ASIAN JOURNAL OF AGRICULTURE
Volume 9, Number 2, December 2025
Pages: 870-880

E-ISSN: 2580-4537
DOI: 10.13057/asianjagric/g090253

Leveraging farmer federation to social capital and motivation enhancement for sustainable *Ipomoea reptans* farming in East Java, Indonesia

HERI SUSANTO♥, RAMON SYAHRIAL, ANDRI KRISNA DIANTO
Faculty of Agriculture, Universitas Wijaya Putra. Jl. Raya Benowo 1-3, Pakal, Surabaya 60197, East Java, Indonesia.
Tel./fax.: +62-271-663375, ♥email: herisusanto@uwp.ac.id

Manuscript received: 29 September 2025. Revision accepted: 15 December 2025.

Abstract. *Susanto H, Syahrial R, Dianto AK. 2025. Leveraging farmer federation to social capital and motivation enhancement for sustainable* Ipomoea reptans *farming in East Java, Indonesia. Asian J Agric 9: 870-880.* This study examines the relationships between social capital, farmer motivation, and the mediating role of Farmer Group Federations (Gapoktan) in improving the productivity and sustainability of *Ipomoea reptans* farming in Balongpanggang, Indonesia. A mixed-methods design was employed using census data from 35 farmers and analyzed through Structural Equation Modeling Partial Least Squares (SEM PLS). The findings show that social capital has a positive and significant association with Gapoktan partnerships, while farmer motivation does not show a significant direct relationship. Gapoktan partnerships significantly improve agricultural productivity and the adoption of sustainable practices. Gapoktan also mediates the relationship between farmer motivation and productivity but does not mediate the relationships between motivation and sustainability or between social capital and either outcome. These results indicate that Gapoktan serves as an important institutional mechanism that converts collective farmer relationships into productive outcomes, with social capital emerging as a stronger predictor than individual motivation. Strengthening Gapoktan's institutional capacity is therefore essential to optimize farmer networks, reinforce collective action, and promote sustainable agricultural development. The study highlights the need for institutional strengthening in rural farming systems to translate social assets into measurable gains in productivity and sustainability.

Keywords: Descriptive statistics, Gapoktan, *Ipomoea reptans*, sustainable agriculture, SEM-PLS

INTRODUCTION

Farmers in Balongpanggang, Gresik District, East Java, Indonesia, have shifted to cultivating *Ipomoea reptans* Poir as an adaptive response to prolonged drought that leaves rice fields dry (Anggoro 2024). This transition shows how unproductive land can be converted into a source of income and reflects sustainable agriculture principles that balance current needs with those of future generations. According to FAO, food systems must ensure food security, protect the environment, build resilience, and promote equity (Fenia 2023). Historical accounts, such as King's (1911) study of East Asian farmers, document long standing soil conservation practices, while contemporary approaches integrate these traditions with technological innovations to maintain ecological and economic stability (Reganold et al. 1990; SARE Outreach 2023).

Productivity remains fundamental in agriculture because it reflects the efficiency of converting inputs into outputs (Ardhiana 2018). Efficiency improves when fewer resources generate greater results and is influenced by internal factors such as input use, allocation, and farmer capacity, as well as external factors including market conditions and price fluctuations (Karmini 2018). Indicators such as production costs, revenues, and net income are commonly used to measure outcomes (FAO 2016). Empirical studies show that participation in farmer groups increases productivity across various commodities, although the extent of improvement varies (Baga et al. 2023; Ayesha et al. 2024; Safitri et al. 2024).

Farmer motivation also plays an important role. Defined as an internal drive that directs action (Suciani et al. 2023), motivation shapes farmers' willingness to adapt, innovate, and persist. Economic objectives interact with social and cultural responsibilities, influencing household strategies and collective resilience (Margawati et al. 2020). Social capital forms the basis for cooperation. Built upon trust, networks, and shared norms (Hanifan 1916; Putnam 1994), it facilitates knowledge exchange and collective problem solving. Previous studies show that social capital supports food security and sustainable farming practices (Prayitno et al. 2019; Nuryati et al. 2023; Abdurrahman and Suek 2024). However, levels of social capital among Indonesian farmers are often moderate and require stronger institutional support (Widjayanthi et al. 2024).

Farmer organizations, particularly Gapoktan, therefore play a strategic role. Regulation 67/2016 defines farmer groups as self-organized associations of farmers, while Gapoktan represent federations that expand scale and efficiency. They function as brokers connecting farmers with inputs, credit, technology, and markets (Pujiharto 2010; Kartika et al. 2023). Their responsibilities include input provision, production, processing, marketing, and microfinance (Sumaryanto and Rustandi 2017). Performance is evaluated through governance quality, partnerships, financial management, and market access.

Institutional theory (North 1990; Pretty 2003) explains how such organizations reduce uncertainty, lower transaction costs, and improve coordination. Despite this potential, Gapoktan in Balongpanggang remain limited in their influence, and farmers continue to depend on middlemen.

Most existing research examines the direct relationships between motivation, social capital, and productivity while placing institutions in a secondary position. Only a few studies assess how Gapoktan function as mediators that translate social and psychological factors into productivity gains and sustainable outcomes. This study addresses this gap by positioning Gapoktan not only as organizational structures but also as strategic intermediaries in the agricultural system.

The research examines whether Gapoktan mediate the effects of social capital and motivation on productivity and sustainability. It also evaluates the partial effects of social capital on Gapoktan, motivation on Gapoktan, and the subsequent influence of Gapoktan partnerships on farming outcomes. By examining Gapoktan in this capacity, the study contributes to a clearer understanding of how institutional partnerships support resilience, inclusivity, and sustainability in rural agribusiness.

Based on these objectives, the study proposes the following hypotheses:

H1: Social capital positively influences Gapoktan partnership.
H2: Farmer motivation positively influences Gapoktan partnership.
H3: Gapoktan partnership positively influences agricultural productivity.
H4: Gapoktan partnership positively influences sustainable agriculture.
H5: Gapoktan partnership positively mediates the influence of social capital on agricultural productivity.
H6: Gapoktan partnership positively mediates the influence of social capital on sustainable agriculture.
H7: Gapoktan partnership positively mediates the influence of farmer motivation on agricultural productivity.
H8: Gapoktan partnership positively mediates the influence of farmer motivation on sustainable agriculture.

MATERIALS AND METHODS

Study type

This study employed a cross-sectional quantitative design in which data were collected at a single point in time from all respondents. The purpose of this design was to identify statistical associations between social capital, farmer motivation, Gapoktan partnerships, productivity, and sustainable agricultural practices. Although the analysis followed a structural modelling framework using Structural Equation Modelling Partial Least Squares (SEM PLS), the relationships identified are associative rather than temporal or causal. The findings therefore describe the direction and strength of relationships that align with theoretical expectations without implying empirical causation.

