CEEW
THE COUNCIL

The Food and Land Use Coalition

INTEGRATED FARMING SYSTEMS IN INDIA

This summary document provides an overview of the state of integrated farming systems in India. And also covers a literature review of impact studies conducted on integrated farming systems in India. **It is a part of the larger CEEW study,** *Sustainable Agriculture in India 2021: What We Know and How to Scale Up*

Sustainable Agriculture in India 2021: What We Know and How to Scale Up, is a handbook on the prevalence, practices and state of affairs of the 16 most promising sustainable agriculture practices in the country. It presents the economic, social and environmental impacts of these practices with recommendations on their potential to scale-up sustainable agriculture in India.

The study is available at: https://www.ceew.in/publications/sustainable-agriculture-india-2021

Image: Pexels

Integrated farming systems (IFS) can be described as a judicious mix and positive interaction between two or more components – such as horticulture crops, livestock, aquaculture, poultry/ducks, apiculture, and mushroom cultivation. It uses the cardinal principles of minimum competition and maximum complementarity with advanced agronomic management tools. Its goal is to sustain an environmentally friendly farm income, family nutrition, and ecosystem services.[1] The integrated farming system approach is based on the following objectives:

- To minimise the waste from various subsystems of the farm by expanding the symbiotic or synergistic systems between livestock, aquaculture, agriculture, and agroindustry, such that the waste of one process becomes the input for other operations. The waste may be treated or not to provide the means of production, such as energy, fertiliser, and feed, for optimum productivity at minimum cost.[2]
- To enhance ecological diversity by selecting the appropriate cropping methodology, including mixed cropping, crop rotation, and intercropping, to reduce competition for water, nutrition, and space.
- To use the entire available area effectively and ensure interactions between biotic and abiotic components.[3]
- To improve the farm household's dietary diversity and achieve sustainable livelihoods by diversifying the rural farm to minimises risks.

Integrated farming models vary depending on resource availability, the farm's physical location, access to markets, water availability, and agro-climatic conditions. There is no one specific integrated farming model. Each farm plans according to its available resources, scope, and needs. However, a few suggested IFS models for different zones in India are listed in Box 11. The All India Coordinated Research Project (AICRP-ICAR) on the IFS network has established various science-based IFS models across 15 agro-climatic regions covering 23 states and 2 UTs.[4]

Image: down to earth

Integrated farming systems models for India's agroecological zones

High altitude cold desert: Pastures with forestry, sheep, goats, rabbits, and yak and limited crops like millets, wheat, barley, vegetables, and fodders.

Arid and desert regions: Animal husbandry with camels, sheep, and goat with moderate crop component involving pearl millet, wheat, pulses, oilseeds, and fodders.

Western and Central Himalayas: Emphasis on horticultural crops with crops like maize, wheat, rice, pulses, and fodders on terraces, pastures with forestry, poultry, sheep, goats, rabbits, and yak.

Eastern Himalayas: Horticultural crops with crops like maize, wheat, rice, pulses, and pasture on terraces, pastures with forestry, sheep, goats, rabbits, yak, and cold-water fisheries at altitudes of more than 2,000 metres above mean sea level (MAMSL). Maize, rice, french bean, rice bean, pigs, poultry, fishery, and cole crops like cabbage at more than 1,000 mamsl. Rice, pulses, dairy, fish culture, vegetables in zones lower than 1,000 m amsl.

Indo-Gangetic Plains: Intensive crop husbandry involving rice, maize, wheat, mustard, pulses, and dairy.

Central and southern highlands: Crops such as millets, pulses, and cotton along with dairy cattle, sheep, goat, and poultry.

Western Ghats: Plantation crops, rice and pulses, and livestock components including cattle, sheep and goats.

Delta and coastal plains: Rice and pulse crops along with fish and poultry.

