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Approach for Resource Conservation and Economic Stability in the Upper Gangetic Plains of India

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ABSTRACT

Background: The IFS Model resolved manifold demands of small farm holders and improved nutritional security. Resource recycling and conservation of farm-based waste from one enterprise into valuable inputs for others. This circular approach maximizes productivity, reduces reliance on synthetic chemicals, and buildings long term ecological sustainability.

Methods: A field experiment was conducted during 2018-2023 at the research farm of ICAR-Indian Institute of Farming Systems Research, Modipuram, Uttar Pradesh to investigate the synergistic effects of IFS modules in terms of higher productivity per unit area and reduces green house gases emission. The total field land was allocated according to the needs of the farm family and surplus for the market. Sustainability was accounted for family requirements. The manure from dairy or poultry was collected regularly and urine was harvested in a fish pond. The crop residues, weeds and dry leaves were collected into pits to decompose well instead of applying raw manure processed *via* vermicompost (using earthworms like *Eisenia fetida*) or mixed with crop residues. This process increases nutrient availability and neutralizes pathogens. The energy requirement and input-output relationship of energy for individual components was worked out.

Result: By-products were collected (22.24 t/year) from the various IFS modules. However, maximum wastes were accumulated from the dairy component as FYM and VC (18.00 t/year), followed by CR (1.25 t/year). The nutrients turned out were highest from dairy component (496.10 kg/year) via FYM and VC, with an economic value of ₹ 9229/year. Maximum GHG was generated by the rice-wheat sequence (1304 kg CO_2-e). The highest energy was created by the sugarcane-ratoon-wheat system (47.33×10^3 MJ/ha) with energy EUE of 596.70×10^3 MJ/ha. SMP (bacteria, fungi, Actinomycetes, *Pseudomonas*, free-living N fixers, Trichoderma, *Rhizobium* and enzymatic activities (DHA) were super under the maize-berseem-green gram in the alluvial soil. Maximum man-days were generated by crop component (220 man-days/year)

Key words: Biological activities, Cropping sequence, Energy input: output ratio, Microbial population, Wheat equivalent yield.

INTRODUCTION

India with its diverse agro-climatic zones and a predominantly agrarian economy faces the twin challenge of ensuring food security and improving farming livelihoods. Traditional monoculture farming has often led to soil degradation, water scarcity and economic vulnerability. In this context, the integrated farming system (IFS) model emerges as a holistic and sustainable approach not only for enhancing productivity but also ensures environmental sustainability and economic resilience. Farmers generally focused on crop production, which is highly unsure in terms of income and employment stability. In India, there are 115 million farm holdings, with 87% being small and marginal. Integrated farming system offers a viable option to the challenges of boosting food production, increasing income, improving the nutrition status of small and marginal farmers with limited resources. Livestock farming combined with crop production is a traditional practice is being followed by farmers. Other additional activities like dairy, fishery, poultry, vermicompost, mushroom cultivation, kitchen gardening and boundary plantation are the integral parts of integrated farming system. These activities should be compatible with farm level infrastructure and ensure the full utilization of farm by-products. Integrated farming system is a promising strategy for the mitigating climate change. IFS model is particularly well suited to ensuring food security, adapt to climate change and reduce green house gas emissions (Meena *et al.,* 2024). Moreover, IFS contributes to climate resilient by improving soil health, conserving water resources and enhancing biodiversity as reported by the (Kumar *et al.*, 2025). Thus, IFS is a resilient and farmer-

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centric model, particularly matched to the needs of small and marginal farmers of India (Kumar, 2025). Its uses the cardinal principles of minimum competition and maximum complementarily with advanced agronomic management tools. The integrated farming system goal is to sustain an environmentally friendly farm income, family nutrition and ecosystem services (Barman *et al.*, 2025).