Study area

The research was conducted in Balongpanggang Sub-district, Gresik District, East Java, Indonesia (Figure 1), an area that has emerged over the past five years as a central hub for the cultivation of *I. reptans*. Agriculture remains the dominant livelihood in this region and reflects its adaptive agrarian character. The area is geographically located in coordinate 7°14′9″S 112°26′33″E. Administratively, Balongpanggang consists of 85 hamlets and 25 villages. With community centres distributed across these villages, the settlement pattern reflects a typical rural organisational structure.

The occupational profile of the population indicates considerable diversity across sectors. Agriculture is the largest contributor, employing 12,543 individuals, which highlights the region's agrarian economic base.

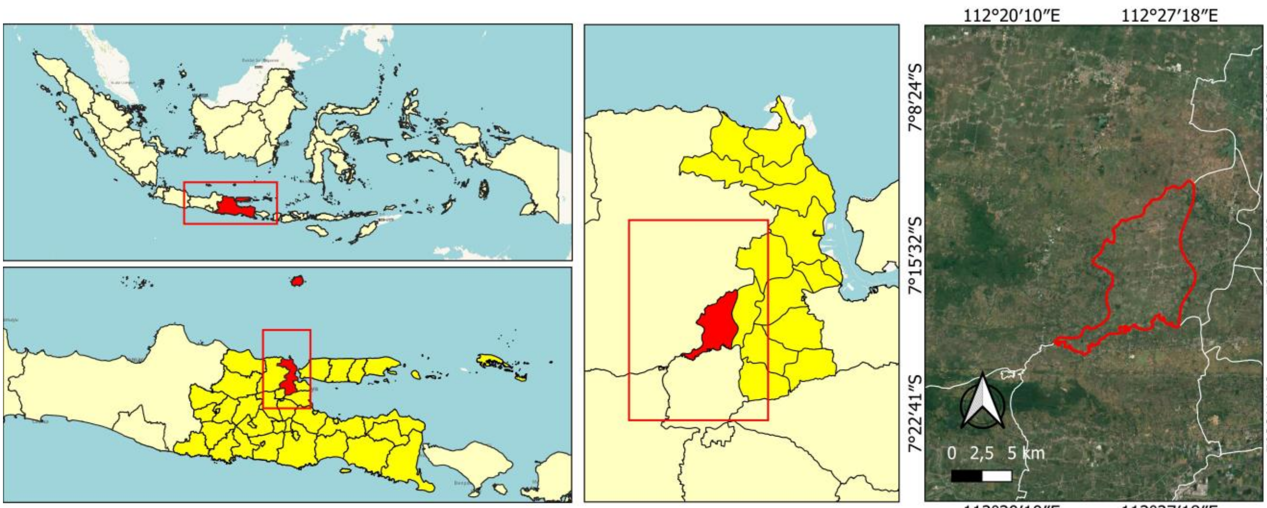

Figure 1. Map of the study area in Balongpanggang Sub-district, East Java Province, Indonesia

Time of study

The study was conducted from May to August 2025, coinciding with the dry season in East Java. This period was intentionally selected because the cultivation of *I. reptans* is most visible during these months as an adaptive response to reduced water availability for paddy cultivation. Conducting the study in this timeframe allowed the research to reflect seasonal dynamics that influence agricultural practices and farmer adaptation strategies.

Study approach

A quantitative methodological approach was used, complemented by qualitative reflection to provide contextual depth. Standardised questionnaires were employed to identify patterns and tendencies within the farming community. This combined perspective enabled the study to capture the underlying factors that shape agricultural behaviour rather than simply documenting actions and perceptions. All constructs were specified as reflective, following Hair et al. (2021).

Population and sample

All 35 *I. reptans* farmers in the Balongpanggang Sub-district were included in the study. A census approach was adopted due to the small population size, ensuring that every farmer contributed to the dataset.

Study instruments

Data were collected using a structured twenty-eight item questionnaire developed from theoretical and conceptual indicators of the study variables (Table 1). The instrument used a four-point Likert scale, which removes the neutral midpoint and encourages respondents to provide a definite opinion (Koo and Yang 2025). Validity was assessed through Average Variance Extracted (AVE) and Discriminant Validity, while reliability was evaluated using Composite Reliability (CR). All indicators exceeded the recommended thresholds, confirming the robustness of the instrument and the accuracy of its measurement.

Table 1. Indicators used in questionnaire

Variables	Indicators	Sub-indicators	Measurement
Social Capital	Trust Social Network Social Norms	-	1: Strongly disagree 2: Disagree 3: Agree 4: Strongly agree
Motivation	Internal External	Age Education, Income, Experience, Farm size, & Family Dependents Capital, Market, Risks, Agricultural Institution, Supporting Facilities	Internal and external indicators were measured using a 1-4 Likert scale (1 = strongly disagree to 4 = strongly agree). The socio-structural indicators were operationalised through motivational questions reflecting farmers' perceived readiness and capacity to engage in farming. For example: "At your current age, do you still have a strong desire to continue farming?"; "Does your level of education support your farming activities?"; "Is your current income sufficient to sustain your household needs?" Similar perceptual statements were used for other sub-indicators.
Gapoktan Partnership	Organizational Governance Facilitating Collective Farming Partnership and Networking Access to Information and Technology Capital Management and Microfinance Commodity Production and Processing Marketing and Distribution	-	1: Strongly disagree 2: Disagree 3: Agree 4: Strongly agree
Productivity	Farming Costs Farming Income Farming Profit	-	1: Strongly disagree 2: Disagree 3: Agree 4: Strongly agree
Sustainable Agriculture	Economic sustainability Social sustainability Environmental sustainability	-	Based on farmers' self-assessment of their latest cultivation cycle (May-August 2025), using a four-point Likert scale 1: Strongly disagree 2: Disagree 3: Agree 4: Strongly agree

Data collection and analysis

Data were collected from May to July 2025, a period when the cultivation cycle of *I. reptans* is most active. Questionnaires were administered to all participating farmers to capture their practices, perceptions, and attitudes within the seasonal context of local agricultural activity.

Quantitative data were analysed using Structural Equation Modelling Partial Least Squares (SEM PLS) in SmartPLS. This method was selected to estimate the directional associations among constructs within the proposed theoretical framework. The analysis employed a bootstrapping procedure with 5,000 resamples and a two tailed significance test to evaluate the stability and statistical reliability of the path coefficients. While the approach identifies relationships consistent with theoretical pathways, it does not determine temporal causation due to the cross-sectional design.

RESULTS AND DISCUSSION

Demographics of the respondents

The study involved thirty-five *I. reptans* farmers from Balongpanggang Sub-district, Gresik District, all of whom were male (Table 2). Most respondents fell within the productive age range of 30 to 55 years, with the largest proportion between 36 and 45 years. This demographic profile reflects a farming community that combines substantial experience in rice cultivation with openness to adopting new techniques and innovations.

