity, Karnataka is equally impressive, hosting around 12 mammal species endemic to the state and approximately 500 bird species, including 16 endemics. The state also boasts around 150 reptilian species, with 29 being unique to Karnataka. Amphibian diversity is notable, with about 79 species endemic to the state. Aquatic ecosystems support around 600 fish species, including 40 endemics. Karnataka's insect biodiversity, including numerous endemic species of butterflies and other insects, further enriches its ecological tapestry. (Karnataka Biodiversity Board)

Agriculture

In Karnataka, agriculture is the major occupation for a majority of the rural population. As per the population Census 2011, agriculture supports 13.74 million workers, of which 23.61 percent are cultivators and 25.67 percent are agricultural workers. A total of 1,23,100 km square of land is cultivated in Karnataka constituting 64.6 per cent of the total geographical area of the state from which only 26.50 per cent of the sown area (30,900 km square) is under irrigation. The agricultural sector of Karnataka is characterized by vast steppes of drought prone region (Karnataka

has the highest proportion (79 per cent) of drought prone area among all major states in the country) and sporadic patches of irrigated area. In Karnataka, the 7 districts viz Belagavi, Vijayapura, Shivamogga, Chikkamagalur, Chitradurga, Hassan and Kodagu were identified as drought prone districts. Thus, a large portion of agricultural land in the state is exposed to the vagaries of monsoon with severe agro-climate and resource constraints. Agriculture employs more than 60 per cent of Karnataka's workforce.

Agriculture in Karnataka relies heavily on the southwest monsoon. The state ranks fifth in India for total horticultural area, fifth in vegetable production, and third in fruit production. It leads in producing spices, aromatic and medicinal crops, and tropical fruits. Karnataka is the second largest milk producer after Gujarat and the second largest grape producer in the country. The state contributes 12 per cent of India's total fruit production, 8 per cent of vegetables, and 70 per cent of coffee. It ranks third in sugar production and fourth in sugarcane production. Karnataka is also a major player in floriculture, occupying the second position, and is the leading silk-producing state in India.

The main crops grown are Rice, Ragi, Jowar (sorghum), maize, and pulses (Tur and gram) in addition to oilseeds and a number of other cash crops. Cashews, coconut, arecanut, cardamom, chillies, cotton, sugarcane and tobacco are also produced. Karnataka is the largest producer of coarse cereals, coffee, raw silk and tomatoes among the states in India. Horticultural crops are grown in an area of 16,300 km² and the annual production is about 9.58 million tons. The income generated from horticulture constitutes over 40 per cent of income generated from agriculture and it is about 17 per cent of the state's GDP. (SLBC Karnataka , 2022-23)

Fisheries:

Karnataka possesses abundant freshwater resources, including 3.02 lakh ha of ponds, tanks, and 2.72 lakh ha of reservoirs, along with 8,000 ha of brackish water areas and a 320 km coastline with a continental shelf of 27,000 sq km. With 9.84 lakh fishers and 729 fishermen cooperative societies (132 marine and 597 inland), of which 667 are active (127 marine, 540 inland), the state's fisheries sector is robust. In 2022-23, marine fish production reached 7.30 lakh metric tons, primarily harvested by 4646 mechanized boats, 10961 motorized boats, and 8657 traditional crafts. Notably, over 85 per cent of the state's fish catch is attributed to mechanized fishing boats. Furthermore, marine products worth Rs. 1962.19 crore were exported from Karnataka during 2021-22. (Director of Fisheries, 2023)

Forestry Management in Karnataka:

Karnataka has total recorded forest area of 40,649 sq. km including 5 national parks, 36 Wildlife Sanctuaries (with five tiger reserves), and various other reserves. The Karnataka Forest Department prioritizes forest protection, biodiversity enhancement, and increasing forest cover through afforestation and sustainable management practices. It operates under central and state laws, such as The Karnataka Forest Act & Rules, 1963, and The Forest Conservation Act, 1980.

To address pressures on Karnataka's forests, the 2022-23 budget allocated Rs. 100 crores for seven activities: barren hillock restoration, degraded forest eco-restoration, mangrove afforestation, coastal shelter belts, Krishna Riverine ecosystem restoration, landslide management, and Bayaluseeme agro-forestry. The state also implements national schemes like the National Afforestation Programme (NAP), the National Bamboo Mission (NBM), and the Green India Mission (GIM) for sustainable forest development and climate adaptation. The Nagaravana scheme aims to enhance urban green cover and biodiversity.

Forests in Karnataka operate under the National Forest Policy of India (1988), with the Karnataka Forest Department managing timber, sandalwood, bamboo, and non-wood forest products. The Wildlife Wing oversees national parks, sanctuaries, and reserves, protecting wildlife species under the Wildlife Protection Act of 1972. Karnataka houses 524 tigers and 6,049 elephants, with compensation for human-wildlife conflicts provided by the government.

The Forest Conservation (FC) wing manages proposals under the Forest (Conservation) Act, 1980, for non-forest land use. Compensatory afforestation efforts include planting and protective measures, with Rs. 30 crores spent by March 2023 on forest land fences. The Vigilance Wing, led by a senior official, deploys 11 Forest Mobile Squads (FMS) to combat smuggling and poaching. These squads, armed and equipped for patrols, ensure forest protection. (Forest Department, Govt of Karnataka, 2023)

A comparison of the annual reports for 2012-13 and 2022-23 shows a decline in forest cover from 43,356.47 sq km in 2012-13 to 40,649.30 sq km in 2022-23. Similarly, the pace of plantation has declined gradually with the area of plantations raised decreasing from approximately 81,349 hectares in 2012-13 to 29,777 hectares in 2022-23. (Forest Department, Govt of Karnataka, 2023)

Challenges like water scarcity especially urban water issues in Bengaluru-

Karnataka, India's second most drought-prone region, faces a severe water crisis impacting thousands of villages, wards, and talukas due to inadequate rainfall. Despite abundant water resources in its seven major river basins, only half are utilized for development. Groundwater, the primary source, is over-drafted by 64 per cent, leading to contamination issues, especially in urban areas like Bengaluru. The city's water demand exceeds its supply, exacerbating the crisis despite reliance on Cauvery water and groundwater.

Multiple factors contribute to this crisis, including insufficient rainfall, urbanization reducing green cover, over-exploitation of groundwater, and pollution. Efforts to address it include relocating tech workers and imposing fines for water misuse. However, comprehensive measures, considering Climate Change and adopting Integrated Water Resources Management (IWRM), are needed. Leveraging technology and community involvement can optimize water use, while sustainable urban planning is crucial to ensure future water security.

Initiatives like Jaladhare and the Jal Jeevan Mission aim to provide safe drinking water to all households, supported by the Karnataka Water Policy 2022 focusing on integrated water management. Short-term measures involve allocating funds, supplying tankers, and real-time monitoring. Long-term strategies emphasize rejuvenating natural water flows, improving sewage management, and enhancing community engagement to address Karnataka's water crisis effectively. (KPSC, 2024) (Tiwari, 2024)

Irrigation projects related to SDG issues

SDG 2, "Zero Hunger," intersects with irrigation by enhancing crop yields, mitigating drought risks, and promoting sustainable agriculture, essential for reliable food production and poverty alleviation. SDG 6 focuses on sustainable water and sanitation management, with Target 6.4

specifically addressing water-use efficiency across all sectors, including agriculture, through technologies like irrigation. (Ministry of Statistics and Programme Implementation, n.d.)

India's major commitments to Sustainable Development Goals (SDGs) 2030, involves managing 260 lakh hectares of land. To support these goals, the Department of Land Resources, Ministry of Rural Development, is implementing the "Pradhan Mantri Krishi Sinchayee Yojana - Watershed Development Component 2.0" (PMKSY-WDC 2.0) across the country from 2021-22 with the motto of 'Har Khet Ko Paani'. This initiative aims to treat 2.75006 lakh hectares of rainfed area in 57 taluks across 30 districts in Karnataka using a new-generation watershed approach. This program aligns with SDGs by improving irrigation, enhancing agricultural productivity, and promoting sustainable land management. (Government of Karnataka, 2023)

By 2030, Karnataka aims to double agricultural productivity the state targets an increase in food grain production from 142 lakh tons in 2017-18 to 181 lakh tons by 2030. Horticulture will also expand, with production expected to rise from 173.6 lakh tons to 270.14 lakh tons by 2030. Irrigation projects are crucial for these goals. By adopting micro-irrigation, the total irrigated area is expected to expand, boosting horticultural crop cultivation and water use efficiency, essential for productivity. Irrigation will also support cropping pattern diversification, benefiting fruits, vegetables, spices, and condiments sectors. Additionally, milk, egg, meat, and fish production are projected to increase significantly by 2030, supported by improved irrigation and agricultural practices. These efforts aim to enhance Karnataka's food security and economic growth in agriculture. (Planning, Programme Monitoring and Statistics Department Karnataka, 2020)

To increase the irrigation efficiency and to save water KNNL has taken up Modernization works under various Projects. Bhadra canal network, Tungabhadra Left Bank Canal and network, Anjanapur, Ambligol, Chandrapalli, Hattikuni projects Modernization works are under progress. thora, Gondi, Vijayanagar channel, Tunga anicut and Ghataprabha left canal Modernization works are programmed to be taken up and are in different stages of implementation. (Govt of Karnataka, 2019)

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Circular Economy in Agriculture: Minimising Waste and Maximising Resource Efficiency

By: Shri. Jayant Sharma, Consultant & Shri. Sumit Kumar Meena, Sr. Ar

Introduction:

We are living in an era of unprecedented population growth. Since the middle of the twentieth century, the world's population has more than tripled in size, reaching almost 8 billion people in 2022 and is expected to reach around 11 billion by 2100 (United Nations, 2022). India has the largest population in the world, which is around 1.44 billion at present. Feeding a constantly growing population is one of the major challenges faced by the country, and increasing agricultural production by making maximum use of available resources has become a constant need. With the help of the latest technologies and tools- hybrid seeds, chemical fertilizers, pesticides, agriculture finance, , etc. the production of agriculture products has achieved significant growth and has succeeded in meeting the challenge. Below Table exhibits the significant growth in agriculture products within a short span of 13 years:

Table below shows Changes in production of four major crops in 2008-09 and 2022-23

(In Million Tonnes)

Crop	Total production in the Year 2008-09	Total production in the Year 2021-22	Difference	Production increase in percentage
Foodgrains	234.47	315.72	162.47	69
Oilseeds	27.72	37.70	9.98	36
Sugarcane	285.03	431.81	186.78	66
Cotton	22.28	31.20	8.92	40

@Production in million bales of 170 kg each **Source:** (The Ministry of Agriculture and Farmers Welfare, GOI)

Agriculture activities impact the environment, and to some extent, are liable for Climate Change. As agricultural production increases, the environment is also adversely affected. This effect occurs mainly in three ways i.e. water stress due to use a lot of fresh water for irrigation, greenhouse gas emissions from the use of chemical fertilizers, pesticides , etc, and degradation of forests and grasslands by enormous land use for agriculture purpose (Our world in Data).

Circular Economy and its necessity in the Agriculture Sector

In **Linear Economy** approach, people use the earth resources, generate products from them, and in the end throw the by-products as waste (take-make-dispose). Today, when resource scarcity and environmental concerns are becoming increasingly pressing, the concept of circularity has gained significant attention. An economic model known as the “**Circular Economy**” seeks to reduce waste, increase resource efficiency, and advance sustainability. *The Circular Economy, also known as a “closed loop” economy, aims to reach holistic sustainability goals and is based on the concept of “No waste”.* The circular economy is a defined phenomenon for greening sectors. It addresses decoupling, resource efficiency, production efficiency, slower material flows rather than linear economic models, and lower resource extraction without reducing economic activity (Science Direct).

Circularity in agriculture (**agroforestry, crop rotation, composting, organic farming, resource efficiency, value-added products and services, regenerative agriculture, , etc.**) tries to close resource loops within the agricultural system, minimising waste and maximising resource efficiency. Under the lens of the circular economy, agriculture practices can offer a multitude of opportunities from primary production using precision agriculture techniques, to the recycling and utilisation of agricultural wastes and materials as explained in the under mentioned paragraphs:

Agroforestry (Gold, Agroforestry, n.d.) is a sustainable agricultural practice that combines trees and shrubs with crops and/or livestock. It is a multi-functional land use system that provides a range of ecological, economic, and social benefits. Agroforestry systems improve soil health, increase biodiversity, conserve water resources, prevents soil erosion, mitigate Climate Change, and provide additional sources of income (wood and fruits) for farmers. While fresh leaves from trees are fodder for Milch cattle, dry and rotten leaves can be a rich compost for the crops. Leaves of some

trees like “Indian lilac” are the best organic pesticides for the crops. Trees and shrubs also provide shade resulting less water requirement for irrigation for crops. Milch cattle dung can be used as fertilizer for the trees and shrubs grown on the agriculture land, ultimately reducing the waste generated by the cattle (Gold, Agroforestry, 2024).

Crop rotation is the practice of growing a series of different types of crops in the same area across a sequence of growing seasons. This practice reduces the reliance of crops on one set of nutrients, pest and weed pressure, along with the probability of developing resistant pests and weeds (Britannica, n.d.).¹

In a Circular Economy, bio-waste from food is not landfilled. Instead, it is turned into **compost** which forms a resource for organic soil improvers, fertilizers, and bio-based products. The carbon and nutrient contents of bio-waste are converted into organic fertilizers for the soil. Waste decomposers in agriculture produce natural fertilizer. The composted output acts as an excellent organic fertilizer, rich in nutrients like nitrogen, phosphorus, and potassium. This fertilizer improves soil health and crop yields. **Organic farming** and manuring system practices are far-reaching and oblige the development of socially, ecologically, and economically sustainable food production systems.