Integrated farming systems' linkages to FAO's agroecological elements

In principle, IFS adheres to and promotes many agroecological elements as defined by the FAO

Elements	Description of agroecological linkages
Diversity	Inter-cropping, mixed cropping, or crop rotation under IFS combine various complementary species to increase the farm's spatial diversity. Similarly, integrating agroforestry and organising crops and trees of different shapes and heights increases the farm's vertical diversity.
Co-creation and sharing of knowledge	Innovations in introducing crops, livestock species, and other systems are the key to enhancing IFS profitability. Instead of a fixed solution, IFS has evolved as a knowledge-intensive system between farmers, civil society organisations, and agricultural scientists. Through the exchange of local knowledge and experiences, region and resource-specific models have evolved in combination with science.
Synergies	Agroforestry with crops, livestock, and other IFS elements ensures synergistic interactions between biotic and abiotic components. For instance, in an integrated rice system with fish, ducks, and trees, the biological synergies between these elements positively affect yields, soil structure, dietary diversity, and overall biodiversity habitat.
Efficiency	The integration is designed so that one enterprise's product could be the input for other enterprises with a high degree of complementary effects, thereby maximising efficiency.
Recycling	A pre-requisite of an integrated farming system is to ensure the efficient recycling of resources, mainly crop residues and animal wastes, because of the micronutrients available

	in biomass and animal waste. For example, crop residue or plant biomass is used as an input into mushroom cultivation as mulch, a substrate in vermicomposting, and as feed.
Resilience	IFS ensures income from at least one enterprise during extreme years and natural calamities, given that the effect of climate variability on different crop/animal/fisheries enterprises will be different. Similarly, by reducing the dependence on external inputs, farmers are less vulnerable to economic risks.
Human and social values	Integrated farming in India is a process that promotes farmer well-being while supporting future generations to maintain a healthy community. It promotes gender equality in labour and respects the traditional and indigenous knowledge of many tribes and communities.

A brief context in India

In India, scientifically designed integrated farming systems are visibly promoted to achieve the national target of doubling farmers' income by 2022. They are explicitly mentioned under the Rainfed Area Development (RAD) division of the *National Mission for Sustainable Agriculture (NMSA).*

From 2003-2008, an all-India Coordinated Program on BIOFARM developed IFS pilot models supported by the Department of Science and Technology of the Government of India. The pilots were developed across 16 states involving 300 farms in different agroecological regions.[5] In 2009, the Project Directorate for Farming System Research (PDFSR) was operationalised in the Indian Council of Agricultural Research (ICAR) to create evidence and develop scientific IFS models across various agro-climatic zones in India. The division is now renamed the Indian Institute of Farming Systems Research (IIFSR) and is the apex body for IFS in India. An all-India coordinated research project on Integrated Farming Systems (AICRP-IFS) initiated in 2010-11. Under its aegis, there are 25 main centres and 12 sub-centers engaged in basic and applied research, located at different state agricultural universities or their regional research centres; 32 on-farm research centres involved in farmer participatory research and situated in different agro-climatic zones. Also, five voluntary centres are located in the ICAR institutes that only pursue IFS model development activities.[1]

ICAR has developed 45 models for climate-resilient integrated farming systems, which are replicated in different Krishi Vigyan Kendras (KVKs) for demonstration and extension.[6] Some state-level initiatives are shown in below.

Some recent integrated farming initiatives

The Kerala Government, as part of the Jaivagriham Project, is providing financial assistance for integrated farming through the Rebuild Kerala Initiative. As part of the project, integrated farming programs are implemented by combining at least five enterprises – crop farming, animal husbandry, poultry, beekeeping, and fish farming. Financial assistance worth INR 30,000 will be given for 0.020-0.121 hectares (5-30 cents) of land, INR 40000 for 0.121 -0.162 ha (31-40 cents), INR 50000 for 41 cents- 2 hectares.[7]

In Tamil Nadu, 600 integrated farming units are about to be formed with an INR 76 crore (USD 10.45 million) subsidy, including INR 10 crore (USD 1.4 million) subsidy from the national agriculture