In terms of experience with *I. reptans* cultivation, most farmers were relatively new to the practice, which has emerged only within the past five years as an adaptive response to declining paddy field productivity after harvest. Of the total respondents, seven farmers had begun cultivating within the last year, ten had two years of experience, eight had three years, six had four years, and only four had maintained the practice for five years. This distribution indicates that the collective knowledge of cultivation is still developing, and that limited experience may influence how farmers interact with Gapoktan institutions and formulate strategies for sustainable farming.

Descriptive statistics

The following table presents the descriptive statistics for all research variables, including the mean, Standard Deviation (SD), and score range. The mean values represent the central tendency of the respondents' answers, while the standard deviations indicate the degree of agreement or variability in their responses. This summary provides an initial understanding of the distribution of each indicator before subsequent analysis.

The results show that the social capital dimension reflects generally positive responses across its components (Table 3). The Trust dimension recorded the highest mean score (3.16), with X1.1a (mean 3.14, SD 0.809) and X1.1b (mean 3.17, SD 0.785) displaying consistently favorable evaluations and relatively low variability. Social Norms produced a moderately positive score (mean 2.80), though the variation between indicators was more pronounced. X1.2a (mean 2.94, SD 0.873) scored higher than X1.2b (mean 2.66, SD 0.838), indicating some inconsistency in farmers' perceptions of social expectations. The Social Network dimension achieved a strong overall performance (mean 3.15), mainly driven by X1.3a (mean 3.29, SD 0.893), while X1.3b (mean 3.00, SD 0.804) remained positive but slightly lower. All indicators displayed the full response range (1 to 4), with SD values below 1.0, indicating reasonable agreement among respondents across all aspects of social capital.

The analysis of internal and external motivation factors shows distinct patterns in respondents' characteristics and perceptions (Table 4). Internal motivation produced a moderately positive overall score (mean 2.79), although farmer's experience (X2.1d) received the lowest rating (mean 2.71). External motivation exhibited a lower collective score (mean 2.42), with risk factors (X2.2c) recording the lowest mean (2.23) and high variability (SD 1.114), indicating varied perceptions of external challenges. Standard deviations above 0.85 across nearly all indicators demonstrate substantial variation in both internal characteristics and external environmental perceptions among respondents.

Table 2. Demographics of the respondents

Categories	Sub-categories	Frequency
Sex	Male	35
	Female	0
Age	30-35	8
	36-45	15
	46-55	12
Farming Experience	1 year	7
	2 years	10
	3 years	8
	4 years	6
	5 years	4

Table 3. Descriptive statistics of social capital indicators

No	Indicators	Score				Mean	SD	Range
		1	2	3	4			
X1.1	Trust					3.16		
	X1.1a	1	12	45	52	3.14	0.809	3
	X1.1b	1	10	48	52	3.17	0.785	3
X1.2	Social norms					2.80		
	X1.2a	3	10	54	36	2.94	0.873	3
	X1.2b	4	16	57	16	2.66	0.838	3
X1.3	Social network					3,15		
	X1.3a	2	8	33	72	3.29	0.893	3
	X1.3b	1	16	48	40	3.00	0.804	3

Table 5. Descriptive statistics of Gapoktan partnership indicators

No	Indicators	Score				Mean	SD	Range
		1	2	3	4			
Z1.1	Governance					2.89		
	Z1.1a	4	14	45	36	2.83	0.954	3
	Z1.1b	2	18	39	44	2.94	0.905	3
Z1.2	Joint Farming Facilitation					2.20		
	Z1.2a	9	26	30	12	2.20	0.933	3
Z1.3	Network and Partnership					2.11		
	Z1.3a	14	22	24	8	1.94	0.938	3
	Z1.3b	11	16	33	20	2.29	1.07	3
Z1.4	Information and Technology					2.90		
	Z1.4a	0	16	63	24	2.94	0.639	2
	Z1.4b	3	16	45	36	2.86	0.912	3
Z1.5	Micro Financial Management					1.76		
	Z1.5a	22	18	12	0	1.49	0.701	3
	Z1.5b	15	16	24	16	2.03	1.070	3
Z1.6	Commodity Production and Processing					1.86		
	Z1.6a	15	24	21	4	1.83	0.857	3
	Z1.6b	19	12	15	20	1.89	1.132	3
Z1.7	Marketing and Distribution					2.67		
	Z1.7a	4	20	39	32	2.71	0.957	3
	Z1.7b	4	20	48	20	2.63	0.877	3

Table 4. Descriptive statistics of motivation indicators

No	Indicators	Score				Mean	SD	Range
		1	2	3	4			
X2.1	Internal					2.79		
	X2.1a	2	16	48	36	2.91	0.853	3
	X2.1b	6	14	45	28	2.74	0.980	3
	X2.1c	4	16	33	48	2.89	1.022	3
	X2.1d	0	30	48	16	2.71	0.667	2
	X2.1e	1	26	36	36	2.83	0.857	3
	X2.1f	2	24	42	28	2.74	0.852	3
X2.2	External					2.42		
	X2.2a	8	20	15	48	2.60	1.193	3
	X2.2b	9	26	18	28	2.31	1.078	3
	X2.2c	12	18	24	24	2.23	1.114	3
	X2.2d	12	16	27	24	2.26	1.120	3
	X2.2e	8	14	36	32	2.57	1.092	3

Table 6. Descriptive statistics of agricultural productivity indicators

No	Indicators	Score				Mean	SD	Range
		1	2	3	4			
Y1.1	Agricultural Cost					2.64		
	Y1.1a	4	16	57	16	2.66	0.838	3
	Y1.1b	5	16	51	20	2.63	0.910	3
Y1.2	Agricultural Income					3.30		
	Y1.2a	0	12	36	68	3.31	0.758	2
	Y1.2b	1	10	36	68	3.29	0.825	3
Y1.3	Agricultural Profit					2.66		
	Y1.3a	5	16	51	20	2.63	0.910	3
	Y1.3b	6	10	54	24	2.69	0.963	3

The assessment of Gapoktan partnership dimensions reveals varied levels of institutional support (Table 5). Governance (Z1.1) performed relatively well (mean 2.89), although Z1.1b showed higher variability (SD 1.044). Joint Farming Facilitation (Z1.2) recorded the lowest score (mean 2.20), suggesting limited effectiveness in coordinated farming activities. Network and Partnership (Z1.3) also showed weak performance (mean 2.11), especially for Z1.3a (mean 1.94). In contrast, Information and Technology (Z1.4) demonstrated the strongest performance (mean 2.90), with Z1.4a showing high consensus (SD 0.639). Micro Financial Management (Z1.5, mean 1.76) and Commodity Production and Processing (Z1.6, mean 1.86) emerged as the most problematic areas, both falling well below neutral levels and demonstrating substantial variability, particularly Z1.5b and Z1.6b (SD greater than 1.000). Marketing and Distribution (Z1.7) performed moderately (mean 2.67), with consistent scores across its indicators.

