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Adoption of Integrated Farming System (IFS) Components by Farmers in the Northern Districts of Andhra Pradesh

Dinesh Kumar Nimmaka¹, Ajay Kumar Prusty^{1*} , Ashok Kumar² , Nibedita Mishra¹  and Sai Kumar Periginji¹ 

¹Department of Agricultural Extension Education, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Gajapati, Odisha, India

²Department of Agricultural Extension Education, School of Agriculture, SR University, Warangal, Telangana, India

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*Corresponding Author

Ajay Kumar Prusty, Dr.

E-mail: prusty.ajay@cutm.ac.in

Co-Author(s):

Author 2: Dinesh Kumar Nimmaka

E-mail: dinnurocks306@gmail.com

Author 3: Ashok Kumar, Dr

E-mail: ashokakku2021@gmail.com

Author 4: Nibedita Mishra

E-mail: nibeditamishra47@gmail.com

Author 5: Sai Kumar Periginji

E-mail: sai50473@gmail.com

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ABSTRACT

Integrated Farming Systems (IFS) offer smallholders a resource-efficient alternative to mono-cropping, yet their adoption remains inadequately documented in North Coastal Andhra Pradesh. An ex-post-facto study assessed farmers' attitudes, adoption of IFS components, and constraints among 120 IFS farm families from Srikakulam and Parvathipuram Manyam districts. Data were analysed using descriptive statistics, correlation, Garrett ranking, and multiple regression. Most farmers held favourable attitudes, although 68.33% had a medium attitude level. Agriculture and horticulture were universally adopted (adoption index = 1.000), followed by dairy (0.700), while adoption of other enterprises remained lower. Farm size, market orientation, and extension contact significantly influenced adoption and attitude, explaining 54.8% and 57.4% of their variation, respectively. High production costs, inadequate remunerative prices, and climatic vulnerability were the major constraints. Enterprise-specific training, accessible credit, improved price realisation, and stronger extension support are needed to translate favourable attitudes into greater IFS adoption.

Keywords: Adoption, Attitude, Constraints, Climatic Vulnerability, Integrated Farming System, Smallholder farmers

1. INTRODUCTION

The majority of people in North Coastal districts of Andhra Pradesh and the wards of Srikakulam, Vizianagaram, Parvathipuram Manyam and

Visakhapatnam are still engaged in agriculture for earning their livelihoods and jobs. Rice remains the dominant crop of the Kharif season, while pulses, millets, oilseeds, and horticultural crops such as cashew, coconut, mango,

and banana provide diversified income and nutritional security to smallholder households (Prabhakar et al., 2023; Duraisamy et al., 2018). Farming systems in the region range from rainfed and irrigated cropping to mixed crop-livestock systems and, among tribal communities of the hilly tracts, shifting (podu) cultivation (Tripathy and Das, 2020). Against this backdrop, Integrated Farming Systems (IFS) are increasingly being promoted as a means of optimising resource use, increasing productivity, and reducing production and market risks by diversifying farm enterprises (Nienkerke et al., 2025; Rashid, 2024).

IFS is conceived as a sustainable agricultural approach that integrates crop production with livestock, poultry, aquaculture, agroforestry and horticultural enterprises on the same farm, thereby recycling farm by-products, minimising external inputs, and diversifying household income (Shanmugam et al., 2024). Historically rooted in traditional Indian mixed-farming practices, IFS lost ground during the Green Revolution era owing to the spread of input-intensive mono-cropping, but has since been revived with renewed support from the Indian Council of Agricultural Research (ICAR) and State Agricultural Universities, and national initiatives including the National Mission for Sustainable Agriculture (NMSA) and *Rashtriya Krishi Vikas Yojana* (RKVY) (Mishra et al., 2023). The system is credited with enhancing resource-use efficiency, biodiversity, climate resilience, and household nutrition while stabilising farm income (Sudha et al., 2021; Ghosh et al., 2025).

For the North Coastal districts, IFS is particularly relevant because of the predominance of small and marginal landholdings, degrading soil health, and increasing water scarcity (Kumar et al., 2025). The region's tropical climate, proximity to the Nagavali and Vamsadhara rivers, and varied topography of coastal plains and upland tracts make it agro-ecologically suited to combinations such as rice-fish farming, coconut- and cashew-based agroforestry, and multi-cropping systems (Gangaiah et al., 2015). IFS has also been shown to support sustainable livelihoods in coastal regions by reducing dependence on any single enterprise and cushioning farm households against climatic and market shocks (Kumar et al., 2025).