Resource use efficiency is a measure of how effectively resources such as land, water, energy, and labour are used in agricultural production. It is an important concept in sustainable agriculture as it can help to reduce the negative environmental impacts of agriculture while maximising productivity and profitability.

Market forces lead to greater opportunities for product differentiation and added value to raw commodities. **Value-added agriculture** entails changing a raw agricultural product into something new through packaging, processing, cooling, drying, extracting or any other type of process

that differentiates the product from the original raw commodity. It added the value of the product by changing or transforming a product from its original state to a more valuable state (Melissa Matthewson, 2007).

The agricultural sector holds the rare potential to not just drastically reduce emissions but also sequester atmospheric carbon back into the soil, providing a natural way to limit global warming whilst producing nutritious food. **Regenerative agriculture** is a way of farming to build and improve soil fertility, whilst sequestering and storing atmospheric CO₂, increasing farm diversity and improving water and energy management. *It is a holistic solution that represents a first step towards a wider set of economic, environmental, and social benefits.* Farms using regenerative practices can benefit from higher and more stable yields, lower input costs and the development of natural capital and ecosystem services whilst building agricultural resilience. Some of the regenerative agriculture practices are: limit soil disturbance, cover the soil, integrate livestock, and keep living roots in the ground , etc. *Its objective is to restore soil health* (Regenagri, n.d.).

Importance of Circular Economy in Agriculture:

- **Efficiency in resource use:** Agriculture is strongly dependent on limited resources, including energy, water, and nutrients. Utilising these resources as efficiently as possible while minimising waste and increasing productivity are circular agriculture practices.
- **Waste Management and Recycling:** Circular agriculture places a strong emphasis on lowering waste production and encouraging recycling within the agricultural system, for example, using crop residues, animal manure, and food scraps as organic fertilizers. Circular agriculture aims to minimise waste generation and utilise by products effectively. This involves practices such as composting organic waste, reusing agricultural residues as animal feed or biofuel, and implementing anaerobic digestion systems to produce biogas from manure. These processes not only reduce waste but also generate valuable resources for the farm or the broader community.
- **Biodiversity conservation:** By fostering diverse and robust ecosystems, circular agriculture practices can help to conserve biodiversity.
- **Climate Change Mitigation:** By lowering greenhouse gas emissions and boosting carbon sequestration, circular agriculture helps to combat Climate Change.

- Food production and consumption practices are more sustainable when agriculture is circular. Circularity fosters a more sustainable and resilient food system, assuring food security and lowering environmental impact by minimising food loss and waste, boosting local and seasonal food production, and promoting healthier diets.
- **Improved Soil Health and Biodiversity:** Circular agriculture practices enhance soil health through organic matter enrichment, reduced erosion, and diversified cropping systems. Healthy soils support higher yields, improve water infiltration, and promote the growth of beneficial microorganisms, ultimately increasing the resilience of farming systems.
- **Economic Possibilities:** Circularity creates economic value and job possibilities, and aids in the growth of a circular bio-economy by valorising agricultural leftovers and by-products through procedures including biomass conversion, bioenergy production, and the creation of bio-based goods.

Farmers can explore opportunities to process and market secondary agricultural products or engage in activities like agritourism, education programmes, and on-farm renewable energy production. These initiatives create additional revenue streams, strengthen local economies, and foster community engagement (Tracex, 8 June 2023).

Conclusion:

Circularity in agriculture is not just a concept but a necessity for building a sustainable and resilient food system. By minimising waste, increasing resource efficiency and advance sustainability, Circular Economy can support not only food security but also offers opportunities from primary production using precision agricultural techniques, to the recycling of agricultural waste and materials. This approach is crucial in mitigating the challenges posed by growing population and environmental degradation, while ensuring sustainability in agriculture.

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Agricultural Markets with a focus on Equilibrium Moisture Content, Processing and Minimum Support Price

By: Shri. Kamal Kumar Sahal, Consultant & Shri. Mohan Lal Meena, Assistant Supervisor

Introduction:

Agriculture occupies a very important role in the growth of the economy of our country. India is primarily an agricultural country. The prosperity of the Indian economy is dependent on the course of agricultural production. The agricultural products that we consume daily reach us through a long journey through the market system from their origin. The efficiency of the system has a direct impact on our day to day lives. Most of the farmers sell their produce through village level markets, fairs, Mandis, Co-operative Societies, etc. The agricultural market system defines the method through which agricultural products reach us from their source and spread all over parts of the country. Marketing in Agricultural Sector is a mechanism through which goods reach different places depending on the market. It is a process that involves assembling, processing, storage, packaging, transportation, grading, distribution, and deciding the support price of various agricultural products across the country. The term encompasses the entire range of supply chain operations of the farming product (Vedantu, n.d.).

Initiatives by the Government:

To assist farmers in directly connecting buyers to enable them to discover the optimum price for their commodities, the Ministry of Agriculture and Farmers' Welfare has brought “**Model Agriculture Produce and Livestock Marketing (Promotion and Facilitation) Act, 2017**” (**APLM Act**) in April 2017. The purposes of the APLM Act are to create a single agriculture market with a single license in which agriculture produce and livestock would be traded as a regulated wholesale Agri-market at a distance of every 80 km. This would enable the farmers and traders to transact all such regulated Agri-markets within the State, provide a single license for trading within the State and the National level, and promote online or spot (e-National Agriculture Market-eNAM) agriculture market platforms. The provisions of the Act include, inter alia, establishing the Agri-market by the Government as well as private stakeholders, farmer-consumer Agri-markets, direct marketing by farmers, special commodity market

yards, declaring warehouses, silos, cold storages, or such structures as market sub-yards so as to reduce the number of intermediaries between producer and buyer and increase the share of the farmer in the consumer's rupee (Ministry of Agriculture and Farmers Welfare, n.d.).

On April 14, 2017, the government introduced the e-NAM system to improve transaction transparency, price discovery, and farmers' access to a wider range of marketplaces to sell their goods to purchasers of their choosing at their convenience. The programme establishes a national web-based unified agri-marketing gateway for inter-market and inter-state trade of agricultural commodities. Transparency and competition will result in greater pricing for farmers' produce and cashless payments directly to their bank accounts. 585 wholesale regulated marketplaces are expected to be connected to e-NAM by March 2018.

The Indian Government also launched the Central Sector Scheme (CSS) in 2020 to form and promote 10,000 Farmer Producer Organisations (FPOs). FPOs formation and promotion will be carried out by Implementing Agencies (IAs), who will then employ Cluster Based Business Organisations (CBBOs) to develop and give professional handholding support to FPOs over a five-year term (Ministry of Agriculture & Farmers' Welfare, 2024).

In the undermentioned paragraphs, we will discuss three focused areas i.e., **Equilibrium moisture content, Processing, and Minimum Support Price (MSP)**, one by one:

(a) Equilibrium Moisture Content:

When a solid is exposed to a steady supply of air at constant temperature and humidity, with a fixed partial pressure of the vapour, p , the solid will either lose moisture by evaporation or receive moisture from the air until the vapour pressure of the solid's moisture equals p . The solid and gas are thus in balance, and the moisture content of the solid in equilibrium with its surroundings is referred to as Equilibrium Moisture Content (EMC).

The EMC is useful for determining whether a product will absorb or lose moisture under specific temperature and relative humidity circumstances. Thus, EMC is inextricably linked to drying and storage. Different materials have varying EMCs. The EMC is affected by ambient temperature and relative humidity, as well as grain variety and maturity. The equilibrium moisture curve, also known as the isotherm, is a representation of a material's equilibrium relative humidity and moisture content at a specific temperature (typically 25°C). (Lodhi, 2021).

Importance of EMC:

EMC is particularly important in the drying and storage of agricultural commodities. The benefits of EMC are:

- (i) EMC tells us if the material will acquire or lose moisture under a certain atmospheric state. It also provides a sense of the rate of moisture evaporation.
- (ii) EMC is useful in determining drying qualities. EMC may be used to anticipate the moisture level at which a product can be dried using hot air (Lodhi, 2021).

(b) Processing of agricultural products:

Most of the agricultural products need some kind of processing before consumption by the ultimate consumers. Agro-processing could be defined as a set of techno-economic activities carried out for the conservation and handling of agricultural produce and to make it usable as food, feed, fibre, fuel, or industrial raw material. Hence, the scope of the agro-processing industry encompasses all activities such as sorting, grading, packaging, preserving, and transforming from the stage of harvest till the material reaches the end users in the desired form.

In ancient India, post-harvest and processing practices were used for preservation and processing of agricultural produce for food and medicinal purposes. By the middle of the nineteenth century, common agro-processing industries in India included hand pounding units for rice, water power driven flour mills, bullock driven oil ghanies, bullock operated sugarcane crushers, paper making units, spinning wheels, and handloom units for

weaving. As time passed, a need was felt for incorporating chemical interventions in the agricultural sector and precision farming through agricultural mechanisation manned by engineers (Tamil Nadu Agriculture, Coimbatore, n.d.).

Agro-processing Sector has now emerged as an important segment of the Indian economy in terms of its contribution to Gross Domestic Product (GDP), employment, and exports. High-frequency pulsed electric field, High hydrostatic pressure, Ohmic heating, Microwave heating, Ultrasonic processes, Infrared heating, Ultraviolet (UV) disinfection, Nanotechnology, and Cool Plasma, , etc. are some of the emerging technologies that are used in the sector (ResearchGate, 2009).

Agro-processing adds value to agricultural commodities, extends their shelf life, improves their marketability, and opens doors to domestic and international markets. The main benefits of processing in the agriculture sector are as follows:

(i) Value Addition and Increased Profitability: Agro-processing allows farmers to command higher prices for their products by adding value through processing. For example, raw cocoa beans can be processed into chocolate, and maize into flour. Value addition increases profitability along the agricultural value chain, benefiting farmers, processors, and other stakeholders.

(ii) Job Creation and Economic Development: Agro-processing has significant potential for job creation. It generates employment opportunities across various stages of the value chain, including production, processing, packaging, marketing, and distribution. By fostering agro-processing industries, India can create sustainable livelihoods, reduce rural-urban migration, and contribute to overall economic development.

(iii) Improved Food Security and Nutrition: Agro-processing enhances food security by reducing post-harvest losses and increasing the availability of processed and preserved foods. Agro-processing also enables the development of nutritious products, addressing malnutrition and promoting healthier diets.

(iv) Export Diversification and Trade Opportunities: Agro-processed goods have a higher potential for export than raw agricultural products. Processed products often command premium prices in international markets, and they meet the quality and safety standards required for export. Agro-processing enables Africa to diversify its export portfolio, reduce reliance on primary commodities, and tap into lucrative global markets.

(v) Processing Makes Meals More Palatable: Wheat and corn are examples of grain crops that are not edible in their natural state. Milling and grinding procedures turn them into flour, bread, and grain-based goods, which ultimately make agricultural products more edible meals.

In addition to the benefits, processing activities in agriculture also have significant challenges, such as limited access to finance and technology, inadequate infrastructure, quality control and standardisation, challenges in accessing markets, developing effective marketing strategies, , etc.

(c) Minimum Support Price:

The prices of agricultural commodities are inherently unstable, primarily due to the variation in their supply, lack of market integration, and information asymmetry. A very good harvest in any year results in a sharp fall in the price of that commodity during that year, which in turn has an adverse impact on the future supply as farmers withdraw from sowing that crop in the next/following years. This then causes paucity of supply next year and a subsequent major price increase for consumers. To protect the interests of farmers and producers against any sharp decline in agricultural prices, the Government has been following the agricultural price support system since 1965. The Minimum Support Price (MSP) for major agricultural products is fixed by the Union Government each year on the recommendations of the Commission for Agricultural Costs and Prices (CACP). The CACP recommends MSP for twenty-five agricultural crops every year, which inter-alia, include paddy, wheat, cotton, oilseeds, jute, and pulses. The MSP is a tool which guarantees farmers, prior to the sowing season, that a fair price is fixed for their upcoming crop to encourage higher investment and production of agricultural commodities. The price support system is expected to help the farmers after the harvesting period which is associated with a high probability of agricultural prices crashing due to surplus stock in the market. A Government guaranteed MSP to farmers is expected to cover the cost of production along with a certain profit margin for them (Lok Sabha Secretariat, New Delhi, Government of India, 2018).

Implementation of MSP System:

The MSP for all the crops under the ambit of the MSP regime is announced before their sowing season. This makes it possible for the farmers to have an idea about the extent of price insurance coverage provided by the Government. Besides, the announcement of the MSP, the Government organises procurement operations for these agricultural commodities through various public and cooperative agencies. The Food Corporation of India is a nodal Central agency along with other State agencies that undertake the procurement of wheat and paddy. Coarse grains are procured by the State Governments' agencies for the central pool, while procurement of oilseeds, pulses, cotton, , etc. is done by the National Agricultural Cooperative Marketing Federation of India Ltd., Small Farmers Agribusiness Consortiums, Cotton Corporation of India Ltd., and other agencies under the Price Support Scheme. For sugarcane, MSP has been assigned a statutory status and is termed as Fair and Remunerative Price (FRP). There is a statutory binding on the sugar factories to pay the FRP declared by the Government each year (Lok Sabha Secretariat, New Delhi, Government of India, 2018).

Potential areas for audit point of view:

Potential areas for audit from a detailed perspective include the implementation of the APLM Act, 2017; the e-NAM Scheme; the Central Sector Scheme for Formation and Promotion of FPOs; and EMC management. Firstly, the audit should verify if the provisions of the APLM Act, 2017 are being effectively implemented. This includes checking for the establishment of agri-markets within the mandated 80-kilometre distance and reviewing the promotion and operationalisation of e-NAM platforms. Secondly, for the e-NAM Scheme, the audit should ensure the integration of wholesale regulated markets with e-NAM by the target date, evaluate the transparency and efficiency of transactions on the e-NAM portal, and check the implementation and effectiveness of cashless payments to farmers. Thirdly, in the Central Sector Scheme for Formation and Promotion of FPOs, the audit should verify the formation and functioning of the 10,000 FPOs, assess the role and performance of IAs and CBBOs, and ensure the preparation and execution of business plans for FPOs. Finally, regarding EMC management, the audit should review the methods and tools used for measuring EMC in agricultural products and ensure the accuracy and consistency of EMC measurement techniques.

