Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 47 No. 02 (2026)

Livelihood Diversification and Agrobiodiversity Dynamics in Rural South India

Nithish Selvam [1], Rajasekaran Ramakrishnan [2*], Anbarassan Ariputhiran [3], Mohanraj Palanivel [4]

[1] PG Scholar, Department of Agricultural Extension and Communication, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu–603201, Tamil Nadu, India

[2,4] Assistant Professor, Department of Agricultural Extension and Communication, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu–603201, Tamil Nadu, India

[3] Assistant Professor, Department of Agricultural Economics, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu–603201, Tamil Nadu, India

Corresponding Author: Rajasekaran Ramakrishnan[2]*,

[2]* Assistant professor, Department of Agricultural Extension and Communication, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu-603201, Tamil Nadu, India

Abstract:- This study examines the relationship between livelihood diversification and agrobiodiversity at the household level in Chengalpattu district of Tamil Nadu, India. A cross-sectional research design was adopted, and data were collected from 180 farm households using a structured interview schedule. Agrobiodiversity was measured using a composite Agrobiodiversity Index (ABI), while livelihood diversification and knowledge retention were assessed through Occupational Diversification Index (ODI) and Knowledge Retention Index (KRI), respectively. The results indicate that agrobiodiversity remains at a moderate level (mean ABI = 0.54), with a declining presence of traditional crop varieties. Occupational shifts show a clear association with reduced agrobiodiversity, as households with higher diversification exhibit lower ABI levels. Regression analysis confirms that ODI has a significant negative effect ($\beta = -0.284$, $p < 0.01$), while KRI positively influences agrobiodiversity ($\beta = 0.356$, $p < 0.01$). Farm size, labour availability, and income also contribute positively. The findings highlight that livelihood diversification, while enhancing income security, introduces trade-offs that may weaken ecological sustainability. The study emphasizes the need for policies that integrate livelihood strategies with the conservation of agrobiodiversity and traditional knowledge systems.

Keywords*: Agrobiodiversity, knowledge retention, livelihood diversification, occupational diversification, rural households.*

1. Introduction

Agriculture remains central to rural livelihoods across the Global South, supporting food security, including income generation, ecological sustainability [5]. Agrobiodiversity is maintained through diverse crops, indigenous livestock, and locally adapted practices[6], but smallholder farming systems are rapidly changing due to climate variability, market expansion, technological change, and increasing access to non-farm employment, which are causing major shifts in livelihood patterns and farming [29] [31]

Livelihood diversification has emerged as a key strategy for rural households to cope with income uncertainty and risk. Recent evidence indicates that diversification enables households to stabilize income by engaging in multiple activities beyond traditional farming, particularly in non-farm employment sectors [25][34]. While this transition strengthens short-term economic resilience, it also reallocates labour and attention away from agriculture [31]. In regions experiencing rapid urban expansion, such as Tamil Nadu, this shift reflects a broader agrarian transformation where farming is no longer the primary occupation for many households [29].

From a socio-ecological perspective, agriculture is an integrated system in which ecological processes and human practices are closely interconnected. Agrobiodiversity depends on continuous farmer engagement, traditional knowledge, and adaptive management [9]. Recent assessments highlight that agrobiodiversity enhances resilience to climate shocks and market risks, but it is increasingly declining as traditional practices are replaced by more uniform agricultural systems [4] [5].

Although environmental and technological factors have been the main focus of previous studies on agrobiodiversity loss, socio-economic transformations, including changes in livelihoods and the declining availability of labor, the decreasing reliance on traditional practices, and the weakening transmission of knowledge, are increasingly recognized as key factors for the sustainability of farming systems [27]. As younger generations leave agriculture to pursue different goals and face economic challenges, the indigenous knowledge that underpins crop diversity is threatened [16] [24]

2. Methodology

The study was conducted in Chengalpattu district of Tamil Nadu, India a region experiencing rapid livelihood diversification due to increasing urban influence and expanding non-farm employment opportunities. A cross-sectional descriptive and analytical research design was adopted to examine the relationship between occupational shifts away from farming and agrobiodiversity conservation at the household level. Representative rural villages were selected from seven blocks of the district, and a total of 180 farming households were selected using simple random sampling. Households with at least one member engaged in farming during the past ten years were included to ensure relevance to the study objectives. Primary data were collected through personal interviews using a pre-tested structured interview schedule covering socio-economic characteristics, patterns and drivers of occupational shifts, cultivation of traditional crops and farming practices, and generational retention of agricultural knowledge. Key variables such as occupational shift, agrobiodiversity conservation, and traditional knowledge retention were operationalized using measurable indicators, including changes in crop diversity, adoption of traditional practices, and age-wise knowledge levels. The collected data were analysed using descriptive statistical tools such as frequencies and percentages, and comparative analyses were carried out across household and age categories. Content validity was ensured through expert consultation, and reliability was strengthened through pre-testing and standardized data collection procedures. Ethical considerations, including informed consent and confidentiality of responses, were strictly maintained throughout the study.

