



Consumption pattern and determinants of household dietary diversity through farming systems approach

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ABSTRACT

Integrated Farming Systems (IFS) is a sustainable agricultural model integrating enterprises such as crops, livestock, fisheries, poultry and agroforestry. This model aims to maximize resource use efficiency, boost productivity, diversify income sources and reduce environmental impacts. By promoting the cultivation of diverse crops and rearing of livestock, this IFS model enables farm households to access a wide range of dietary options. This diversity contributes to improved nutrition, fostering balanced diets and enhancing human well-being. The present study was carried out during 2022–23 to examine IFS interventions under state schemes in Kerala and Tamil Nadu, collecting 412 sample observations through simple random sampling. Dietary Diversity Scores (DDS) and their determinants were analyzed using multinomial logit regression. The results identified four dominant farming systems, viz. crop-based, vegetable-based, livestock-based, and fisheries-based, with livestock-based systems achieving the highest DDS. Conversely, low DDS groups had significantly lower consumption of meat, fruits, and fish. Factors such as education, intercropping, crop rotation, and net income positively influenced dietary diversity, favouring higher DDS. The study underscores the critical role of intercropping and crop rotation in enhancing dietary diversity and recommends policymakers focus on their widespread adoption. Additionally, improving livestock systems is essential to ensure better access to diverse food groups for farm households.

Keywords: Dietary diversity score, Integrated farming system, Multinomial logit, Nutrition

After the green revolution in the late 1960s, farmers increasingly focused on a limited number of key enterprises due to challenges such as decreasing farm sizes, fluctuating commodity prices, and labour shortages during peak agricultural periods (Ponnusamy and Devi 2017). While the introduction of high-yielding crop varieties improved food availability and aimed to achieve food and nutritional security, it also had adverse effects on the environment and biodiversity. These impacts disproportionately affected small and marginal farmers when compared to their larger counterparts (BIRTHAL *et al.* 2014). Resource-poor farmers are particularly vulnerable to risks and uncertainties, as these challenges undermine their adaptive capacity (Raghavendra and Suresh 2018). Farmers practicing monocropping or

traditional methods face heightened risks from climate variability, such as droughts, floods, and uneven rainfall, which threaten their income and overall livelihoods. To mitigate these risks and minimize income losses, there is a pressing need to diversify agricultural production through a combination of enterprises, including livestock, poultry, and fisheries.

Integrated Farming Systems (IFS) serve as a holistic approach to sustainable agriculture, integrating multiple enterprises such as crop cultivation, livestock rearing, aquaculture, agroforestry, and poultry farming to optimize resource use and improve overall productivity. The key features of IFS include efficient residue recycling, optimal land utilization, and enhanced sustainability (Paramesh *et al.* 2022). This system enables farmers to minimize waste by reusing crop residues, livestock manure, and organic matter, reducing their dependency on synthetic fertilizers and external inputs. By effectively interlinking different components within the farming system, farmers can achieve higher productivity per unit of land, enhance resource use efficiency, and lower production costs. One of the significant advantages of IFS is its potential to reduce the use of chemical fertilizer by up to 25% through efficient recycling

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of farm waste and adoption of sustainable composting methods (Manjunath *et al.* 2017). This reduction in synthetic inputs not only lowers costs for farmers but also improves soil health, enhances microbial activity, and promotes long-term sustainability. Furthermore, the adoption of integrated farming techniques ensures environmental conservation by reducing carbon footprints, preventing soil degradation, and maintaining ecological balance.

Beyond economic and environmental benefits, IFS plays a crucial role in improving dietary diversity and food security, particularly for small and marginal farmers in resource-constrained settings. The availability of homegrown fruits, vegetables, and animal products directly reduces malnutrition (Khandoker *et al.* 2022), enhances micronutrient intake, and lowers the risk of diet-related health disorders. In addition, IFS reduces risks associated with monoculture and market fluctuations, providing income stability and year-round food security for farming households. By ensuring a continuous supply of farm produce, IFS minimizes reliance on volatile market prices and external supply chains, thus making smallholder agriculture more resilient to economic shocks and climate variability.

