35th Foundation Day Lecture

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Dr. Suresh Kumar Chaudhari, born in Teegaon (Madhya Pradesh), India on 5 March, 1963, a distinguished figure in the realm of Natural Resource Management (NRM), renowned for his significant contributions to sustainable development and environmental conservation is currently holding the post of Deputy Director General (Natural Resource Management) in Indian Council of Agricultural Research, New Delhi since 2020. With a robust academic background having educated at JNKVV, Jabalpur; MPKV, Rahuri in the field of agriculture, joined Agricultural Research Service (ARS) in 1993 and served as in different scientific capacities as Senior Scientist, Principal Scientist, Head (Soil and Crop Management Division), ICAR-CSSRI, Karnal to research management positions as Assistant Director General (SWM) (2014-20) before shouldering the responsibilities as DDG (NRM) in 2020. Dr. Chaudhari has emerged as a leading authority in guiding transformative initiatives and fostering innovation in NRM practices.

Dr. Chaudhari has a number of prestigious Honors and Awards to his credit *viz*: Jawahar Ratna Award 2020, ICAR- Rafi Ahmed Kidwai Award 2015; Salinity Excellence Award 2010-11; Outstanding Achievement Award of Institution of Engineers (India), 2010; 12th International Congress Commemoration Award of Indian Society of Soil Science, 2009; TWAS-Medal, Italy, 2009; K.C. Das Memorial Award, The Institute of Engineers (India), 2008; Zonal Award of Indian Society of Soil Science, 1999; Tata Endowment Award for Research, Tata Institute of Fundamental Research, 1999; Young Scientist Award of Madhya Pradesh Council of Science and Technology, 1992. Dr. Chaudhari is also Fellow of National Academy of Agricultural Science (Elected), 2010 and Fellow of Indian Society of Soil Science; Maharashtra Academy of Sciences.

Dr. Chaudhari's career spans over two decades of dedicated service in NRM covering research areas of Soil physics, Agricultural water management, Management of salt affected soils and poor-quality water, Climate Change impact on agriculture *etc*. Dr. Chaudhari's academic pursuits and research endeavours have significantly enriched the understanding of NRM challenges and solutions. He has authored numerous scholarly publications, contributing valuable insights to the scientific community, and shaping discourse on sustainable resource utilization demonstrating exemplary leadership and expertise in the domain.

Revolutionizing Agriculture: Advances in Farming Systems Research

It is my pleasure to deliver the 35th Foundation Day Lecture on this occasion. I take this opportunity to congratulate each one of you and thank the Director for this honour.

In today's rapidly evolving agricultural landscape, the pursuit of sustainability and efficiency has become paramount. Amidst this quest, the emergence of innovations in Farming Systems Research stands as a beacon of hope and progress. This pioneering field embodies a holistic approach to farming, seamlessly integrating various agricultural practices to optimize productivity, enhance resource utilization, and mitigate environmental impact. From the fusion of crop cultivation with livestock management to the incorporation of agroforestry and aquaculture, integrated farming systems research represents a paradigm shift in agricultural science. By harnessing synergies between different components of the farming ecosystem, novel pathways towards resilience and profitability for farmers are being unlocked. This interdisciplinary endeavor transcends traditional silos, fostering collaboration between multi-disciplinary researchers to address complex agricultural challenges. Through innovative technologies, such as precision agriculture and IoT-enabled monitoring systems, integrated farming systems research empowers farmers with data-driven insights and decision-making tools. Moreover, it champions principles of agroecology, promoting biodiversity, soil health, and ecosystem resilience in a nature positive way. As we navigate the complexities of global food security and environmental sustainability, the transformative potential of innovations in farming systems research offers a beacon of hope for a more resilient, equitable, and sustainable agricultural future.