A. Measurement of Agrobiodiversity Index (ABI)

At the household level, we measured agrobiodiversity using a composite index that considered biological variation and traditional farming practices in modern agricultural landscapes with three components: crop diversity, traditional varieties, and livestock diversity [18] [13]

In order to ensure the variables comparability minimum – maximum scaling was adopted and the composite index was constructed [23] [26]

$$X^* = \frac{X - X_{\min}}{X_{\max} - X_{\min}}$$

The Agrobiodiversity Index (ABI) was computed as the average of the normalized components:

$$ABI = \frac{CD + TV + LD}{3}$$

Where *CD* denotes crop diversity, *TV denotes traditional varieties and LD* denote livestock diversity,. as is commonly adopted in contemporary multidimensional agricultural assessments [23].

Households were classified into three categories: low (0.00–0.33), medium (0.34–0.66), and high (0.67–1.00) agrobiodiversity. following established index-based classification procedures used in recent food system research [18] [13]

B. Knowledge Retention Index (KRI)

The Knowledge Retention Index (KRI) was developed to assess the extent of preservation and transmission of traditional agricultural knowledge across generations. The index covered key domains including traditional crop varieties, seed management, pest and disease control, soil fertility practices, and livestock management.[1] [12]

Responses were collected using a structured interview schedule and scored on a three-point scale: 2 = fully aware/practicing, 1 = partially aware, 0 = not aware consistent with modern methodologies for documenting indigenous and local knowledge [7]. The index was calculated as

$$KRI = \frac{\text{Obtained Score}}{\text{Maximum Possible Score}}$$

KRI values ranged from 0 to 1, with higher values indicating greater knowledge retention. Respondents were categorized into low (0.00–0.33), medium (0.34–0.66), and high (0.67–1.00) knowledge retention levels aligned with classification techniques used in recent agroecological studies [3] [12]

C. Econometric Analysis

A multiple linear regression model (OLS) was used to identify the determinants of the Agrobiodiversity Index (ABI) at the household level. ABI was considered as the dependent variable, while Occupational Diversification Index (ODI), Knowledge Retention Index (KRI), farm size, family labour availability, and annual farm income were included as explanatory variables[32] [33].

- The model is specified as:
- $ABI = \beta_0 + \beta_1(ODI) + \beta_2(KRI) + \beta_3(FS) + \beta_4(FL) + \beta_5(INC) + \varepsilon$

Diagnostic tests confirmed that **multicollinearity (VIF < 5)**, **normality**, and **homoscedasticity** assumptions were satisfied. The model significance was tested using the **F-statistic**, and individual coefficients were assessed using **t-tests** at 1% and 5% levels.

3. Findings and Discussion

Table 1. Distribution of Households Based on Agrobiodiversity Index (ABI) (n = 180)

S.No	Category of Agrobiodiversity	Agrobiodiversity Index Score Range	Number of Households	Percentage (%)
1.	Low Agrobiodiversity	0.00-0.33	52	28.89
2.	Medium	0.34-0.66	86	47.78
3.	High Agrobiodiversity	0.67 – 1.00	42	23.33
			180	100

Table 2. Component wise Mean Scores of Agrobiodiversity Index

Component	Mean Score (0–1 scale)	Standard deviation
Crop Diversity	0.61	0.18
Traditional varieties	o.48	0.21
Livestock diversity	0.52	0.17
Overall Agro-Biodiversity Index	0.54	0.19

The distribution of households based on the Agrobiodiversity Index (Table 1) indicates that a majority of respondents (47.78%) fall within the medium agrobiodiversity category, followed by 28.89% in the low category and only 23.33% in the high category. The overall mean ABI value of 0.54 (Table 2) further confirms

that agrobiodiversity in the study area is at a moderate level, suggests that while diverse farming persists, it is underutilized relative to its potential for strengthening food systems [18] [13]

