

Adopting Climate-Resilient Agriculture: The Role of Institutional Support, Information, and Behavior

Dyah Sugandini¹, Rahajeng Arundati², Muhammad Kundarto³, Abdul Ghofar¹, Rava Fernanda Purnama⁴, Muktiarya Yodhatama¹

¹ Department of Management, UPN "Veteran" Yogyakarta, Indonesia

² Department of Management, Universitas Nahdlatul Ulama Yogyakarta, Indonesia

³ Faculty of Agriculture, UPN "Veteran" Yogyakarta, Indonesia

⁴ Doctoral Program of Management, Universitas Islam Indonesia, Yogyakarta, Indonesia

Received : October 6, 2026

Revised : October 11, 2026

Accepted : October 12, 2026

Online : October 24, 2026

Abstract

Climate-resilient agriculture is increasingly important for protecting smallholder livelihoods and food systems from climate variability, yet adoption remains uneven because technical availability does not automatically produce behavioral change. This study examines how training, information access, and institutional support shape farmers' perceived usefulness, subjective norms, and perceived behavioral control, and how these mechanisms influence adoption. A quantitative cross-sectional survey generated 200 usable farmer responses. We analyzed seven latent constructs measured with 34 items using Partial Least Squares Structural Equation Modeling (PLS-SEM). The model explained 65.5% of the variance in adoption. Training significantly strengthened perceived usefulness, subjective norms, and perceived behavioral control, while institutional support positively affected all three mechanisms. Information access improved perceived usefulness and subjective norms but did not significantly strengthen perceived behavioral control. Perceived behavioral control was the strongest direct predictor of adoption, followed by perceived usefulness and subjective norms. The findings show that adopting climate-resilient agriculture requires not only information but also practical capability, institutional resources, perceived benefits, and social reinforcement.

Keywords: *Climate-Resilient Agriculture, Farmer Adoption, Training, Institutional Support, PLS-SEM*

INTRODUCTION

Climate change is intensifying uncertainty in agricultural production through changing rainfall patterns, temperature variability, drought, flooding, soil degradation, and pest pressures. These conditions are particularly important for smallholder farmers whose livelihoods depend on climate-sensitive production systems.

Climate-resilient and climate-smart agricultural practices, including crop diversification, soil and water conservation, improved nutrient management, climate-resilient varieties, mulching, and efficient irrigation, are therefore increasingly promoted to strengthen adaptive capacity while maintaining productivity and resource efficiency (Musafiri et al., 2022; Kifle et al., 2022; Shrestha et al., 2024). However, the availability of appropriate practices does not guarantee that farmers will adopt or continue using them.

Adoption is better understood as a behavioral process shaped by both farmers' evaluations and the conditions that enable implementation. Previous studies show that farmers may adopt, discontinue, re-adopt, or intensify sustainable practices depending on perceived benefits, self-efficacy, social communication, farm resources, experience, and institutional conditions (Han & Niles, 2023).

Behavioral research also indicates that perceived usefulness, subjective norm, and perceived behavioral control are central to farmers' decisions. Farmers are more likely to adopt an innovation

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Corresponding author's email: rahajeng.arundati@unu-jogja.ac.id

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when they see it as beneficial, believe important people support its use, and feel capable of implementing it under real farming conditions (Yang et al., 2022; Shrestha et al., 2024).

External enabling factors can strengthen these behavioral evaluations. Training can increase technical competence and confidence and provide opportunities for practical learning. Access to information can reduce uncertainty and help farmers understand the agronomic and economic consequences of climate-resilient practices.

Institutional support can provide extension assistance, inputs, subsidies, farmer organizations, technical guidance, and other resources that lower barriers to implementation. Evidence from several agricultural contexts shows that training, extension, climate information, communication networks, and institutional arrangements can influence both awareness and adoption (Asule et al., 2024; Alidu et al., 2022; Tanti et al., 2022; Bahinipati et al., 2024).

However, researchers often examine these streams separately. Studies of agricultural adoption frequently focus on socio-economic characteristics, access to extension, farm resources, or institutional support as direct predictors.

In contrast, behavioral studies concentrate on cognition, social influence, perceived control, or intention. This separation offers limited explanation of how support systems translate into farmers' internal readiness to adopt. This gap matters in Indonesia, where climate-resilient agricultural transformation occurs under heterogeneous economic, educational, institutional, and agroecological conditions.