India faces daunting challenges from climate change impacts, fragmentation of landholdings, land degradation and ensuring sustainable natural resources management is crucial for securing food, water, livelihoods, and environmental stability within a realistic timeframe. This endeavor demands substantial financial resources, a robust scientific foundation, effective policies, strong institutional mechanisms, and comprehensive monitoring systems. Adoption of innovative technologies have shown a positive impact on agricultural productivity and agricultural production besides impacting on increasing farmers' income, conserving natural resources, improving input use efficiencies, generating employment opportunities and promoting diversification. Hence, expediting the broader adoption of enhanced agricultural technologies requires a multifaceted approach. This involves instituting institutional reforms aimed at streamlining processes and enhancing efficiency. Furthermore, facilitating seamless access for farmers to technology delivery systems and markets is imperative. This can be achieved through the establishment of robust networks and platforms that bridge the gap between technology providers and end-users. Additionally, reinforcing the agricultural credit system is vital to farmers with the financial resources necessary to invest in and implement these advancements effectively. By addressing these critical aspects comprehensively, we can accelerate the integration of improved technologies into agricultural practices, thereby fostering greater productivity and sustainability across the agricultural sector.

Nature Positive Farming for Sustaining Food Production Systems and Conserving Natural Resources

The present input intensive agriculture and irrational use of natural resources (land and water) for food production is not sustainable and often severely impacted the human and environmental health. It is vitally important to transform the conventional food production system into a nature-positive food production to meet the projected food demand and also safeguard nature's legacy for our future generations. By protecting, managing, and restoring the key components and functions of nature, we can ensure food and nutritional security in ways that benefit people and contribute to climate stability, without compromising livelihoods and economic security. The chemical and heavy machinery led agricultural activities are accounted for 80% of global deforestation, 70% loss of terrestrial biodiversity, 52% agricultural land degradation, 50% of loss of freshwater biodiversity and 29% GHG emissions.

The challenge for the future of agriculture is how to feed a growing population, expected to reach around 10 billion by 2060 (United Nations, 2022), with the limited available resources within the planetary boundaries. Besides, future agriculture not only needs to be environmentally sustainable, but it should also assist our efforts of ecosystems recovery by incorporating all the good agricultural practices aiming towards natural resource conservation. Therefore, nature-positive food systems are pertaining to regenerative, non-depleting and non-destructive use of natural resources. Followings are three main pillars of nature-positive agriculture:

1. Protect: Protect natural habitats and prevent the expansion of agriculture in protected areas;

2. Manage: Sustainably manage existing food systems to ensure our food, nutrition, and livelihood security and

3. Restore: Restore degraded production systems and bring them back within the boundaries of long-term sustainability (Cohen-Shacham et al., 2016).

The concept of nature-positive farming seeks to understand and exploit the possible synergies between food and agriculture production and nature. Another concept of nature-positive production system is the complementarity between food production and environmental stewardship (including biodiversity conservation). Agriculture needs biodiversity, while biodiversity can flourish in return from the increased primary production that nature-positive production agriculture can inspire.

Climate Impacts on Agriculture and Food Production

The agricultural landscape of India spanning over different agro-climatic regions making it particularly vulnerable to the impacts of climate change. Variability in monsoon rainfall and temperature fluctuations within seasons pose significant challenges to food production systems across the country. Studies conducted by the Indian Council of Agricultural Research (ICAR) highlight the heightened risk faced by *Rabi* crops, with wheat production suffering a notable decline of 4-5 million tonnes for every 1°C rise in temperature. Beyond staple grains, even minor shifts in temperature and precipitation exert profound effects on the quality and yield of various crops, including fruits, vegetables, tea, coffee, aromatic and medicinal plants, and basmati rice. The repercussions of climate change extend beyond crop yields to encompass broader agricultural and related sectors. Livestock productivity, exemplified by dairy cattle, is expected to diminish, while fish breeding, migration, and harvests are likely to witness declines. Globally, projections suggest a significant reduction of 10-40% in crop production by 2100, underscoring the urgency of mitigating climate-related risks in agriculture. In navigating these challenges, concerted efforts are required to enhance the resilience of agricultural systems, bolster adaptive capacities, and implement sustainable practices. Strengthening institutional frameworks, investing in climate-resilient technologies, and promoting adaptive agricultural practices are imperative to safeguarding food security and livelihoods in the face of a changing climate.