Agricultural financial performance shows varied outcomes across different dimensions (Table 6). Agricultural Cost (Y1.1) produced a moderate overall rating (mean 2.64) with closely aligned results between Y1.1a (mean 2.66, SD 0.838) and Y1.1b (mean 2.63, SD 0.910), suggesting stable perceptions of production expenditure. Agricultural Income (Y1.2) displayed the strongest performance (mean 3.30), as both Y1.2a (mean 3.31, SD 0.758) and Y1.2b (mean 3.29, SD 0.825) received high evaluations, although Y1.2a showed a slightly restricted response range. Agricultural Profit (Y1.3) returned to moderate levels (mean 2.66), with Y1.3b (mean 2.69, SD 0.963) performing slightly better but with greater variability than Y1.3a (mean 2.63, SD 0.910). The pronounced gap between high income ratings and moderate profit ratings suggests that although income generation is strong, high production costs may limit overall profitability.

Table 7. Descriptive statistics of agricultural sustainability indicators

No	Indicators	Score				Mean	SD	Range
		1	2	3	4			
Y2.1	Economic Sustainability					3.20		
	Y2.1a	1	14	30	68	3.23	0.877	3
	Y2.1b	2	10	39	60	3.17	0.891	3
Y2.2	Social Sustainability					3.27		
	Y2.2a	2	12	39	56	3.11	0.900	3
	Y2.2b	2	2	36	80	3.43	0.815	3
Y2.3	Environment Sustainability					2.84		
	Y2.3a	4	14	45	36	2.83	0.954	3
	Y2.3b	3	16	45	36	2.86	0.912	3

Table 8. Statistical output of hypothesis testing through O-value, t-statistic, and p-value

Hypotheses	Original sample	T statistic	P value
Social Capital → Gapoktan Partnership	0.326	4.921	0.000
Motivation → Gapoktan Partnership	0.188	1.312	0.190
Gapoktan Partnership → Agriculture Productivity	0.093	2.021	0.043
Gapoktan Partnership → Sustainable Agriculture	0.346	6.082	0.000
Social Capital → Gapoktan Partnership → Agriculture Productivity	0.303	1.906	0.086
Social Capital → Gapoktan Partnership → Sustainable Agriculture	0.112	1.210	0.227
Motivation → Gapoktan Partnership → Agriculture Productivity	0.017	3.487	0.001
Motivation → Gapoktan Partnership → Sustainable Agriculture	0.065	1.084	0.279

The sustainability assessment reveals higher performance in social and economic dimensions compared to environmental sustainability (Table 7). Social Sustainability (Y2.2) achieved the highest overall score (mean 3.27), driven particularly by Y2.2b (mean 3.43, SD 0.815), which shows both strong performance and high agreement among respondents. Economic Sustainability (Y2.1) also performed well (mean 3.20), with both indicators (Y2.1a and Y2.1b) reflecting favorable economic conditions. Environmental Sustainability (Y2.3) produced a lower overall score (mean 2.84), with both Y2.3a (mean 2.83) and Y2.3b (mean 2.86) showing only moderate evaluations. All indicators maintained the full response range (1 to 4), and SD values below 1.0 indicate reasonable agreement among respondents. Nevertheless, the comparatively lower environmental scores suggest that this dimension requires greater attention to enhance sustainability outcomes.

Hypotheses testing

The hypotheses in this study were evaluated using three principal statistical indicators: the Original Sample (O), the t-statistic, and the p-value. The O-value reflects both the direction and magnitude of the relationship between constructs; positive values denote reinforcing effects, while negative values indicate opposing influences (Hair et al. 2021). The t-statistic serves as the threshold for determining significance, where values greater than 1.96 indicate that the relationship is statistically meaningful at the 95% confidence level. Complementing this, the p-value provides the probability of observing the effect by chance, with values below 0.05 regarded as statistically significant (Hair et al. 2022). Together, these indicators translate the interactions among constructs into quantifiable evidence of influence. The statistical results are summarized in Table 8.

Direct and indirect effects

The results (Table 8) reveal several important patterns. Social Capital exhibits a positive and significant influence on the Gapoktan Partnership (O = 0.326, p = 0.000), indicating that higher levels of trust, shared norms, and social networks contribute to stronger institutional collaboration. Motivation also shows a positive path coefficient toward Gapoktan Partnership (O = 0.188), but this relationship is not statistically significant (p = 0.190), suggesting that individual motivation alone may be insufficient to enhance collective institutional participation without adequate organizational reinforcement.

The pathway from Gapoktan Partnership to Agricultural Productivity is statistically significant (p = 0.043), demonstrating that stronger institutional collaboration contributes to improvements in production efficiency and yield outcomes. Similarly, Gapoktan Partnership has a strong and significant effect on Sustainable Agriculture (O = 0.346, p = 0.000), confirming its central role in supporting environmentally and socially responsible farming practices.

Regarding indirect effects, most mediated pathways through Gapoktan Partnership were not statistically significant. The only significant indirect effect appears in the Motivation → Gapoktan Partnership → Agricultural Productivity pathway (p = 0.001), indicating that farmers' motivation can translate into productivity gains when channeled through collective institutional mechanisms.

Model explanatory power

The R^2 values presented in Table 9 demonstrate varying levels of explanatory power across endogenous constructs. Gapoktan Partnership (R^2 = 0.028) and Agricultural Productivity (R^2 = 0.074) show weak explanatory capacity, suggesting that other unmeasured factors—such as market access, climatic fluctuations, local governance support, or technological inputs—likely contribute more strongly to variance in these outcomes. In contrast, Sustainable Agriculture (R^2 = 0.326) demonstrates moderate explanatory strength, indicating that the model is more effective in explaining sustainability-related outcomes compared to productivity outcomes.

Effect size (f^2)

Effect size values (Table 10) indicate the relative contribution of each predictor within the model. Social Capital (f^2 = 0.182) exerts a moderate effect on the Gapoktan Partnership, whereas Motivation (f^2 = 0.055) shows a small contribution. Gapoktan Partnership demonstrates a moderate effect on Agricultural Productivity (f^2 = 0.156) and Sustainable Agriculture (f^2 = 0.323). According to Cohen's (1988) criteria (0.02 = small, 0.15 = medium, 0.35 = large), the influence of Gapoktan Partnership is particularly meaningful for sustainability outcomes, reaffirming its strategic role in promoting sustainable farming practices.

Predictive relevance (Q^2)

The Q^2 values (Table 11) confirm that the model possesses acceptable predictive relevance for the endogenous constructs. Gapoktan Partnership (Q^2 = 0.045) and Agricultural Productivity (Q^2 = 0.062) exhibit weak predictive strength, whereas Sustainable Agriculture (Q^2 = 0.211) shows moderate predictive capability. These findings suggest that although the model has limited predictive accuracy for productivity outcomes, it provides a reasonably strong predictive framework for sustainability-related variables.