The present study aims to evaluate dietary diversity across different farming systems and assess the key factors influencing food consumption patterns. The findings will provide policy recommendations to strengthen food security, promote sustainable agricultural practices, and support small-scale farmers in improving their livelihoods and well-being.

MATERIALS AND METHODS

The study was carried out during 2022–23 as a primary survey in Kerala and Tamil Nadu, where state government initiatives actively promote Integrated Farming Systems (IFS). The IFS scheme in Tamil Nadu and the Jaivagriham project in Kerala are among the key programmes designed to encourage sustainable farming practices. These schemes aim to enhance resource efficiency, improve farm productivity, and ensure food security for small and marginal farmers through diversified farming approaches. To assess the impact of these schemes, a structured methodology was adopted to identify beneficiary farmers who had adopted IFS under these initiatives. A random selection process was employed from the official list of beneficiaries to ensure unbiased representation. The total sample consisted of 412 farmers who had successfully adopted IFS practices across different agricultural systems. After removing outliers to enhance the accuracy of the analysis, a final sample of 253 farmers from Kerala and 159 farmers from Tamil Nadu was included in the study.

Key aspects covered in the survey included household demographics (family size, age, education level of the household head), social participation, resource endowment, cropping systems, livestock management, economic status, and household consumption patterns. The collected data provides valuable insights into the effectiveness of IFS

adoption, its impact on farmers' livelihoods, and the potential for scaling up such initiatives in other regions.

Dietary diversity score (DDS): Dietary diversity serves as a qualitative measure of food consumption, reflecting a household's access to a diverse range of food items. It is a key indicator of nutritional adequacy and food security. The DDS was estimated based on food frequency questionnaire (FFQ) data, following the guidelines set by the Indian Council of Medical Research (ICMR 2012). Initially, DDS was assessed using 13 food groups, but for this study, it was modified to include 10 essential food groups, viz. cereals, meat, fruits, roots and tubers, fish/seafood, oils/fats, pulses/legumes/nuts, eggs, milk and milk products and vegetables. Food groups such as nuts and oilseeds, condiments and spices, sugars, and jaggery were excluded. The variable DDS10 was computed by summing the number of food groups consumed by a household during the reference period, with scores ranging from 1–10 (FAO 2011). This score provides insights into household dietary diversity, nutritional status, and food access, helping policymakers design effective interventions for improving food security and nutrition.

Multinomial logit: The Multinomial Logit (MNL) Model is a statistical technique used to analyze categorical dependent variables when there is no inherent ordering among the outcome categories (Long and Freese 2006). This model was applied to examine the key decision-making factors influencing dietary diversity among farmers, focusing on whether a farmer's diet was nutritionally diverse and to what extent. In this study, the dependent variable DDS was categorized into three discrete levels, 0 (Low DDS), Limited dietary diversity; 1 (Medium DDS), Moderate dietary diversity; and 2 (High DDS), High dietary diversity. The probability of a farmer falling into one of these dietary diversity categories was taken as base using the multinomial logit equation. This model helps identify the socio-economic and demographic factors influencing dietary diversity, thereby providing valuable insights for targeted policy interventions and nutrition-focused agricultural strategies to improve food security and dietary quality. Given the alternatives before the respondent, the probability that an individual chooses an alternative j can be expressed by the equation:

$$\Pr[Y_i = j] = \frac{\exp(\beta_j' X_i)}{\sum \exp(\beta_j' X_i)}$$

where, $\Pr[Y_i = j]$, Probability that an individual i belongs to either 'low DDS', 'medium DDS' and 'high DDS'; j , 1, 2, 3; i , 1, 2, 3, ..., 412; X_i , Vector of the predictor variables; and β_j , Vector of the estimated parameters.

The independent parameters considered for the study include farming systems, management practices followed, education, experience, income sources and livestock. This model determines the effect of the independent variable on the probability that a household will belong to any of the mentioned categories. The model was estimated by keeping the dependent variable 0 (i.e. Low DDS) as the base category.