MATERIALS AND METHODS

The present study was conducted during 2018-2023 on 1.5 ha of land under assured irrigation conditions having diverse components as arable crops (1.04 ha), livestock (3 buffaloes and 1 cow), horticultural crops (0.22 ha), fishery (0.1 ha), mushroom 0.02 ha), poultry (10 birds), vermicompost (0.02 ha), kitchen garden (20 m^2) and boundary plantation was made across the all boundaries. Cow dung and farm wastes can be effectively utilized and speedily recycled, as compared to the conventional method of vermicompost preparation from farmyard manure (FYM). Mushroom spent can be used as annual fodder and organic manure for field crops. Livelihood analysis of the IFS model was worked out. The field experimental site was located at 29° 43′ N latitude and 77° 23′ E longitude at the elevation of 237 meters above the mean sea level (SML), is classified as a semi-arid sub-tropical region with monsoonal climate and sandy loam soil is classified as Typic Ustifluvents. The experimental site received a total of 730.3 mm, 976.7 mm, 824.3 mm, 794.6 mm and 897.5 mm annual rainfall in 37, 44, 42, 39 and 44 rainy days, respectively. More than 80% of precipitation was received through southwest monsoon. The mean annual minimum and maximum temperatures ranges varied from 18.1°C and 30.7°C (2018-19), 17.4°C and 30.5°C (2019-20), 17.0°C and 29.9°C (2020-21), 17.8°C and 30.5°C,(2021-22) and 16.9°C and 30.2°C (2022-23), respectively. While the atmospheric humidity stood at 72.7%, 72.7%, 74.2%, 73.4% and 75.2%, respectively. The mean data over a period of time (2018-2023), showed sunshine hours were 6.3 and pan evaporation 1575.45 mm. The total soil organic carbon (TSOC) was 0.89% (CHNS analyzer). Available N was low (176.6 kg/ha) in soil estimated by the alkaline permanganate (KMnO4) method. Similarly, available P was medium (29.3 kg/ha) analyzed by the Jackson (1973) method and available soil K was medium (194.7 kg/ha) estimated by the NH4OAc method. The economic yield of each crop was converted into wheat equivalent yield (WEY), considering crop production's prevailing farm gate price (₹/kg). The energy efficiency parameters were determined to evaluate the relationship between energy consumption, energy inputs-outputs ratio, total inputs and total outputs/ha. The nutrients turned over from various components were worked out based on dry matter accumulation in the byproducts and chemically analyzed the nutrient content through prescribed standardized procedures. Energy productivity, energy profitability and net energy gained were calculated using the formulas suggested by (Mani *et al.,* 2007) and (Rathke *et al.*, 2007). Energy output-input ratio showed the efficiency of energy input and also marginal increase of output per unit increase in energy input. This ratio is generally higher with lower energy input and higher energy output, which indicates the law of diminishing returns applied in energy input. Energy efficiency was used to measure the economic efficiency of crop production (main and by-products). Energy inputs were estimated based on the human labour required for running machinery and the quantity of materials used; energy was computed for different input and output equivalents. The following energy derivations have been designed as mentioned below:

$$\text{Energy productivity} = \frac{\text{Wheat equivalent yield (kg/ha)}}{\text{Energy input (MJ/ha)}}$$

$$\text{Energy profitability} = \frac{\text{Net energy (MJ/ha)}}{\text{Energy input (MJ/ha)}}$$

$$\text{Energy ratio} = \frac{\text{Energy output (MJ/ha)}}{\text{Energy input (MJ/ha)}}$$

Net energy yield (MJ/ha) =

Output energy (MJ/ha) - Input energy (MJ/ha)

WEY =

$$\frac{\text{Yield of individual crop (kg/ha)} \times \text{Price of individual crop (₹/kg)}}{\text{Price of wheat crop(₹/kg)}}$$

Emission of greenhouse gases (GHGs) from different components of the integrated farming system (IFS) model was designed by the Indian Institute of Farming Systems, Research, Modipuram, Meerut, Uttar Pradesh, using the IPCC guidelines. The data are worked out based on already available predicted values, fertilizer usage, machinery usage and chemical usage for different crops. The greenhouse gas emissions from different cropping systems and other components of the IFS model were converted into carbon dioxide equivalent between components for their comparison.

$$\text{Emission} = A \times EF$$

Where,

Emission = Annual emission in units of kg of CO_2 eq. per farm.