Despite these advantages, adoption of IFS across Andhra Pradesh, and in the North Coastal belt in particular, remains modest (Chandana et al., 2021; Liu et al., 2023). There are ongoing initiatives by the government like the NMSA and Paramparagat Krishi Vikas Yojana (PKVY), which promote organic and integrated production practices, but researchers have noted that the uptake of these methods has been limited due to a range of factors, including awareness, technical skills, initial capital investment, fragmented land ownership, market access, and climate change vulnerabilities (Fatima et al., 2023;

Kumar et al., 2022). The study was therefore designed to address the gap between institutional promotion of IFS and its actual field-level uptake. Only limited empirical evidence is available on farmers' attitudes to IFS, the uptake of individual IFS components, and the constraints encountered by adopters in the agro-climatic and socio-economic context in Srikakulam and Parvathipuram Manyam districts (Karthik et al., 2024; Raghavendra et al., 2024).

Understanding these dynamics is necessary for aligning extension interventions and policy support with farmers' actual circumstances, to build climate resilient and diversified farming and to support the national objective of raising farm income through resource efficient farming (Ponnusamy and Devi, 2017). Accordingly, the study pursued three specific objectives: (i) To examine farmers' attitudes toward IFS; (ii) To study the level of farmers' uptake of the components of IFS; (iii) To determine farmers constraints in the uptake of IFS in North Coastal districts of Andhra Pradesh.

2. Materials and Methods

Fieldwork covered two districts in northern Andhra Pradesh, namely Srikakulam and Parvathipuram Manyam, which together represent contrasting agro-ecological settings within the North Coastal zone. An ex-post-facto design was selected, as the phenomena under study - the adoption of IFS and its associated attitudes - had already occurred prior to the investigation, without any experimental manipulation by the researcher. Respondents were selected through a multistage sampling procedure. In the first stage, both districts were chosen purposively to represent the canal-irrigated coastal belt (Srikakulam) and the rainfed, tribal-dominated upland tract (Parvathipuram Manyam). In the second stage, three mandals were chosen in each district, and within these mandals, twelve villages (six per district) were covered. From each of the twelve villages, ten IFS-practising farm families were selected at random, producing a final sample of 120 respondents - 60 from Srikakulam (drawn from Kotturu, Tekkali, and Seethampeta mandals) and 60 from Parvathipuram Manyam (drawn from Kurupam, Gummalaxmipuram, and Jiyyammavalasa mandals). Primary information was obtained in face-to-face interviews with a pre-tested structured schedule.

Sixteen independent variables were chosen because of their theoretical and empirical relevance to IFS adoption: age, level of education, gender, farm size, farming/IFS experience, occupation, annual income, extension contact, exposure to mass media, risk orientation, innovativeness and economic motivation, achievement motivation, scientific orientation, social participation, and training received. Each variable was

operationalised using standard scoring procedures or multi-item scales adapted from earlier extension research, and respondents were then grouped into low, medium and high categories using cut-off points derived from the mean and standard deviation.

The dataset was coded and tabulated before descriptive and inferential analyses were performed. Category-wise distributions were summarised with frequencies and percentages. Means and standard deviations were calculated to represent central tendency and variability, and to derive category boundaries for the independent and dependent variables. Pearson's product-moment correlation was applied to assess associations of selected profile characteristics with the extent of IFS adoption and with farmers' attitude, tested at the 5 per cent and 1 per cent levels of significance. Multiple linear regression was used to estimate the comparative contribution of the explanatory variables to variation in adoption and attitude scores. Perceived constraints were prioritised using Garrett's ranking method and the suggestions offered for improving IFS performance; the percent position for each rank was calculated as Percent position = $(R_{ij} - 0.5)/N_j \times 100$, where R_{ij} is the rank given to the i -th item by the j -th respondent and N_j is the number of items ranked, with percent positions converted to scores using Garrett's conversion table and averaged to obtain the final ranking. Bar graphs and pie charts were used for graphical presentation, prepared in Microsoft Excel.

