



Climate Resilient Farming: Influence of Livelihood Assets on Agrochemical vs Organic Input Use in Coastal India

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HIGHLIGHTS

- Livelihood assets strongly influence farmers' adaptation choices between an increase in agrochemical and organic input usage in farming.
- Physical capital encourages the use of organic inputs and reduces reliance on agrochemicals, whereas human capital reduces reliance on agrochemicals.
- Social capital enhances organic inputs use; however, it might also promote use of agrochemicals without targeted interventions.

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ABSTRACT

Climate change poses immense pressure on global agriculture, particularly in coastal regions. Several adaptation strategies to climate change were taken by farmers, though not all are aligned with long-term sustainability. Through logistic regression, the study assesses the role of livelihood assets in farmers' choices between agrochemical intensification and organic farming, where livelihood assets were measured using the Department for International Development's (DFID) framework. The study covered five coastal states and one coastal union territory of India. Using a stratified random sampling method, 520 agricultural households were surveyed during 2024–2025. Villages were selected based on proximity to the sea and the implementation of the National Innovation on Climate Resilient Agriculture (NICRA) and Project on Climate Resilient Agriculture (PoCRA) programmes. Findings indicate physical capital as a pivotal factor encouraging organic farming and curbing agrochemical intensification, while human capital reduces reliance on agrochemicals. Natural and financial capital enhance agrochemical use. The dual positive influence of social capital on organic farming and agrochemical intensification underscores the need for tailored guidance, as affirmed by sustainability-oriented initiatives, proven effective in limiting agrochemical intensification as NICRA and PoCRA. Inclusion in such programmes and enhancing human and physical capital may reinforce farmers' orientation with sustainable adaptation trajectories.

INTRODUCTION

The multifaceted effect of climate change (CC) poses immense pressure on the agricultural systems across the globe. Over the past few decades, significant economic disruption to the agricultural sector in least developed countries has been caused by the increasing

frequency and severity of wildfires, storms, floods, and droughts, which have placed substantial pressure on food production systems and rural livelihoods (FAO, 2021). The direct impacts of CC include changes in crop growth cycles and yield fluctuations, while indirect impacts manifest themselves through increased frequency and intensity of extreme climatic events, changes in soil fertility, erratic

in rainfall patterns, and changes in the distribution and prevalence of pests and diseases, which adversely affect overall agricultural productivity (Yuan et al., 2024). Despite a global concern, coastal areas are more susceptible to climate change-induced sea level rise; it is mentioned that 21st-century sea-level rise may exceed the projection of the Intergovernmental Panel on Climate Change (IPCC), i.e., 0.61 to 1.10 meters compared to the 1950s (Siebert et al., 2020).

Climate variability poses a serious threat to food security (Pradhan et al., 2025). Increasing temperatures, erratic rainfall, and intensified cyclonic storms are crumbling up the livelihood of the densely populated coastline of India (Dasgupta et al., 2020). The impact of CC on reducing crop productivity in coastal regions jeopardises food security and lowers the income and livelihood stability of coastal populations (Gopalakrishnan et al., 2019). Subsequently, increased reliance on agrochemicals, referred to as agrochemical intensification (Pelinson et al., 2023), in order to maintain agricultural productivity has been driven by rising temperatures (Quan et al., 2024) and rainfall shocks (Guo & Chen, 2022), inadvertently exacerbating environmental degradation (Sharma et al., 2020). In contrast, organic farming, as an adaptive measure, provides greater sustainability, care for biodiversity, and augments carbon sequestration relative to conventional practices with more reliance on agrochemicals, thereby supporting CC mitigation (Murry, 2019). From the standpoint of smallholding farmers, organic farming promotes comprehensive growth by reducing input costs and improving profit (Sahu & Tiwari, 2024). Das et al. (2024) advocated that farmers' resiliency is not only shaped by the factors related to agriculture, but also by their livelihood assets. As highlighted by Ren et al. (2022), such livelihood assets play a crucial role in reducing the reliance on agrochemicals and advancing sustainable agricultural practices. Also, organic farming contributes to the pursuit of sustainable livelihoods by strengthening livelihood assets (Sibarani & Somboonsuke, 2024). In this backdrop, present study examines the role of various livelihood assets, that include human, natural, financial, physical, and social capital, in influencing farmers' decisions to use organic inputs or agrochemical intensification in India's climate-vulnerable coastal regions. It further examines how sustainability-focused initiatives, such as NICRA and PoCRA, shape both agrochemical intensification and sustainable agricultural practices.