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The Influence of Agricultural Practices on Soil Erosion and Land Degradation

By: Dr. Mahesh Kumar Saini, Research Associate

Introduction

Soil erosion and land degradation are escalating rapidly, presenting a significant risk to soil fertility, productivity, and ultimately, global food security (Pimentel 2006). The world's food supply, ecosystem health, and sustainable development are all under threat due to soil degradation, which arises from a combination of human activities, agricultural practices, and natural processes (Powlson 2011).

Issues and Agricultural Practices Influencing Soil Erosion and Land Degradation

The most common agricultural practices that contribute to soil erosion and land degradation are:

1. **Conversion of natural ecosystems to farmland:** The clearing of forests, grasslands, and other natural habitats for crop fields and pastures leads to the loss of topsoil and the destruction of soil characteristics that support plant growth (Smith 2016).
2. **Intensive tillage and mechanization:** The use of heavy machinery and intensive tillage practices, such as moldboard plowing², can lead to soil compaction, reducing water infiltration, increasing runoff, and making it harder for plant roots to penetrate the soil. This makes the soil more vulnerable to erosion by water and wind (Haghnazari 2015).
3. **Monoculture cropping systems:** The prevalent practice of cultivating a single crop species over large areas, is a significant contributor to soil degradation and economic losses in agriculture. This intensive farming approach often leads to decreased crop yields, diminished

² The moldboard plow performs the following tillage operations and soil-conditioning functions: It cuts, lifts, breaks up, and loosens soil that has been compacted through machinery traffic or natural causes to a depth of usually 100–200 mm below the soil surface.

product quality, and increased susceptibility to diseases and pests. The primary drivers behind these adverse effects are the changes in soil microbial communities, nutrient availability, and the allelopathic interactions³ between plants (Belete 2023).

4. **Overgrazing:** The conversion of natural ecosystems to pasture land may not immediately cause significant damage, unlike crop production. However, this change in land use can lead to high rates of erosion and loss of topsoil and nutrients over time. Overgrazing can reduce ground cover, making the land susceptible to erosion and compaction by wind and rain. This can lead to reduced plant growth, decreased water infiltration, and harm to soil microorganisms, ultimately resulting in severe land erosion (WWF 2024).
5. **Excessive use of agrochemicals:** The overuse of pesticides, herbicides, and other chemicals can change soil composition and disrupt the balance of microorganisms, stimulating the growth of harmful bacteria at the expense of beneficial ones. This can lead to soil contamination, biodiversity decline, and reduced soil fertility (Pathak 2022).
6. **Improper irrigation practices:** Poorly managed irrigation can lead to the accumulation of salts in the soil, a process known as salinization. This can reduce soil fertility, limit plant growth, and eventually lead to desertification (Machado and Serralheiro 2017).
7. **Soil salinization:** Soil salinization, which may be defined as a high concentration of soluble salts in the soil, has adversely affected many agricultural areas around the world. However, it is more pronounced in arid areas where the rate of evaporation is high, and rainfall is insufficient to leach salts out of the soil. Inefficient management of irrigation and drainage waters, inefficient fertilization practices, and Climate Change are major contributors to this issue (Haj-Amor 2023).

These practices, combined with natural factors such as climate and topography, contribute to the widespread problem of soil erosion and land degradation in agricultural systems worldwide.

³ Chemically mediated plant–plant interactions are represented by allelopathy. Allelopathy exerts mostly negative effects on the establishment and growth of neighboring plants by allelochemicals, therefore, plants can chemically affect the performance of neighboring plants through the allelopathy. (Chui-Hua Kong, 2024)

Solution:

The solution to mitigate the influence of agricultural practices on soil erosion and land degradation involves adopting sustainable land management techniques. Conservation tillage methods such as no-till or reduced tillage are crucial in preserving soil structure, retaining moisture, and enhancing organic matter content while minimizing degradation risks. Crop rotation plays a vital role by breaking pest cycles, improving soil fertility, and reducing nutrient depletion through alternating crop types seasonally. Implementing strip cropping further aids in effective soil management by diversifying crop types across fields. Efficient irrigation practices like drip irrigation help prevent issues such as secondary salinization and sodification caused by over-irrigation (UCDAVIS 2024).

Initiatives by India:

1. The Green India Mission (GIM):

The Green India Mission (GIM), part of India's National Action Plan on Climate Change, aims to enhance forest/tree cover, restore degraded ecosystems, and improve biodiversity. Launched in 2014, it targets increasing forest cover on 5 million hectares (mha) and improving forest quality on another 5 mha. By 2023, GIM has made significant progress with 1.5 mha afforested and 2 mha of forest quality improved, contributing to carbon sequestration and absorbing 30-35 million tonnes of CO₂ annually. The mission also promotes community involvement, sustainable agriculture, soil and water conservation, and livelihood improvements, enhancing ecological balance and climate resilience (MoEFCC 2023).

2. The National Mission for Sustainable Agriculture (NMSA):

The National Mission for Sustainable Agriculture (NMSA) in India aims to enhance agricultural productivity while ensuring sustainability and climate resilience. Key targets include promoting efficient water use, improving soil health, and adopting conservation agriculture. Achievements include the dissemination of drip and sprinkler irrigation systems, reducing water wastage, and the Soil Health Card Scheme, which has provided

millions of farmers with soil nutrient data for balanced fertilizer use. NMSA has fostered organic farming and agroforestry, improving soil fertility and reducing erosion, and constructed water conservation structures to enhance groundwater recharge and reduce runoff. Overall, NMSA has significantly improved sustainable agricultural practices and resilience to climate variability (Ministry of Agriculture and Farmers Welfare 2019).

3. The Integrated Watershed Management Programme (IWMP):

The Integrated Watershed Management Programme (IWMP) in India targets holistic development of rain-fed areas to combat soil erosion, water scarcity, and land degradation. Its goals include improving water availability, enhancing agricultural productivity, promoting sustainable land use, and ensuring livelihood security for rural communities. Key achievements include constructing check dams, farm ponds, and contour bunds, which have reduced soil erosion and increased groundwater recharge. The program has also promoted sustainable agricultural practices, improved soil health, and enhanced community participation, leading to better water management, increased agricultural output, and improved socio-economic conditions (Singh 2010).

Conclusion:

Soil erosion and land degradation, pose significant threats to soil fertility, productivity, and global food security, stemming from human activities, agricultural practices, and natural processes. Factors like conversion of natural ecosystems, intensive tillage, monoculture cropping, overgrazing, agrochemical use, improper irrigation, and soil salinization contribute to these challenges. Addressing these issues through sustainable land management practices is crucial for preserving soil health, biodiversity, and resource sustainability, ensuring food security, ecosystem well-being, and sustainable development for future generations

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Stubble Burning: Challenges and Solutions

By: - Dr. Gulshan Sharma, Research Associate

Introduction

Stubble burning, a common agricultural practice in many parts of the world, especially in regions with intensive farming like India, poses significant challenges to the environment, public health, and overall sustainability. This article delves into the challenges associated with stubble burning and explores potential solutions to mitigate its adverse effects.

Challenges of Stubble Burning

- One of the primary challenges is the severe air pollution it causes, as stubble burning releases a substantial amount of harmful pollutants like particulate matter, carbon monoxide, and nitrogen oxides into the atmosphere (Kadian, 2024).
- This deterioration in air quality leads to respiratory issues, cardiovascular diseases, and other health problems, especially among vulnerable populations. Additionally, stubble burning contributes to the already high levels of air pollution in many regions, exacerbating the situation and posing a serious threat to public health. Another major challenge is the degradation of soil health caused by this practice (Prakash, 2021).
- Burning crop residue depletes the soil of essential nutrients and reduces soil organic matter, which is crucial for maintaining soil fertility and agricultural productivity. This practice also contributes to Climate Change by releasing greenhouse gases like carbon dioxide and methane into the atmosphere, further exacerbating global warming (Bhuvaneshwari, 2019).

- Burning of crop residue increases the temperature of soil to a very high level. The level of high temperature is beyond the tolerance limits of most of soil organisms, which results in death of beneficial soil organisms and other organisms like earthworm. (Richa Khanna, 2021)
Addressing these challenges requires an approach that involves technological innovations, policy interventions, and community engagement to promote sustainable agricultural practices and mitigate the adverse impacts of stubble burning (Kadian, 2024)

Solutions to Stubble Burning

- Addressing the challenges posed by stubble burning requires the implementation of effective solutions to promote sustainable agricultural practices and mitigate its adverse effects (MoA & FW, 2024).
- One key solution is the adoption of mechanical alternatives such as Happy Seeders and Mulchers, which enable farmers to manage crop residues without resorting to burning. These machines facilitate the mulching of crop residues back into the soil, promoting soil health and fertility while reducing the need for burning (Prakash, 2021).
- Providing financial incentives to farmers who refrain from stubble burning is another effective solution. Subsidies for purchasing machinery, implementing alternative practices, or compensating for additional costs can motivate farmers to adopt eco-friendly alternatives. Furthermore, raising awareness and educating farmers about the detrimental effects of stubble burning and promoting sustainable agricultural practices through training programs, workshops, and demonstrations are essential steps in encouraging a shift towards responsible farming practices (Kadian, 2024).
- To support the efforts of the Governments of Punjab, Haryana, Uttar Pradesh and NCT of Delhi to address air pollution and to subsidize machinery required for management of crop residue, a Central Sector Scheme on ‘Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi’ is being implemented from 2018-19. To facilitate in-situ management of paddy straw as also for baling / raking machines and equipments to facilitate ex-situ applications, Central Government has released funds to the tune of about Rs. 3,333 crore till so far under the Crop Residue Management Scheme, to the State

Government of Punjab, NCR States and GNCT of Delhi for subsidised procurement of machines by individual farmers / custom hiring centres and cooperatives (MOEFCC, 2023)

- Initiatives can be taken to develop fodder and feed markets and regular supply of crop left can be supplied to the areas with deficit supply of fodder for farm animals. (Richa Khanna, 2021)
 - The use of PUSA Decomposer developed by the ICAR- Indian Agriculture Research Institute (IARI), New Delhi could be a better option. It is a microbial consortia of eight types of micro-organisms that assist in producing enzymes essential to accelerate the decomposition of bio-mass. (Richa Khanna, 2021)
 - After harvesting, paddy straw can be utilized for other ventures such as recyclable straw for drinking, cardboards, animal bedding use in thermal power plants, bio refineries, biochar production, , etc. (Richa Khanna, 2021).
 - It can also be used as an alternative for mushroom cultivation. (Richa Khanna, 2021).
 - Haryana Government has unveiled a paddy stubble management policy aimed at utilising paddy straw for sustainable energy and completely curbing crop residue burning practices by 2027. (Buisness Standard, 2023)
 - In accordance with the Framework and the Action plans, the State Governments of Punjab and Haryana have therefore been advised by the Commission for Air Quality Management in NCR and Adjoining Areas (CAQM) to mobilize the entire State administrative machinery to take all preventive and corrective measure for control of stubble burning (MOEFCC, 2023).
 - The Commission is also monitoring the paddy stubble burning incidents and taking up with State Governments of Punjab, Haryana and Uttar Pradesh on a daily basis including with Chief Secretaries and Deputy Commissioners of Districts concerned. (MOEFCC, 2023).
- By implementing these solutions and fostering a culture of sustainability in agriculture, we can effectively address the challenges associated with stubble burning and work towards a healthier environment and more sustainable future.

Conclusion

In conclusion, addressing the challenges associated with stubble burning requires a multi-faceted approach involving technological innovations, policy interventions, and community engagement. By implementing sustainable solutions and promoting responsible agricultural practices, we can mitigate the adverse impacts of stubble burning on the environment and public health. The audit should ensure that farmers are provided with training and awareness programs on sustainable agricultural practices and the harmful effects of stubble burning and should evaluate the engagement of local communities in addressing the challenges of stubble burning and promoting sustainable solutions.

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Agri-Waste “Challenges And Solutions With A Focus On Its Use, Transportation And Storage”

By: Akash Sharma, Research Associate

Background:

Agricultural waste encompasses a wide range of organic and inorganic materials discarded after agricultural processes, including crop residues like stalks, leaves, husks, animal manure, waste feed, agricultural chemicals, and packaging used in the production and supply chain. This waste, if not managed properly, can lead to environmental degradation, influencing air and water quality, reduced soil fertility, climate impact by releasing methane (CH₄) and carbon dioxide (CO₂), and health risks (Bala S 2023, Khan 2024).

India's stance in Agri waste management:

In India, agricultural waste management is a crucial step towards a cleaner and greener environment. The country has implemented policies to promote sustainable practices, such as the National Policy for Management of Crop Residue (NPMCR) to optimize the utilization of crop residue, prevent soil nutrient loss, and encourage diverse uses of crop residue in industrial applications. This policy also focuses on promoting appropriate crop machinery, using remote sensing technologies for monitoring, and providing financial support for innovative projects in agricultural waste management (Bhuvaneshwari S, 2019).

The challenges in the use, storage, and transportation of agricultural waste:

1. **Storage Issues:** Proper storage of agricultural waste is crucial to prevent environmental pollution and health hazards which can result in the release of harmful gases, odors, and contamination of water sources, if not managed effectively (Columbia 2015).
2. **Seasonal Fluctuations:** The process of creating agricultural waste exhibits seasonal patterns, which can create logistical issues and pose environmental dangers if waste is not handled effectively during peak times (Kumar 2024).
3. **Lack of Awareness:** Lack of awareness or knowledge about the importance of proper waste management can hinder compliance with regulations (Kumar 2024).