Synergizing Sustainability: Unlocking the Potential of Integrated Farming Systems

In the dynamic landscape of modern agriculture, integrated farming systems emerge as a beacon of innovation and sustainability. By diversifying income sources and reducing dependency on a single crop or livestock species, integrated farming systems mitigate the risks associated with market fluctuations and climate variability. Furthermore, the integration of various components allows for the efficient utilization of resources, such as nutrients and water, while minimizing environmental degradation. Overall, integrated farming systems represent a comprehensive and adaptable approach to agriculture, offering a pathway towards food security, economic viability, and environmental sustainability in the face of diverse adversaries.

The modern agricultural production systems are simplified due to specialization and are intensified with high rates of external inputs to keep production conditions favourable but this has led to cause environmental problems, depletion of soil nutrients, affecting soil biota, and leading to higher cost of production. Likewise, intensification in other enterprises such as large dairy, poultry industry, piggery industries, and animal feed preparations with much external dependencies especially on concentrates, feeds have also affected the diversity in flora and fauna and increase vulnerability of resource poor farmers to weather and market fluctuations. Intensive agriculture systems in India are unable to provide regular income and employment, failing to achieve food, environmental, and energy security at the farm level. So, farmers depending on single farm enterprise, such as a typical mono-cropping system, are unable to sustain their livelihood.

Addressing the shortcomings inherent in specialized, input-driven agriculture requires a shift towards integrated farming systems. This entails harmonizing crop cultivation, livestock management, and fishery components to ensure not only food and nutritional security but also consistent and reliable income for farmers. By seamlessly amalgamating diverse agricultural activities such as crop cultivation, livestock rearing, aquaculture, and agroforestry, integrated farming systems unlock a wealth of potential. This holistic approach not only enhances productivity but also fosters resilience and environmental stewardship. Through synergistic interactions among different components of the farming ecosystem, integrated systems optimize resource utilization, minimize waste, and mitigate environmental degradation. Moreover, by diversifying income sources and reducing reliance on monocultures, integrated farming systems bolster economic stability for farmers. As we navigate the complexities of global food security and environmental sustainability, harnessing the potential of integrated farming systems represents a transformative step towards a more resilient and equitable agricultural future. Embracing this integrated approach is paramount to overcoming the challenges posed by conventional agricultural practices and building a more resilient and sustainable region-specific IFS models.

Research and Development in India- IIFSR and its Network

ICAR-Indian Institute of Farming Systems Research has 70 years of history contributing significantly for the development of agronomic management practices, encouraging use of nutrients and alternative cropping systems and methodologies for assessment and evaluation of crop management practices at country levels. Since 2010 onwards, the mandate of Institute is changed to farming systems to address the holistic issues in agriculture. The genesis of the Cropping Systems Research Project may be traced back to the visit of Dr. A.B. Stewart of Macaulay Institute of Soil Research, Aberdeen, U.K., somewhere in mid- nineteen forties. He was invited by the then 'Imperial Council of Agricultural Research' to review the status in respect of soil fertility investigations, in general, and manuring in particular, and to suggest necessary steps which might be taken to obtain adequate information under different conditions of soil and climate within a very short time so that the agricultural departments could provide relevant instructions to the farmers for increasing the crop yields. His review report, published in 1947, significantly influenced the philosophy and practice of fertilizer experimentation in the county. The importance of conducting simple fertilizer trials on cultivators' fields and complex experiments at selected centers was emphasized in the report which led to initiation of “Simple Fertilizer Trials on Cultivators Fields” in 1953 under Indo-American Technology Cooperation Agreement through Soil Fertility and Fertilizer Use Project.” Later, in 1956, Model Agronomic Experiments, i.e., complex experiments on carefully selected centers, were also brought under the purview of the project and it was renamed as 'All India Coordinated Agronomic Experiments Scheme (AICAES)'. With the passage of time the scheme went through various stages of evolution to keep pace with the development in science and technology and to meet the increasing demands. Further, the research arena was expanded to include agronomic research encompassing cultural practices, irrigation, nutrition, chemical weed control and multiple cropping. But the emphasis continued to remain on soil fertility and fertilizer use efficiency. In 1968-69 the scheme was sanctioned as 'All India Coordinated Agronomic Research Project (AICARP) with two components viz; 'Model Agronomic Experiments and 'Simple Fertilizer Trials'. Nevertheless, even after green revolution, agricultural research centered on only individual crops in isolation. But for a sustainable development the system approach is a must. This realization might have given an impetus to start cropping systems-oriented research and the project was upgraded into a Directorate during 7th fiveyear plan and was established as the 'Project Directorate for Cropping Systems Research (PDCSR)', which became functional in March, 1989 with its headquarters at Modipuram, Meerut, U.P. Further, during 11th five year plan PDCSR has been re-designated as 'Project Directorate for Farming Systems Research (PDFSR)' during 2009-2010. During 2014 (12th five year plan) PDFSR was upgraded to a full-fledged institute and renamed as “ICAR-Indian Institute of Farming Systems Research” besides AICRP on IFS (74 centres) and NPOF (20 cooperating centres,) as an integral part of institute, covering 26 States/ UTs. The profile of ICAR-IIFSR has spread in two ways by covering different regions of the country.