Table 1 Identified farming systems prevailing in Kerala and Tamil Nadu

Farming systems	Kerala	Tamil Nadu
Crop based IFS	Crop + Orchard + Poultry Crop + Vegetable + Dairy; Crop + Vegetable + Dairy + Poultry; Crop + Orchard + Dairy + Poultry; Crop + Orchard + Dairy + Sheep; Crop + Vegetable + Orchard + Dairy	Crop + Dairy, Crop + Dairy + Goat, Crop + Dairy + Goat + Poultry, Crop + Dairy + Poultry, Crop + Orchard + Dairy, Crop + Orchard + Dairy + Goat + Poultry, Crop + Orchard + Dairy + Poultry
Vegetable based IFS	Vegetable + Orchard; Vegetable + Orchard + Dairy; Vegetable + Dairy; Vegetable + Dairy + Sheep; Vegetable + Dairy + Poultry; Vegetable + Orchard + Dairy + Poultry; Vegetable + Orchard + Poultry	
Livestock based IFS	Dairy + Vegetable, Dairy + Orchard + Poultry; Dairy + Orchard; Dairy + Vegetable + Poultry; Dairy + Goat + Vegetable; Dairy + Vegetable + Goat + Poultry	Dairy + Crop; Dairy + Crop + Goat; Dairy + Crop + Poultry; Dairy + Goat + Crop; Dairy + Orchard + Goat + Poultry; Dairy + Goat + Crop + Poultry
Fisheries based IFS	Fisheries + Vegetable + Orchard; Fisheries + Dairy + Orchard; Fisheries + Vegetable + Dairy + Poultry; Fisheries + Orchard	

IFS, Integrated farming system.

Odds ratios or relative risk ratios will be calculated to determine the magnitude of change. The relative risk ratios give an idea of how strongly a given explanatory variable may be related to the dependent variable.

RESULTS AND DISCUSSION

Kerala and Tamil Nadu exhibit a diverse range of IFS, shaped by their unique agro-climatic conditions and socio-economic context (Table 1). These farming systems incorporate multiple agricultural components to enhance farm productivity, income stability, and resource utilization. Dairy and poultry emerge as common integrated components across different systems, highlighting their importance in nutritional security and economic sustainability for farmers. Crop-based systems, found in both states, prioritize crop cultivation as the core activity, integrating elements such as orchards, livestock (dairy, poultry, sheep), and vegetables to optimize land use and diversify revenue streams. Vegetable-based systems, unique to Kerala, center around

vegetable cultivation while incorporating orchards and dairy, a structure similar to fisheries-based systems, which improve resource efficiency and create additional income opportunities. Meanwhile, livestock-based systems focus primarily on animal husbandry, integrating dairy farming, small ruminants, and poultry to maximize farm profitability and food security. The prevalence of such systems across both states reflects their adaptability and effectiveness in ensuring sustainable livelihoods. Similar kind of farming systems have been documented by Saravanakumar *et al.* (2020), Chandran and Chakravarty (2022) and Raghavendra *et al.* (2024), reinforcing the importance of IFS in building resilient and profitable agricultural enterprises.

The various socio-economic and agricultural characteristics segmented by four types of major farming systems are presented in Table 2. The largest group of farmers practice a vegetable-based system (191) followed by a crop-based (164). Around 7 farmers practice fisheries-based system where fisheries component contribution is

Table 2 Descriptive statistics of the numeric variables of interest under study

Variables (N=412)	Units	Crop based	Vegetable based	Livestock based	Fisheries based
Frequency	Numbers	164	191	50	7
Farming experience	Years	28.95	18.93	21.51	16.42
Education	Years	10.18	8.79	10.58	10.71
Family labour	Numbers	2.03	2.03	2.14	2.28
Intercropping practice	If Yes; 1, otherwise 0	92.68	73.82	86	42.85
Crop rotation practice	If Yes; 1, otherwise 0	86.58	67.53	76	71.42
Off farm income	If Yes; 1, otherwise 0	48.17	10.99	38	0
Crop diversification index	-	0.48	0.46	0.51	0.5
Livestock					
Cows	Numbers	2.84	2.94	6.23	1
Buffalo	Numbers	2.13	1.75	6.22	0
Goat/sheep	Numbers	5.01	4.85	17.17	6.6
Poultry	Numbers	19.13	48.2	56.11	21.3
Fisheries	kg				280