A = Activity data (kg of N used, liters of fuel used, *etc*.).

EF-Emission factor = IPCC default emission factors or Country-specific emission factors. Country-specific emission coefficient (Tier III) and IPCC default coefficient was applied to get the total emission from each category of IFS Modules.

Soil samples were collected before the experiment was conducted and at the end of each crop cycle at the depth of 0-15 cm for the purpose of counting microorganisms' population and dehydrogenase enzymatic activity. Traditionally, the diversity of soil microorganisms has been analyzed through visible and cultivable methods, community-level physiological profiling (CLPP). Maximum man-days were generated by crop component (220 man-days/year from 1.04 ha of land).

RESULTS AND DISCUSSION

Recycling of farm based byproducts and nutrient harvesting

Nutrient recycling in IFS is a common practice of efficiently reusing and redistribution of nutrients within the system as it involves the utilization of organic waste, residues, or byproducts from one component of the farming system to another. The main purpose of IFS is to recycle of farm wastes in order to reduce the cost of chemical fertilizers and also provide an eco-friendly production environment, nutrient recycling within the system is a prerequisite for the development or integration of any component in the IFS model (Sharma *et al.*, 2017). Priorities should be given to those components at the same time whose byproducts can be recycled within the system or can be reused as input for another component to increase nutrient use efficiency on one hand and also for decreasing the cost of cultivation and addition of organic matter (OM) to the model for enhancing its sustainability (Kumar *et al.*, 2025). Model spanning over 1.5 ha comprising of crop, dairy, horticulture, fishery, poultry, mushroom, kitchen garden, vermicompost and boundary plantation produced a total of 22.24 t/year of farm byproducts or wastes. The farm byproducts or wastes comprised of green manure (*dhaincha*) 870 kg/year from 1800 m^2 area. The *dhaincha* crop contains high amount of nutrients (28.61 kg NPK from 1800 m^2 area) and their economic worth to the tune of ₹ 544. The other important sources of farm base wastes were vermicompost and FYM which produced a sum of 357.64 kg NPK/year from 11500 kg vermicompost and 138.45 kg NPK from 6500 kg FYM (farm yard manure). Apart from these farm wastes, mushroom spent (46.08 kg NPK), crop residues (23.13 kg NPK) and pulses stubbles (15.75 kg NPK) were equally important for recycling of nutrients into the soil. Besides, dry tree leaves and poultry dropping (manure) were also recycled to the tune of 320 kg/year and 125 kg/year from 10 birds of poultry component. The dry tree leaves and poultry manure have the content of 10.46 kg and 3.87 kg of NPK, respectively. While the recycling of farm wastes in 1.5 ha model increased net income of ₹ 11394/ year from 22.24 t farm byproducts produced (Table 1). Moreover, farm base wastes added about 265.18 kg N, 51.36 kg P and 269.48 kg K and 586.02 kg/year NPK in the soil which is equivalent to 576 kg of urea, 354 kg of SSP and 449 kg of MOP, respectively. In addition to these nutrients, an ample quantity of micronutrients was also added to the soil through nutrient recycling in an IFS model. While the total N, P and K requirements of crops and fruit plants are 540 kg N, 270 kg P and 360 kg K, respectively. The rest needs of nutrients (275 kgN, 218.64 kgP and 90.52 kgK) would be purchased from the outside of model to fulfil the demands of crops, fruit plants, vegetables and kitchen garden *etc*. Thus, in terms of per cent requirement of these major nutrients are to be met out from the market the tune of 275 kg N (50.90%), 218.64 kg P (80.97%) and 90.52 kgK (25.14%), respectively (Meena *et al.*, 2022).