METHODOLOGY

This study is based on primary data collected between October 2024 and March 2025 across five coastal states—West Bengal, Odisha, Tamil Nadu, Kerala, and Maharashtra—and one UT, Andaman & Nicobar Islands. Districts, blocks, and villages were selected considering coastal proximity and the implementation of NICRA/PoCRA programme. One district was selected from each State/UT, except Maharashtra, where three districts were included to capture coastal proximity and presence of both NICRA and PoCRA programme. From each district two blocks—one with NICRA/PoCRA intervention and one without—except in Maharashtra, where one block from each district represented interventions under NICRA, PoCRA and no intervention. Accordingly, 13 selected blocks were: Kultali and Gosaba (South 24 Parganas, West Bengal); Marshaghai and Mahakalpara

(Kendrapara, Odisha); Thirupulani and Ramanathapuram (Ramanathapuram, Tamil Nadu); Kunnummal and Panthalayani (Kozhikode, Kerala); Ferrargunj and Port Blair (South Andaman, Andaman & Nicobar Islands); Ambajogai (Beed), Kankavli (Sindhudurg), and Risod (Washim) in Maharashtra. Two villages per block were chosen, where 20 farm-households per village were selected through stratified random sampling based on net cultivated area. Thus in total, from 26 villages a sample of 520 agricultural households were surveyed.

The “Balanced Weighted Average Approach” (Namgyal et al., 2025) was used to construct the index values of livelihood assets, i.e., human, natural, financial, physical, and social capital, after normalizing the subcomponents (listed in Table 1) through “Linear Scaling Technique” (De & Das, 2021). For, subcomponent (x_i) positively associated with livelihood assets, Eq. 1 and for the negatively associated subcomponent (x_i) Eq. 2 was applied.

$$X_i = \frac{x_i - \text{Min}(x)}{\text{Max}(x) - \text{Min}(x)} \quad \dots (\text{Eq. 1})$$

$$X_i = \frac{\text{Max}(x) - x_i}{\text{Max}(x) - \text{Min}(x)} \quad \dots (\text{Eq. 2})$$

Where, $\text{Max}(x)$ and $\text{Min}(x)$ are the maximum and minimum values of x_i respectively. The transformed variable (X_i) is positively associated with the index and lies between intervals (0,1).

Let, x_{ji} ($j=1,2,\dots,k$) denote the values of the j^{th} subcomponent of the d^{th} asset for the i^{th} observation ($i=1,2,\dots,n$), and X_{ji} represent the corresponding normalized value. Composite index of the d^{th} asset, comprising k subcomponents, is derived using (Eq. 3).

$$I_i^d = \frac{\sum_{j=1}^k X_{ji}}{k} \quad \dots (\text{Eq. 3})$$

Further, the logistic regression technique is used to explain the dummy variable Y with values 0 and 1. Considering, $z = XB + u$ as the regressor, the probability of $Y=1$ is defined as,

$$P(Y=1) = \frac{1}{1 + e^{-z}} \quad \dots (\text{Eq. 4})$$

The ‘odds ratio’ is

$$\frac{P}{1-P} = \frac{1}{e^{-z}} = e^z \quad \dots (\text{Eq. 5})$$

So, regressand Y (0,1) can be represented as the logarithm of the odds ratio as:

$$L = \ln\left(\frac{p}{1-p}\right) = z = XB + u \quad \dots (\text{Eq. 6})$$

Parameter B is estimated using maximum likelihood method. Estimated coefficients provide the marginal effects of change in X on the likelihood function (i.e., $\partial L / \partial X$).