highest to earnings from the farm. Crop-based farmers have the most experience (29 years), whereas fisheries-based farmers have the least (16.4 years). On an average fisheries-based farmers are slightly more educated (10.7 years) compared to the others, while vegetable-based farmers have the least number of years in schooling (8.8 years). All the households have around 2 family labourers available for work on the farms. The practices of integrated farming such as intercropping are followed by 92% of farmers in crop-based systems, whereas, only 42% are followed in fisheries-based systems. Similarly, crop rotation was also followed in majority by crop based IFS models compared to other systems. None of the fisheries-based farmers have off-farm income sources, while 48% of crop-based farmers have off-farm income sources. The crop diversification index using the Herfindhal-Hirschman index shows that livestock-based farmers have higher diversification followed by fisheries based. Livestock holding showed that a higher number of cows, buffalo, sheep/goats and poultry are available in livestock-based systems. The least number of livestock are in a fisheries-based system.

Fig. 1 presents a comparative analysis of household dietary diversity (DD) scores across different farming systems, crop-based, vegetable-based, livestock-based, and fish-based in Tamil Nadu and Kerala. Among these, the livestock-based system recorded the highest dietary diversity score, with Tamil Nadu (6.16) surpassing Kerala (5.96) (Sekaran *et al.* 2021). This highlights the significant role of livestock in enhancing household nutrition through diversified food sources such as milk, eggs, and meat (Retheesh *et al.* 2024). In Kerala, the vegetable-based system ranked second in terms of dietary diversity, reflecting the contribution of homegrown vegetables and integrated livestock components. Overall, most farming systems exhibited a dietary diversity score above 6, suggesting a moderate level of dietary diversity among the sampled farmers across both states.

Fig. 2 illustrates the percentage of households consuming various food groups across three categories of dietary diversity score (DDS), low DDS (<5); medium DDS (5.01–7.5); and high DDS (>7.51). The data highlights how food consumption patterns vary significantly among these groups, reflecting differences in dietary quality and nutritional intake. In the low DDS category, 77% of households consume cereals, making it the dominant staple

food. However, the intake of nutrient-rich foods is notably low, with only 33% consuming meat, 14% consuming fruits, and a mere 8% consuming fish/seafoods. This suggests that households with low DDS primarily rely on staple foods like cereals and root/tuber crops, leading to potential nutrient deficiencies (Kumar and Gautham 2022). For the moderate DDS group, cereals remain the most consumed food group (91%), followed by milk and milk products (78%) and vegetables (72%). However, the consumption of fish/seafoods and eggs is relatively low at 28% each, indicating limited protein and micronutrient intake despite moderate dietary diversity. Households in the high DDS category exhibit a greater variety in food consumption, with over 90% consuming cereals, milk and milk products, oils/fats, and vegetables. This group demonstrates a balanced diet, incorporating diverse protein, vitamin, and mineral-rich foods, leading to better nutritional outcomes. Overall, low DDS households face dietary inadequacies, heavily relying on staple foods, while high DDS households benefit from a more diverse and nutritionally adequate diet (Rajendran *et al.* 2017), emphasizing the need for improved food accessibility and nutrition awareness among resource-poor households.