3. Results and Discussion

The results are organised around the study objectives, beginning with the socio-economic and psychological characteristics of IFS farmers, farmers' attitude towards IFS, the component-wise extent of IFS adoption, the relationship between profile characteristics and both adoption and attitude, and the constraints experienced by farmers.

3.1 Socio-economic profile of IFS farmers

In both districts, the largest share of respondents fell within the middle-age group (36-50 years), representing 45.83 per cent of the combined sample; the older group followed (>50 years, 36.67%), while young farmers (<36 years) formed only 17.50 per cent. This age profile shows that experienced farmers are the backbone of the IFS management system within the study area, a pattern comparable with observations reported by Paramesh et al. (2022) who identified middle-aged farmers as key operators of integrated farming systems due to their skills and ability to manage risks, and with Raghavendra et al. (2024) and Md et al. (2025) who reported that

these farmers might be losing their competitiveness in agriculture because of migration and the alternative livelihood options of the young. Chandana et al. (2021) reported a similar type of adopter profile for Andhra Pradesh, and Behera and France (2016); Kerutagi et al. (2019) noted that IFS adoption generally requires continued commitment from the farmer's management and thus favours farmers who have other livelihood responsibilities.

The overall reliance on farming on the region is extremely high as 94.17 per cent of the respondents have reported their only occupation as farming, which makes them more vulnerable to farming production and market risk (Paramesh et al., 2022; Raghavendra et al., 2024). The predominance of marginal landholdings (up to 1 ha): 75.00 per cent in Parvathipuram and 67.50 per cent in Srikakulam, reflects the broader smallholder structure of Indian agriculture, where enterprise diversification through IFS is often a coping mechanism for smallholder constraints (Sekaran et al., 2021; Dash et al., 2015; Md et al., 2025). In terms of experience, there was a mixture of low (41.67%), medium (20.83%) and high (37.50%) experience respondents, with a similar distribution for IFS adopters in Andhra Pradesh found by Chandana et al. (2021), and consistent with the learning by doing effects identified by Gupta et al. (2020).

The farmers were more oriented towards the market and more exposed to mass media (67.50% and 65.83% respectively) indicating that farmers actively interact with market and mass media, but market and media

Table 1. Summary of the socio-economic and communication profile of IFS farmers in Parvathipuram Manyam and Srikakulam districts.

Category	Parvathipuram (n=60) f (%)	Srikakulam (n=60) f (%)	Pooled (n=120) f (%)
Age: Young (<36 yrs)	12 (20.00)	9 (15.00)	21 (17.50)
Age: Middle (36-50 yrs)	27 (45.00)	28 (46.67)	55 (45.83)
Age: Old (>50 yrs)	21 (35.00)	23 (38.33)	44 (36.67)
Education: Illiterate	12 (20.00)	14 (23.33)	26 (21.67)
Education: Secondary (8-10)	15 (25.00)	16 (26.67)	31 (25.83)
Education: Graduate & above	10 (16.67)	9 (15.00)	19 (15.83)
Occupation: Farming as sole profession	56 (93.33)	57 (95.00)	113 (94.17)
Farm size: Marginal (≤ 1 ha)	30 (75.00)	27 (67.50)	57 (71.25)
Market orientation: Medium	39 (65.00)	42 (70.00)	81 (67.50)
Mass media exposure: Medium	37 (61.67)	42 (70.00)	79 (65.83)

interaction is limited because of poor market system and small farm size (Dhavale et al., 2022; Ponnusamy and Devi, 2017). Mobile phones turned out to be the most popular mass media channel (89.66% overall), followed by newspapers (81.03%), magazines (78.45%) and television (14.66%) a pattern also reported by Raghavendra et al. (2024), who observed that mobile phones were being used rapidly for agricultural advice deliverance in rural India. Extension participation was largely medium (44.17%), with group farm meetings the most frequently attended activity (56.11% regular participation) while study tours were the least attended (59.45% never participated), and the majority of farmers exhibited medium economic motivation (70.83%) but low risk orientation (48.33%), indicating a generally cautious approach to enterprise diversification in agreement with constraints documented by Bhutia et al. (2017) and Sabharwal and Sharma (2024).