[1] ICAR, http://www.iifsr.res.in/

development project. One hundred integrated farming systems in each block are being set up in 29 districts. Farmers with the land of one hectare and over are eligible for a subsidy under this scheme. Agriculture crops, kitchen gardens, milch cows, buffaloes, goat backyard poultry birds, permanent vermicompost units, horticulture fruit plants, apiary units, fodder trees compost pits are covered under this scheme.[8]

Welthungerhilfe India, a non-profit organisation, with support of the German Ministry of Economic Development, UNICEF, and GiZ, promoted IFS on a large scale in West Bengal, Jharkhand, Madhya Pradesh, Odisha, Bihar, and Rajasthan from 2012 to 2018. Further collaboration with the Government of West Bengal and the Government of Odisha are initiated to include IFS planning as part of a pilot in four blocks (A. Das, stakeholder consultation).

Integrated farming systems: acreage, geographies, and cultivation details

How much area in India is under IFS? It is not easy to quantify the area under different IFS practices, and no information on the area is available. Stakeholder consultation with the ICAR estimated the area to be less than 0.5 million ha. India's achievement under the Rainfed Area Development website of the *NMSA*[2] in 2019-20 were 52,079 hectares under various IFS activities. These include horticulture-based farming, livestock-based farming, agroforestry-based farming systems, water-harvesting and management, and green manuring.

How many farmers in India are practising IFS? There are no government data available on the number of farmers involved. However, stakeholders consulted indicated the number could be in tens of thousands and thus estimated as less than 0.1 million.

Where in India is IFS prevalent? A survey of existing farmers' systems indicates 19 predominant farming systems in India, with a majority (85 per cent) consisting of crop and livestock farming systems. This does not mean that all of them follow the IFS principles.

Which are the major crops cultivated under IFS in India? Not relevant for this practice as all crops are covered.

[2] Refer: https://nmsa.dac.gov.in/RptActivityAchievement.aspx

Impact of Integrated farming systems?

ECONOMIC IMPACT

1. Yields

Several on-station and on-farm studies have looked at the impact of various IFS models on yields in a range of agro-climatic areas. IFS models in varied farming situations of the country show an enhancement of the "total production rice equivalent yields (REY) ranging from almost 9 per cent in Eastern Himalayan Regions to as high as 366 per cent in Western plains and Ghat region as compared to the prevailing farming systems of the region."[9]

However, the mainstream economics methods for calculating production and productivity, yields per crop, should not be compared with integrated systems. This is because there are several other benefits – such as the benefits of straw as fodder/mulching or edible water/weeds/small fish from the rice fields, which are not captured in the conventional method of calculating productivity. The total productivity of enterprises should be looked at instead of individual efficiency (A. Das, stakeholder consultation).

2. Income

More than 20 peer-reviewed journals on net income and reduced production costs suggest that IFS offers great promise to improve farmers' income and profitability by diversifying the farming method all year round. In rainfed areas, where resource availability is a challenge for farmers, IFS models integrated with poultry and livestock on 1 hectare have proven to be more profitable than monocropping.[10] Activities such as poultry and duck rearing increase income, diversify diets, and provide additional employment, especially for farming women. In irrigated areas, employment generation offers greater potential thanks to intensive cultivation, animal husbandry activities, and more diverse enterprises than rainfed models.[11] In states like Punjab and Bengal, predominantly mono-cropped rice-wheat, the integration of dairy, horticulture, and aquaculture showed three times higher net returns than rice-wheat cropping alone.[12]

In general, with regions receiving 500-700 mm of rainfall, it is advised to integrate livestock with low-water input crops and trees. In 700-1100 millimetre of rainfall, areas, crops, horticulture, and livestock farming systems are profitable. Above 1100 millimetre, including fisheries, is also useful (ICAR Modipuram, stakeholder consultation).

Income diversity is another incentive, as IFS reduces dependency on one livelihood option, and income is spread across the year from different sources. This allows for greater cash availability throughout the year. IFS is a labour-intensive farming practice, which has both pros and cons. On the one hand, this means more employment generation in more days of on-farm employment[13,14,15,16,17] In areas where labour is short, this could be a constraint. However, it is also noticed that additional labour employment (person-days) is contributed mainly by the farmer's family. For a smaller landholding of 1 hectare, the IFS model of crop-livestock-dairy generated 750 person-days of employment versus the prevalent 225-person days from the rice-maize cropping system.