A closer examination of the component-wise scores (Table 2) reveals important insights into the nature of this transition. Crop diversity records the highest mean value (0.61), indicating that farmers continue to cultivate multiple crops, possibly as a strategy for risk management and food security. [33] [35]. However, the relatively lower mean score for traditional varieties (0.48) highlights a gradual decline in the use of indigenous crops. This pave opportunity to move towards commercially. Interm expected outcome would be attained but adversely it affects agrobiodiversity. [30]

With regard to Livestock diversity (0.52) it stands in the medium level, which shows that the livestocks were the important component of the mixed farming systems. At the same time the further diversification and richness among the livestock species was not observed. This might be due to increased cost for maintaining the live stock and changing trend of livelihood preferences [22] [35].

The evidence from this study indicates that, a transition was observed from more of traditional way and diversification rich to undiversified, homogenous, commercial and economically driven systems [2]. Though the house holds were still maintaining the considerable level of diversity, the gradual disappearance of traditional varieties gives an alarm that the weakening of agro biodiversity and ecological systems. The changing trends creates avenues for the non farm activities which reduces the time, labour and care given to farming.

Traditional crops and practices, which are often labour-intensive and less market-oriented, may be gradually replaced by less diverse but more economically viable alternatives. As a result, agrobiodiversity is not abruptly lost but is slowly eroding, particularly in its traditional and knowledge-intensive dimensions

Overall, the findings indicate that agrobiodiversity in the study area is in a state of partial retention and gradual decline, reflecting the influence of socio-economic transformations on farming systems. This underscores the need to strengthen support mechanisms that promote traditional varieties and diversified farming practices to ensure long-term ecological sustainability [14] [17].

Table 3. Relationship between Occupational Shift and Agrobiodiversity Index (ABI)

Occupational Shift Category	Low ABI (0.00–0.33)	Medium ABI (0.34–0.66)	High ABI (0.67–1.00)	Total
No Shift (n = 52)	8 (15.38)	22 (42.31)	22 (42.31)	52 (100)
One Member Shift (n = 104)	32 (30.77)	56 (53.85)	16 (15.38)	104 (100)
Two Members Shift (n = 24)	12 (50.00)	8 (33.33)	4 (16.67)	24 (100)
Total (n = 180)	52 (28.89)	86 (47.78)	42 (23.33)	180 (100)

(Figures in parentheses indicate percentage within each category)

The association between occupational shift and agrobiodiversity was found to be statistically significant (χ^2 = XX, $p < 0.05$)."

The results presented in Table 3 revealed a clear pattern linking occupational shifts with variations in agrobiodiversity levels. Households with no occupational shift exhibit relatively higher levels of agrobiodiversity, with a substantial proportion (42.31%) falling in the high ABI category. In contrast, households with one or two members shifting away from farming show a progressive increase in the proportion of low agrobiodiversity households, rising to 30.77% and 50.00%, respectively. This gradient indicates that greater engagement in non-farm activities is associated with reduced agrobiodiversity at the household level

This pattern can be explained through the reallocation of household labour and time. Farming systems that sustain agrobiodiversity—such as cultivation of multiple crops, maintenance of traditional varieties, and mixed farming practices—are typically labour-intensive and require continuous engagement typically labour-intensive and require continuous engagement typically labour-intensive and require continuous engagement [20]. As

household members move towards non-farm occupations, the availability of labour for such practices declines, leading to simplification of farming systems [11]. Daum et al. found that labour constraints frequently prevent farmers from adopting biodiversity-improving practices, as these often increase labour intensity beyond the household's capacity.

This finding is consistent with the study's theoretical framework, which emphasizes labour reduction as a key pathway through which livelihood diversification affects agrobiodiversity.

In addition to labour constraints, occupational shifts also influence knowledge dynamics within households. Reduced participation of younger members in farming limits opportunities for learning and transmitting indigenous agricultural knowledge, which is essential for maintaining traditional crop diversity[19]. Kalra et al. documented that the disappearing resource of indigenous knowledge is a critical factor in the loss of local crop varieties. Over time, this may contribute to the observed decline in high agrobiodiversity households among those experiencing greater occupational shifts. [21].