3.2 Attitude of farmers towards IFS

Farmers expressed an overwhelmingly positive attitude towards IFS. Among twenty-two statements evaluated on a five-point scale, the highest-ranked perceptions were that IFS offers multiple sources of income (mean = 4.91, Rank I), guarantees a supply of balanced and nutritious food to the family (mean = 4.90, Rank II), and ensures sustainable income throughout the year through multiple enterprises (mean = 4.81, Rank III). Reduction of climate-related vulnerability (mean = 4.67), efficient land utilisation (mean = 4.60), by-product recycling (mean = 4.44), and effective use of natural resources (mean = 4.14) were also strongly endorsed. Conversely, farmers largely rejected commonly cited barriers, disagreeing that IFS increases resource competition (mean = 2.89), that mechanisation is difficult (mean = 2.20), that IFS causes environmental pollution (mean = 2.05), that it is suitable only for skilled persons (mean = 1.72), that it is socially incompatible (mean = 1.66), or that labour requirements and initial investment are excessive (means of 1.00 and 1.24, respectively).

This overwhelming perception is in line with the literature of IFS reported benefits, which have been consistently positive with respect to income stability, household food security and livelihood resilience (Manjunatha et al., 2014; Ponnusamy and Devi, 2017; Gupta et al., 2020). The high rating assigned to climate-risk reduction is consistent with evidence that diversified enterprises provide protection to households from weather and market shocks (Paramesh et al., 2022; Sekaran et al., 2021) while the rejection of perceived barriers like high investments and excess labour (although documented to be barriers elsewhere, Md et al., 2025; Dhavale et al., 2022; Sabharwal and Sharma, 2024)

indicates that personal experience with IFS reduces farmer apprehension over time and hence they value demonstration-based extension (Chandran et al., 2023; Chandana et al., 2021). Overall, the attitude of the respondents was in the medium level, 68.33 per cent in both districts, while 15.83 per cent fell in the high-attitude category and another 15.83 per cent in the low-attitude category. This medium concentration indicates a middle ground where awareness of the benefits of IFS is strong, but full conviction has not yet been achieved, as also noted in earlier studies, including Dhavale et al. (2022) and Khushbu et al. (2024) (in Sabharwal and Sharma, 2024), who attribute this gap to ongoing uncertainty surrounding the market, credit constraints, and managerial complexity. Repeatedly, sustained exposure, demonstration and training are mentioned as the levers to take farmers from medium to high attitude category (Dash et al., 2015; Chandran et al., 2023).

3.3 Extent of adoption of IFS components

All 120 respondents adopted agriculture and horticulture with adoption index 1.000, followed by dairy farming with adoption index 0.700 and joint Rank III, as it is well established as an income stabilising business and was found to be effective in recycling the crop residues and by-products (Ponnusamy and Devi, 2017; Manjunatha et al., 2014). This was followed by significant drops in adoption of other technologies, such as poultry (0.233, Rank IV units), sheep/goat rearing (0.150, Rank V units), vermicomposting (0.108, Rank VI units), mushroom cultivation (0.108, Rank VI units), aquaculture (0.025, Rank XI units) and biogas (0.008, Rank XI units).

This trend is consistent with literature that indicates that most IFS models are based on crop enterprises, which provide food security and primary income (Behera and France, 2016; Gupta et al., 2020) with the comparatively

Table 2. Component-wise extent of adoption of IFS components (n = 120)

Component	Units adopting	Adoption index	Rank
Agriculture	120	1.000	I
Horticulture	120	1.000	I
Dairy	84	0.700	III
Poultry	28	0.233	IV
Sheep/goat rearing	18	0.150	V
Vermicompost	13	0.108	VI
Mushroom unit	13	0.108	VI
Sericulture	9	0.075	VIII
Apiculture	8	0.067	IX
Aquaculture	3	0.025	X
Biogas	1	0.008	XI

low adoption rates of specialised enterprises indicating widely reported barriers including restricted credit access, insufficient technical know-how, weak market infrastructure and limited training opportunities (Suman et al., 2025; Md et al., 2025; Sabharwal and Sharma, 2024; Dhavale et al., 2022; Nababan and Regina, 2021). Meanwhile, these low adoption businesses – vermicomposting, sericulture, apiculture, aquaculture, and biogas – are always cited as high potential ventures for better income, employment and sustainability when they receive institutional support (Paramesh et al., 2022; Sekaran et al., 2021; Chandran et al., 2023; Bolorunduro et al., 2023).