On-Station Research

Development of prototype IFS models

- Sustainable resource management for climate smart IFS (25 main, 2 sub and 5 ICAR institute centres)
- Development of region-specific IFS models (9 locations)
- Carbon crediting and GHG emission in IFS models (25 main, 11 sub and 5 ICAR institute centres)
- Scaling and impact assessment of IFSS implemented by States (5 States)

Development of efficient alternative cropping systems

- Identification of cropping systems module for farming systems (25 main and 11 sub centres)

On-Farm Research

Resource characterization and refinement of existing farming systems

- Farm typology analysis for resource characterization (32 districts in 21 States)
- Diversification and improvement of existing farming systems under small and marginal household conditions (900 farm HH in 150 villages in 25 districts of 19 States)
- Model value chain development in IFS (2222 farm HH in 7 districts of 7 States)
- Capacity building of researchers and farmers on IFSs (32 districts in 21 States)

Improvement of existing cropping systems

- On-Farm evaluation of different managements practices pre-dominant cropping systems (600 farm HH in 25 districts of 19 States)
- FLDS on Cropping and farming systems involving oilseeds (30 FLDs in Soybean & Groundnut; 2 trainings for Farmers).

Under AINPOF the following achievements are reported

Characterization of organic and natural farming inputs and practices

- Geo-tagged characterization of organic and natural farming farmers (20 locations in 16 States)
- Documentation & validation of organic ITKs (5 locations in 4 States)
- Biochemical characterization & molecular identification of microbial population of different organic and natural farming inputs (5 locations in 5 States)

Development and validation of scientific package of practices for organic and natural farming

- Evaluation of organic, inorganic, and integrated production systems (20 locations in 16 States)
- Evaluation of response of different varieties of major crops for organic farming (20 locations in 16 States)
- Evaluation of organic management practices for insect pest in various crops (4 locations in 3 States)

- Evaluation of organic management practice for diseases in crops (3 locations in 3 States)
- Evaluation and validation of Natural Farming practices in different agro-ecologies (20 locations in 16 States)
- Farmer participatory validation of organic and natural farming practices in farmers' field under SCSP/STC sub plans (6 locations in 6 states)

Integrated Organic Farming Systems

- Development of Integrated Organic Farming System models (10 locations in 9 States)

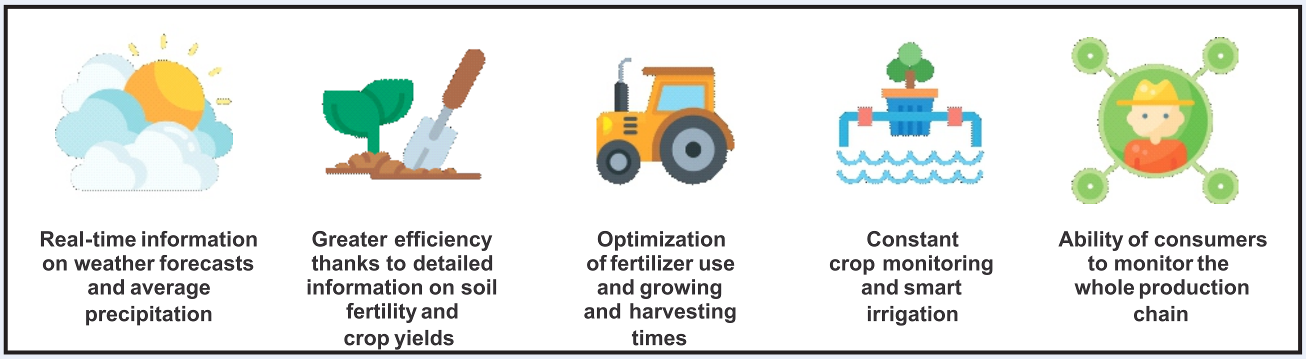
Capacity building including policy support to Central and State agencies