The findings also reflect broader processes of agrarian transformation in peri-urban regions, where increasing access to non-farm employment encourages partial withdrawal from agriculture. While households do not entirely abandon farming, their reduced engagement often leads to prioritization of less labour-intensive and more market-oriented crops, thereby affecting overall diversity. [8]. Castañeda Navarrete described trade-offs in time allocation between on-farm and urban jobs that specifically reduce the diversity of home gardens and traditional milpa systems [8]

Importantly, the findings do not claims an immediate loss of agrobiodiversity but rather indicate a slow and steady transition. Many households with moderate occupational shifts still fall within the medium ABI category, suggesting that diversification and farming continue to coexist. However, the declining share of high agrobiodiversity households signals potential long-term risks if current trends persist.

The research outcomes are supported by the results of regression model (Table 4), where occupational diversification shows a significant negative effect on agrobiodiversity.

Table 4. Multiple Regression for Determinants of Agrobiodiversity Index (ABI)

Variables	Coefficient (β)	Std. Error	t-value	p-value
Constant	0.612	0.079	7.75	0.000***
Occupational Diversification Index (ODI)	-0.284	0.068	-4.18	0.000***
Knowledge Retention Index (KRI)	0.356	0.072	4.94	0.000***
Farm Size	0.148	0.061	2.43	0.016**
Family Labour Availability	0.192	0.066	2.91	0.004***
Annual Farm Income	0.121	0.058	2.08	0.039**

- *** $p < 0.01$, ** $p < 0.05$
- Dependent Variable: Agrobiodiversity Index (ABI)
- Adjusted $R^2 = 0.59$ (good model fit)

The results of the multiple regression analysis indicate that the model is statistically significant ($F = 28.47$, $p < 0.01$), explaining 62% of the variation in the Agrobiodiversity Index ($R^2 = 0.62$). The Occupational Diversification Index (ODI) exhibits a negative and highly significant effect on agrobiodiversity ($\beta = -0.284$, $p < 0.01$), suggesting that increased engagement in non-farm activities reduces farm-level diversity.

In contrast, the Knowledge Retention Index (KRI) shows a positive and significant influence ($\beta = 0.356$, $p < 0.01$), indicating that households with stronger retention of traditional agricultural knowledge tend to maintain higher levels of agrobiodiversity.

Among the control variables, farm size, family labour availability, and annual farm income all have positive and statistically significant effects, implying that resource-endowed households are better positioned to sustain diverse farming systems [15]. Hoang et al. found that the total area of land cultivated and available household assets impact farm-level agrobiodiversity positively.

Overall, the findings confirm that both livelihood strategies and knowledge systems play a critical role in shaping agrobiodiversity outcomes, with diversification exerting a trade-off effect on ecological sustainability.

Table 5. Distribution and Summary Statistics of Occupational Diversification Index (ODI)

S.No	Category of ODI	ODI Score Range	Number of Households	Percentage (%)	Mean ODI	Standard Deviation
1.	Low Diversification	0.00 – 0.33	50	27.78		
2.	Medium Diversification	0.34 – 0.66	70	38.89		
3.	High Diversification	0.67 – 1.00	60	33.33		
			180	100	0.58	0.16

The results show that occupational diversification has become quite common among the sampled households. About one-third (33.33%) fall under the high diversification category, while the largest share (38.89%) is in the medium group. Only 27.78 percent of households depend mainly on a single or limited number of occupations. The mean ODI value of 0.58 also indicates that most households are moving towards combining multiple income sources rather than relying entirely on farming.

This pattern suggests that rural households are gradually adjusting their livelihood strategies. The increase in non-farm employment opportunities, especially in nearby towns and industrial areas, appears to be encouraging people to take up additional work outside agriculture [36]. Workie identified that while diversification helps combat poverty, a significant portion of households now engage in a mix of on-farm and non-farm activities to sustain their lives [36]. At the same time, many households are not leaving farming completely; instead, they continue to practice it along with other occupations. This explains the higher concentration in the medium diversification category.

The smaller proportion of households in the low diversification group shows that dependence on agriculture alone is becoming less common. Rising costs of cultivation, uncertain returns, and changing aspirations among younger members may be pushing families to look for more stable sources of [10]. Danso-Abbeam et al. found that farmers who simultaneously work in non-farming industries must dedicate significant time and energy to other endeavours, leaving less time for the labour-intensive nature of on-farm diversification. As a result, labour within the household is being shared between farm and non-farm activities.