RESULTS

The study examines the influence of livelihood assets on farmers' decision-making regarding agrochemical intensification (AGROCHEMICAL) versus the adoption of organic input usage (ORGANIC), both of which are important for sustaining agricultural productivity. Livelihood assets, operationalised as a composite

Table 1. Description of the sub-components of the livelihood assets

Asset	Subcomponents	Description of Sub-components	Unit	Effect
Human Capital	Dependency Ratio	% of non-working household (HH) members	%	-ve
	Head's Education	Education level of HH head	Years	+ve
	Average Education	HH's average education level	Years	+ve
	Maximum Education	Highest education level in the HH	Years	+ve
	Illness Ratio	% of HH members with health challenges	%	-ve
Natural Capital	Agricultural Land	Net sown area of the HH	Acres	+ve
	Natural Fuel	Access to natural cooking fuel	Binary	+ve
	Surface Water	Access to surface water irrigation	Binary	+ve
	Ground Water	Access to groundwater irrigation	Binary	+ve
Financial Capital	Livestock	Estimated HH livestock worth	Rupees	+ve
	Health Insurance	% of health-insured HH members	%	+ve
	Govt. Assistance	HH Govt. financial aid sources count (Central/State)	Count (0,1, 2)	+ve
	Kisan Credit Card	Possession of a Kisan Credit Card	Binary	+ve
	Institutional Loan	Access to institutional loans	Binary	+ve
Physical Capital	Pucca Dwelling	Ownership of a pucca dwelling	Binary	+ve
	Dwelling Distance	Distance of the dwelling from an all-weather road	Kilometres	-ve
	Agricultural Land Distance	Distance of agricultural land from an all-weather road	Kilometres	-ve
	Drinking Water	Access to drinking water facilities within the dwelling premises	Binary	+ve
	Latrine	Possession of a sanitation facility meeting hygienic standards	Binary	+ve
	SHG Participation	% of adult female HH members engaged in Self-Help Groups	%	+ve
Social Capital	Membership	Association with a Farmers' Producers Organization or Cooperative Society	Binary	+ve
	Media Access	Number of media sources (Print & Social) accessed by the HH	Count(0,1, 2)	+ve

index comprising multiple subcomponents (Table 1), exert statistically significant effects on farmers' choices. The socio-economic profile of sample households across selected states and UT (Table 2) reveals notable variation in agricultural land holdings, major crops grown, irrigation sources, and livelihood asset endowments. Furthermore, the household-level responses presented in Table 3 highlight region-specific exposure to climatic stressors.

Regional variations in the distribution of agricultural land size among sample households can be seen from Table 2. In West Bengal, 70% of households have less than 1 acre of agricultural land, highlighting the prevalence of marginal farming and land fragmentation. Kerala also has a high number of smallholders, with 75% of people owning less than 2 acres of land, although this is slightly more balanced than in West Bengal. In contrast, Maharashtra and Odisha show a more equitable distribution, with more than 30% of households in each state owning 3 acres or more of land, indicating better access to cultivable land. Tamil Nadu is skewed to medium-sized agricultural land, with more than 50% of sample households in the 1-2 acre category, whereas only 13.75% of households have 3 acres or more of land. Andaman and Nicobar Islands show a unique scenario, with a relatively high proportion (33.75%) of households owning 3 acres or more of land, and a comparatively even distribution across all size categories.

Like agricultural land holding, regional disparities can also be seen in the irrigation patterns. In Kerala, 82.5% of sample households are completely dependent on rainwater, indicating limited irrigation availability. Similarly, Tamil Nadu has a rain-fed dependency rate of 51.25%, although 41.25% of farmers have access to both groundwater and surface water, reflecting higher diversity

than others. In West Bengal, 76.25% depend only on surface water, with no reported use of groundwater. Odisha presents a balanced profile, with 35% sample respondents using both ground as well as surface water and 27.5% dependent on rainfall, indicating moderate irrigation benefits. In Maharashtra, where 40.83% of the sample households depend primarily on rainwater for agriculture, a significant proportion rely solely on groundwater (22.5%) or surface water (20%). Additionally, 16.67% of households reported access to both groundwater and surface water sources, indicating a degree of hydrological diversity within the region. A mixed pattern is observed in the Andaman and Nicobar Islands, with 47.5% using only surface water and 33.75% relying on rainfall, due to island-specific hydrology and limited groundwater availability.