Solutions in the use, storage, and transportation of agricultural waste:

To mitigate environmental emissions, especially methane and nitrous oxide, from agricultural waste:

1. **Anaerobic digestion:** Anaerobic digestion (AD) is a promising option to treat the large biodegradable fraction of agricultural waste ('biowaste') in India (Breitenmoser L 2019).
2. **Composting:** Another effective ways to recycle agricultural waste into valuable organic fertilizer (Breitenmoser L 2019).
3. **Technological advances:** Emerging technologies like enzymatic hydrolysis and microbial fermentation can convert agricultural waste into biofuels, enzymes, vitamins, and other valuable products (Breitenmoser L 2019).
4. **Waste Segregation and On-Site Processing:** The use of emerging technologies such as automatic waste segregator and on-site waste processing technologies like composting, bio-methanation, and gasification/pyrolysis can transform agricultural waste into useful products like compost, biogas, and syngas (Invest India 2023)

Several initiatives implemented by the Indian Government to manage agricultural waste and promote sustainable practices:

1. **Galvanizing Organic Bio-Agro Resources Dhan (GOBARdhan)** is a major multi-ministerial initiative of the Government of India that aims to convert biodegradable/organic waste, including cattle dung, agricultural residues, and other biomass, into valuable resources such as biogas, compressed biogas (CBG), and organic manure. The initiative promotes a circular economy through a "Whole of Government" approach. As of July 2023, 643 GOBARdhan plants have been set up under the Swachh Bharat Mission - Grameen, including 200 compressed biogas (CBG) plants and 300 community or cluster-based plants. Announcing the establishment of 500 new "waste to wealth" plants with an investment of Rs. 10,000 Crore in Budget 2023-24 (Ministry of Jal Shakti 2024).
2. The Government of India provides a **subsidy on crop residue management machinery** of 50-80 per cent for machinery that helps farmers mix crop residue with soil to make it more productive. Farmer groups are also provided financial assistance of up to 80 per cent of the project cost for establishing Farm Machinery Banks for Custom Hiring of crop residue management machinery. Provision of Rs 1151.80 crores for two years has

been made under the scheme for states like Punjab, Haryana, Uttar Pradesh, and NCR to manage crop residue (Ministry of Agriculture & Farmers Welfare 2018).

3. Centrally Sponsored Schemes under **Rashtriya Krishi Vikas Yojana** on Crop Residue Management (CRM): This scheme was implemented from 2018-19 in Punjab, Haryana, Uttar Pradesh and NCT of Delhi. Its objectives include protecting environment from air pollution and preventing loss of nutrients and soil micro-organisms caused by burning of crop residue through promoting in-situ management of crop residue. In this regard, it proposes to set up Farm Machinery Banks for custom hiring of in-situ crop residue management machinery. It also aims to create awareness among stakeholders through demonstration, capacity building activities and differentiated information, education and communication strategies for effective utilization and management of crop residue. Rs. 3333.17 crore has been released under the scheme since inception and more than 2,95,845 Crop Residue Management (CRM) machinery has been distributed. CRM is now merged with Sub Mission on Agricultural Mechanization (SMAM) (Ministry of Agriculture & Farmers Welfare 2024).

4. Under the RKVY, the government has implemented various projects and activities to promote sustainable agricultural practices, including bio-conversion and bio-compost production from agro-waste. **The setting up of mechanised Fruit/Vegetable market waste/Agro waste compost production units** is a significant initiative aimed at promoting sustainable waste management and organic farming practices. These units are designed to process waste from fruit and vegetable markets as well as agricultural waste into compost, which can then be used as organic fertilizer. The government provides financial assistance and support for the establishment of these units, with a maximum limit of Rs. 190.00 lakh per unit for 3000 Total Per Annum production (Ministry of Agriculture & Farmers Welfare 2015).

5. Waste to Energy Programme. - The main objective of this programme is to support in setting up of Waste to Energy Projects for generation of Biogas/BioCNG/ Power/ producer or syngas from urban, industrial and agricultural wastes/residues. It provides Central Financial Assistance (CFA) to project developers and service charges to implementing/inspection agencies in respect of successful commissioning of Waste to Energy

plants for generation of Biogas, Bio-CNG/enriched Biogas/Compressed Biogas, Power/ generation of producer or syngas. (Ministry of New and Renewable Energy, 2024)

Conclusion:

The successful management of agricultural waste will require a multifaceted approach that integrates technological innovation, policy support, and stakeholder collaboration. By adopting a circular economy mindset and leveraging the potential of agricultural waste, we can create a more sustainable and resilient food system for future generations.

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Eco-Friendly Pest Management Techniques in Agriculture: Balancing Productivity and Environmental Protection

By: Shri. Manoj Kumar, AAO and Shri. Ram Niwas Sharma, Sr. Ar.

Introduction

The indiscriminate and unilateral use of pesticides has been the most preferred form of plant protection tool, especially during the sixties and seventies, for sustaining of agricultural production potential of the high-yielding varieties under the intensive cropping systems. It has resulted in various negative impacts such as like human and animal health hazards, ecological imbalance, development of resistance in the pests to pesticides, pests resurgence and environmental pollution as well as the destruction of natural enemies (bio-control agents) of pests and increased level of pesticides residues in soil, water, food with the increased use of pesticides (Ministry of Agriculture and Farmers Welfare 2014).

Forms of Sustainable Pest Control Practices

1. Biological practices:

Biological control of insect pests and diseases using biological methods is a pivotal aspect of sustainable pest management practices. In a broader context, biocontrol entails employing living organisms to regulate undesired living organisms (pests). Put simply, it involves intentionally utilizing parasitoids, predators, and pathogens to keep pest populations below economically damaging levels. This can be achieved either by introducing new bio agents into pest environments or by enhancing the efficiency of those already existing in the field.

2. Parasitoids:

These organisms lay eggs in or on the bodies of their hosts and complete their life cycles on these hosts, ultimately resulting in the death of the hosts. Parasitoids can take various forms depending on the developmental stage of the host in or on which they complete their life cycle. Examples

include egg, larval, pupal, adult, egg-larval, and larval-pupal parasitoids. Examples of parasitoids include various species of *Trichogramma*, *Apanteles*, *Bracon*, *Chelonus*, *Brachemeria*, *Pseudogonotopus*, among others.

3. Predators:

These are organisms that exist independently and prey on other organisms for sustenance. Examples include various species of spiders, dragonflies, damselflies, ladybird beetles, *Chrysopa* species, birds, and others.

4. Pathogens:

These are microorganisms that infest and induce diseases in their hosts, resulting in the death of the hosts. Major groups of pathogens include fungi, viruses, and bacteria. Additionally, some nematodes also cause diseases in certain insect pests. Notable examples of fungi include various species of *Hirsutella*, *Beauveria*, *Nomuraea*, and *Metarhizium*, which have been documented to infect and eliminate a significant number of insects in agricultural fields. Among viruses, prominent examples include Nuclear *Polyhedrosis Virus (NPV)* and *Granulosis viruses*. Regarding bacteria, common examples include *Bacillus thuringiensis (B.t.)* and *B. popillae*.

5. Bio pesticides

Pest diseases can be efficiently mass-produced in laboratory settings at a low cost, often in liquid or powdered forms suitable for application via spraying, akin to conventional chemical pesticides (Directorate of Plant Protection, Quarantine & Storage GOI, 2024).

Apart from the aforementioned sustainable Pest Control Practices, there are other forms of Pesticides which are designed to kill pests (rodents, insects, etc.) and protect plants from weeds. They are elaborated as under:-

Pesticides:

Pesticides in general, protect plants from weeds, fungi, or insects. They serve as plant protection products, also known as crop protection products. They are the chemical substances that are meant to kill pests. In general, a pesticide is a chemical or a biological agent such as a virus, bacterium, antimicrobial, or disinfectant that deters, incapacitates, kills, pests. They are commonly used to control a variety of agricultural pests that can damage crops and reduce farm productivity. The types of pesticides includes:

a) Insecticides with their Chemical Composition-

Acephate/ Asatof/Starthene(O-S Dimethyl acetylphosphoramidothioate,), Actara(Thiamethoxam,), Admire(Imidacloprid,), etc.

b) Fungicide & Bactericide with their Chemical concentration- Aliette (Fosetyl-AL,), Amistar (Azyoxystrobin Recommended), Aureofungin (Aureofungin), etc.

c) Organic Chemicals- Adhar (Azospirillum), Azab (Azotobacter), Biocatch (verticillium lecani), etc.

d) Herbicide - Gramoxone (Paraquat dichloride), Oxy gold (Oxyfluorfen), Round -up (Glyphosate), etc. (Directorate of Agriculture, Govt of Assam, 2023)

Pesticides designed to kill pests (rodents, insects, or plants) that may affect agricultural crops or carry diseases like malaria and typhus. (U.S Centre for Disease Control, 2008) are listed as under:-

Substances Listing:-

- 2,4-Dichlorophenoxyacetic Acid (2,4-D)
- Aldrin/Dieldrin
- Atrazine
- Chlordane
- Chlordecone
- DDT, DDE, DDD

- Endosulfan
- Endrin
- Glyphosate
- Heptachlor/Heptachlor Epoxide
- Hexachlorobenzene
- Methoxychlor
- Methylene Chloride
- Pentachlorophenol
- Polychlorinated Biphenyls (PCBs)
- Pyrethrins and Pyrethroids
- Toxaphene

The various bio-control practices are categorized as follows:-

6.1 Introduction

In this procedure, a new species of bio agent is introduced into a particular area with the aim of establishing it against its host. This step is taken only after rigorous laboratory examinations and field trials to assess its effectiveness.

6.2 Augmentation

During this process, the population of existing natural enemies in the region is augmented by releasing either laboratory-raised or field-collected bio agents of the same species, in quantities sufficient to control the pest population in that specific area.

6.3 Conservation

In this process, natural enemies present in nature are protected from being killed (Ministry of Agriculture and Farmers Welfare 2014).

Administrative and Legislative Framework

The Directorate of Plant Protection Quarantine & Storage was established in the year 1946 as an apex organization for advising the Government of India and state governments on all matters related to Plant Protection. It operates as an attached Office within the Ministry of Agriculture and Farmers Welfare. The Directorate looks after the Plant Protection strategy and activities that encompass activities aimed at minimising crop losses due to pests through integrated pest management, plant quarantine, regulation of pesticides, locust warning & control and training in desert areas besides training and capacity building in plant protection (Department of Agriculture and Farmers Welfare n.d.).

For the effective enforcement of the Insecticides Act, two bodies have been constituted at the Central level viz. Central Insecticides Board and Registration Committee. By virtue of Section 16 of the Insecticide Act, 1968, the Government of India established the Central Insecticides Laboratory (CIL) on 28th February, 1981 by Gazette Notification.

Laws Related to Agriculture Pest Control in India

1. The Destructive Insects and Pests Act, 1914- An act to prevent the introduction into and the transport from one state to another in India of any insect, fungus or other pest which is or may be destructive to crops (Ministry of Agriculture and Farmers Welfare n.d.).

A list of amending Acts and adaptation orders is given below:

- The Destructive Insects and Pests (Amendment) Act, 1930 (20 of 1930)
- The Government of India (Adaptation of Indian Laws) (Order, 1937)
- The Destructive Insects and Pests (Amendment) Act, 1938 (6 of 1938)

- The Destructive Insects and Pests (Amendment) Act, 1939 (3 of 1939)
 - The Indian Independence (Adaptation of Central Acts and Ordinances) Order, 1948
 - The Adaptation of Laws Order, 1950
 - The Part B States (Laws) Order, 1951 (3 of 1951)
 - The Jammu & Kashmir (Extension of Laws) Act, 1956 (62 of 1956)
2. The Insecticides Act, 1968, Act No. 46 of 1968- An Act to regulate the import, manufacture, sale, transport, distribution and use of insecticides with a view to prevent risk to human beings or animals, and for matters connected therewith.
3. Insecticides Rules, 1971
4. The Destructive Insects and Pests (Amendment and Validation) Act 1992- Amendment of section 3 of Act 2 of The Destructive Insects and Pests Act, 1914.
5. Plant Quarantine Order, 2003 (Consolidated version) and Amendments
6. Notification regarding Amendments in Insecticides Rules (Bilingual) (G.S.R. 399(E), dated 20.04.2018)

Initiatives by the Government of India

Govt. of India has adopted Integrated Pest Management (IPM) as a cardinal principle and main plank of plant protection in the overall Crop Production Programme since 1985.

The National Policy statement on IPM in India was made in the year 1985. Later on National Policy on Agriculture - 2000 and National Policy on Farmers – 2007 also supported the IPM. It was also supported by the Planning Commission document for the 12th Plan addressing the negative impact of chemical pesticides. In order to minimise the use of hazardous chemical pesticides and to manage insect pest/disease

IPM is an eco-friendly approach which encompasses cultural, mechanical, biological and need-based chemical control measures. The IPM approach is being disseminated through various schemes/ projects at the national and state level.

attacks as well as to increase crop productivity, the Government of India, Ministry of Agriculture, Department of Agriculture & Co-operation (DAC) has launched a scheme “Strengthening and Modernization of Pest Management (IPM) Approach in India in 1991-92”, considering it a fundamental principle and central strategy of Plant protection strategy in overall crop production programme. The Annual Target (2023-24) for IPM was (Ministry of Agriculture and Farmers Welfare n.d.) –

- Pest Monitoring 11.31 lakhs ha
- Field releases of biocontrol agents 3300 million
- Area Coverage 10.02 lakh ha (Augmentation & conservation of biocontrol agents)

As part of the IPM programme, the Government of India has set up 36 Central IPM centres across 28 states and two union territories. In the 12th Five-Year Plan's EFC (Expenditure Finance Committee) Memo, a “National Mission on Agricultural Extension and Technology (NMAET)” was established, introducing a “sub-mission on Plant Protection and Plant Quarantine” starting in 2014-15. One component of this sub-mission, “Strengthening and Modernization of Pest Management Approach in India,” aims to promote the adoption of Integrated Pest Management (IPM) through training and demonstrations in crops, along with the promotion of biological control methods in crop protection technology. (Ministry of Agriculture and Farmers Welfare 2014).