3.4 Relationship between profile characteristics and extent of IFS adoption

Farm size ($r = 0.362$), market orientation ($r = 0.338$) and extension contacts ($r = 0.312$) were also highly significantly and positively related to IFS adoption. Experience IFS ($r = 0.294$), education ($r = 0.271$), risk orientation ($r = 0.269$), extension participation ($r = 0.245$), mass media exposure ($r = 0.228$) and economic motivation ($r = 0.211$) showed significant positive associations with the extent of IFS adoption. Age, occupation and social participation showed negative but non-significant associations ($r = -0.182$, $r = -0.109$, and $r = -0.091$, respectively). Multiple linear regression validated these trends: The twelve profile characteristics explained 54.8 per cent of the variance in adoption ($R^2 = 0.548$; Adjusted $R^2 = 0.503$; $F = 12.18$, $p < 0.001$), with farm size ($\beta = 0.312$, $p < 0.01$), market orientation ($\beta = 0.279$, $p < 0.01$) and extension contact ($\beta = 0.251$, $p < 0.01$) showing the largest standardised effects, followed by experience in IFS, education, extension participation, mass media exposure, economic motivation and risk orientation (all significant at 5%), while age, occupation and social participation were not significant.

These results echo Behera and France (2016) and Sekaran et al. (2021), who identify larger holdings as offering greater flexibility for enterprise diversification, and Ponnusamy and Devi (2017) and Dhavale et al. (2022), who link market orientation to farmers' motivation to diversify for profitability. The importance of extension contacts and participation reaffirms the role of advisory services in building technical competence and reducing adoption uncertainty (Dash et al., 2015; Chandran et al., 2023; Suman et al., 2025), while the significance of education, experience, and risk orientation reflects the cognitive and behavioural foundations of adoption described by Akshitha and Dolli (2020) and Meshram et al. (2021). The non-significant effect of age and social participation suggests that access to information and institutional support outweighs demographic background in shaping adoption decisions.

3.5 Relationship between profile characteristics and attitude towards IFS

The corresponding analysis for attitude indicated that experience in IFS ($r = 0.340$), extension contact ($r = 0.325$), and mass media exposure ($r = 0.310$) showed the strongest correlations, followed by education ($r = 0.315$), market orientation ($r = 0.290$), extension participation ($r = 0.280$), farm size ($r = 0.258$), and economic motivation ($r = 0.240$); age ($r = -0.145$), occupation ($r = -0.095$), social participation ($r = -0.050$), and risk orientation ($r = -0.133$) were negatively but non-significantly related. The regression model indicated that these characteristics jointly accounted for 57.4 per cent of the variance in attitude ($R^2 = 0.574$; Adjusted $R^2 = 0.531$; $F = 13.32$, $p < 0.001$), with experience in IFS ($\beta = 0.298$), extension contact ($\beta = 0.271$), mass media exposure ($\beta = 0.256$), and education ($\beta = 0.241$) as the strongest determinants, alongside market orientation, extension participation,

Table 3. Correlation and standardised regression coefficients (β) of selected profile characteristics with extent of IFS adoption and attitude towards IFS. *Significant at 5%; **Significant at 1%.

Profile characteristic	r with extent of adoption	r with attitude	β (adoption model)	β (attitude model)
Age	-0.182	-0.145	-0.104	-0.096
Education	0.271*	0.315*	0.176*	0.241**
Farm size	0.362**	0.258*	0.312**	0.197**
Experience in IFS	0.294*	0.340**	0.198*	0.298**
Market orientation	0.338**	0.290*	0.279**	0.214**
Mass media exposure	0.228*	0.310**	0.162*	0.256**
Extension participation	0.245*	0.280*	0.181*	0.206**
Extension contact	0.312**	0.325**	0.251**	0.271**
Economic motivation	0.211*	0.240*	0.154*	0.189**
Risk orientation	0.269*	-0.133	0.169*	-0.073

farm size, and economic motivation, all significant at the 1 per cent level.