The distribution of livelihood resources of the selected farm households clearly reveals regional strengths and weaknesses. Kerala and the Andaman & Nicobar Islands topped the list in physical capital with scores of 0.949 and 0.925, respectively, indicating strong infrastructure and access to basic services. Odisha and Kerala also exhibit strong social capital (0.601 and 0.649), indicating better community networks and institutional support. In contrast, West Bengal has relatively low scores in financial (0.288) and social capital (0.305), although it maintains moderate levels of natural (0.446) and physical capital (0.724). Maharashtra shows balanced performance in most categories, with significant strengths in physical (0.792) and social capital (0.609). Tamil Nadu shows high human capital (0.640) but limited natural capital (0.251), indicating strong education and skills but limited environmental resources. Odisha stands out for its financial capital (0.552), perhaps due to better access to credit or income diversification. Kerala (0.594) and

Table 2. Selected states and UT-wise socio-economic profile of sample households

	West Bengal	Odisha	Tamil Nadu	Kerala	Maharashtra	Andaman & Nicobar Islands
Number of sample households	80	80	80	80	120	80
<i>Agricultural land holding (% of sample households)</i>						
Less than 1 acre	70.00	5.00	10.00	33.75	2.50	20.00
1 to less than 2 acre	25.00	36.25	53.75	41.25	44.17	32.50
2 to less than 3 acre	2.50	28.75	22.50	18.75	12.50	13.75
3 acre and more	2.50	30.00	13.75	6.25	40.83	33.75
<i>Major field crops Grown</i>						
Kharif	Paddy, Jute	Paddy, Jute	Cotton, Groundnut, Black gram	Paddy	Millet, Paddy, Soybean	Paddy, Sugarcane
Rabi	Paddy, Potato, Sunflower	Paddy, Green gram, Black gram, Groundnut	Paddy, Cotton	Paddy	Sorghum, Gram	Maize, Green gram, Black gram
Summer	Paddy	Paddy	Paddy	Paddy	-	-
<i>Sources of Irrigation (% of sample households)</i>						
Only groundwater	0.00	3.75	7.50	6.25	22.50	1.25
Only surface water	76.25	33.75	0.00	0.00	20.00	47.50
Both ground and surface water	0.00	35.00	41.25	11.25	16.67	17.50
Fully dependent on rainwater	23.75	27.50	51.25	82.50	40.83	33.75
<i>Livelihood Asset (Average index value)</i>						
Human Capital	0.510	0.671	0.640	0.632	0.595	0.612
Natural Capital	0.446	0.328	0.251	0.086	0.351	0.429
Financial Capital	0.288	0.552	0.279	0.572	0.424	0.220
Physical Capital	0.724	0.723	0.625	0.949	0.792	0.925
Social Capital	0.305	0.601	0.338	0.649	0.609	0.313
Composite Asset Index	0.469	0.584	0.443	0.594	0.558	0.520

Table 3. Comparative vulnerability to climatic stressors across selected states and UT

Climatic stressors	% of sample households					
	West Bengal	Odisha	Tamil Nadu	Kerala	Maharashtra	Andaman & Nicobar Islands
Frequent occurrence of storm surges	83.75	100.00	42.50	53.75	46.67	42.50
Frequent occurrence of drought	8.75	47.50	17.50	53.75	56.67	20.00
Frequent occurrence of floods	63.75	98.75	0.00	3.75	50.83	12.50
Change in rainfall pattern	63.75	78.75	52.50	92.50	90.83	65.00
Water scarcity in surface water bodies	45.00	71.25	17.50	63.75	63.33	16.25
Decline in groundwater level	31.25	72.50	17.50	61.25	76.67	6.25
Increase soil erosion	15.00	78.75	35.00	23.75	37.50	8.75
Increase in soil salinity	27.50	67.50	0.00	3.75	14.17	10.00
Degradation of soil fertility	75.00	100.00	35.00	52.50	37.50	63.75
Increase in pests and disease outbreaks	77.50	100.00	17.50	75.00	68.33	58.75
Decrease in crop productivity	62.50	85.00	52.50	91.25	50.00	58.75
Increasing incidence of crop loss	47.50	100.00	52.50	83.75	69.17	28.75