The results from the multinomial logistic regression analysis (Table 3) provide valuable insights into the factors influencing household DDS. The dependent variable in the model is classified into three categories, low DDS (base category); moderate DDS; and high DDS. The regression coefficients indicate how various predictor variables affect the likelihood of households belonging to the moderate DDS or high DDS group compared to the low DDS group. A key finding is the highly significant positive effect of intercropping practices on dietary diversity. Farmers engaging in intercropping have a significantly greater likelihood of being in the moderate DDS category, highlighting the role of diversified cropping in improving food access. Similarly, crop rotation practices were found to have a positive influence on dietary diversity, increasing the probability of a household belonging to moderate DDS by 2.1 times and high DDS by 3.2 times, compared to the low DDS group. These findings align with Mhlanga *et al.* (2021) and Tacconi *et al.* (2023), who emphasize that agricultural management practices have a direct impact on diet and food security. Additionally, education levels among farmers emerged as a significant factor influencing dietary diversity. Higher education levels increase the probability of being in the Moderate and High DDS categories, indicating that awareness and knowledge of nutrition, farming innovations, and better decision-making contribute to improved dietary outcomes. This is consistent with the findings of Sharma *et al.* (2021) and Tacconi *et al.* (2023). Another significant determinant is farm net income, which is positively associated with high DDS. Higher-income households are more likely to have greater access to a variety of nutritious foods, reducing reliance on staple foods. This relationship was also observed in Ali *et al.* (2022), reinforcing that financial stability enhances food diversity and overall dietary quality. Overall, the study underscores the importance of

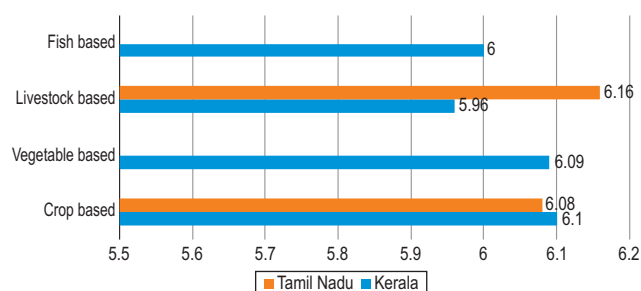


Fig. 1 Dietary diversity score under different farming system.

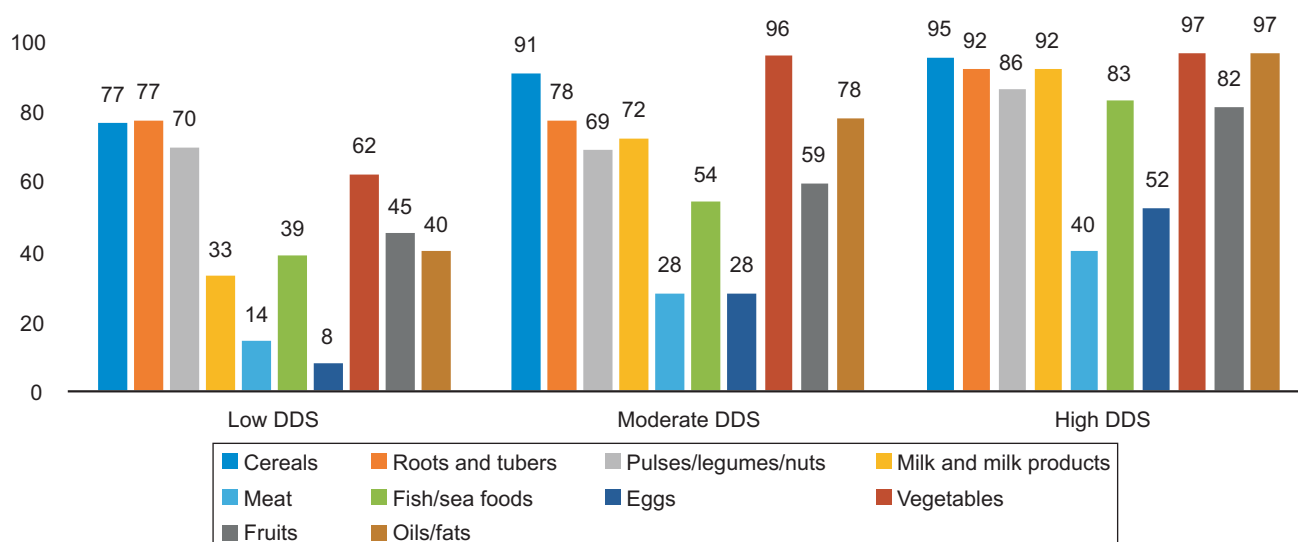


Fig. 2 Consumption of different food groups across DDS groups (%). DDS, Dietary Diversity Score.