- Value chain development with aggregation model for organic farming (5 locations in 5 States)

New Paradigms

Digital Transformation of Agriculture using Smart Technologies

Traditional farming practices often face challenges related to resource optimization, climate change impacts, and market fluctuations. Integrated Farming Systems emerged as a response to these challenges, promoting diversification and synergy among different farming components. However, the adoption of digital tools has taken this concept to new heights, offering farmers unprecedented control and insights into their operations. Some of the key enablers of the digital transformation are smart farming technologies, artificial intelligence, robotics, smart sensors, IoT (Internet of Things) etc for which mobile phone and internet services are most common gateway. India, with its diverse agro-climatic zones and a significant agricultural workforce, stands to benefit immensely from the application of digital tools in farming systems. Several digital tools and technologies have been introduced and adopted in the country, addressing various challenges faced by farmers. There are various modes- push and pull SMS, interactive voice response, mobile apps, and so on- through which mExtension services are provided either individually or in combination. While SMS and interactive voice response services are accessible from both conventional and smart phones, mobile apps require smart phones. Services can be free or subscription-based. Communication tools, info graphics, video, specific social media tools. Farm Software, web and phone application, Digital education and training materials and supports, Digital sensors and data collection and analysis, decision support tools, Digital marketing support tools. Benefits of incorporating digital technologies in agriculture are many fold



Customized need-based Farming System Models for Sustainable Agriculture

In contemporary agricultural discourse, the adoption of resource-specific need-based farming system models emerge as a pivotal strategy to address the diverse challenges confronting farmers worldwide. This approach acknowledges the heterogeneity of agricultural landscapes, recognizing that the optimal farming system may vary depending on factors such as soil fertility, water availability, climate conditions, and socio-economic context. Rather than adopting a one-size-fits-all approach, resource-specific need-based farming system models advocate for tailored solutions that align with the specific requirements and constraints of each farming environment. At the core of this concept lies the principle of needs-based analysis, which entails a thorough assessment of the resources, capabilities, and challenges inherent to a particular agricultural setting. By conducting comprehensive analyses, including soil assessments, water availability studies, climate vulnerability assessments, and socio-economic surveys, stakeholders can gain valuable insights into the unique dynamics shaping agricultural production in a given area. Armed with this knowledge, farmers, agricultural extension workers, policymakers, and researchers can collaboratively design and implement farming system models that optimize resource utilization, enhance productivity, and promote sustainability.

Landscape approach for Sustainable Agri-food System

Agriculture faces big challenges, such as feeding a growing population and providing an increasing amount of biomass for energy production. Land is through a limited resource and intensification of agricultural practices is deprecated because of the negative impacts on natural resources. Effective answers should therefore be fostered by the development of smarter spatial configurations of agricultural activities. As a result, people around the globe, especially in areas where agricultural practices are intensifying, are increasingly demanding high-quality landscapes from which all desired services can be derived. Therefore, fostering the design of smarter spatial configurations appears a promising way to support the agricultural land management at meeting these overwhelming expectations. Understanding farmers' decision-making about the spatial organization of agricultural activities becomes therefore crucial to achieve desired land change transitions. The application of a landscape approach in integrated farming systems can be significantly enhanced through clustering, which involves grouping farms based on geographical proximity, similar agro-ecological conditions, and shared socio-economic contexts. By clustering farms within a landscape, several key benefits and applications arise viz. synergistic resource management, diversified production systems, market access and value chain, social and institutional collaborations etc.