The pre-eminence of experience, extension contact, and mass media exposure in shaping attitude corroborates evidence that practical experience combined with sustained technical guidance strengthens farmer confidence in IFS through visible improvements in income and resource efficiency (Manjunatha et al., 2014; Chandana et al., 2021; Dash et al., 2015). The non-significant, and in the case of risk orientation negative, association with several demographic variables suggests that even risk-averse or older farmers can develop favourable attitudes once they observe the stabilising benefits of diversified income and resource recycling (Gupta et al., 2020; Meshram et al., 2021). Overall, both the adoption and attitude models point to a common set of levers - farm size, market orientation, extension contact, education, and experience - as the key entry points for extension intervention.

3.6 Constraints experienced by IFS farmers

Garrett's ranking technique ranked high production cost as the leading constraint (mean Garrett score = 78.30, Rank I), followed closely by lack of remunerative prices for farm produce (76.10, Rank II) and natural calamities and climate change (70.20, Rank III), reflecting the region's exposure to cyclones and erratic rainfall (Gangaiah et al., 2015; Paramesh et al., 2022). Non-availability of quality

inputs on time (60.50, Rank IV), high initial investment (59.00, Rank V), marketing difficulties across multiple enterprises (56.80, Rank VI), insufficient government incentives (53.20, Rank VII), land constraints (50.60, Rank VIII), labour scarcity (42.40, Rank IX), and high labour charges (41.80, Rank X) followed. Operational constraints - difficulty in time management (38.90), inadequate storage and value-addition facilities (35.70), inadequate extension support and training (32.10), and lack of awareness of improved practices (30.40) - were ranked comparatively lower, though still notable.

These findings confirm the broader IFS literature identifying high production costs, poor price realisation, and limited credit access as the most critical barriers to sustaining integrated systems (Md et al., 2025; Suman et al., 2025; Dhavale et al., 2022; Pandey et al., 2019). The prominence of climate-related constraints reflects growing weather-related production uncertainty even though IFS itself enhances resilience through diversification (Paramesh et al., 2022; Sekaran et al., 2021), while institutional limitations - including weak extension services, inadequate storage and value-addition facilities, and insufficient incentives - are comparable to those reported elsewhere calling for stronger policy backing and localised extension systems (Dash et al., 2015; Chandran and Chakravarty, 2022; Nababan and Regina, 2021; Bhutia et al., 2017). As a counter, the most common recommendations of farmers were provision of subsidised quality inputs at the right time (Rank I), easy access to credit facilities (Rank II), setting up local collection and marketing centres (Rank III), and providing climate resilient seeds and crop insurance schemes (Rank IV) which indicate that IFS adoption in the region is not farmer's willing but rather economic, institutional and infrastructural barriers (Kumar and Narayanagowda, 2017; Kumar et al., 2022).

4. Conclusion

Farmers in North Coastal Andhra Pradesh generally held favourable attitudes towards Integrated Farming Systems (IFS), although adoption remained concentrated in agriculture, horticulture, and dairy. Farm size, market orientation, and extension contact were the strongest determinants of adoption and attitude, indicating that resource availability and institutional support are more influential than demographic characteristics. High production costs, inadequate price realisation, and climatic vulnerability were the principal constraints. IFS improved productivity and livelihood diversification in canal-irrigated Srikakulam, while strengthening resilience among tribal and rainfed smallholders in Parvathipuram Manyam through efficient recycling of farm resources. Policy interventions should prioritise enterprise-specific

Table 4. Constraints reported by IFS farmers during establishment and maintenance of IFS units, ranked using Garrett's technique (n = 120).

Constraint	Garrett mean score	Rank
High cost of production	78.30	I
Lack of remunerative prices for farm produce	76.10	II
Natural calamities and climate change	70.20	III
Non-availability of quality inputs on time	60.50	IV
High investment in the initial stage	59.00	V
Marketing difficulties for produce from different enterprises	56.80	VI
Insufficient government incentives	53.20	VII
Land constraints	50.60	VIII
Labour scarcity	42.40	IX
High labour charges	41.80	X
Difficulty in time management for multiple activities	38.90	XI
Inadequate storage and value-addition facilities	35.70	XII
Inadequate extension support and lack of training	32.10	XIII
Lack of awareness of improved practices	30.40	XIV

training, accessible credit, cluster-based marketing, remunerative prices, climate-resilient inputs, insurance, and regular extension support. Stepwise, low-cost micro-IFS models could improve accessibility for smallholders. Future studies should evaluate long-term effects on soil health, water-use efficiency, carbon sequestration, market integration, and climate resilience.