Model fit

Model fit indices (Table 12) indicate that the structural model meets contemporary SmartPLS standards for good fit. The SRMR value (0.065) is below the recommended threshold of 0.08, indicating good model fit. The NFI value (0.921) exceeds the 0.90 criterion, demonstrating acceptable model adequacy. RMS Theta (0.089), which is below the 0.12 threshold, confirms good composite reliability. Collectively, these indicators show that the model's structural pathways and construct specifications are well aligned and statistically sound.

Discussion

The analysis revealed a network of associative relationships among social capital, farmer motivation, and Gapoktan partnerships that collectively shaped farming outcomes. These relationships reflected theoretical linkages rather than direct causation, as the data were collected cross-sectionally within a single agricultural season. Although the findings indicated directional patterns consistent with institutional and social capital theory, the study design limited causal interpretation. In this context, the term "influence" referred to statistical association derived from SEM-PLS estimation rather than temporal or experimental causality. Future research using longitudinal or experimental designs would have strengthened the interpretation of these associative patterns as causal mechanisms.

Drivers of Gapoktan partnership

Partnership dynamics within Farmer Groups (Gapoktan) emerged from the interaction between social capital and farmer motivation, although the magnitude of their associations differed. Social capital functioned as a collective base that channelled individual efforts toward shared action. It exerted external pressure through community norms, reciprocal expectations, and longstanding relationships that encouraged consistent participation in Gapoktan activities. Motivation, while positive, often remained insufficient to sustain engagement without support from social networks and institutional mechanisms.

Table 9. Statistical output of coefficient of determination

Dependent variables	R^2	Adjusted R^2
Gapoktan Partnership	0.028	0.022
Agriculture Productivity	0.074	0.063
Sustainable Agriculture	0.326	0.318

Table 10. Statistical output of effect sizes

Variables	Gapoktan partnership	Agriculture productivity	Sustainable agriculture
Social capital	0.182		
Motivation	0.055		
Gapoktan partnership		0.156	0.323

Table 11. Statistical output of Q^2 (predictive relevance)

Construct	Q^2	Interpretation
Gapoktan Partnership	0.045	Very small predictive relevance
Agriculture Productivity	0.062	Small predictive relevance
Sustainable Agriculture	0.211	Moderate-small predictive relevance

Table 12. Statistical output of model fit

Variables	Threshold	Model value	Interpretation
SRMR	< 0.08	0.065	Good Model Fit
NFI	> 0.90	0.921	Acceptable fit
RMS Theta	< 0.12	0.089	Good Composite Reliability

Field observations showed that farmers cultivating *I. reptans* during the past five years remained embedded in Gapoktan and Poktan structures oriented toward rice, maize, cassava, and other established commodities. Existing Gapoktan units did not yet provide dedicated enterprises, production systems, marketing channels, or information services for *I. reptans*. Consequently, even highly motivated farmers lacked formal pathways through which their motivation could be translated into meaningful institutional participation.

Seed acquisition and distribution practices further shaped this pattern. Most farmers obtained seeds and sold their harvests through intermediaries linked directly to seed companies. This pathway was faster and more practical than waiting for Gapoktan support. As a result, while individual motivation remained high, formal participation in Gapoktan activities remained limited because existing market mechanisms already met farmers' immediate needs.

This context clarified why motivation exerted only a small and statistically non-significant influence on Gapoktan partnerships. Strong personal drive encouraged information exchange and small-scale experimentation, yet these activities rarely developed into structured participation because institutional frameworks had not yet adjusted to the needs of emerging commodities. Motivation alone could not generate substantial behavioural change without reinforcement from organizational support and social networks.

In contrast, social capital showed a more stable and substantial influence. Community networks, shared norms, mutual obligations, and longstanding reputations encouraged participation even in the absence of Gapoktan services for *I. reptans*. Farmers exchanged cultivation techniques, seed quality assessments, and market information through informal community channels. Because these farmers were already active within rice-focused Gapoktan, their accumulated trust and cooperative experience from rice partnerships shaped positive perceptions that extended to *I. reptans* cultivation. Thus, participation patterns remained strongly influenced by past experiences with rice partnerships, enabling social capital to operate effectively despite limited institutional support for the new crop.

Social networks therefore acted as collective resources directed toward shared objectives. Within Gapoktan, social capital enabled coordinated action, including knowledge sharing, marketing insights, and procurement strategies. Reciprocal expectations and community norms acted as informal governance mechanisms, discouraging opportunistic behaviour, fostering participation, and maintaining a sense of collective ownership. Through social capital, individual motivation—potentially constrained by weak institutional support—was strengthened by community pressures and expectations, promoting consistent involvement in Gapoktan activities.

Vonneilich (2022) reported that social capital provided access to information and resources that were difficult to obtain individually. Farmers lacking detailed knowledge of seed quality or harvesting efficiency relied on peer networks to fill these gaps, transforming social capital into communal capacity. In rice-focused Gapoktan, these networks were already established, and *I. reptans* farmers used them as an initial framework for collective action despite the absence of formal support. Past experience in rice farming thus became inherited social capital that shaped favourable perceptions of partnership, explaining why social capital remained significant while motivation showed limited influence.

Putnam (1993) argued that trust, civic engagement, and social norms formed the foundation of resilient local institutions. Trust reduced concerns about exploitation and enabled cooperation. Within Gapoktan, trust and expectations of support encouraged voluntary sharing of knowledge, experience, and resources. Social norms reinforced this behaviour, prompting members to contribute actively to partnership activities. Even without dedicated structures for *I. reptans*, farmers helped one another source seeds from intermediaries or exchange marketing strategies to improve bargaining power. These informal interactions illustrated how social capital compensat-ed for institutional gaps.

Empirical studies supported these observations. Llones et al. (2022) found that bonding and bridging social capital significantly influenced collective action in participatory irrigation management in northern Thailand. This mirrored the cooperative patterns in Gapoktan, where trust and dense networks enabled structured collaboration and shared resource use.

North (1990) highlighted that formal and informal institutions reduced uncertainty and transaction costs. Although formal guidelines—such as those outlined in the Ministry of Agriculture Decree No. 67/2016—were designed to strengthen partnerships, Gapoktan systems remained oriented toward traditional crops and had not yet adapted to *I. reptans*. In this situation, social capital acted both as a substitute and complement to formal institutions. Zhu and Wang (2024) reported that agricultural cooperatives strengthened collective action by integrating formal structures with informal trust-based networks. Supported by such social capital, farmers faced lower uncertainty and reduced risks when adopting new crops.