Overall, the findings indicate that rural livelihoods are in a stage of transition. Diversification is helping households improve income stability, but it may also reduce the time and effort devoted to farming. In particular, households with higher diversification may give less attention to maintaining multiple crops, traditional varieties, and mixed farming systems.. Reduced labour availability and shifting priorities can gradually affect crop and livestock diversity, along with the continuity of traditional knowledge associated with farming practices.

However, the present findings do not directly establish agrobiodiversity loss. Rather, the higher level of occupational diversification points to a possible reduction in farm-level engagement, which may, over time, influence the maintenance of crop diversity, traditional varieties, and mixed farming practices.

Table 3. Distribution and Summary Statistics of Knowledge Retention Index (KRI) (n = 180)

S.No	Category of KRI	KRI Score Range	Number of Respondents	Percentage (%)	Mean KRI	Standard Deviation
1.	Low Knowledge Retention	0.00 – 0.33	58	32.22		
2.	Medium Knowledge Retention	0.34 – 0.66	**76**	42.22		
3.	High Knowledge Retention	0.67 – 1.00	46	25.56		
			180	**100**	**0.49**	**0.19**

The distribution of respondents based on the Knowledge Retention Index (KRI) indicates that a majority (42.22%) fall under the medium category, followed by 32.22 percent in the low category and only 25.56 percent in the high category. The mean value of 0.49 indicates medium level of retention of farming knowledge among the respondents.

The majority of the respondents responses were medium category which indicates the local knowledge systems are in the transitional phase where the components of traditional farming knowledge continued to exist but those knowledge elements are not frequently followed or transferred to the next generation. It was learnt during the observation and investigation that majority of the respondents expressed that level of knowledge on traditional farming practices especially associated with crop diversity, seed selection and livestock management are received from their preceding generation.

The noticeably higher proposition of the respondents were fell in the category of low knowledge retention to a gradual weakening of traditional knowledge which is associated with the livelihood diversification. As the majority of the farm families involved in non farm activities leads to declining of the degree of participation in traditional farming and transferring those knowledge across generation will get decreased. [5]

The minimum percentage of respondents in the category of high level of knowledge retention indicates that only a narrow segment of the farming population contin ues to actively practice traditional farming, conserve and utilize the traditional farming practices. Hence the households plays a vital role in the conservation and restoration of traditional farming knowledge in particular, local crop varieties and mixed farming systems [28].

The findings Shows that shifts in livelihood trends are influencing economic activity and also the system of knowledge that conserve agro biodiversity . the observed decline in knowledge retention may eventually leads to reduced diversity in crops, varieties, livestock's and farming methods, even though this study was not specifically quantify knowledge loss as a contributing component. This stresses the requirement of strengthening livelihood strategy and knowledge based interventions to ensure the long-term sustainable future of agrobiodiversity in rural South India.

4. Conclusion

The findings indicate that rural households have diversified their livelihoods for income security but reduced farm-level engagement to produce a moderately high level of agrobiodiversity with low levels of traditional crop varieties and only moderate livestock diversification indicating erosion of on-farm diversity which is also reflected by the observed impacts of occupational change in lower agrobiodiversity.

Reference

[1] Amare, G., & Gacheno, D. (2021). Indigenous knowledge for climate smart agriculture—a review. *International Journal of Food Science and Agriculture*, *5*(2). http://dx.doi.org/10.26855/ijfsa.2021.06.019

[2] Arndt, M., & Helming, K. (2025). Agricultural diversification across spatial levels–A contribution to resilience and sustainability?. *Agriculture, Ecosystems & Environment*, *385*, 109547. https://doi.org/10.1016/j.agee.2025.109547

[3] Benyei, P., Calvet-Mir, L., Reyes-García, V., & Rivera-Ferre, M. (2020). Resistance to traditional agroecological knowledge erosion in industrialized contexts: A study in La Plana de Vic (Catalonia).

Agroecology and Sustainable Food Systems, *44*(10), 1309–1337. https://doi.org/10.1080/21683565.2020.1712571

[4] Bisht, I. (2023). Engaging rural youth in strengthening the local food movement in India. *Journal of Agriculture Food Systems and Community Development*, 1–4. https://doi.org/10.5304/jafscd.2023.131.012

[5] Bisht, I. S., Rana, J. C., Jones, S., Estrada-Carmona, N., & Yadav, R. (2021). Agroecological Approach to Farming for Sustainable Development: the Indian Scenario. In *IntechOpen eBooks*. https://doi.org/10.5772/intechopen.100281