SOCIAL IMPACT

1. Human health

Diet diversity in IFS is a significant factor linking this agricultural production method with health and nutrition. Yet, very little research is done on the topic except for the case mentioned below.

2. Gender

Women's involvement and empowerment through integrated farming is still an under-researched subject in the scientific community. However, a few insights on this indicator were collected from the stakeholders consulted.

Traditionally in Indian agriculture, animal husbandry, poultry management, compost-making, and seed-keeping are women's responsibilities. For example, in many eastern states, livestock management – milking, cleaning, feeding – is mostly done by women. Similarly, in dairy production, women account for almost 90 per cent of total employment.[18] On the one hand, this means more employment opportunities for women, but at the same time, it increases their workload significantly. IFS is time-consuming, and the number of tasks increases. Without mechanization, this is one of the significant constraints to overcome. IFS is also knowledge-intensive. While many civil society organisations are now working with women farmers on capacity building, this remains another barrier to IFS scale-up.

Impacts on integrated farming system on diets

Mr Anshuman Das, from Welthunghilfe India, shared his findings from analysing IFS on 8,495 farms:

"Whereas the major crop diversity changes to minimum 2 or 3 (during 2011) to maximum 4 or 5 (during 2014 after intervention) in the cropland at one time, the home gardens seem to be more diverse, which stabilizes to 6-7 on an average. This has a big impact on diet diversity and self-sufficiency. In 2014, diet diversity score was conducted in Jharkhand, which showed about 70 per cent of women eat at least five types of food groups. This differed from 2011, where the majority were consuming mostly variations of starchy staples.'

ENVIRONMENTAL IMPACTS

1. Soil and nutrients

IFS principles promote resource efficiency. The use of vermicompost, organic compost, and direct residue incorporation into the soil helps increase organic carbon and microbial activities. For example, when perennial trees are integrated with livestock, the trees' deeper roots and greater biomass enhance the soil organic matter. Perennial trees and grasses form a vegetative cover to the soil, which minimises soil erosion. Trees grown with arable crops promote efficient nutrient cycling. The recycling of farm waste – poultry waste, stubbles, and weeds – through vermicompost increased organic carbon and

available NPK by 0.06 in a one-acre model farm developed by integrating agriculture and horticulture fishery and poultry.[19]

The long-term IFS benefits for soil physical, chemical, and biological health is an under-researched area in India and should be systematically studied and monitored.

2. Water

There is a lack of systemic studies into the impact of integrated farming models on India's water use efficiency; this topic deserves more attention.

3. Emissions

Long-term empirical evidence on carbon sequestration and emissions was not found. This area requires more research and evidence generation.

In principle, however, crop-livestock integration should reduce emissions because crop residues are fed to animals instead of disposing them of. When manure is applied to the fields, emissions from manure storage are also reduced. The integration of trees with crops increases the soil's carbon storage (as in agroforestry), trees in livestock paddocks have reduced fertiliser needs. Reducing the use of fertilisers means avoiding fossil fuel emissions. However, there is a need to systematically study and document these impacts.[20]

4. Biodiversity

There is no systematic literature on the impact of IFS on biodiversity other than the BIOFARM report – which was the first project by the Government of India on IFS. The report found a significant increase in the diversity of vegetables and horticulture trees on the IFS farms with homestead gardens; 33 per cent of the farms studied recorded a 50-100 per cent increase in species diversity.[21] The stakeholders interviewed, however, reported an increase in flora and fauna from the IFS practices.