From coordination to productivity

Farm-level productivity reflected the extent to which farmers transformed inputs into outputs. In the case of *I. reptans*, Gapoktan partnerships acted as formal institutions that organized farmer groups, improved access to production facilities, and facilitated marketing to enhance efficiency. Although *I. reptans* gained popularity only within the past five years, existing Gapoktan structures initially focused on rice and other staples gradually adapted to accommodate this crop. Field evidence and model estimation confirmed that Gapoktan partnerships had a positive and statistically significant influence on productivity ($p = 0.049$), demonstrating that institutional coordination and resource sharing translated into efficiency gains.

Farmers involved in active Gapoktan programmes reported easier access to inputs, collective purchasing, and coordinated marketing channels that reduced transaction costs and increased profit margins. These results aligned with Wulandari et al. (2022), who showed that adaptive farmer institutions improved participation and performance. Wonde et al. (2022) similarly observed that training and institutional support significantly improved farm productivity, suggesting comparable outcomes in the *I. reptans* sector.

From an institutional perspective, Gapoktan reduced uncertainty and facilitated collective action. As organizational adjustments progressed, the alignment between institutional design and crop-specific needs improved, enabling positive productivity outcomes. This was consistent with Schulze and Matzdorf (2023), who emphasized the importance of institutional adaptation for enhancing efficiency and accelerating innovation uptake.

Informal networks complemented these formal mechanisms. Farmers continued to exchange cultivation information, seed quality insights, and marketing practices based on shared knowledge from other crops. These informal exchanges reinforced institutional support and echoed the findings of Campuzano et al. (2023), who argued that peer collaboration strengthened productivity gains under active organizational learning.

However, productivity improvements might also have been influenced by external seasonal and market factors such as rainfall variation, input price fluctuations, or concurrent government programmes. These factors should be considered when interpreting the generalisability of the observed relationships.

Overall, the results showed that Gapoktan partnerships had a positive and statistically significant effect on *I. reptans* productivity. The combination of institutional coordination and social capital enhanced operational efficiency and yield performance. These findings suggested that further institutionalisation of crop-specific support systems would be important to sustain productivity gains.

Pathways to sustainability

Gapoktan partnerships had the potential to promote sustainable agricultural practices through information dissemination, production coordination, and support for environmentally friendly technologies. However, for *I. reptans*, these partnerships remained constrained because existing structures continued to prioritise rice, maize, and cassava. The absence of dedicated business units or programmes for sustainable *I. reptans* cultivation left formal mechanisms for organic fertilization, post-harvest management, and water efficiency underdeveloped.

Farmers nevertheless began adopting sustainable practices informally. They recycled harvest residues as organic fertilizer, coordinated planting schedules to reduce risk, and maintained soil fertility through crop rotation and responsible land use. One notable traditional practice was crop rotation: *I. reptans* seedlings were sown in irrigated paddy fields and matured as the fields dried, utilising otherwise idle land. Crop rotation enriched soil fertility, reduced pest and disease pressure, and supported production continuity (Tanveer et al. 2017; Lamichhane et al. 2023; Koli et al. 2025; Liang et al. 2025; Mihrete and Mihretu 2025). Through this inherited practice, farmers supported sustainable agriculture (Al-Musawi et al. 2025) by balancing economic, social, and ecological factors (Dietrich et al. 2025).

Economically, crop rotation stabilised harvests and reduced losses. Evidence from West Java showed that integrating rotation into farming systems strengthened economic viability and community resilience (Judijanto and Silamat 2024). Diversification allowed farmers to distribute risk and maintain income stability under shifting market or climatic conditions.

Socially, crop rotation supported cooperation as farmers shared experiences, coordinated planting, and exchanged land management strategies. These cooperative dynamics reinforced collective learning and cohesion.

Ecologically, crop rotation improved soil fertility, limited erosion, and reduced pesticide dependence. A six-year field experiment showed that diversified rotations improved soil microbial communities and ecological functions (Sun et al. 2024). Complementary studies also demonstrated enhanced biodiversity and carbon sequestration under well-designed rotations (Cerveny et al. 2023).

While most sustainability initiatives remained rice-oriented, Gapoktan extension services nevertheless strengthened adaptive thinking among *I. reptans* farmers. These services encouraged farmers to apply sustainable methods to the new crop while maintaining economic, social, and ecological balance.

Although Gapoktan had not yet fully aligned its programmes with *I. reptans* farmers' needs, its training and extension activities still promoted environmentally sound practices. Informal networks and collective norms further encouraged farmers to adopt sustainable practices such as water management, rotation cropping, and ecosystem protection.

Overall, although the influence of Gapoktan partnerships on sustainability remained limited, internal networks, collective norms, inherited crop rotation practices, and extension services provided a foundation for sustainable farming that addressed economic, social, and ecological dimensions.

The mediation effect of Gapoktan partnerships

Gapoktan partnerships served as a mediator linking social capital and farmer motivation to practical outcomes. Social capital provided networks of trust, norms, and solidarity that supported coordinated action. Motivation acted as an internal drive but often remained individualistic without institutional scaffolding. Gapoktan transformed both social capital and motivation into organized practices that improved production efficiency and strengthened sustainable agriculture.

In relation to productivity, Gapoktan coordinated input use, resource distribution, and access to capital, improving technical efficiency and resource allocation. This strengthened farmer interactions, eased the spread of knowledge, and reduced risks arising from uncoordinated decisions. The mediation of social capital through Gapoktan generated a stronger effect because social capital provided collective energy that individual motivation alone could not.

Individual motivation had limited influence on Gapoktan participation because institutional structures had not yet accommodated emerging crops. Most farmers participated in rice-oriented Gapoktan, so their perceptions of partnership benefits were shaped by past experiences. Motivation to engage with *I. reptans* partnerships remained restricted, whereas social capital, expressed through networks and collective norms, encouraged more consistent involvement.

In mediating sustainable agriculture, Gapoktan played a strategic role by coordinating environmentally sound practices. Rotation cropping balanced ecological and economic goals by utilising water and land efficiently. Gapoktan's mediation facilitated the collective application of these practices and integrated economic, social, and ecological sustainability principles.

Gapoktan also provided extension services and training that shared knowledge on conservation, input management, post-harvest techniques, and sustainable marketing. These mechanisms transformed social capital into practical knowledge and strengthened collective motivation to adopt sustainable practices.

From Coleman (1988)'s perspective, Gapoktan mobilised social capital by supporting coordination, communication, and joint decision-making. From Putnam's (1993, 1994) perspective, trust and social norms enhanced the effectiveness of formal institutions. North's (1990) perspective highlighted that Gapoktan reduced uncertainty and transaction costs, ensuring consistent application of rotation cropping, input management, and soil conservation.

The mediating role of Gapoktan strengthened the economic, social, and ecological pillars of sustainable agriculture. Economically, collective practices improved efficiency and income. Socially, interaction fostered solidarity, shared responsibility, and norms that supported sustainability. Ecologically, these practices maintained soil fertility, reduced land degradation, and strengthened ecosystem resilience.