[6] Bisht, I. S., Rana, J. C., Yadav, R., & Ahlawat, S. P. (2020). Mainstreaming agricultural biodiversity in traditional production Landscapes for Sustainable Development: The Indian Scenario. *Sustainability*, *12*(24), 10690. https://doi.org/10.3390/su122410690

[7] Buthelezi, S. C., Ocholla, D., & Dlamini, P. (2024). Strategies for documenting and disseminating indigenous knowledge at a South African university. *South African Journal of Information Management*, *26*(1). https://doi.org/10.4102/sajim.v26i1.1648

[8] Castañeda-Navarrete, J. (2021). Homegarden diversity and food security in southern Mexico. *Food Security*, *13*(3), 669–683. https://doi.org/10.1007/s12571-021-01148-w

[9] Chapke, R. R., Satyavathi, C. T., Babu, K. S., & Laxmiprasanna, P. (2025). Integrating indigenous traditional knowledge and ergonomic efficiency for sustainable millets farming: a study from Koraput, Odisha, India. *Frontiers in Sustainable Food Systems*, *9*. https://doi.org/10.3389/fsufs.2025.1673772

[10] Danso-Abbeam, G., Ogundeji, A. A., Ehiakpor, D. S., Korir, L., & Djokoto, J. (2025). Exploring the linkages between on-farm enterprise diversification and food security in Northern Ghana. *Discover Food*, *5*(1), 73. https://doi.org/10.1007/s44187-025-00352-3

[11] Daum, T., Baudron, F., Birner, R., Qaim, M., & Grass, I. (2023). Addressing agricultural labour issues is key to biodiversity-smart farming. *Biological Conservation*, *284*, 110165.https://doi.org/10.1016/j.biocon.2023.110165

[12] Dei, D. G. J., Anane-Donkor, L., Dzandza, P. E., Peasah, T., & Puttick, C. P. (2025). Synthesizing the Characteristics and Applications of Indigenous Knowledge for Sustainable Development: A Systematic Review. *SAGE Open*, *15*(3), 21582440251383843. https://doi.org/10.1177/21582440251383843

[13] Escárraga-Torres, L. J., Cuevas-Sánchez, J. A., Baca-del Moral, J., de Lourdes Maldonado-Méndez, M., & Sibelet, N. (2023). Evaluación del estado de la agrobiodiversidad en el sistema agroalimentario de México. *Tropical and subtropical agroecosystems*, *26*(2), 063.DOI : 10.56369/tsaes.4618

[14] Hailu, F. (2025). The role of agrobiodiversity and diverse causes of its losses and methods of conservation: A review. *Food and Humanity*, *4*, 100500. https://doi.org/10.1016/j.foohum.2025.100500

[15] Hoang, K. T., Nabuuma, D., Swaans, K., Naziri, D., & Vernooy, R. (2026). Understanding agrobiodiversity and nutritional outcomes: a study of socio-economic differentiation among smallholder vegetable farming in northern Vietnam. *Agroecology and Sustainable Food Systems*, *50*(5), 1182-1208. https://doi.org/10.1080/21683565.2025.2560914

[16] Iyer, S., & Rao, N. (2022). Skills to stay: social processes in agricultural skill acquisition in rural Karnataka. *Third World Quarterly*, *45*(4), 677–697. https://doi.org/10.1080/01436597.2022.2132929

[17] Jenkins, T., Landschoot, S., Dewitte, K., Haesaert, G., Reade, J., & Randall, N. (2023). Evidence of development of underutilised crops and their ecosystem services in Europe: a systematic mapping approach. *CABI Agriculture and Bioscience*, *4*(1), 55. https://doi.org/10.1186/s43170-023-00194-y

[18] Jones, S. K., Estrada-Carmona, N., Juventia, S. D., Dulloo, M. E., Laporte, M. A., Villani, C., & Remans, R. (2021). Agrobiodiversity Index scores show agrobiodiversity is underutilized in national food systems. *Nature food*, *2*(9), 712-723. https://doi.org/10.1038/s43016-021-00344-3

[19] Kalra, L., Srinatha, T. N., Abhishek, G. J., Naik, P. B., Sujatha, G. S., Hanji, S. S., ... & Kumawat, P. K. (2024). A Comprehensive Review of Indigenous Knowledge Systems in India and its Importance and Role in Biodiversity Conservation. *International Journal of Environment and Climate Change*, *14*(9), 250-265.