Green house gases emission from IFS model

The huge usage of agricultural chemicals in crop production results in immense GHGs emissions from crop fields and other linked enterprises. The result shows that under different cropping systems, rice-wheat system produced higher GHGs (1304 kg CO_2-e from 1800 m^2area) among cropping systems. Another important cropping system is sugarcane-ratoon-wheat (641 kg CO_2-e from 3500 m^2area) which is more responsible for emission of higher GHGs. But the least CO_2-e was valued from 400 m^2 area where perennial fodder component hybrid bajra Napier planted in cropping systems (33kg CO_2-e). Moreover, in other components of integrated farming system (IFS), livestock module emitted highest GHGs into the atmosphere (3378 CO_2-e in kg), however, emission took place from fish cultivation (515 CO_2-e in kg). The total C-sink of the IFS model was about 44028 CO_2^{-e}(kg) as against the total C-sources (6638 CO_2-e kg). The higher C-sink was absorbed by fruit trees and boundary plantations. Thus, the net GHGs emission exhibited as negative in

Table 1: Recycling of farm wastes/byproducts for nutrient harvest and economic gain under integrated farming system model.

Farm waste sources	Quantity produced on dry weight basis (kg)	Nutrient content (%) and recyclable nutrients (kg)			Total NPK (kg) gain upon recycling	Economic value (Rs.)
		N	P	K		
Green manure	875	1.27 (11.11)	0.36 (3.15)	1.64 (14.35)	28.61	544.0
Pulses dry matter	870	0.52 (4.52)	0.21 (1.83)	1.06 (9.22)	15.57	316.0
Mushroom spent	800	1.50 (12.0)	0.65 (5.2)	0.61 (4.88)	46.08	542.0
Dry tree leaves	320	1.29 (4.13)	0.36 (1.15)	1.62 (5.18)	10.46	198.0
Poultry manure (litter)	125	0.9(1.12)	0.6(0.75)	1.6(2.00)	3.87	74.0
Crop residues	1250	0.56(7.0)	0.09(1.13)	1.20(15.00)	23.13	493.0
FYM	6500	0.60 (39.0)	0.18 (11.7)	1.35 (87.75)	138.45	2911.0
Vermicompost	11500	1.62 (186.3)	0.23 (26.45)	1.26 (144.90)	357.65	6318.0
Total	22240	265.18 Kg N	51.36 kg P	269.48 Kg K	586.02 NPK	11394.0

Where: N: Nitrogen; P: Phosphorus; K: Potassium; VC: Vermicompost; FYM: Farmyard manure. Nutrients prices in the market (N: 11.65/kg, P: 26.25/kg and K: 26.73/kg)

balances of IFS model, since over-intensification of crops or other enterprises can be optional for this IFS model. In view of environmental safety, the sink should always be larger than source, which indicates, GHGs emission from IFS model had a negative balance (-37390 CO_2-e kg) as shown in (Fig 1), advocating IFS model is environmentally safe and more activities can also be added into system for better synergy with economics and clean environment (Meena *et al.*, 2025). Therefore, an integrated farming system approach may be one of the most important ways to mitigate the adverse effects of climate change as reported by (Yadav *et al.,* 2019). In the highly intensified cropping systems the pulses, oilseed and fodder crops should be added to build up underground carbon besides aerial biomass. Model as a whole, the crops contribute to carbon sequestration in the soil over initial status and this helps to mitigate global warming potential (GWP) as created by the livestock component of the model as reported by (Sathiya *et al.*, 2020).