Impact evidence

State of available research discussing impact of integrated farming systems on various outcomes

Evidence Type	Yield	Income	Health	Gender	Soil and nutrients	Water	Energy	GHG emissions	Bio-diversity
Journals	11	28	0	3	4	3	0	1	0
Reports	6	3	2	4	2	2	0	0	1
Articles/ case-studies	0	3	1	0	0	0	0	0	0
Others **	2	2	0	0	0	0	0	0	1
Total	19	36	3	7	6	5	0	1	2

*** Thesis, guidelines, conference papers, etc*

Source: Authors' compilation

Note – The evidence is from the first 75 results examined in Google Scholar Advanced search and the first 30 results from Google Advanced Search. Only those papers which clearly established the evidence for different indicators were selected.

Stakeholder mapping

The following institutions are involved in the research and promotion of IFS; a few were consulted for this research:

Government institutions	Research/implementation institutions	NGOs/Civil society organisations
Central Research Institute for Dryland Agriculture (CRIDA)	Faculty Centre for Integrated Rural Development and Management An Off-campus Faculty-Centre of Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI)	Welthungerhilfe
Indian Council of Agricultural Research (ICAR) – IIFSR Modipuram Meerut	Tamil Nadu Agricultural University (TNAU)	Foundation for Ecological Security
ICAR-Mahatma Gandhi Integrated Farming Research Institute (MGIFRI), Earlier NRC on Integrated Farming-NRCIF, Piprakothi, Motihari, (East Champaran)	Rani Laxmibai Central Agricultural University, Jhansi	Abhivyakti Foundation
Integrated farming systems research station, Karamana		Society for Promotion of Wastelands Development (SPWD)
Agriculture Technology Application Research Institutes (ATARI)		Development Research Communication and Services Centre

Source: Authors compilation

Note – The stakeholders list is indicative and not exhaustive

Endnotes

[1] Panwar A.S, Ravisankar N, Shamim M, and Prusty A. 2018. "Integrated Farming Systems: A Viable Option for Doubling Farm Income of Small and Marginal Farmers" *Bull Indian Soc Soil Sci* 32:

[2] Kumar S, Bhatt BP, Dey A, et al (2018) Integrated farming system in India: Current status, scope and future prospects in changing agricultural scenario. Indian J Agric Sci 88:1661–1675

[3] Basu P. and Das A. (no date). *Resource Integrated Farming System: Emergence of BIOFARM initiative* [report shared by a stakeholder consulted]

[4] Ministry of Agriculture & Farmers Welfare. 2017. Report of the Committee on Doubling Farmers' Income - Volume VI "Strategies for Sustainabilty in Agriculture". Available at <http://agricoop.gov.in/sites/default/files/DFIper cent20Volumeper cent206.pdf>Accessed 25 October 2020

[5] Basu P. and Das A. (no date). *Resource Integrated Farming System: Emergence of BIOFARM initiative* [report shared by a stakeholder consulted]

[6] Ministry of Agriculture & Farmers Welfare. 2020. Lok Sabha Unstarred question no. 2063, 'Organic Farming' dated 3 March 2020, Government of India, http://164.100.24.220/loksabhaquestions/annex/173/AU2063.pdf.

[7] The Hindu. 2020. "Financial aid to farmers - 'Jaivagriham' project envisages income to peasant". 25 May 2020. Available at <https://www.thehindu.com/news/national/kerala/financial-aid-to-farmers/article31672080.ece>. Accessed 25 October 2020

[8] Press Information Bureau. 2020. "Integrated farm system to help farmers sustain food security Rs 76 crore subsidy for 7600 integrated farming units in Tamil Nadu". Posted on 17 June. Available at <https://pib.gov.in/PressReleasePage.aspx?PRID=1632086> Accessed 25 October 2020.

[9] Kumar S, Kumar U, Bhatt BP (2012) Integrated farming system for improving agricultural productivity

[10] Nath S.K, De H.K, and Mohapatra B.K. 2016. "Integrated farming system: is it a panacea for the resource-poor farm families of rainfed ecosystem?" *Current Science*, 110(6).