Odisha (0.584) top the composite asset index, indicating overall livelihood resilience, while West Bengal (0.469) and Tamil Nadu (0.443) lag behind, indicating multidimensional asset gaps that may require targeted interventions.

The challenges faced by the agricultural households due to climate change show stark differences among the selected states and UT. Based on the reported suffering of the sample households, Table 3 reveals that Odisha is facing the most severe and multifaceted impacts; 100% of sample households reported windstorms, soil

erosion, insect outbreaks, and crop damage, as well as widespread flooding and groundwater depletion. West Bengal has high storm surge (83.75%) and flood (63.75%), but limited drought impact, indicating dependence on monsoon and salinity risks. Intense rainfall variability (over 90%), combined with drought and groundwater depletion, in Kerala and Maharashtra, indicates severe hydrological stress. Kerala's risk is further reflected by high insect infestations (75%) and crop damage (83.75%), although flood risk is low. Tamil Nadu has moderate climate stress, with more than half of households

Table 4. Binary logistic regression related to agrochemical intensification and organic farming

Regressor	Regressand: [AGROCHEMICAL]		Regressand: [ORGANIC]	
	Model 1.1	Model 1.2	Model 2.1	Model 2.2
	Marginal effect	Marginal effect	Marginal effect	Marginal effect
HUMAN_CAP	-0.649*** (0.165)	-0.745*** (0.171)	0.152 (0.156)	0.154 (0.156)
NATURAL_CAP	0.191* (0.105)	0.240** (0.107)	0.014 (0.101)	0.012 (0.101)
FINANCIAL_CAP	0.330*** (0.117)	0.463*** (0.124)	0.077 (0.107)	0.071 (0.110)
PHYSICAL_CAP	-0.416*** (0.126)	-0.403*** (0.128)	1.278*** (0.136)	1.278*** (0.136)
SOCIAL_CAP	0.214** (0.103)	0.207* (0.105)	0.197** (0.099)	0.197** (0.099)
NICRA_PO CRA	-	-0.213*** (0.047)	-	0.010 (0.044)
Chi ²	40.87	61.22	115.39	115.45
Prob > Chi ²	0.00	0.00	0.00	0.00
Pseudo R ²	0.057	0.086	0.172	0.172
Log likelihood	-336.29	-326.12	-277.72	-277.69
Akaike crit. (AIC)	684.59	666.244	567.442	569.389
Bayesian crit. (BIC)	710.113	696.021	592.965	599.166
Number of observations	520	520	520	520

Note: *** p<.01, ** p<.05, * p<.1. Values in parentheses are standard errors.

affected by rainfall variability and crop damage, but the risk of salinity and storm surge is relatively low. Under stress, rainfall variability, groundwater depletion, and soil degradation emerge as widespread threats, with Odisha and Maharashtra particularly affected. Andaman and Nicobar Islands, although less exposed overall, still report significant soil fertility decline (63.75%) and pest outbreaks (58.75%), emphasizing ecological fragility.

As evident from Table 4, Model 1.1 estimates the likelihood of agrochemical intensification, where the regressand AGROCHEMICAL takes the value 1 if any household reported increased use of chemical fertilisers or pesticides, and 0 otherwise. The regressors include five dimensions of livelihood assets: human capital (HUMAN_CAP), natural capital (NATURAL_CAP), financial capital (FINANCIAL_CAP), physical capital (PHYSICAL_CAP), and social capital (SOCIAL_CAP). Model 1.2 builds on this by incorporating an additional regressor, NICRA_PO CRA, which takes the value 1 if the household is a beneficiary of either the NICRA or PoCRA programme, and 0 otherwise. As explanatory variables, Model 2.1 uses the same set of livelihood asset variables as Model 1.1, but considers ORGANIC as the regressand, which takes the value 1 if any household reported use of organic inputs, and 0 otherwise. Model 2.2 mirrors Model 2.1, with the inclusion of NICRA_PO CRA as an additional regressand. All four models are based on a consistent sample of 520 households. This uniform sample size ensures comparability across model specifications and allows for a comprehensible understanding of the effects of livelihood assets and the impact of NICRA & PoCRA on both agrochemical intensification and organic farming adoption.