Livelihood analysis

Livelihood experimental IFS Model (1.5 ha) was analyzed as per demand of householders and sale of surplus in market after consumption. The model generated ₹ 672276 of gross return with a marketable surplus (₹ 468364) and family savings was ₹ 251794. In the IFS model gross production (A) from crops/ cropping system was ₹ 241185 out of which the family consumed (B) produce worth ₹ 26000 cropping system waste/ by-produce could be recycled (C) worth ₹ 8172 with net market surplus (A-B-C=D) of ₹ 207013 resulting in net family savings of (D-CP) ₹ 101313. Followed by dairy (milch animals) with total produce (A) of ₹ 226574 out of which family consumption (B) was ₹ 21285 recycled value worth ₹ 48380, marketable surplus of dairy was ₹ 156909 with family savings of ₹ 58409 followed by horticulture module with marketable surplus of Rs. 67400 and net savings of ₹ 38850 (Table 2). Vermicompost also gave a net savings of ₹ 38600. Fishery contributes ₹ 10800 to net savings; Value addition could enhance the net savings by ₹ 3200. Kitchen garden and poultry added ₹ 1900 and ₹ 1340, respectively. The total quantity of mushroom produced was entirely used for family consumption.

Employment generation from IFS model

It is often said that there is hidden employment in agriculture which can be best described with an example of seven members in a family (four adults and three children), they possess a land of one acre in which rice-wheat cropping system is being followed. It is observed that all the members are engaged in the farming itself in one or other ways while it is not required. Most of the times they appear to be sitting idle. IFS model make a guarantee to overcome this type of problem by integrating a greater number of remunerative components in the system (Nair *et al.,* 2019). By integrating small components like fish, poultry, mushrooms, vermicompost, kitchen garden and boundary plantation about 221 man-days would be required additionally to maintain their steady activities and family members can perform extra work easily in addition to already ongoing enterprises of IFS model at the same time without extra remuneration. Family woman and Childrens' can also be involved in various agriculture-based activities like primary processing of farm produces at home and vegetable nursery raising and collecting farm wastes. It was observed that multifarious activities of different enterprises were included in the IFS model which provides a lot of opportunities for employment generation and keeps farmers and their family members engaged throughout

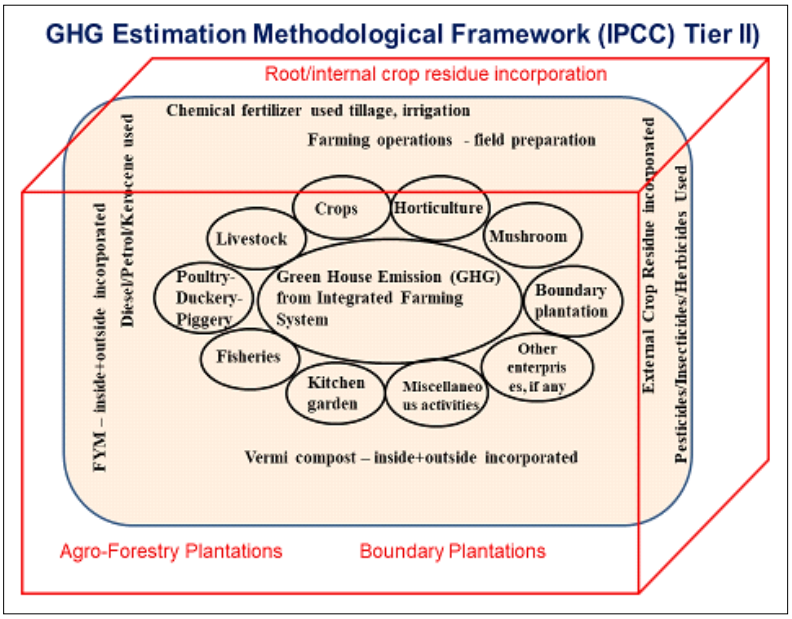


Fig 1: Green house gases emission estimation by IIPC-Tier II (2006) at ICAR-IIFSR, Modipuram.

Table 2: Livelihood analysis of IFS Model.