Biocontrol Laboratories/ Units in India

- CIPMCs (Central Integrated Pest Management Centres) 36 Nos.
- ICAR/SAUs/ DBT 49 Nos.
- State Biocontrol Labs 98 Nos
- Private Sector Labs 141 Nos.
- State Biocontrol Labs covered under Grants-in-Aids of Government of India 38 Nos.

Total 362 Nos.

(Ministry of Agriculture and Farmers Welfare, 2024)

Conclusion

The indiscriminate and injudicious use of chemical pesticides in agriculture has led to numerous adverse effects, including environmental pollution, ecological imbalances, pesticide residues in food, fruits, vegetables, fodder, soil, and water, pest resurgence, health hazards to humans and animals, destruction of bio-control agents, and the development of resistance in pests. Thus the use of eco-friendly practices and pesticides in agricultural practices has become all the more significant and essential. Employing bio-control agents, bio-pesticides, and bio-fertilizers can diminish the reliance on chemical pesticides and fertilizers. As a result, this reduction in chemical usage can mitigate adverse environmental and human health effects while enhancing soil and plant health. Initiatives such as the introduction of IPM, establishment of laboratories, and public awareness about using eco-friendly practices of pesticides in agriculture will further enhance their use resulting in curtailing the adverse effects of chemical pesticides.

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Importance Of Proper Seed Selection For Maximizing Crop Yields

By: Shri. Lokesh Kumar Meena, AAO and Shri. Jaipal Singh Meena Sr.Ar.

Introduction: Seed is the most important and vital input for agricultural production. In fact, it is the most cost-efficient means of increasing agricultural production and productivity. The efficiency of other agricultural inputs in enhancing productivity and production, such as fertilizers, pesticides and irrigation is largely determined by the quality of seeds. Quality of seed accounts for twenty-to-twenty five percent of productivity. It is, therefore, important that quality seeds are made available to the farmers of the country. (Department of Agriculture & Farmers Welfare | MoA & FW | Government of India, 2022)



Image 1, Image source: (Department of Agriculture & Farmers Welfare | MoA & FW | Government of India, 2022)

Importance of Seed Selection:

Seed selection in agriculture is the process of choosing the right type of seed for the crop development. It is important to choose the right type of seed wisely, as the wrong choice for seeds can result in poor yields. It is crucial to consider various factors, such as climate, soil type, and pest resistance while selecting right type of seeds. With careful planning and research, we can choose the right seeds for our farm and have a successful harvest. The selection of seeds is used to improve the quality and quantity of yields. There are several diseases that are transmitted via seeds. If the selected seeds are from the infected fields, then the seed-borne diseases will cause severe problems in the agricultural process. Along with the disease free and healthy seeds, farmers also need to check the germination period of the seeds, nutrients required and other benefits in terms of yield and finance. Overall, selecting good quality seeds are essential for growing strong and healthy crops.

Structural Concept of seeds quality.

Knowledge about the various quality aspects of seeds greatly contributed to agricultural development in the past and will continue to play a major role in future enhancement of crop production. Seed quality is a multiple concept comprising several components (Thomson, 1979). The components are divided in four major groups:

- i. Genetic quality
- ii. Physical quality
- iii. Physiological quality
- iv. Pathological quality

Issues related to Seed Selection in India

- India has as many as 45 major crops for which the seed has to be produced within the country. Hence it is quite a challenging task to meet the seed requirement of such a diversified crop range.
- There is lack of suitable varieties for rainfed upland and lowland areas, flood prone or cold tolerant varieties. This is one of the major reason for non-availability of modern varieties in some areas.
- There are missing links in seed production system. It is highly needed for states to ensure production, multiplication and replacement of seed to increase SRR⁴ (Seed Replacement Rate), especially related to regional important varieties. It shows significant disparity between the initial supply of breeder's seed to producers and its transformation into certified seed for farmers. This inefficiency leads to wasted time, land, and resources, diverting valuable research fields away from productive seed production that could meet national agricultural needs. (Singh, 2013)

Initiatives taken by the Government of India:-

⁴ Seed Replacement Rate (SRR) or Seed Replacement Ratio is the percentage of area sown out of the total area of the crop planted in the season by using certified or quality seeds other than the farm-saved seed (Pandey et al., 2017). SRR influences the seed quality by ensuring varietal and physical purity, seed health, and seed vigor.

a) Seed Village Scheme

In order to upgrade the quality of farmer-saved seed, comprising approximately about 80-85per cent of the total seed used for crop production programme, financial assistance is provided for distribution of foundation/certified seed. This covers 50per cent cost of the seed of crops, which aims at producing certified/quality seeds only and for training on seed production and technology to the farmers.

b) Transport subsidy on movement of seeds

This program includes states in the North-East such as Sikkim, Jammu & Kashmir, Himachal Pradesh, Uttarakhand, and hilly regions of West Bengal. It offers two types of support:

1. It reimburses 100 per cent reimbursement of the extra cost when seeds are transported by rail instead of road from outside the state.
2. It covers the actual transportation cost within the state, up to a maximum of Rs. 60 per quintal, for moving seeds from state capitals or district headquarters to sales outlets or counters.

c) Quality Control Arrangement on Seeds

This initiative focuses on ensuring the quality of seeds under the Seeds Act of 1966. It strengthens organizations like State Seed Certification Agencies, State Seed Testing Laboratories, Central Seed Testing Laboratory, and the Central Seed Committee. The goal is to enforce seed laws and ensure farmers receive high-quality seeds. Additionally, the National Seeds Research and Training Centre in Varanasi, Uttar Pradesh, plays a crucial role as a leading seed testing laboratory and training center for seed technology.

Financial support is also provided to the Central Seed Testing Laboratory (CSTL) to:

- Start testing programs in collaboration with recognized State Seed Laboratories to ensure consistent test results across India.
- Continuously gather data on the seed market to share with the Central Seed Committee.
- Coordinate and standardize seed testing procedures nationwide.

d) Assistance for Creation/Strengthening of Infrastructure Facilities for production and distribution of quality seeds :This

scheme aims to enhance the infrastructure for producing and distributing high-quality seeds through State Seeds Corporations, and support is given to build and upgrade facilities for cleaning, grading, processing, packing, and storing seeds. (Ministry of Agriculture and Farmers Welfare, n.d.)

Seed Quality:-Image 2 below shows the various components i.e Genetical, Physical, Physiological and Pathological components of a seed quality.

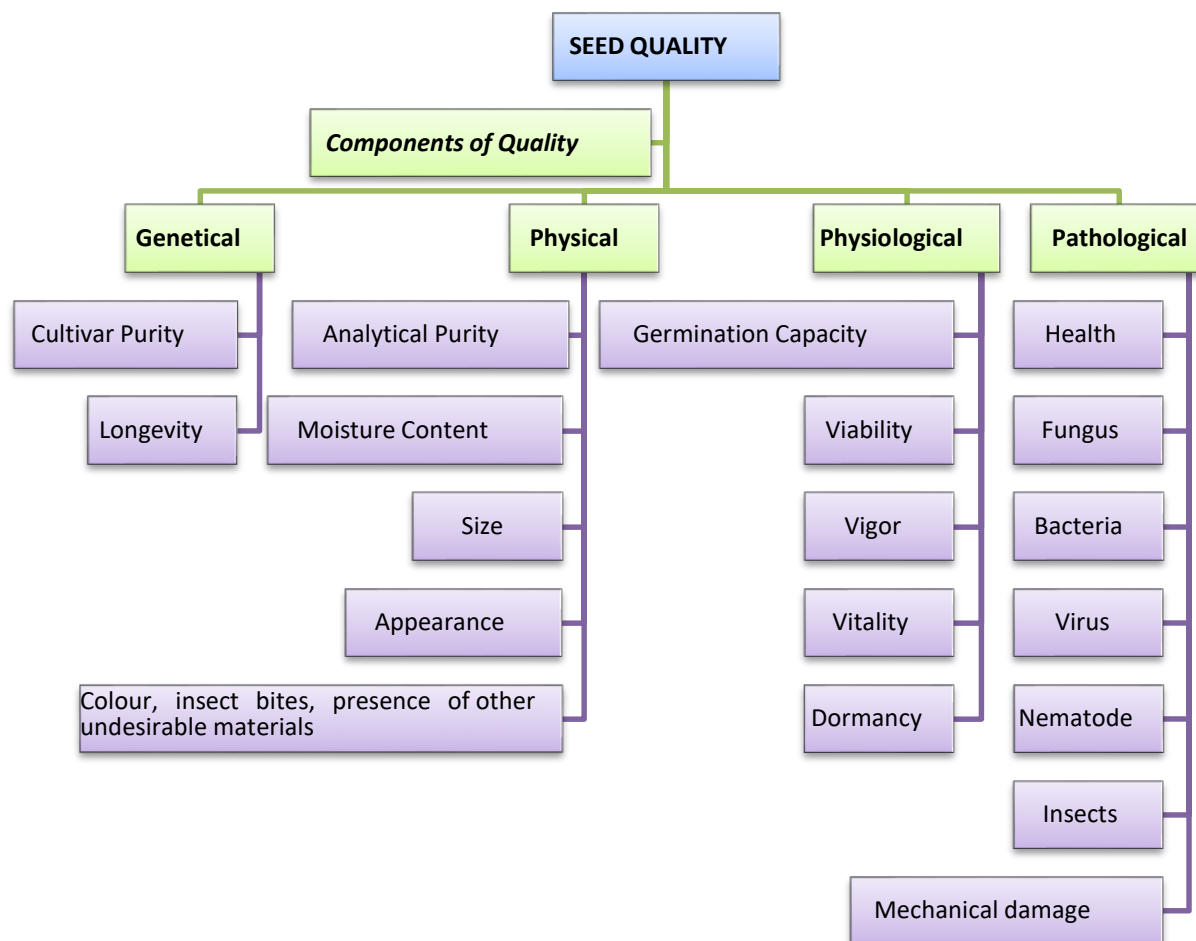


Image 2, Image source: Concept paper by Mirza Hasanuzzaman, Associate Professor, Department of Agronomy, Sher-e-Bangla Agricultural University (Mirza Hasanuzzaman, Associate Professor, 2015)

The Department of Agriculture and Co-operation is implementing a Central Sector Scheme as ‘Development and Strengthening of Infrastructure Facilities for Production and Distribution of Quality Seeds’ since 2005-06. The objective of the ongoing scheme is to ensure production and multiplication of high yielding certified/quality seeds of all crops in sufficient quantities and make the seeds available to farmers, including those in remote areas, not easily accessible by rail/road on time and at affordable price. (India D. o., 2022)

Importance of Selecting Right Seed Quality

a) Seed Germination:

Seed germination is the second stage that directly correlates with a farmer’s crop yield. Germination and seedling development is very important for early establishment of plants under stress condition. Quality seed insures good germination, rapid emergence, and vigorous growth. These aspects translate to a good stand (Whether greenhouse or field). Poor quality seed results in “skips”, excessive thinning, or yield reductions due to overcrowding, all of which diminish profitability. Germination of seed should be such that can ensure establishment of optimum plant stand for desirable production. (Mirza Hasanuzzaman, Associate Professor, 2015)

b) Resistance to Pests and Diseases:

To obtain maximum crop yields, tolerance to diseases and pest is extremely important and a major objective of plant breeders. Tolerance to pests and diseases means that a plant can live with these organisms without significant loss of yield and quality. Tolerance and resistance can breakdown with time due to mutations in the parasites or hosts. New sources of resistance and tolerance are always being sought by plant breeders. Having precise information on disease and pest tolerance of a variety is important when considering the introduction of new crop and varieties. Use of High-quality insect-resistant crop varieties is economically, ecologically, and

environmentally advantageous. Economic benefits occur because crop yields are saved from loss to insect pests and money is saved by not applying insecticides that would have been applied to susceptible varieties.

c) Uniform and Timely Planting

Uniform and Timely planting in favourable climate conditions resulting in higher and generally more stable yields. Specifically, timely crop planting raises system productivity by (a) mitigating risks of yield losses caused by pushing crop growth into periods of sub-optimal or extreme weather conditions such as cold and heat waves, drought, or flooding; (b) increasing resource use efficiencies; and (c) allowing for more crops to be grown per year on the same land.

d) Maximize yield potential:

To get maximize yield potential, it requires strategic seed selection, soil health management, efficient water usage, integrated pest control, optimal planting density, balanced nutrient application, effective weed management, climate-resilient practices, and vigilant monitoring. By integrating these factors, farmers can enhance crop productivity, mitigate risks, and boost economic returns.

Conclusion: Investing in good-quality seeds is a critical step in achieving a sustainable and productive harvest. By carefully choosing seeds with a good performance history, suitability to local growing conditions, and conducting seed testing, good crop yield can be ensured. This approach ensures good productive harvest, thereby reducing environmental impact, and optimizing returns on investment.

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Organic Farming And Its Impact On Environment

By: Shri. Pavan Kumar Meena, AAO and Shri. Mukesh Bhamu, Sr. Ar.

Introduction

Organic farming system is a method of farming system which is primarily aimed at sustainable agricultural production in an eco-friendly pollution free environment and is being followed from ancient time in India.

Organic Production system, keep the environment and ecology alive and in good health by use of natural resources to harness desired agricultural production for human consumption.