Table 3 Determinants influencing DDS

Base: Low DDS	Moderate DDS		High DDS	
	RRR (std. err)	P value	RRR (std. err)	P value
Livestock based system	0.70 (0.30)	0.394	1.50 (0.85)	0.471
Vegetable based system	0.89 (0.32)	0.765	1.87 (0.94)	0.183
Net income	1.00 (0.001)	0.3	1.00 (0.001)	0.03**
Cow number	1.02 (0.03)	0.48	0.97 (0.06)	0.629
Net income/rupee	1.05 (0.12)	0.613	1.03 (0.16)	0.836
Farming experience	1.00 (0.010)	0.608	0.99 (0.01)	0.587
Intercropping practice	3.09 (1.16)	0.002***	2.13 (1.05)	0.12
Crop rotation	2.12 (0.679)	0.013**	3.20 (1.54)	0.021**
Off farm income	0.68 (0.22)	0.253	1.18 (0.53)	0.707
Crop diversification	1.61 (1.12)	0.501	1.74 (1.69)	0.592
Education	1.06 (0.03)	0.074*	1.09 (0.05)	0.069*
Constant	0.09 (0.08)	0.005	0.01 (0.02)	0

Figures within the parentheses indicate standard errors; DDS, Dietary Diversity Score; RRR, Relative Risk Ratio; ***, significant at 1%, **, at 5% and *, at 10% levels of significance.

sustainable farming practices, education, and economic stability in enhancing dietary diversity, improving food security, and promoting better nutritional outcomes among farming households.

This study analyzes the beneficiaries of Integrated Farming System (IFS) schemes in Kerala and Tamil Nadu, with a focus on household consumption patterns and dietary diversity. The results categorize enterprise combinations into four major farming systems based on their contribution to gross income: crop-based, vegetable-based, livestock-based, and fish-based systems. Among these, households practicing livestock-based systems exhibited the highest dietary diversity, followed by vegetable-based systems. This underscores the significant role of animal components in enhancing dietary diversity, as livestock contributes milk, eggs, and meat, which are essential for a balanced diet. The integration of livestock in farming not only improves dietary diversity but also provides valuable byproducts such as dung and urine, which can be converted into compost, reducing dependence on chemical fertilizers and enhancing soil fertility. Conversely, households with low Dietary Diversity Scores (DDS) were found to have minimal consumption of meat, fruits, and vegetables, leading to nutrient deficiencies. Further analysis of DDS determinants reveals that farmers adopting IFS management practices, such as intercropping and crop rotation, are significantly more likely to achieve higher DDS. Additionally, education and net farm income levels were found to have a positive impact on dietary diversity, indicating that higher income and awareness contribute to better nutrition choices. The findings highlight the need for state-specific programs that align with local farming systems. Strengthening policy interventions, providing farmer education, and encouraging diversified farming practices can effectively enhance dietary diversity, improve food security, and promote sustainable agriculture in Kerala and Tamil Nadu.