The findings show that social capital and farmer motivation are positively associated with farm-level productivity and the adoption of sustainable agricultural practices when mediated through Gapoktan partnerships. Gapoktan partnerships exert a positive and statistically significant effect on agricultural productivity ($p = 0.049$), demonstrating that coordinated activities, shared resources, and institutional support now translate into measurable efficiency gains. Although Gapoktan has only recently integrated *I. reptans* into its programmes, its institutional role has already enhanced farmers' productive performance.

Social capital remains the strongest underlying factor, as trust, solidarity, and collective norms encourage active participation and knowledge exchange, which in turn strengthen the influence of individual motivation. Gapoktan further promotes the application of sustainable agricultural principles across economic, social, and ecological dimensions. Through coordinated action, extension services, farmer training, and resource facilitation, it enables crop rotation, soil conservation, and efficient post-harvest practices that reduce risks and support long-term resilience.

These results show that Gapoktan functions as a strategic institutional mechanism that links individual motivation with collective action, thereby reinforcing productivity and sustainability. Strengthening Gapoktan through specialised units for emerging commodities, expanded training initiatives, and adaptive governance frameworks would increase its mediating capacity and improve the translation of social capital and motivation into productive outcomes.

All respondents in this study were male, which reflects the actual demographic composition of *I. reptans* cultivation in the study area rather than sampling bias. In this context, the cultivation of *I. reptans* is culturally and operationally dominated by men, and no female farmers were identified during data collection. Although this gender homogeneity limits broader generalisability, it accurately represents current farming conditions. Future research should examine the potential reciprocal relationships between social capital, farmer motivation, and Gapoktan partnerships, as the cross-sectional design limits interpretation of the directionality of these interactions. Studies involving multiple districts, gender-balanced samples, and more diverse farming contexts are recommended to further validate and extend these findings.

REFERENCES

Abdurrahman M, Suek J. 2024. Social capital and its role in sustainable dryland agricultural development: Case study in West Kupang Subdistrict, Kupang Regency. Edelweiss Appl Sci Technol 8 (6): 6830-6839. DOI: 10.55214/25768484.v8i6.3468.

Al-Musawi ZK, Vona V, Kulmány IM. 2025. Utilizing different crop rotation systems for agricultural and environmental sustainability: A review. Agronomy 15 (8): 1966. DOI: 10.3390/agronomy15081966.

Anggoro YD. 2024. Kesulitan Air dan Waduk Mengering, Petani Balongpanggang Gresik Beralih Tanam Kangkung. Radar Gresik, 30 Jul. https://radargresik.jawapos.com/lifestyle/834918846/kesulitan-air-dan-waduk-mengering-petani-balongpanggang-gresik-beralih-tanam-kangkung. [Indonesian]

Ardhiana R. 2018. Analisis Efisiensi Ekonomi Usahatani: Pendekatan Stochastic Production Frontier. Sefa Bumi Persada, Lhokseumawe. [Indonesian]

Ayesha I, Harahap G, Cahya DL. 2024. Effect of farmer group empowerment and agribusiness training program on productivity and income of coffee farmers in West Java. West Sci Interdiscip Stud 2 (9): 1823-1832. DOI: 10.58812/wsis.v2i09.1302.

Baga LM, Utami AD, Wahyudi AF. 2023. Exploring the relation between farmer group membership and agricultural productivity: Evidence from Indonesian rice farming. Agraris: J Agribus Rural Dev Res 9 (1): 65-78. DOI: 10.18196/agraris.v9i1.115.

Campuzano LR, Llanoz GAH, Sossa JWZ, Mendoza GLO, Palacio JC, Herrera M. 2023. Barriers to the adoption of innovations for sustainable development in the agricultural sector—Systematic Literature Review (SLR). Sustainability 15 (5): 4374. DOI: 10.3390/su15054374.

Cerveny J, Prochazka P, Soukupova J, Svoboda R, Severova L, Smutka L, Cabelkova I, Dvorak M. 2023. Rooted in richness: Unearthing the economic and ecological synergy of crop rotation. Front Sustain Food Syst 7: 1298897. DOI: 10.3389/fsufs.2023.1298897.

Cohen J. 1988. Statistical Power Analysis for the Behavioral Sciences. 2nd ed. Lawrence Erlbaum Associates, Hillsdale, NJ.

Coleman JS. 1988. Social capital in the creation of human capital. Am J Sociol 94 (Suppl): S95-S120. DOI: 10.1086/228943.

Dietrich AS, Carini V, Vico G, Bommarco R, Hansson H. 2025. Changing the understanding of crop production: Integrating ecosystem services into the production function. Ecol Econ 230: 108526. DOI: 10.1016/j.ecolecon.2025.108526.

FAO. 2016. Handbook on Agricultural Cost of Production Statistics: Guidelines for Data Collection, Compilation and Dissemination. Food and Agriculture Organization, Rome.

Fenia RW. 2023. Manfaat Penerapan Pertanian Berkelanjutan di Indonesia. Mertani, 28 Mar. https://www.mertani.co.id/post/manfaat-penerapan-pertanian-berkelanjutan-di-indonesia. [Indonesian]

Hair JF Jr, Hult GTM, Ringle CM, Sarstedt M, Danks NP, Ray S. 2021. Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook. Springer, Cham. DOI: 10.1007/978-3-030-80519-7.

Hair JF Jr, Hult GTM, Ringle CM, Sarstedt M. 2022. A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). 2nd ed. Sage, Los Angeles.

Hanifan LJ. 1916. The rural school community center. Ann Am Acad Polit Soc Sci 67: 130-138. DOI: 10.1177/000271621606700118.

Judijanto L, Silamat E. 2024. Effectiveness of no-till farming, cover cropping, and crop rotation in improving the sustainability of the agricultural sector in West Java. West Sci Nat Technol 2 (2): 91-101. DOI: 10.58812/wsnt.v2i02.1015.

Karmini. 2018. Ekonomi Produksi Pertanian. Universitas Mulawarman Press, Samarinda. [Indonesian]

Kartika D, Ismiasih I, Yusuf IF. 2023. Motivasi petani terhadap program corporate farming dan dampaknya pada produktivitas usahatani padi di Desa Trimulyo Kabupaten Bantul DIY. Jurnal Dinamika Sosial Ekonomi 23 (1): 16-31. DOI: 10.31315/jdse.v23i1.6755. [Indonesian]

King FH. 1911. Farmers of Forty Centuries, or, Permanent Agriculture in China, Korea and Japan. Mrs. FH King, Madison. DOI: 10.5962/bhl.title.20418.

Koli M, Laxman T, Kashyap M, Kumar A, Nandan D, Jain M, Bajad S, Kumar M. 2025. Interaction effect of crop rotation and diversification on soil health and productivity: A review. Arch Curr Res Intl 25(10): 57-72. DOI: 10.9734/acri/2025/v25i101547.

Koo M, Yang SW. 2025. Likert-type scale. Encyclopedia 5 (1): 18. DOI: 10.3390/encyclopedia5010018.