In Organic production, environmental focus is on using naturally available resources as inputs, such as organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (biofertilizers/ bio control agents) to release nutrients to crops and protect them from insect pest and diseases for increased agricultural production. (NCONF, 2024)

History

The concept and ideal of organic agriculture emerged in the early twentieth century, primarily in Europe and the United States. The pioneers of this movement were driven by a desire to address longstanding agricultural challenges such as erosion, soil depletion, loss of crop diversity, poor quality food and livestock feed, and rural poverty. They advocated a holistic approach, recognizing that a nation's agricultural health hinges on the long-term vitality of its soil. Central to their philosophy was the belief that soil health and vitality are intricately linked to its biology and the organic fraction known as humus.

The term "humus farming" fell out of favor in the 1940s as "organic" gained popularity. According to sources, the first documented use of "organic" to describe this agricultural approach appeared in Lord Northbourne's book "Look to the Land," published in 1940. Northbourne used "organic" to characterize farms employing humus farming methods, highlighting their resemblance to the nutrient and energy flows within biological

organisms—a balanced yet dynamic living whole. Thus, "organic" was originally intended to denote the process and function within a farming system, rather than the chemical nature of fertilizers used or adherence to outdated ideas of plant nutrition. (Kuepper, 2010)

Need of Organic Farming

The stress of feeding the growing population pressure on agriculture, necessitates not only to keep agricultural production continuous but to surge it further in sustainable way. (Samiti, n.d.)

Impact on Conventional farming on Environment?

Conventional farming, while productive in terms of yield, has some disadvantages which impact on environment including biodiversity and human beings:

- a. **Environmental Impact:** Conventional farming often involve heavy use of synthetic fertilizers, pesticides, and herbicides, which can lead to soil degradation, water pollution, and loss of biodiversity. Chemical runoff from fields can contaminate water sources and harm aquatic ecosystems.
- b. **Soil Degradation:** Continuous use of chemical inputs can degrade soil quality over time, leading to decreased fertility, erosion, and loss of organic matter. This can result in long-term productivity challenges and increased susceptibility to pests and diseases.
- c. **Water Usage:** Conventional farming practices can be water-intensive, with irrigation systems sometimes inefficiently using water resources. This can lead to water scarcity in certain regions and exacerbate competition for water between agricultural, industrial, and domestic uses.
- d. **Health Concerns:** Pesticide residues in food products from conventional farming may pose health risks to consumers if not properly managed. There are concerns about the long-term effects of exposure to these chemicals on human health, including links to certain cancers, developmental disorders, and other health problems.

- e. **Loss of Genetic Diversity:** Conventional farming tends to favor monoculture cropping systems, where large areas are planted with the same crop varieties. This can lead to a loss of genetic diversity within plant populations, making them more susceptible to pests, diseases, and environmental stresses.
- f. **Economic Issues for Small Farmers:** The high cost of chemical inputs and machinery in conventional farming can create economic barriers for small-scale and subsistence farmers. These farmers may struggle to compete with larger, more mechanized operations, leading to rural poverty and the abandonment of traditional farming practices.
- g. **Resistance and Resilience:** Pests and weeds can develop resistance to the chemicals used in conventional farming, requiring increasingly higher doses or different chemicals to control them. This cycle of chemical dependency can lead to diminishing returns and greater challenges in pest management.
- h. **Impact on Pollinators:** The use of certain pesticides in conventional farming can harm pollinators such as bees and butterflies, which are essential for the reproduction of many crops. Declines in pollinator populations can have far-reaching ecological and agricultural consequences. (Andreas, n.d.) (NICHE Agriculture, n.d.)

Impact of Organic farming on Environment:

- a. **Long term Sustainability:** Environment is drastically changing over time. Organic farming keeps in mind the medium- and long-term impacts of agricultural interventions on the agro-ecosystem. Its objective is to provide food while maintaining a biological parity to avoid problems with soil fertility and plant pests. Organic farming adopts a proactive strategy instead of treating issues after they arise.
- b. **Soil:** Strategies such as crop rotations, intercropping, natural composts and minimum tillage are fundamentals of organic practices. They stimulate soil flora and fauna; improve soil formation and structure and stabilize soil systems. Nutrient Cycling is promoted, thus increasing water and nutrient retention capacity of the soil. These strategies also play a vital role in controlling soil erosion, which in turn protects soil biodiversity and productivity.

- c. **Water:** Water pollution due to the usage of chemical fertilizers and pesticides is a major issue giving rise to several serious health problems. Organic farming doesn't involve the use of any of these chemical plant growth products. Instead, it meets the requirements of the plant with plant and animal manure and compost. In areas where groundwater is highly polluted, the adaptation of organic farming should be encouraged as a restorative measure.
- d. **Air and Climate Change:** Fossil fuels, the governing source of energy for agriculture, are majorly used for the manufacturing of fertilizers and pesticides that are used in the conventional farming resulting in the depletion of this non-renewable source of energy. Since organic farming doesn't involve the use of chemical-based products, it contributes to the conservation of valuable natural resources. Organic farming practices such as minimum tillage, nutrient cycling and crop rotation results in the return of carbon to the soil.
- e. **Biodiversity:** Biodiversity, at all levels, is the key element in organic farming. At the genetic level, conventional and improved breeds and seeds are selected owing to their resistance to extreme climatic changes and disease-causing pests. At the species level, various groups of flora and fauna are involved in the nutrient and energy cycling. At the ecosystem level, absence of chemical inputs protects various plants and animals on both land and aquatic ecosystems including human beings. The soil biodiversity is protected by implementing crop rotation. Many studies confirmed that organic farming protects biodiversity more than other farming systems. (IFOAM Organics Europe)

f. **Ecological services.** Organic farming is less polluting to water, soil and environment. It facilitates various healthy interactions within the agro-systems that contribute to both agricultural productivity and nature conservation. Carbon sequestration, nutrient cycling, crop rotation, water cycling, soil stabilization, predation, pollination and niches are key elements of organic farming that makes it environment friendly. By choosing organic products, the customer through his/her choice endorses a less polluting framework and better health. (FAO, n.d.) (PATHAK, 2020)

Status of Organic farming in India:

Farmers and enterprises adopt organic agriculture in India for different reasons. In the low rainfall areas, which tend to be no- or low-input zones, it has always been the traditional practice.

The Government of India has been promoting organic farming in the country through two dedicated national schemes: Paramparagat Krishi Vikas Yojana (PKVY) and Mission Organic Value Chain Development for North East Regions (MOVCD-NER) since 2015-16 through State Governments. Training and Capacity Building forms an essential part of the scheme. The government has provided Direct Benefit Transfer (DBT) to the farmers for using organic inputs including organic fertilizers. PKVY is being implemented in all the States other-than North Eastern (NE) States across the country whereas MOVCDNER scheme is being implemented exclusively in the NE States. (Minsitry of Agriculture and Farmers Welfare, 2023)

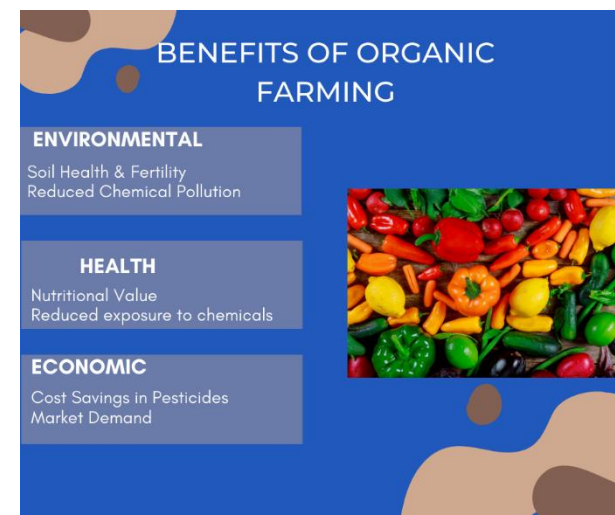


Image 1: Benefits of organic farming, Image Source :- (TraceX, 2023)

Under PKVY, an assistance of Rs.50,000 per ha for a period of three years is provided to States including States of Tamil Nadu & Rajasthan for promotion of organic farming to cover different components like Training & Capacity Building, Data Management, PGS Certification, Value Addition, Marketing and Publicity. Out of this, assistance of Rs. 31,000 per ha for a period of three years is provided to farmers through DBT for on- farm /off –farm organic inputs. Whereas under MOVCDNER, an assistance of Rs. 46,575/ha for 3 years is provided for creation of Farmer Producer Organization (FPO), support to farmers for organic inputs, quality seeds/ planting material and training, hand holding and certification. Out of this, assistance @ Rs. 32500/ ha for 3 years is provided to farmers for off -farm /on –farm organic inputs under the scheme including Rs. 15,000 as DBT to the farmers and Rs. 17,500 for the planting material to be given to the farmers by State Lead Agency (SLA) in kind. (Minsitry of Agriculture and Farmers Welfare, 2023)

Under PKVY assistance @ Rs 8800/ha for 3 years is provided to facilitate value addition, marketing and publicity to all the states/UTs including Tamil Nadu. Assistance is provided for certification and training, handholding & capacity building respectively @ Rs 2700/-ha for 3 years and Rs 7500/- ha for 3 years under PKVY for farmers of all the States including Rajasthan. Where as under MOVCDNER scheme assistance is provided @ Rs 10,000/-ha for 3 years for training, capacity building & certification. (Bureau, 2023)

Keeping in view the increasing demand of organic farming products of India in the global market, Government is facilitating value addition, certification and marketing. In accordance with the requirement of International market, Government has taken initiative for third party certification under National Programme for Organic Production (NPOP) in 2001. (Minsitry of Agriculture and Farmers Welfare, 2023)

Organic farming is supported under other national schemes, such as Rashtriya Krishi Vikas Yojana (RKVY), the Mission for Integrated Development of Horticulture (MIDH), and the All-India Network Programme on Organic Farming under the Indian Council of Agricultural Research (ICAR). Certification of organic farming is either done through the Participatory Guarantee System (PGS) or third-party certification by the Agriculture Processed Food and Export Development Authority (APEDA) in the Ministry of Commerce. (CEEW, n.d.)



Image 2: National Programme For Organic Production (NPOP), Image Source: (APEDA, Ministry of Commerce and Industry, GOI, n.d.)

As on 31st March 2023, total area under organic certification process (registered under National Programme for Organic Production) is 10.17 mha (2022-23). This includes 5391792.97 ha cultivable area and another 4780130.56 ha for wild harvest collection.

Among all the states, Madhya Pradesh has covered largest area under organic certification followed by, Maharashtra, Gujarat, Rajasthan, Odisha, Karnataka, Uttarakhand, Sikkim, Chhattisgarh, Uttar Pradesh and Jharkhand.

India produced around 2.9 Million MT (2022-23) of certified organic products which includes all varieties of food products namely Oil Seeds, fibre, Sugar cane, Cereals & Millets, Cotton, Pulses, Aromatic & Medicinal Plants, Tea, Coffee, Fruits, Spices, Dry Fruits, Vegetables, Processed foods, , etc. The production is not limited to the edible sector but also produces organic cotton fiber, functional food products, , etc.

In terms of commodities, Fiber crops are the single largest category, followed by Oil Seeds, Sugar crops, Cereals and Millets, Medicinal/ Herbal and Aromatic plants, Spices & Condiments, Fresh Fruit Vegetable, Pulses, Tea & Coffee.

The total volume of export during 2022-23 was 312800.51 MT. The organic food export realization was around INR 5525.18 Crore (708.33 million USD). Organic products are exported to USA, European Union, Canada, Great Britain, Switzerland, Turkey, Australia, Ecuador, Korea Republic, Vietnam, Japan, , etc. (APEDA, n.d.)

Conclusion

Organic farming is an essential method of agriculture that supports longevity, environmental protection, and the creation of wholesome food. Organic farmers support a more robust and balanced ecosystem by adhering to values including soil health, biodiversity preservation, and avoiding synthetic inputs. Reduced chemical exposure, improved soil quality, improved nutrition, and greater animal welfare are all advantages of organic

farming. However, managing pests and diseases, nutrients, weeds, and market access are additional difficulties for organic farming. These difficulties can be overcome with creative approaches and assistance, allowing organic farming to flourish and play a vital part in creating a more resilient and sustainable food system for future generations.

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Crop Insurance Policies

By: Shri. Rajesh Kumar, AAO & Shri. Kamal Ram Meena, Sr. Ar

India is an agricultural dependent country and different varieties of crops have been cultivated in India. The farming and agricultural activities in India are frequently affected by natural disasters and prone to various types of natural risks such as drought, floods, cyclone, storm, landslide, earthquake etc. Due to larger and extensive risks of loss, efforts have been made in India since a long time to introduce crop insurance.

An Overview of Crop Insurance in India

Crop or Agriculture Insurance covers risks of anticipated loss in yield of various crops. Insurance Schemes/Programme operate on principles of 'Area Approach' (Tamil Nadu Agricultural University, n.d.). Coverage is compulsory for farmers taking crop loans from rural financial institutions (RFIs) for cultivation of crops, i.e., loanee farmers. Non-loanee farmers can also insure their crops under the same schemes.

A Pilot Crop Insurance Scheme (PCIS), initiated in 1979 by the General Insurance Corporation (GIC) introduced the 'Area Approach' to provide insurance against crop yield deficits for targeting the loanee farmers from institutional sources. This covered cereals, millets, oil-seeds, cotton, potato, and chickpea crops on a voluntary basis across 12 states until 1984-85.

Subsequently, the National Agricultural Insurance Scheme (NAIS) launched in 1999 to cover all farmers, regardless of their loanee status.

National Agricultural Insurance Scheme (NAIS)

GIC launched National Agricultural Insurance Scheme (NAIS) or Rashtriya Krishi Bima Yojana (RKBY) from Rabi 1999-2000, which was taken over by Agricultural Insurance Company of India Limited (AICIL) after it commenced business from 1st April 2003.

Administered by the Agriculture Insurance Company of India Ltd. (AIC), NAIS was accessible to all farmers, irrespective of whether they were loanee or non-loanee and regardless of the size of their landholding. Its primary aim was to extend coverage to a broader spectrum of farmers, crops, and risks, offering protection against losses caused by natural calamities like drought, flood, hailstorm, cyclone, pests, and diseases and stabilize farm incomes, particularly in disaster years. Further, to encourage the farmers to adopt progressive farming practices, high value inputs and higher technology in agriculture.