Findings from Model 1.1 and Model 2.1 demonstrate that livelihood assets, human (HUMAN_CAP), natural

(NATURAL_CAP), financial (FINANCIAL_CAP), physical (PHYSICAL_CAP), and social capital (SOCIAL_CAP) significantly shape the choice between agrochemical and organic input use, respectively, albeit with varied directional effects. Increased access to natural resources (natural capital) and stronger household financial capacity (financial capital) are positively associated with the likelihood of increased application of chemical fertilisers and pesticides, showing marginal effects of 0.191 and 0.330, with statistical significance at the 90 and 99 per cent levels, respectively. However, neither natural nor financial capital appears to significantly encourage the adoption of organic input use. Conversely, enhanced human capital, encompassing education, health status, and labour availability, demonstrates a restrictive effect on increased agrochemical use, reflected by the most pronounced marginal effect (-0.649) and significance at the 99 per cent level, though it does not exert a statistically significant influence on organic input uptake. Physical capital, indicating access to infrastructural amenities such as pucca housing, potable water, sanitation, and all-weather roads, contributes positively to organic farming. It is associated with a reduction in agrochemical intensification (marginal effect: 0.416) and simultaneously fosters organic input adoption (marginal effect: 1.278), both with significance at the 99 per cent level. Notably, social capital, measured through household association with various organisations and access to print and social media, emerges as a dual influencer. It positively correlates with both agrochemical intensification and organic input usage, registering marginal effects of 0.214 and 0.197, respectively, with 95 per cent confidence, indicating that organisational affiliations may currently lack a coherent sustainability agenda, thereby facilitating divergent farming behaviours.

To further examine the role of organisational alignment with sustainability goals, Models 1.2 and 2.2 incorporate two government-led initiatives, NICRA and POCRA (NICRA_PO CRA), as additional explanatory variables. The National Innovations in Climate Resilient Agriculture (NICRA), implemented by the Indian Council of Agricultural Research (ICAR), has played a significant role in promoting the use of sustainable inputs and facilitating organic farm inputs usage. NICRA has shown a set of climate-resilient technologies, including zero-till sowing, green manuring, integrated pest and nutrient management, and region-specific organic farming packages, across diverse agro-climatic zones (Ministry of Agriculture and Farmers Welfare, 2025). Complementing this, the Project on Climate Resilient Agriculture (PoCRA), implemented by the Government of Maharashtra in partnership with the World Bank, has demonstrated a comprehensive approach to enhance climate-resilient farming and reduce environmental degradation with a strong focus on reducing agrochemical dependency. It promotes organic farming, integrated nutrient and pest management, and farmer-led capacity building to enhance ecological sustainability and input efficiency (Leena, 2017).

The result reveals that the presence of NICRA and POCRA interventions is significantly associated with a reduction in the likelihood of agrochemical intensification among beneficiary households, with a marginal effect of 0.213 and statistical significance at the 99 per cent level (Model 1.2). This underscores the potential of structured policy interventions in reducing reliance on agrochemicals through capacity building, awareness campaigns, and access to alternative technologies. However, while these initiatives are effective in curbing agrochemical intensification, it is evident from Model 2.2 that they do not exert a statistically significant influence on the adoption of organic input use, indicating the limitations in the emphasis of programmes on organic cultivation or barriers faced by beneficiaries in transitioning to organic methods, such as challenges regarding certification, access to the market, or availability of inputs.