Lamichhane JR, Alletto L, Cong WF, Dayoub E, Maury P, Plaza-Bonilla D, Reckling M, Saia S, Soltani E, Tison G, Debaeke P. 2023. Relay cropping for sustainable intensification of agriculture across temperate regions: Crop management challenges and future research priorities. Field Crops Res 291: 108795. DOI: 10.1016/j.fcr.2022.108795.

Liang X, Yu S, Ju Y, Wang Y, Yin D. 2025. Integrated management practices foster soil health, productivity, and agroecosystem resilience. Agronomy 15 (8): 1816. DOI: 10.3390/agronomy15081816.

Llones C, Mankeb P, Wongtragoon U, Suwanmaneepong S. 2022. Bonding and bridging social capital towards collective action in participatory irrigation management: Evidence in Chiang Rai Province, Northern Thailand. Intl J Soc Econ 49 (2): 296-311. DOI: 10.1108/IJSE-05-2021-0273.

Margawati E, Lestari E, Sugihardjo S. 2020. Motivasi petani dalam budidaya tanaman jagung manis di Kecamatan Colomadu Kabupaten Karanganyar. Soc Pedagogy: J Soc Sci Educ 1 (2): 174-184. DOI: 10.32332/social-pedagogy.v1i2.2743. [Indonesian]

Mihrete TB, Mihretu FB. 2025. Crop diversification for ensuring sustainable agriculture, risk management and food security. Glob Chall 9 (2): 2400267. DOI: 10.1002/gch2.202400267

Ministry of Agriculture. 2016. Peraturan Menteri Pertanian Nomor 67 Tahun 2016 tentang Pembinaan Kelembagaan Petani. Dirjen Peraturan Perundang-Undangan, Kemenkumham RI, Jakarta. [Indonesian]

North DC. 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press, Cambridge. DOI: 10.1017/CBO9780511808678.

Nuryati R, Ruslan JA, Faqihuddin F, Bunda CAP. 2023. Pengaruh modal sosial terhadap keberlanjutan Usahatani Polikultur Perkebunan Terintegrasi (UTPPT) dan dampaknya bagi kesejahteraan rumah tangga petani. Suluh Pembangunan: J Ext Dev 5 (1): 41-50. DOI: 10.23960/jsp.vol5.no1.2023.177. [Indonesian]

Prayitno G, Maulida RF, Nugraha AT. 2019. Modal sosial, ketahanan pangan dan pertanian berkelanjutan Desa Ngadireso, Indonesia. Region: J Pembangunan Wilayah Perencanaan Partisipatif 14 (2): 229-243. DOI: 10.20961/region.v14i2.30018. [Indonesian]

Pretty J. 2003. Social capital and the collective management of resources. Science 302 (5652): 1912-1914. DOI: 10.1126/science.1090847.

Pujiharto. 2010. Kajian pengembangan gabungan kelompok tani (Gapoktan) sebagai kelembagaan pembangunan pertanian di pedesaan. Agritech 12 (1): 64-80. [Indonesian]

Putnam RD. 1993. What makes democracy work? Natl Civic Rev 82 (2): 101-107. DOI: 10.1002/ncr.4100820204.

Putnam RD. 1994. Social capital and public affairs. Bull Am Acad Arts Sci 4 (8): 5-19. DOI: 10.2307/3824796.

Reganold JP, Papendick RI, Parr JF. 1990. Sustainable agriculture. Sci Am 262 (6): 112-121. DOI: 10.1038/scientificamerican0690-112.

Safitri SN, Nuraini C, Tedjaningsih T. 2024. Hubungan peran kelompok tani dengan produktivitas jagung di Desa Karangreja Kecamatan Cimanggu Kabupaten Cilacap: sebuah analisis korelasi rank spearman. J Sos Ekon Pertan (J-SEP) 17 (1): 77-86. DOI: 10.19184/jsep.v17i1.43473. [Indonesian]

SARE Outreach. 2023. What is Sustainable Agriculture? Sustainable Agriculture Research and Education, Maryland.

Schulze C, Matzdorf B. 2023. The institutional design of agri-environmental contracts—how stakeholder attitudes can inform policy making. Q Open 3 (1): qoad001. DOI: 10.1093/qopen/qoad001.

Suciani A, Baruwadi MH, Wibowo LS. 2023. Faktor-faktor yang berhubungan dengan motivasi petani dalam berusahatani jagung di Desa Tabongo Timur Kecamatan Tabongo Kabupaten Gorontalo. Agrinesia 7 (3): 234-246. DOI: 10.37046/agr.v0i0.20530. [Indonesian]

Sumaryanto, Rustandi Y. 2017. Buku Ajar Penumbuhan dan Pengembangan Kelembagaan Petani. Pusat Pendidikan Pertanian, Jakarta. [Indonesian]

Sun Y, Yang X, Elsgaard L, Du T, Siddique KHM, Kang S, Butterbach-Bahl K. 2024. Diversified crop rotations improve soil microbial communities and functions in a six-year field experiment. J Environ Manag 370: 122604. DOI: 10.1016/j.jenvman.2024.122604.

Tanveer M, Anjum SA, Hussain S, Cerdà A, Ashraf U. 2017. Relay cropping as a sustainable approach: Problems and opportunities for sustainable crop production. Environ Sci Pollut Res 24: 6973-6988. DOI: 10.1007/s11356-017-8371-4.

Vonneilich N. 2022. Social relations, social capital, and social networks: a conceptual classification. In: Klärner A, Gamper M, Keim-Klärner S, Moor I, von der Lippe H, Vonneilich N (eds.). Social Networks and Health Inequalities. Springer, Cham. DOI: 10.1007/978-3-030-97722-1_2.

Widjayanthi L, Kusmiati A, Ibanah I, Agung S, Wijayanto Y, Wulanjani D, Prastowo S, Gabrillo CA. 2024. Learning from community practices: Social capital of farming communities in supporting sustainable agriculture. J Lifesci 5: 135-143. DOI: 10.37899/journallalifesci.v5i2.1017.

Wonde KM, Tsehay AS, Lemma SE. 2022. Training at farmers training centres and its impact on crop productivity and households' income in Ethiopia: A Propensity Score Matching (PSM) analysis. Heliyon 8 (7): e09837. DOI: 10.1016/j.heliyon.2022.e09837.

Wulandari ST, Wildayana E, Aryani D. 2022. Farmers' perceptions of the role of Gapoktan in the implementation of Serasi programme in Tanjung Lago District, Banyuasin Regency. Agrisocionomics: Jurnal Sosial Ekonomi Pertanian 6 (1): 9-22. DOI: 10.14710/agrisocionomics.v6i1.12451.

Zhu X, Wang G. 2024. Impact of agricultural cooperatives on farmers' collective action: A study based on the socio-ecological system framework. Agriculture 14 (1): 96. DOI: 10.3390/agriculture14010096.