Organic and Natural Farming as new Business Opportunity

Organic farming is practiced globally in 191 countries covering 104.9 million ha area which includes both cultivated (74.9 million ha) and wild harvests (30.00 million ha). India is also an emerging country in organic food production, which has more than 4.0 million nos. of organic growers covering 10.30 million ha area. From 42000 ha area under certified organic farming in 2003-04, the organic agriculture has grown many folds and currently 590 million ha area is under organic certification process. As per the Vision of Organic Farming Policy for 2025, India has to bring at least 10% area (14 million ha) under organic farming. Looking for the average growth rates (CAGR) of 23.35% for export of organic commodities from India during the recent past, the target of 14 million ha area looks achievable in near future. States like Madhya Pradesh, Rajasthan, Maharashtra are the major states having big acreage and production share of organic commodities in India. The total market size organic produce in India is around Rs.27000 crores with export share of Rs.7050 crores and Rs.19500 crores of domestic market. USA, Canada, EU, Australia, Vietnam, Japan are major importing countries for organic commodities from India. Almost every food commodity right from organic processed food, cereals and millets, oilseeds, pulses, sugars and jaggary, medicinal plants to tea, coffee and other beverages are having good export potential and employment opportunities. Processed organic foods are having major share among exported commodities hence, showing good potential for value addition, processing, and packaging sector. Looking for higher pesticide residue problems in chemically produced fruits and vegetables, there is high demand for organic version of these commodities in the international markets. Besides, animal, and dairy products are another rising area for international organic market.

Different parts of India have developed their own local or regional systems for ecological agriculture that are now gathered in one umbrella term 'Jaivik Krishi' or 'Jaivik Kheti' which includes natural farming as a means of low cost self-dependent sustainable farming. Government of India is promoting organic agriculture through various developmental programmes and schemes which includes National Programme for Organic Production (NPOP), National Project on Organic Farming (NPOF), National Mission on Sustainable Agriculture (NMSA) and Paramparagat Krishi Vikas Yojana (PKVY). Considering the importance of Organic Farming, Indian Council of

Agricultural Research (ICAR) launched Network Project on Organic Farming during 2004 with at present having 20 centres in 16 states, to study the changes in crop productivity and soil health and to develop scientific package of practices for organic production of crops in cropping/farming systems perspective. The results of the study clearly indicates that adoption of scientific organic farming practices is essential to keep the crop productivity at comparable or higher level and these practices needs to be adopted in the developmental schemes.

Significant strides have been made in organic and natural farming research, reflecting a growing recognition of the importance of sustainable agricultural practices. ICAR has been actively engaged in conducting research to enhance the understanding of organic farming techniques, promote the adoption of natural inputs, and develop resilient cropping systems that minimize reliance on synthetic inputs. There has been tremendous spurt in organic farming in Indian (22% annual growth rate since 2015) and across the world. The area under organic farming has increased 113 folds since 2003-04 in India (4.73 Mha) and rank 1st in terms of total number of organic producers. With the government emphasis on organic farming through convergence of schemes, NPOP, PKVY, MoVCD-NER etc has shown great scope in the future. Further intensive scientific research is need of time for standardization of Natural farming package through multi-location experimentation for identification of niche area and crops. Through collaborative efforts with research institutions, agricultural universities, and farmers' organizations, ICAR has undertaken numerous initiatives to evaluate the efficacy of organic farming methods, improve soil health, conserve biodiversity, and enhance crop resilience to pests and diseases. Moving forward, ICAR aims to further strengthen its research capabilities in organic and natural farming, focusing on innovation, technology transfer, and capacity building. By leveraging scientific knowledge, traditional wisdom, and modern technologies, ICAR endeavors to mainstream organic and natural farming practices, thereby contributing to sustainable agriculture, food security, and environmental conservation in India.