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REFERENCES

- Ali M, Raihan M J, Siddiqua T J, Haque M A, Farzana F D, Ahmed S T, Shahed R, Naz F, Faruque A S G and Ahmed T. 2022. Factors associated with low and medium household dietary diversity compared with high dietary diversity among marginalised households in rural Bangladesh: Findings from a Suchana baseline survey. *BMJ Open* **12**(11): e062143.
- Birthal P S, Digvijay N, Shiv K, Shaily A and Suresh M K. 2014. How sensitive is Indian agriculture to climate change. *Indian Journal of Agricultural Economics* **69**(4): 474–87.
- Chandran V and Chakravarty R. 2022. Extent of adoption of available components in the IFS units of Kerala. *Indian Journal of Extension Education* **58**(4): 130–33.
- FAO. 2011. *Guidelines for Measuring Household and Individual Dietary Diversity*. Food and Agriculture Organization, United Nations, Rome.
- ICMR. 2012. *Nutritive Value of Indian Foods*. Indian Council of Medical Research, National Institute of Nutrition, Hyderabad.
- Khandoker S, Singh A and Srivastava S K. 2022. Leveraging farm production diversity for dietary diversity: Evidence from national level panel data. *Agricultural Economics* **10**(15). <https://doi.org/10.1186/s40100-022-00221-y>
- Kumar I and Gautam M. 2022. Determinants of dietary diversity score for the rural households of Uttar Pradesh state. *International Journal of Food, Nutrition and Dietetics* **10**(1): 9–16.
- Long J S and Freese J. 2006. *Regression models for categorical dependent variables using Stata*. STATA Press Publication, Texas.
- Manjunath B L, Paramesh V, Mahajan G R, Das B, Reddy K V, Chakurkar E B and Singh N P. 2017. Sustainability through resource recycling, soil fertility and carbon sequestration from integrated farming systems in west coast India. *Bioscan* **12**: 1–6.
- Mhlanga B, Mwila M and Thierfelder C. 2021. Improved nutrition and resilience will make conservation agriculture more attractive for Zambian smallholder farmers. *Renewable Agriculture and Food Systems* **36**(5): 443–56.
- Paramesh V, Ravisankar N, Behera U, Arunachalam V, Kumar P, Solomon Rajkumar R, Mishra S D, Kumar R M, Prusty A K, Jacob D, Panwar A S, Mayenkar T, Reddy V K and Rajkumar S. 2022. Integrated farming system approaches to achieve food and nutritional security for enhancing profitability, employment, and climate resilience in India. *Food and Energy Security* **11**(2): e321.
- Ponnusamy K and Devi M K. 2017. Impact of integrated farming system approach on doubling farmers' income. *Agricultural Economics Research Review* **30**(3): 23–24.
- Raghavendra K J and Suresh A. 2018. Risk management in rainfed agriculture: An analysis of strategies and adaptations followed by farmers in Madhya Pradesh. *Indian Journal of Agricultural Sciences* **88**(6): 895–901.
- Raghavendra K J, John J, Jacob D, Rajendran T, Prusty A K, Ansari M A, N Ravisankar, S Kumar, R Singh, M Shamim, P Punia, Nirmal, A L Meena, P Kashyap, Shivaswamy G P and Dutta D. 2024. Unraveling determinants of integrated farming systems adoption for sustainable livelihood and dietary diversity. *Frontiers in Nutrition* **11**: 1264658.
- Rajendran S, Afari Sefa, V, Shee A, Bocher T, Bekunda M, dominick I and Lukumay P J. 2017. Does crop diversity contribute to dietary diversity? Evidence from integration of vegetables into maize-based farming systems. *Agriculture and Food Security* **6**: 1–13.
- Retheesh P K, Santhosh R, Karunakaran N, Rejuna C A and Midhun V P. 2024. Unveiling diet quality in Kerala: A study on healthy food diversity and socio-economic influences. *MSW Management Journal* **34**(2): 109–28.
- Saravanakumar V, Malaikarasan U, Balasubramanian R and Angles S. 2020. Production efficiency and profitability of major farming systems in Tamil Nadu. *Agricultural Economics Research Review* **33**(3): 99–108.
- Sekaran U, Lai L, Ussiri D A, Kumar S and Clay S. 2021. Role of integrated crop-livestock systems in improving agriculture production and addressing food security—A review. *Journal of Agriculture and Food Research* **5**: 100190.
- Sharma I K, Prima D S, Essink D and Broerse J E. 2021. Nutrition-sensitive agriculture: A systematic review of impact pathways to nutrition outcomes. *Advances in Nutrition* **12**(1): 251–75.
- Tacconi F, Waha K, Ojeda J J, Leith P, Mohammed C, Venables W N, Rana J C, Bhardwaj R, Yadav R, Ahlawat S P, Hammond J and Van W M. 2023. Farm diversification strategies, dietary diversity and farm size: Results from a cross-country sample in South and Southeast Asia. *Global Food Security* **38**: 100706.