Farm enterprises	(A) Value of all the farm commodities produced (₹)	(B) Value of farm commodities consumed in family (₹)	(C) Value of all farm commodities recycled within the system (₹)	(A-B-C)=D Marketable Surplus (₹)	(D-CP) Family savings (If any) (₹)
Crops/Cropping systems	241185	26000	8172	207013	101313
Dairy (Milch animals)	226574	21285	48380	156909	58409
Horticulture (Fruit crops)	72500	5100	-	67400	38850
Fishery	28800	5400	-	23400	10800
Poultry	15025	7200	625	7200	1340
Mushroom	11042	7200	1200	2642	-3118
Boundary plantation (fruit trees)	5400	2300	300	2800	500
Vermicompost/ FYM	64000	-	64000	-	38600
Kitchen garden	3250	3250	-	-	1900
Value addition	4500	4500	-	-	3200
Total of all the farm produces (GR)	672276	146235	122677	468364	251794

CP: Cost of production.

Table 3: Man-days generated from different components of integrated farming system model developed on 1.5 ha of land.

Component	2018-19	2019-20	2020-21	2021-22	2022-23	Mean
Crops alone	252	245	240	192	171	220
Dairy	168	160	152	150	149	156
Horticulture	57	65	57	67	54	60
Fishery	94	85	75	55	52	72
Poultry	35	26	26	38	33	32
Mushroom	38	30	32	25	45	34
Kitchen garden (KG)	27	a 18	20	15	10	18
Boundary plantation (BP)	25	10	15	18	15	17
Vermicompost (VC)	57	55	45	43	40	48
All values on (1.5 ha) area basis	753	694	662	603	569	656
All values on hectare basis	502	463	441	402	379	437

the year as such it helps in resolving the joblessness problem of the farmers in the western part of the UP mainly for rural educated youths. The total annual man-days generated from various components varied from 17 boundary plantation) to 220 (crop component). Maximum man-days were generated by crop component (220 man-days/year from 1.04 ha of land) followed by dairy component (156 man-days/year), fishery (72 man-days/ year), horticulture (60 man-days/year), vermicompost (48 man-days/year), mushroom (34 man-days/ year), poultry (32 man-days/year), kitchen garden (18 man-days/year) and boundary plantation (17 man-days/year), respectively. The man-days required for the production of crops alone was 220 /year under IFS model. This might be due to IFS model which is based on crop and requires more man-days as compared to other components of the model. The IFS model has generated 656 man-days/ year from 1.5 ha of land area and 437 man-days on the hectare basis on average data of 5 years. Similar results related to man-days are required and generated under IFS model in the hilly area of Meghalaya as reported by (Ansari *et al.,* 2014). However, commencement of model, the manpower requirement was higher than in succeeding years (Table 3).

CONCLUSION

The findings of the present study clearly establish the effectiveness of the Integrated Farming System (IFS) as a sustainable and climate-resilient production model for the Upper Gangetic Plains of India. Despite considerable inter-annual variability in meteorological conditions, the integrated system consistently demonstrated superior performance in terms of productivity, economic returns and soil health. Moreover, Results showed notable improvements in soil physicochemical and biological properties, including increased organic carbon and available nutrients, along with reduced bulk density, indicating enhanced soil quality indices and long-term sustainability of the system. The integration of diversified cropping sequences with dairy farming not only optimizes resource use but also enhances the income of the farmers and reduces risk during harsh climatic conditions. Higher net returns and benefit-cost ratio were observed in the later

years, reflecting improvement in system stability and management efficiency. Overall, Integrated Farming System (IFS) proved to be a viable climate-smart farming approach capable of enhancing livelihood security, conserving natural resources and improving resilience to climate variability. This study underscores the potential of IFS for wider adoption in the Upper Gangetic Plains of India, with a scope for scaling up through appropriate policy support, capacity building and location-specific refinements.

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Disclaimers

The experiment, views and results conveyed and shown in this article is an original and unpublished work. The authors take full responsibility for the accuracy of the information provided, but will not be held responsibility for losses that may result from the utilization of this work.

Conflict of interest

The authors declare that there is no conflict of interest for the publication of this article and preparation of this manuscript.