Climate Smart IFS/IOFS

Climate-Smart Agriculture (CSA) epitomizes integrated resource management to optimize productivity, ensuring the best utilization of available growing space through an integrated farming approach. By diversifying agricultural activities, CSA not only enhances nutritional and economic security but also fosters the overall health and well-being of farming families. Through the cultivation of a variety of fruits, cereals, vegetables, livestock products, and cash crops on their own land, farmers gain resilience against climate variability and market fluctuations. Moreover, CSA promotes local production and consumption, reducing dependence on external sources and mitigating the need for migration. Integrated farming practices empower farmers to adapt to climate change by cultivating different crops on the same land and utilizing farm resources sustainably. To further enhance climate resilience, there is a need to promote high-yielding germplasm with climate-smart attributes, such as pest resistance and drought tolerance, directly at farmers' fields. Both public and private sectors must collaborate to promote livelihood improvement through integrated farming, facilitated by micro-finance initiatives and awareness campaigns among producers. Minimizing transportation costs of farm products not only reduces emissions but also encourages local consumption, thus reinforcing the sustainability of climate-smart agriculture initiatives. Agriculture must be "carbon neutral" in order to combat climate change, meaning that all agricultural activities remove greenhouse gases from the atmosphere in amounts equal to or greater than those that they release. In most of the IFS models developed for different ACZ, the net emission of GHG i.e. source and sink difference as estimated using IPCC Tier II coefficients were found to be negative suggesting environmental suitability of these IFS models.

Water and Energy-Smart Farming Systems

Water and Energy-Smart Integrated Farming Systems (IFS) represent a paradigm shift towards sustainable agricultural practices that optimize water and energy resources while maximizing productivity. These innovative farming systems leverage efficient irrigation techniques, such as drip irrigation and rainwater harvesting, to minimize water usage and mitigate the impacts of water scarcity. Additionally, renewable energy technologies, such as solar panels and biogas digesters, are integrated into farming operations to reduce reliance on fossil fuels and minimize greenhouse gas emissions. By harnessing water and energy resources smartly, these farming systems not only enhance resource efficiency but also improve farm resilience to climate change and variability. Moreover, water and energy-smart IFS contribute to the long-term sustainability of agricultural landscapes. Approximately 80%of the total water resources are used for agricultural purpose. Using multiple use of water in IFS, we can re-use the water in agriculture, so that we can save water and energy. Inter-sectoral management of natural resources needs to be strengthened for progressive sustained productivity rather than simple sustainable productivity. Due care should be taken for water conservation and improvement and management, keeping in view weather forecasting models for different regions. Through research, innovation, and stakeholder collaboration, these farming systems offer promising solutions to address the water and energy challenges facing agriculture.

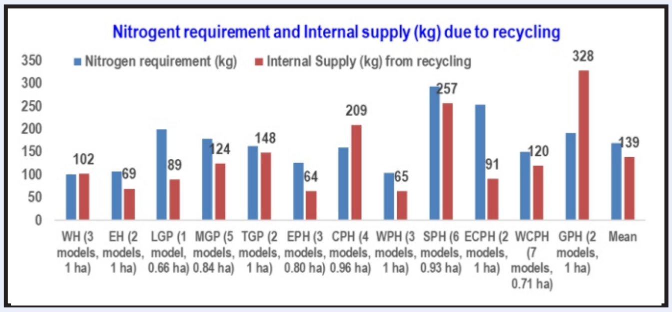
IFS towards opportunities for 'C' trading

International treaties have set quotas on the amount of GHG countries can produce, which in turn set quotas for businesses. Instruments like carbon credits and carbon offset are introduced in order to improve the scenario by encouraging firms to be more environment friendly in conducting their business. One carbon credit allows one tone of carbon dioxide or a corresponding amount of other greenhouse gases to be discharged in the air. Its goal is to stop the increase of carbon dioxide emissions. The Kyoto Protocol presents nations with the challenge of reducing greenhouse gases and storing more carbon. A nation that finds it hard to meet its target of reducing GHG could pay another nation to reduce emissions by an appropriate quantity. The system also motivates the organizations to be more ecofriendly so that they can increase their earnings by selling carbon credits. By following the integrated farming system, the system can make neutral or negative, by way of resource recycling, use of inputs from within the system and less market dependency etc.