[20] Kocziszky, G., & Szendi, D. (2023). Comparative analysis of development paths in Central and Eastern European countries (V4+ 2) using a composite index, 1995–2020. *Regional Statistics*, *13*(6), 1026-1058..

[21] Marrero, A., Nicoson, C., & Mattei, J. (2023). Food laborers as stewards of island biocultural diversity: reclaiming local knowledge, food sovereignty, and decolonization. *Frontiers in Sustainable Food Systems*, *7*, 1093341.

[22] Mottet, A., Bicksler, A., Lucantoni, D., De Rosa, F., Scherf, B., Scopel, E., ... & Tittonell, P. (2020). Assessing transitions to sustainable agricultural and food systems: a tool for agroecology performance evaluation (TAPE). *Frontiers in Sustainable Food Systems*, *4*, 579154.

[23] Mutua, K., & Goda, P. (2021). Multidimensional assessment of European agricultural sector adaptation to climate change. *Studies in Agricultural Economics*, *123*(1), 8-22.

[24] Nandi R, Pratheepa CM, Nedumaran S, Rao N and Rengalakshmi R (2022) Farm Parent and Youth Aspirations on the Generational Succession of Farming: Evidence From South India. Front. Sustain. Food Syst. 5:804581. doi: 10.3389/fsufs.2021.804581.

[25] Patidar, H., & Chothodi, S. (2021). Livelihood diversification in rural India. *Space and Culture India*, *9*(3), 32–44. https://doi.org/10.20896/saci.v9i3.1206

[26] Paucek, I., Durante, E., Pennisi, G., Quaini, S., Gianquinto, G., & Orsini, F. (2023). A methodological tool for sustainability and feasibility assessment of indoor vertical farming with artificial lighting in Africa. *Scientific Reports*, *13*(1), 2109.

[27] Puneeth, G. M., Gowthami, R., Katral, A., Laxmisha, K. M., Vasudeva, R., Singh, G. P., & Archak, S. (2024). On-farm crop diversity, conservation, importance and value: a case study of landraces from Western Ghats of Karnataka, India. *Scientific Reports*, *14*(1), 10712. https://doi.org/10.1038/s41598-024-61428-1

[28] Rathoure, A. K. (2024). Cultural practices to protecting biodiversity through cultural heritage: Preserving nature, preserving culture. *Biodivers. Int. J*, *7*, 71-75.

[29] Saha, D., & Nambiyar, S. (2025). From Fields to Cities: Mapping Agrarian Exit and Migrant Labor Transitions in Tamil Nadu. DOI:10.21203/rs.3.rs-6572387/v1

[30] Seidler, R., Gavai, P., & Bawa, K. S. (2025). Rethinking agrobiodiversity for agricultural sustainability. *Frontiers in Sustainable Food Systems*, *9*, 1639264.

[31] Singh, P., & Pattanaik, F. (2025). Beyond the fields: tracing India's labour transition from agriculture to non-agricultural sectors. *International Journal of Social Economics*, *52*(4), 608-627. https://doi.org/10.1108/IJSE-11-2023-0904

[32] Tacconi, F., Waha, K., Ojeda, J. J., & Leith, P. (2022). Drivers and constraints of on-farm diversity. A review. *Agronomy for Sustainable Development*, *42*(1), 2.

[33] Tacconi, F., Waha, K., Ojeda, J. J., Leith, P., Mohammed, C., Venables, W. N., ... & van Wijk, 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.

[34] Vihi, S. K., Jesse, B., Dalla, A. A., Owa, G. T., Bassey, E. A., Ochelle, B., & Fatoke, V. (2021). Analysis of livelihood diversification among rural farming households in Vandeikya Local Government Area of Benue State, Nigeria. *Russian Journal of Agricultural and Socio-Economic Sciences*, *117*(9), 89-101. DOI 10.18551/rjoas 2021-09.11

[35] Waseem, M., Li, X., Jamil, I., Islam, A. H. M. S., Abbas, Q., Raza, M. H., & Eliw, M. (2023). Do crop diversity and livestock production improve smallholder intra-household dietary diversity, nutrition and sustainable food production? Empirical evidence from Pakistan. *Frontiers in Sustainable Food Systems*, *7*, 1143774.

[36] Workie, D. M. (2023). Livelihood Diversification Strategies and Determinants by Smallholder Farmers in the Highland Areas of North Shewa Ethiopia. *Journal of Agribusiness and Rural Development*, *68*(2), 217-228.