REFERENCES

Ansari, M.A., Prakash, N., Baishya, L.K., Punitha, P., Sharma, P.K., Yadav, J.S., Kabuei, G.P. and Levis, C.K. (2014). Integrated farming system: An ideal approach for developing more economically and environmentally sustainable farming systems for the Eastern Himalayan Region. *Indian Journal of Agricultural Sciences*. **84(3)**: 356-362.

Barman, S., Malhotra, R., Sen, B. and Paul, S. (2025). Economic inter-linkage analysis of dairy-based integrated farming systems and pathways to profitability in the coastal region of West Bengal. *Bhartiya Krishi Anusandhan Patrika*. **40(3):** 317-325. doi: 10.18805/BKAP872.

IPCC (2006). (Intergovernmental Panel on Climate Change) IPCC Guidelines for National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change, Paris, 2006.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, p 498.

Kumar, S., Kumar, A., Shivani, Kumar, S., Kumar, R., Dubey, R., Shubha, K., Saurabh, K., Manibhushan and Das, A. (2025). Enhancing farm productivity, profitability, sustainability and livelihood of small farm holders through integrated farming system. *The Indian Journal of Agricultural Sciences*. **95(3):** 272-279.

Kumar, S., Singh, R. and Kumar, K. (2025). Integrated farming systems for enhancing productivity and livelihood of small farmers. *Indian Farming*. **75(12):** 09-13.

Mani, I., Kumar, P., Panwar, J.S. and Kant, K. (2007). Variation in energy consumption in production of wheat-maize with varying altitudes in hilly regions of Himachal Pradesh, India. *Energy*. **32:** 2336-2339.

Meena, L.R., Kochewad, S.A., Prusty, A.K., Bhanu, C., Kumar, S., Meena, A.L. and Singh, S.P. (2022). Sustainable integrated farming system model for small farm holders of Uttar Pradesh. *The Indian Journal of Agricultural Sciences*. **92(9):** 1080-1085.

Meena, L.R. and Anjali. (2025). Development of sustainable IFS model for enhancing productivity, profitability, sustainability and resource conservation under changing climate. *Medicon Agriculture and Environmental Sciences*. **8(3):** 01.

Meena, L.R., Kochewad, S.A., Kumar, D., Malik, S., Meena, S.R. and Anjali. (2024). Development of sustainable Integrated farming systems for small and marginal farmers and ecosystem service- A comprehensive review. *Agricultural Science Digest*. **44(3):** 391-397. doi: 10.18805/ag.D-5961.

Meena, L.R., Subash, N., Anjali, Kumar, D. and Nirmal (2022). Integrated farming system models development for small and marginal households for sustainable production and livelihood improvement in India: An overview. *Medicon Agriculture and Environmental Sciences*. **3(1):** 5-18.

Nair, G.M., Jayalaxmi, G. and Kishore Kumar, N. (2019). Utility of Integrated Farming Systems: A perception study from Kuttand. *Agricultural Science Digest*. **39(4):** 332-334. doi: 10.18805/ag.D-4876.

Rathke, G.W., Wienhold, B.J., Wilhelm, W.W. and Diepenbrock, W. (2007). Tillage and rotation effect on corn-soybean energy balances in eastern Nebraska. *Soil and Tillage Research*. **97:** 60-70.

Sathiya Bama, K., Latha, K.R., Vasuki, V. and Ravishankar, N. (2020). Prediction of greenhouse gas emission in the integrated farming system model: Implication on the soil environment. *Journal of Pharmacognosy and Phytochemistry*. **9(4):** 525-532.

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 Agricultural Research*. **51(1):** 64-68. doi: 10.18805/ijare.v51i1.7064.

Yadav, A.K., Ramawat, N. and Singh, D. (2019). Integrated farming systems approach: Increase food security, agricultural farm income and rural economy. *International Journal of Current Microbiology and Applied Sciences*. **8(2):** 1167-1185.