Following are some of the strategies to make the system carbon neutral or negative viz., use conservation tillage and controlled traffic techniques in cropping operations, avoid burning crop residues and retain pruning's and stubble where practical, if cultivation is absolutely necessary, do not till excessively wet or dry soils, avoid periods of bare fallow and ensure continuous plant cover where possible, manage irrigation and soil drainage to reduce water logging, rotate crops and include rotations of perennial pastures and legumes, add composted material where practical, manage soil structure to maximize plant uptake and minimize nitrogen loss (e.g. use gypsum on sodic soils), manage livestock waste (dung and urine) to minimize nitrous oxide emissions, manage soil nutrient levels by choosing nutrient targets, completing a nutrient budget to determine fertilizer requirements, match nutrients to the nitrogen input and hence maintain those targets, keep sufficient groundcover throughout the year etc.

IFS for Ecosystem Services and their Monetization

Ecosystem services encompass a range of benefits provided by ecosystems, including soil fertility, pollination, water purification, and climate regulation. favors a better apprehension of interactions between the functioning of parts of ecosystems and components of human wellbeing such as leisure time, health, education, income, purchasing power, etc. The greatest challenge before agricultural researchers, planners, and farmers in developing world at present is to produce more food for growing population from less land, water, and other resources with unstable and stressed agro ecosystems. Integrated and organic farming systems play a crucial role in enhancing these services, leading to tangible economic benefits. Studies indicate that organic farming practices promote soil health and biodiversity, resulting in increased carbon sequestration and reduced greenhouse gas emissions compared to conventional agriculture. The IFS provide diversification and intensification opportunities that enhance the production of quality food, profitability, and ecosystem sustainability, while imparting risk proofing against climate-related vulnerabilities. IFS could be considered as a key solution for increasing livestock and crop production and protecting the soil and ecosystems through effective recycling. The ecosystem service component of IFS, especially the supporting (biodiversity, nutrient, resources, wastes, and by-product recycling), regulating (soil fertility, water infiltration, carbon sequestration, and energy use pattern), and cultural services (knowledge, learning, recreation, and living standard) are higher compared to mono-system. Furthermore, integrated farming systems, which combine multiple agricultural activities such as crop cultivation, livestock rearing, and agroforestry, enhance ecosystem resilience and provide additional ecosystem services. Monetizing these ecosystem services can yield substantial economic returns.



Integrating Ago-ecotourism into Farming Systems

Agro-ecotourism integration represents a promising approach to diversifying income streams for farmers while promoting environmental conservation and rural development. This innovative concept leverages the natural and cultural assets of farming landscapes to attract tourists seeking authentic experiences in rural settings. By integrating agro-ecotourism into farming systems, farmers can showcase their agricultural practices, biodiversity, and cultural heritage, while visitors gain insights into sustainable agriculture, local food production, and rural lifestyles. In recent years, there has been a growing interest towards agro-ecotourism in India, fueled by a desire for authentic travel experiences that celebrate the country's rich agricultural heritage and diverse natural landscapes. Tourists are increasingly drawn to the opportunity to engage with local farmers, learn about traditional farming practices, and savor farm-fresh cuisine straight from the source. IFS model sites with multiple enterprises seamlessly blended together in natures harmony act as living labs and provide potential opportunity to offer unforgettable encounters with nature, agriculture, and local culture for the tourists.

Future Opportunities

- Carbon Farming and exploring and linking Carbon Credit market for IFS under CSR funds
- Whole Farm Modelling and application of Sustainability Assessment Tool in IFS models
- Landscape Design of farming systems using modelling tools
- Scope for diversification and intensification of farm holdings through crop planning
- Bankable models to be popularized with technological backstopping
- Convergence of Govt. Schemes like PKVY, NFSM, NPOP, MoVCD-NER, Modi-Ladakh and their alignment in systems approach for achieving desired SDGs, millennium goals and UNFCC goals.
- Promotion of cluster farming (FPOs, SHGs)
- Scope for business farming through vertical farming
- Employment opportunity to rural youth, women, and weaker sections
- Developing business models in different regions by encouraging agri-startups
- Nature positive farming

I firmly believe that addressing these issues with an integrated and mission-oriented approach will lead to significant advancements in enhancing food security and increasing farmers' income at both regional and national levels. As we work together to tackle these challenges, I extend my heartfelt best wishes to all individuals associated with this great institution of international repute for their commendable contributions. May this institute continue to achieve even greater milestones in the future.

Thank you.

Jai Hind