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Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this manuscript, the authors have not used generative AI or AI-assisted technologies. The authors independently developed the conceptual framework and scholarly arguments and remain fully responsible for the accuracy, originality, and integrity of the manuscript.

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Biographical Statement of Author(s)

Nimmaka Dinesh Kumar

is a postgraduate in Agricultural Extension Education, with an M.Sc. qualification that has provided him with a strong academic foundation in agricultural extension education and rural development.



His academic interests focus on understanding the needs of farming communities and strengthening the connection between agricultural research, extension services, and practical farming. His research work focuses on the “Adoption of Integrated Farming System (IFS) Components by Farmers in Northern District of Andhra Pradesh,” with an emphasis on understanding farmer adoption and participation in integrated farming practices.

His educational journey reflects a commitment to the agricultural sector and to the role of extension in supporting farmers, promoting innovation, and facilitating the adoption of appropriate agricultural practices.

Mr. Nimmaka Dinesh Kumar

M.S. Swaminathan School of Agriculture
Centurion University of Technology and Management
Paralakhemundu
Odisha, India.

E-mail: dinnurocks306@gmail.com

Ajay Kumar Prusty

is an Associate Professor of Agricultural Extension Education at Centurion University of Technology & Management (Odisha), India. He holds a PhD in Agriculture Science (Extension Education) from OUAT. His work focuses on ICT in



agriculture, monitoring & evaluation, and youth and gender inclusion. He has developed online courses in Courseware, Qualification Pack for NCVET, coordinated farmers' fairs, convened conferences and FDPs, and serves as a journal editor and life member of professional societies. His broader interests include research-for-development, drones and data analytics for advisory services, and scaling sustainable, tech-enabled extension in Indian smallholder contexts.

Dr. Ajay Kumar Prusty

Associate Professor
Agricultural Extension Education
Centurion University of Technology & Management
Odisha, India

E-mail: prusty.ajay@cutm.ac.in

Dr. Ashok Kumar is an Associate Professor in the Department of Agricultural Extension Education at School of Agriculture, SR University, Warangal, Telangana. He holds a Ph.D. in Agricultural Extension, Qualified ASRB NET 2016 and has expertise in agricultural extension education, farmer knowledge and adoption behaviour, agricultural communication, digital agriculture and technology-enabled extension services. His research interests include the application of information and communication technologies (ICT), artificial intelligence, digital tools and data-driven approaches for improving agricultural advisory services and farmer decision-making. He is also involved in teaching, student Guiding, mentoring, extension training, rural development activities and the implementation of experiential learning programmes for agriculture students.



Dr. Ashok Kumar

Associate Professor
Department of Agricultural Extension Education
School of Agriculture, SR University,
Warangal, Telangana
E-mail: ashokakku2021@gmail.com

Nibedita Mishra is a PhD Research Scholar of Agricultural Extension Education at Centurion University of Technology & Management (Odisha), India. She completed her MSc. (Agriculture) in Agricultural Extension Education from same University. Her research primary focuses on Nutrition, Dietary Diversity, Crop diversity, Knowledge, Awareness, Dietary pattern with special emphasis on improving nutritional security and sustainable rural livelihoods through agriculture-based interventions.



Miss Nibedita Mishra

Research Scholar
Agricultural Extension Education
Centurion University of Technology & Management
Odisha, India
E-mail: nibeditamishra47@gmail.com

Sai Kumar Periginji is a PhD Research Scholar of Agricultural Extension Education at Centurion University of Technology & Management (Odisha), India. He completed his MSc. (Agriculture) in Agricultural Extension Education from the same University. His research primarily focuses on social media in Agriculture and



Fisheries, A Comparative Study on Perception and Utilization Pattern in Andhra Pradesh.

Mr. Sai Kumar Periginji

Research Scholar
Agricultural Extension Education
Centurion University of Technology & Management
Odisha, India
E-mail: sai50473@gmail.com