The scheme was in operation from 1999-2000 till 2015-16 and during this period 26 states and 2 Union Territories had participated. It encompassed a wide range of crops including cereals, millets, pulses, oilseeds, and annual commercial/horticultural crops, provided historical yield data was available for a sufficient number of years. (Saheli Bhattacharya, 2018)

MODIFIED NATIONAL AGRICULTURAL INSURANCE SCHEME (MNAIS)

To enhance accessibility and simplify the Scheme for farmers, a proposal for the Modified National Agricultural Insurance Scheme (MNAIS) was developed and subsequently endorsed by the Government of India for pilot implementation in 50 districts starting from the Rabi season of 2010-11. Over the course of five seasons, spanning across 17 states, MNAIS provided coverage to 45.80 lakh farmers at a premium of Rs. 1,08,800 lakh, with claims amounting to Rs. 86,400 lakh until the Rabi season of 2012-13 (Press Information Bureau, 2010).

Currently main four insurance schemes are being implemented namely by the government to support farmers.

A. Pradhan Mantri Fasal Bima Yojana (PMFBY)

Pradhan Mantri Fasal Bima Yojana scheme was launched in India by Ministry of Agriculture & Farmers Welfare (MoA&FW), New Delhi in all over India from Kharif 2016 Season onwards, but due to some technical reason it was implemented from Rabi 2016-17 Season in Assam (National Insurance). Considering the farmers demands, the scheme has been revamped in February 2020.

Eligibility and Coverage

All farmers who have been sanctioned Seasonal Agricultural Operations (SAO) loans (Crop Loans) from Financial Institutions (FIs), i.e. loanee farmers, for the notified crop(s) season would be covered compulsorily. The Scheme is optional for non-loanee farmers. Now, the scheme is optional for both type of farmer and Insurance Unit (Notified Area) is Village/ Village Panchayat (National Insurance).

Coverage of Crops

The scheme covered various crops i.e. Food crops (Cereals, Millets and Pulses), Ahi Paddy, Sali Paddy, Summer Paddy, Wheat, Black Gram and Green Gram; Oilseeds (Rape & Mustard) and Annual Commercial/Annual Horticultural crops (Potato, Sugarcane and Jute).

Rate of Premium

The Scheme is being implemented through 18 General Insurance Companies including 5 Government Sector Companies. Under PMFBY, a uniform maximum premium of only 2per cent of the sum insured is paid by farmers for Kharif crops and 1.5per cent for Rabi crops. In case of annual commercial and horticultural crops, the maximum premium to be paid by farmers is up to 5per cent. The premium rates to be paid by farmers are very low and the balance of actuarial premium is being borne by the Government, to be shared equally by the State & Central Government, (except in North Eastern States where the subsidy sharing pattern between Central and State Govt. is 90:10) to provide full insured amount to the farmers against crop loss on account to natural calamities (National Insurance).

Coverage of Risks and Exclusions

Various stages of the crop risks (i.e. Prevented Sowing/Planting/Germination Risk, Standing Crop, Post-Harvest Losses, Localized Calamities etc.) leading to crop loss are covered under the Scheme. Earlier, addition of new risks by the State Govt other than the one mentioned above, by the State Govt. is not permitted. *Add-on coverage for crop loss due to attack by wild animals: The States may consider providing add- on coverage for crop loss due to attack by wild animals wherever the risk is perceived to be substantial and is identifiable.* **Further, In view of the demand**

of many States, option has been given to States to choose additional risk covers besides shortfall in yield-based cover depending upon the local weather challenges and requirements of the farmers (Department of Agriculture & Farmers Welfare, 2023).

Implementation of Scheme under revamped scheme

For effective implementation, an integrated National Crop Insurance Portal (www.pmfby.gov.in) has been developed to integrate all the stakeholders on a single platform on a real time basis. This has also enabled access to individual farmer-wise detailed data (Ministry of Agriculture & Farmer Welfare, n.d.). Further, it has been decided to obtain the Aadhar number of insured farmers and details of land records for de-duplication. In addition, Direct Transfer of Benefits (Claims) to farmers account has been initiated from Kharif 2018 season onward.

Process of claim.

A two-step process of crop yield estimation using weather and satellite indicators etc. is adopted, which will help in early assessment of loss.

Use of smart sampling technique through satellite data for crop cutting experiments by some states has shown increased efficiency in implementation. This will now be universalized. The delay by some States in submission of crop yield data will now be suitably addressed using technological solutions.

The total funds released by Government of India during last 5 years under various schemes for crop insurance areas under:

Insurance Schemes: PMFBY and RWBCIS ⁵	
Plan/ Year	Expenditure as on 24.01.2022 (Rs. crore)
2017-18	9419.79
2018-19	11945.38
2019-20	12638.32
2020-21	14165.44
2021-22	9719.24

⁵ <https://www.pmfby.gov.in/>

B. Restructured Weather Based Crop Insurance Scheme (RWBCIS)

The Restructured Weather Based Crop Insurance Scheme (RWBCIS) was introduced to provide coverage for crops lacking a standard methodology for yield assessment, addressing shortcomings of the earlier NAIS (Department of Agriculture, Cooperation and Farmers Welfare). Initially launched as a pilot in 20 states in 2007-08, it became a full-fledged component of the National Crop Insurance Programme (NCIP) from Rabi 2013-14 to Rabi 2015-16. *From Kharif 2016, it has been restructured and aligned with the premium and administrative framework of PMFBY.*

Objective

RWBCIS aims to mitigate financial losses for farmers due to adverse weather conditions such as rainfall, temperature, wind, and humidity. It uses weather parameters as proxies for crop yields to compensate for deemed crop losses. Pay-out structures i.e. Term Sheets are developed to the extent of losses deemed to have been suffered keeping the weather triggers as per requirement of the crop and comparing it with actual weather data for the specific period (Department of Agriculture, Cooperation and Farmers Welfare).

Coverage

All farmers, including sharecroppers, tenant farmers, and women farmers, growing crops in notified areas are eligible. Coverage is voluntary and based on land records and tenancy contracts. There are no extra provisions specifically for women farmers, but the government subsidizes the premium for all farmers, including women.

RWBCIS offers quicker claim settlements due to its reliance on weather data rather than physical crop yield assessments, providing timely financial support to farmers facing adverse weather impacts. (Ministry of Agriculture & Farmers Welfare, n.d.)

C. National Agricultural Insurance Scheme (NAIS)

Although superseded by PMFBY, NAIS is still operational in some regions. It provides financial coverage and support to farmers in the event of crop failure due to natural calamities, pests, and diseases (Agriculture Insurance Company of India Limited, n.d.). The scheme insures food crops, oilseeds, and annual commercial/horticultural crops. The premium rates and subsidy patterns vary, and the scheme aims to encourage farmers to adopt improved farming practices.

These schemes collectively aim to stabilize farmers' incomes, encourage the adoption of modern agricultural practices, and ensure the flow of credit to the agriculture sector, ultimately contributing to food security and crop diversification.

Conclusion and way forward

The shift from a crop insurance system primarily driven by social welfare and occasional governmental support to one based on market dynamics with carefully calculated premiums and well-structured products is a significant advancement. This change promises substantial benefits for farmers, including quicker claims processing, a fairer distribution of subsidies, and reduced uncertainties in coverage.

Looking ahead, it's crucial to continue refining this market-driven approach by gathering input from all stakeholders and addressing any remaining hurdles. Collaboration between policymakers, insurance providers, and agricultural experts will be essential in fine-tuning the scheme to better serve the diverse needs of farmers across different agricultural regions.

In conclusion, the transition to a market-based crop insurance scheme marks a crucial step towards building resilience and sustainability in India's agricultural sector.

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Carbon Farming: Harnessing Agriculture To Sequester Carbon And Combat Climate Change

By: Shri. Vikas Dhir, AAO & Shri. Mukesh Mawliya ,Sr.Ar

INTRODUCTION: - Carbon Farming refers to farm management practices that aim to deliver climate mitigation in agriculture. This involves the management of both land and livestock, all pools of carbon in soils, materials, and vegetation, plus fluxes of carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). (Hugh McDonald, 2021) This article explores various carbon farming methods, including forest management, grasslands conservation, and reduced fertilizer application. It highlights the importance of carbon farming in combating greenhouse gas emissions and identifies challenges such as monitoring, permanence, and additionality. Additionally, the article discusses the financial costs and benefits associated with carbon farming for both farmers and administrators, emphasizing the need for supportive policies and funding mechanisms.

CARBON FARMING AND ITS MECHANISM:

- Carbon farming focuses on controlling carbon levels and greenhouse gas emissions on farms to combat Climate Change. This involves managing both land and livestock, including all carbon in soil, plants, and materials, as well as emissions like CO₂, methane, and nitrous oxide. It includes farming methods and land changes that lead to :

- 1) Storing carbon in plants and in soil,
- 2) Preventing future emissions, and
- 3) Lowering current emissions to combat global warming. (Hugh McDonald, 2021)

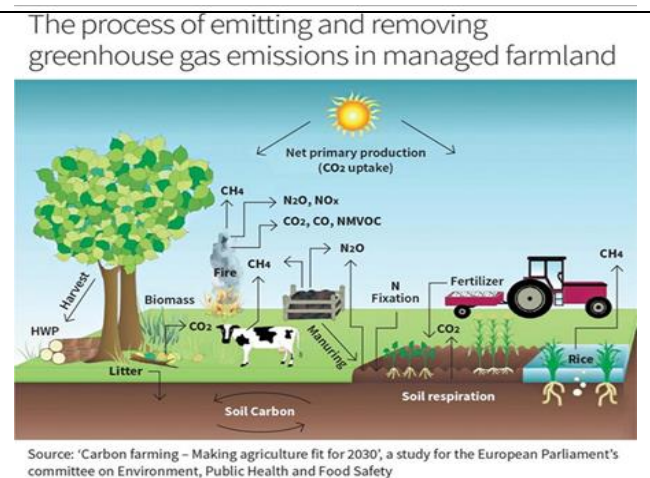


Image Source: (Hugh McDonald, 2021)

Since the industrial revolution, the Green House Gases (GHGs) Emission have increased drastically and have become a primary driver of global Climate Change. Major GHGs gases associated with human activities are : Carbon Dioxide (CO₂), Methane (CH₄) , Nitrous Oxide (N₂O) and fluorinated gases. Burning fossil fuels, clearing forests, and disturbing soils are among the main factors of GHGs Emission. Carbon farming plays a vital role to combat against some Climate Change issues. (United States Enviorenmental Protection Agency, 2024)

Methods of Carbon Farming

There are some methods of Carbon Farming practices in agriculture which are categorized as below:

- **Forest Management:** Healthy forests play a vital role in capturing and storing carbon dioxide, essential for mitigating greenhouse gas emissions. Enhanced forest management strategies such as thinning, selective harvest, and regeneration support ongoing carbon sequestration. Deforestation accounts for 15-20per cent of the global rise in greenhouse gas levels, underscoring the importance of sustainable forest practices.
- **Grasslands Conservation:** Just like forests, native grasses and vegetation naturally absorb and store greenhouse gases. Carbon offsets in this area prioritize conserving native plant life by preserving land and preventing its conversion for commercial or intensive agricultural purposes.
- **Reduced Fertilizer Application:** Chemical inputs diminish soil's carbon sequestration ability and can be wasteful when overused.. Reducing chemical fertilizer application is a cost-effective approach to optimize nutrient use for crops and enhance soil health. And
- **Reduced Tillage:** Frequent and intensive tilling accelerates soil carbon dioxide release and compromises soil structure, leading to erosion and reduced crop productivity. Regenerative tillage, employing minimal or no-tillage practices, preserves soil quality and carbon content, thereby enhancing crop yields.
- **Improved Residue Management:** - Another soil conservation technique in agriculture involves leaving crop residue in fields. Mulching or using crop residue materials like straw maintains soil moisture and fertility, fostering interactions between organic matter and microorganisms for improved soil composition and health.

- **Improved Water Management:** Excess water can wash away nutrients and cause erosion. Proper irrigation management involves watering at the right times, rates, depths, and distances from crops, optimizing growth and minimizing resource waste.
- **Agroforestry:-** Agroforestry integrates trees with agriculture, aiding in emission mitigation and carbon storage in both soil and trees. It offers above-ground and below-ground benefits, enhancing farm productivity, soil protection, air and water quality, wildlife habitat, and diversified income. (Mishra, 2023)

Importance of Carbon Farming in Agriculture

As the earth's atmosphere has a limited Carbon space, hence, Emission Trading Schemes or Carbon Trading has come into play with the ultimate objective to curb and reverse global warming and Climate change. As per the Third Biennial Update Report submitted by the Government of India in early 2021 to the United Nations Framework Convention on Climate Change (UNFCCC), the agriculture sector contributes 14 per cent of the total GHG emissions (energy 75.01 per cent; industrial process and product use 8 per cent; and waste 2.7 per cent, as per 2016 data). (Down to Earth, 2022) Thus, adopting low Carbon Footprint⁶, agricultural practices presents a win-win strategy for India and its farmers, tapping into the growing carbon market while reaping benefits like improvement in soil properties, soil health and increase in the crop production sustainability. (National Academy of Agricultural Sciences, New Delhi, 2014)

Challenges in Carbon Farming

Carbon farming's effectiveness is influenced by various factors such as location, soil type, crop choice, water access, biodiversity, and farm size. Success also hinges on sound land management, robust policy backing, and community involvement. These diverse elements collectively determine the impact and viability of carbon farming initiatives. There are also some certain issues which pose challenges while designing

⁶ Carbon Footprint refers to identifies the source, quantity, and sink of GHGs released from on-farm and off-farm activities.

policies or other incentives that will translate carbon farming mitigation potential into real actions which are discussed as below: (Hugh McDonald, 2021)

- **Monitoring, reporting and verification (MRV):** Monitoring, reporting, and verification (MRV) are vital for ensuring the effectiveness of carbon farming in combating Climate Change. Monitoring measures emission decrease or sequestration increase, Reporting communicates results, and Verification ensures truthfulness and accuracy. Robust MRV guarantees environmental integrity, avoiding issues like carbon leakage and double counting. However, high MRV costs pose a challenge, impacting the net benefits of carbon farming and acting as a barrier to adoption by farmers or policymakers. Balancing MRV accuracy with affordability is crucial for successful carbon farming implementation.