DISCUSSION

The role of agrochemicals in order to enhance agricultural yield, particularly in the context of increasing challenges from CC, is undeniable. However, the upsurge in use of chemical inputs has led to higher production costs and increasing environmental problems, which undermine the broader objectives of sustainable agriculture. Chen et al. (2024) highlighted that farmers' access to livelihood assets has a strong influence on their decisions to either increase agrochemical use or to come up with sustainable organic farming practices. The findings of the present study are partially in line with those of Chen et al. (2024), particularly in showing that improvements in human and physical capital help reduce the overuse of agrochemicals. Similarly, Yang & Cui (2025) stated that natural, human, financial, and social capital significantly affect farmers' environment-friendly production behaviour, although they do not find an obvious connection between physical capital and green production practices. In contrast, the present study finds that physical capital plays a key role in encouraging farmers to adopt organic farming. The importance of infrastructure is also highlighted by Maksimovich et al. (2023), who noted that reduced

transportation and transaction costs support organic farming. Mishra et al. (2015) also emphasised the role of better road connectivity in enabling the smooth transport of organic products. On the other hand, Karki et al. (2012) noted that poor road connectivity affects both conventional and organic farming. While it limits access to agrochemicals in remote areas, it also makes it difficult for government agencies to provide support for organic farming in remote areas.

The financial capital that is essential for maintaining inputs and productivity was found here to be positively associated with intense use of agrochemicals. This supports the argument made by Combarry (2022) that farmers with more financial resources tend to apply more chemical inputs. Interestingly, this study does not find any significant relationship between financial capital and the use of organic inputs. This differs from the findings of Zhang et al. (2025), who claimed that, depending on the situation of organizational and market structure, access to credit can support both conventional as well as organic input use. Similarly, the present study finds that access to natural capital increases the likelihood of higher agrochemical use. This aligns with Xie et al. (2020), who described a non-linear relationship where chemical input use first decreases with larger farm size but then increases after a certain threshold.

Social capital shows a mixed influence on both the intensification of agrochemicals and the adoption of alternative organic practices, which is also noted by Ren & Jiang (2022). While Hu (2020) linked social capital with higher agrochemical use, another study by Ma et al. (2022) associated it with increased participation in organic farming. Drawing from evidence in the climate-vulnerable state of Odisha, Das et al. (2020) found that institutional arrangements notably impact the adaptation decisions of farm households. In this line, the present study finds that the Institutional program NICRA, which promotes climate-resilient agriculture (Yadav et al., 2025) and also organic farming across India, alongside the region-specific program PoCRA in Maharashtra, contributed significantly to reducing chemical input use. However, the limited impact of these programmes on farmers' willingness to adopt organic methods suggests that deeper structural and behavioural issues need to be explored. Targeted interventions are required to enhance climate resilience and promote climate-smart agricultural practices. The key livelihood indicators (such as infrastructure, connectivity, community network, landholding, irrigation access, and income) are reported as determinants of the resilience of the farmers in Odisha (Das et al., 2025). Therefore, policy interventions that strengthen human and physical capital, along with institutional support need to be specifically designed to ease the transition to organic farming, paving the way to the achievements of both productivity and sustainability goals.

CONCLUSION

The differences in livelihood assets and climatic stressors highlight the need for region-specific policy frameworks that align resource growth with climate adaptation goals. The study validates the critical role of livelihood assets in farmers' decision-making under coastal climate stress in India. While natural and financial capital influence the agrochemical intensification, human and physical capital

evidently restrict the reliance on such practices. Physical capital was found to promote sustainable organic input use in agriculture. Social capital exerted a double-edged influence in supporting agrochemical intensification as well as organic input use, directing towards institutional alignment. NICRA and POCRA, with their alignment with climate-resilient and organic agriculture, play a significant role in curbing increased agrochemical use, yet fall short in facilitating transitions to the use of organic inputs. Targeted policies, enhancing physical and human capital, and integrating sustainability requirements within grassroots organizations can promote more comprehensive and resilient pathways for agricultural adaptation.

DECLARATIONS

Ethics approval and informed consent: Informed consent was sought from the respondents during the course of the research.

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