[11] Sharma R. L., Abraham S., Bhagat R., and Prakash O. 2017. "Comparative performance of integrated farming system models in Gariyaband region under rainfed and irrigated conditions". *Indian Journal of Agriculture Research*, 51 (1): 64-68

[12] Walia S.S, Aulakh C.S, and Gill R.S, et al. 2016. "Intensive integrated farming system approach-a vaccination to cure agrarian crisis in the Punjab". *Indian J Econ Dev* 12:451. https://doi.org/10.5958/2322-0430.2016.00104.9

[13] Kashyap P, Kansal A, Prusty AK, Singh JP (2015) Evaluation of Horticulture Based IFS Models for Providing Nutritional Security to Small and Marginal Farmers of Western Plain Zone of Uttar Pradesh, India Fruits, nutritional security, higher returns, Sustainable development, Vegetables

[14] Ravisankar N, Shamim M, Prusty A (2018a) Integrated Farming Systems: A Viable Option for Doubling Farm Income of Small and Marginal Farmers Nutrients management in soils View project Network Project on organic agriculture View project. Bull Indian Soc Soil Sci 32:

[15] Bhati A, Makanur B, Akshaya Bhati C (2019) Permaculture: A way of sustainable living. ~ 3028 ~ J Pharmacogn Phytochem 8:

[16] Rathore VS, S Tanwar SP, Yadav OP (2019a) Integrated Farming System: Key to sustainability in arid and semi-arid regions

[17] Basavanneppa, MA AKG (2020) Doubling the small farmers income through integrated farming system approach in irrigated ecosystem All India Co-ordinated Research Project on Integrated Farming System View project Sorghum and Legume Intercropping Systems for Improving Forage Quality and. https://doi.org/10.22271/chemi.2020.v8.i2o.8889

[18] Patel S.J., R. Kumar, A.S. Patel, N.R. Patel, and V.N. Paramar. 2017. "*Involvement of Farm Women in Decision Making Regarding Dairy Farming in Junagadh District of Gujarat State*" Indian Journal of Hill Farming June 2017, Volume 30, Issue 1, Page 45-58

[19] Kumar S, Bhatt BP, Dey A, et al (2018) Integrated farming system in India: Current status, scope and future prospects in changing agricultural scenario. Indian J Agric Sci 88:1661–1675

[20] Rathore VS, S Tanwar SP, Yadav OP (2019a) Integrated Farming System: Key to sustainability in arid and semi-arid regions

[21] Basu P. and Das A. (no date). *Resource Integrated Farming System: Emergence of BIOFARM initiative* [report shared by a stakeholder consulted]

Suggested citation: Gupta, Niti, Shanal Pradhan, Abhishek Jain, and Nayha Patel. 2021. *Sustainable Agriculture in India 2021: What We Know and How to Scale Up*. New Delhi: Council on Energy, Environment and Water

The **Council on Energy, Environment and Water (CEEW)** is one of Asia's leading not-for-profit policy research institutions. The Council uses data, integrated analysis, and strategic outreach to explain – and change – the use, reuse, and misuse of resources. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions, and engages with wider public. In 2021, CEEW once again featured extensively across ten categories in the *2020 Global Go To Think Tank Index Report*. The Council has also been consistently ranked among the world's top climate change think tanks. Follow us on Twitter @CEEWIndia for the latest updates.

FOLU Coalition: Established in 2017, the Food and Land Use Coalition (FOLU) is a community of organisations and individuals committed to the urgent need to transform the way food is produced and consumed and use the land for people, nature, and climate. It supports science-based solutions and helps build a shared understanding of the challenges and opportunities to unlock collective, ambitious action. The Coalition builds on the work of the Food, Agriculture, Biodiversity, Land Use and Energy (FABLE) Consortium teams which operate in more than 20 countries. In India, the work of FOLU is being spearheaded by a core group of five organisations: Council on Energy, Environment and Water (CEEW), the Indian Institute of Management, Ahmedabad (IIMA), The Energy and Resources Institute (TERI), Revitalising Rainfed Agriculture Network (RRAN) and WRI India.

Contact shanal.pradhan@ceew.in/ abhishek.jain@ceew.in for queries

CEEW
THE COUNCIL