Although monitoring can be achieved by direct measurement or on-site measurement of carbon stored e.g., in trees or soil and by Modelling which requires previous scientific research to establish relationships between proxies and estimated emissions/sequestration. Direct measurement can monitor GHG impacts with considerable accuracy but can be prohibitively expensive while Modelling has higher uncertainty than direct measurement but lower costs.

- **Permanence:** Permanence presents a substantial challenge for carbon farming, particularly concerning sequestration and storage. Sequestered carbon can be unstable and released intentionally or unintentionally. For example, alterations in cropping methods or tillage can intentionally release stored soil carbon, while events like droughts or fires can lead to unintentional release, such as the loss of agroforestry trees. Monitoring permanence is especially challenging for soil carbon, particularly in peatlands or mineral soils, which adds to the complexity of ensuring long-term carbon storage in carbon farming initiatives.
- **Additionality:** Assessing additionality in carbon farming often involves comparing outcomes against a baseline, describing what would have occurred without incentives for carbon farming. This baseline serves as a reference point to determine actual mitigation efforts. Anything surpassing sequestration or emission reductions beyond the baseline is deemed additional. However, developing baselines involves various methods, each with its own pros and cons. Complex baselines can be costly and time-consuming, requiring historical data that may not always be accessible. Conversely, simpler methods are vulnerable to manipulation by participants, potentially leading

to non-additional mitigation efforts. Achieving a balance between accuracy and practicality in baseline setting is crucial for effective carbon farming assessment.

- **Co-benefits and risks of carbon farming:** Carbon farming not only aims at climate mitigation but also yields additional environmental, socio-economic, and adaptation benefits. While farmers enjoy co-benefits like cost savings and increased productivity, society benefits from public goods such as biodiversity conservation and improved water quality, justifying increased public investment in carbon farming. However, some mitigation measures may inadvertently harm other farmer or societal objectives. For instance, certain soil organic carbon methods like biochar or municipal composting could negatively impact soil health. Similarly, implementing agro forestry measures that aren't suitable for the local environment might lead to adverse effects on biodiversity or adaptation efforts. Balancing these risks and benefits is crucial for the success and sustainability of carbon farming initiatives.

Cost in Carbon Farming

From a business angle, carbon farming is feasible when benefits outweigh farmers' costs. However, decision-makers must ensure Carbon farming benefits, like climate mitigation, biodiversity and other external benefits, exceed costs for both farmers and administrators. The types of costs to set-up and run a carbon farming mechanism faced by farmers and administrators are as follows: (Hugh McDonald, 2021)

Cost at Administrative level: At administrative level cost associated with Carbon Farming is categorized as set-up costs and ongoing costs.

The Set-up cost includes :

- Mechanism design to develop the methodology, governance and operating rules,
- Scientific research/data collection cost to calculate mitigation depends on research and data,
- Baseline setting and validation cost to set participant baselines and to validate new participants/projects and
- Outreach/ training cost to attract farmer participants.

While the ongoing costs includes:

- monitoring and verification cost to ensure that the farmers comply with the methodology and verify results,

- Mechanism administration cost for contracting, Registry Management, Governance and System evaluation and
- Funding cost, which is associated with getting funding for marketing and selling offset credits to buyers.

Cost at Farmer level: At farmer level, cost associated with Carbon Farming is also categorized as set-up costs and ongoing costs.

The set-up costs include:

- Learning cost to train farmers about Carbon farming mechanism,
- Implementation cost for technology purchase, tree plantation and rewetting of soil.

While ongoing cost includes:

- Implementation cost to mitigate measures i.e., time, additional equipment cost and running costs and
- Transaction costs for Farmer MRV and Administrative costs.

Conclusion

The increasing human demands and environmental impacts necessitate sustainable agricultural practices. Carbon farming emerges as a comprehensive solution, integrating forest vegetation with crop farming and livestock production through agroforestry. It improves agricultural production, food security, and soil quality while reducing greenhouse gas emissions. Despite its benefits, carbon farming faces challenges in adoption. Effective advisory services are crucial to encourage farmers to adopt Carbon Farming Initiatives (CFI) and mitigate unsustainable farming practices.

Additional funding is needed to support research, technical assistance, and policy adjustments. Public sources like the new CAP(Common Agricultural Policy) offer various support mechanisms, while voluntary carbon markets may also contribute, albeit with risks. Transparent monitoring and verification are essential to ensure effective carbon mitigation, but reliance solely on carbon farming for offsetting emissions in other sectors poses risks to climate goals.

Moving forward, collaborative efforts between policymakers, farmers, and researchers are essential to overcome these challenges and promote the widespread adoption of carbon farming practices. This includes continued investment in research, development of supportive policies, and provision of financial incentives to incentivize farmers to engage in carbon farming initiatives. By implementing these measures, we can harness the full potential of carbon farming to achieve sustainable agricultural practices and combat Climate Change effectively.

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Biodiversity at iCED Jaipur

By:-Shri. Vikas Dhir ,AAO & Shri. Rajesh Kumar Meena ,Sr.Ar

Birds at iCED



*Coppersmith Barbet found in iCED Campus
Photo Credit: Capt. Shashank. (Dy.Chief
Mechanical Engineer-North Western Railway)*

Coppersmith Barbet:

(Psilopogon haemacephalus)

The Coppersmith barbet is a bird from Asia that makes a distinctive sound like a hammer hitting metal. They live in forests where they can dig holes to make their homes. You can find them in South and Southeast Asia, usually in gardens, small forests, and places with a few trees..In northern India, they are found in the valleys of the outer Himalayas and are rare in northwestern Indian states and in wet forests in Assam. Coppersmith barbets are herbivores (frugivores) . They prefer to rely on banyan, peepul, and other wild figs, various drupes and berries, and flower petals. (Animalia, 2024)



*Green Bee-eaters found in iCED Campus
Photo Credit: Capt. Shashank. (Dy.Chief
Mechanical Engineer-North Western Railway)*

Green Bee-eaters:

(Merops Orientalis)

The Asian green bee-eater (Merops orientalis) is a a bright colored member of the bee-eater family, commonly found across Asia. While not known for long-distance migrations, it undertakes seasonal movements often prompted by rainfall patterns. Unlike some bird species, distinguishing between male and female Asian green bee-eaters based on appearance alone is challenging. As carnivores, they primarily subsist on insects, including bees, bugs, beetles, termites, moths, flies, butterflies, crickets, dragonflies, caterpillars, and spiders. These birds tend to reside farther away from water sources, favoring habitats conducive to their insect-rich diet. (Animalia, 2024)

Insects at iCED



*Photo Credits: - Shri. Mehul Grover
Director (Training and Research)
iCED, Jaipur*

Anthia (Anthia) sexguttata

The Six-spot Ground Beetle, belonging to beetle family Carabidae (Hasan, 2023)

They are found in Scrub forests, both in plains and hilly tracts. They are predacious and feed on other small insects including grasshoppers and snails carnivorous and could nip smaller children's fingers. Anthia has unusual life cycle as the young larvae enter ants' nests and feed on them, assuming their scent and get accepted as members of the colony. In general, Anthia spp. are able to spray a jet of formic acid (upto 30cms), an irritating acrid fluid, to disable their predators and hence popularly called as oogonpissar i.e. eye squirter. (Hasan, 2023)

June bug, (Genus Phyllophaga)

Genus of nearly 300 species of plant-eating beetles that commonly appear in the Northern Hemisphere during warm spring evenings and are attracted to lights. (Missouri Department of Conservation, 2024)

The bugs vary from 12 to 55 mm and have shiny wing covers. June bugs, are usually brown, rusty, or black, without patterns such as spots or stripes, and rather hairy beneath. They are nocturnal and are attracted towards lights at night. They belong to large family of beetles called scarabs. They eat plant leaves and flowers. The grubs live underground for one to four years. (Missouri Department of Conservation, 2024)

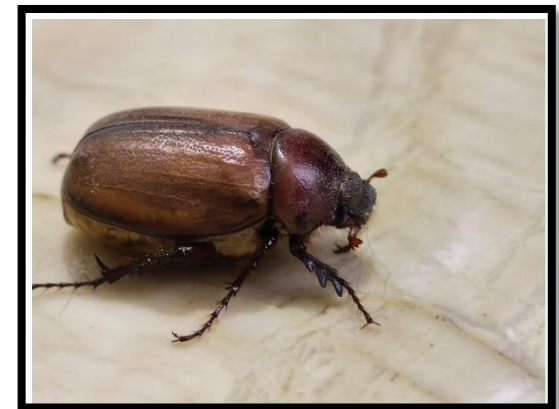


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Plants at iCED

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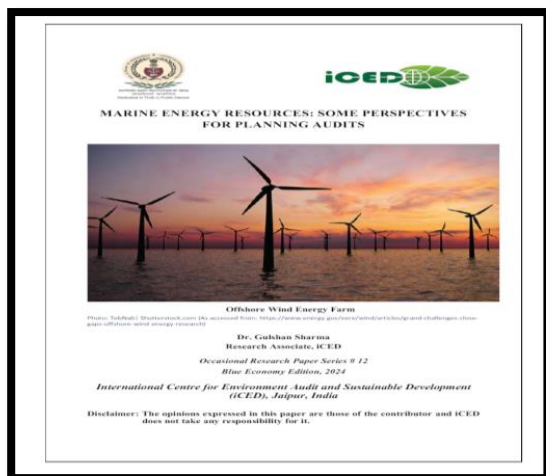
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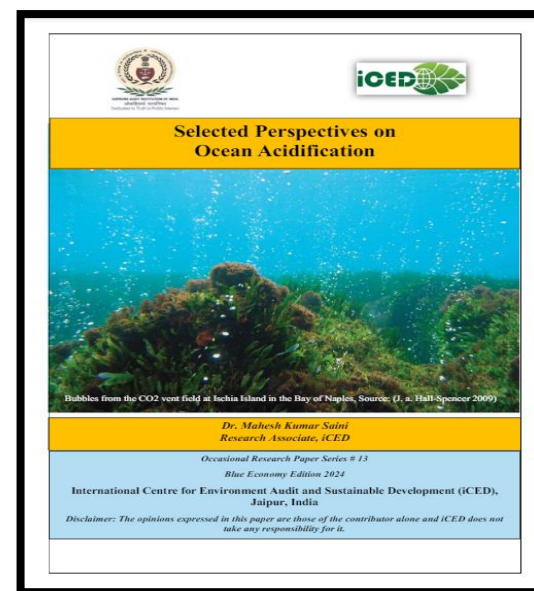
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The research paper “Marine Energy Resources: Some Perspectives For Planning Audits” highlights the Marine Renewable Energy sources, with an emphasis on Tidal Energy. Furthermore, this paper also highlights some of the audit approaches, along-with reports relating to Marine Renewable Energy sectors, which provide important dimensions to the understanding of the auditors. The research paper can be accessed at: https://iced.cag.gov.in/wp-content/uploads/ORPper_cent2012per_cent20Marineper_cent20Energyper_cent20Resourcesper_cent20Someper_cent20Perspectivesper_cent20forper_cent20Planningper_cent20Audits.pdf

The research paper “Selected Perspectives on Ocean Acidification” highlights how ocean acidification causes concerns towards sustainability of the ocean ecosystems and highlights the areas for concern in and around the Indian coastal states through calculation of a composite value based on selected indicators such as Sea Surface Temperature (SST), Particulate Inorganic Carbon (PIC), Particulate Organic Carbon, Dissolved Oxygen (DO), and salinity. This research underscores the importance of the Ocean Acidification thematic area as a valuable resource for assessing the trends and associates impacts of Ocean Acidification. It can be used to identify risk areas and prioritise action. The research paper can be accessed at: https://iced.cag.gov.in/wp-content/uploads/PDFper_cent2027.3.2024per_cent20ORPper_cent20onper_cent20Oceanper_cent20Acidification.pdf





**Ethical and Sustainable Use of Plastic Value Chain
and Gradual Phasing-out of Plastic Waste**



Photo: Safai Sathis (waste pickers) sort materials at Swachhta Kendra facility in Patna, India. Credit: UNDP India

Team iCED and Dr. Divya Singh
Occasional Research Paper Series # 11

*International Centre for Environment Audit and Sustainable
Development (iCED), Jaipur (India)*

The research paper “Ethical and Sustainable Use of Plastic Value Chain and Gradual Phasing-out of Plastic Waste” focuses on the role and different stages of the Plastic Value Chain from the perspective of circularity in plastic management with special focus on ethical aspects and sustainable use of plastics throughout the value chain. It provides a comprehensive review of the different components of the Plastic Value Chain and their contributions to plastic circularity. The study also highlights challenges like technological and cost barriers, lack of information on post-consumer plastic use, design, production, and overall plastic utilisation as factors impeding the adoption of sustainable alternatives. The research paper can be accessed at: [https://iced.cag.gov.in/wp-content/uploads/Final.per_cent20Divyaper_cent20Researchper_cent20Paperper_cent20Approvedper_cent20byper_cent20ADAI\(1\).pdf](https://iced.cag.gov.in/wp-content/uploads/Final.per_cent20Divyaper_cent20Researchper_cent20Paperper_cent20Approvedper_cent20byper_cent20ADAI(1).pdf)