Accordingly, this study integrates training, information access, and institutional support as enabling conditions with perceived usefulness, subjective norm, and perceived behavioral control as behavioral mechanisms leading to adoption. The study contributes by explaining the support-behavior-adoption pathway rather than treating external resources and behavioral factors as isolated determinants. It also provides context-specific evidence from Indonesian farmers. It offers practical insight into whether greater adoption requires more information alone or a combination of knowledge, resources, social reinforcement, and implementation capability.

LITERATURE REVIEW

Behavioral Perspective on Climate-Resilient Farming Adoption

The adoption of climate-resilient agriculture can be viewed through two connected layers. The first consists of Training (TR), Information Access (IA), and Institutional Support (IS) as external enabling conditions. The second comprises Perceived Usefulness (PU), Subjective Norm (SN), and Perceived Behavioral Control (PBC) as proximal behavioral mechanisms.

This structure reflects evidence that no single conventional adoption theory fully captures technological attributes, social influence, psychological processes, and contextual constraints in lower- and middle-income agricultural settings (Karbo et al., 2024). Meta-analytic evidence identifies perceived usefulness and other socio-psychological factors as important determinants of sustainable agricultural adoption (Swart et al., 2023).

Training helps farmers understand how an agricultural innovation works, assess its relevance, and gain the knowledge needed to implement it. Demonstrations and participatory learning can make benefits such as improved productivity, reduced risk, soil conservation, and resource efficiency more visible.

Training also has a social dimension because farmers interact with extension officers, facilitators, and peers, which can strengthen shared expectations regarding appropriate farming practices. Finally, training can improve perceived control by reducing uncertainty and increasing practical competence. Evidence from agricultural training and participatory workshops supports these cognitive, normative, and capability-building effects (Martey et al., 2021; Mgendi et al., 2022; Alif et al., 2024).

H1: Training positively affects farmers' perceived usefulness of climate-resilient agricultural practices.

H2: Training positively affects farmers' subjective norms regarding climate-resilient agricultural practices.

H3: Training positively affects farmers' perceived behavioral control over climate-resilient agricultural practices.

Information access allows farmers to obtain timely and understandable knowledge from extension officers, fellow farmers, farmer groups, traditional media, digital media, and other sources. Such information can reduce uncertainty about the advantages and consequences of climate-resilient practices and make it easier to evaluate practical benefits.

Interpersonal information also communicates what trusted farmers and agricultural authorities consider desirable, thereby strengthening social influence. In addition, technical information may improve confidence by explaining inputs, procedures, and solutions to implementation problems, although information alone may not remove resource constraints. Farmer-to-farmer extension and interpersonal communication have been shown to support the diffusion of sustainable agricultural practices ([Li et al., 2024](#); [Abe et al., 2025](#)).

H4: Information access positively affects farmers' perceived usefulness of climate-resilient agricultural practices.

H5: Information access positively affects farmers' subjective norms regarding climate-resilient agricultural practices.

H6: Information access positively affects farmers' perceived behavioral control over climate-resilient agricultural practices.

Institutional support includes extension services, agricultural programs, subsidies, input assistance, farmer organizations, demonstrations, technical guidance, and related formal support. These mechanisms can make the benefits of climate-resilient practices more visible, reinforce their legitimacy, and reduce constraints that limit farmers' confidence in implementation.

Institutional involvement is especially important for smallholders who may recognize an innovation's value but lack finance, inputs, technical assistance, or supporting infrastructure. Prior studies show that extension, incentives, institutional arrangements, and communication systems can facilitate the adoption of climate-smart and sustainable agricultural practices ([Tanti et al., 2022](#); [Swami & Parthasarathy, 2024](#); [Bahinipati et al., 2024](#)).

H7: Institutional support positively affects farmers' perceived usefulness of climate-resilient agricultural practices.

H8: Institutional support positively affects farmers' subjective norms regarding climate-resilient agricultural practices.

H9: Institutional support positively affects farmers' perceived behavioral control regarding climate-resilient agricultural practices.

Perceived usefulness reflects whether farmers believe climate-resilient practices can improve productivity, reduce production risk, conserve resources, improve soil fertility, or strengthen long-term farm sustainability. When these advantages are clear, adoption becomes more attractive than continuing established routines. Subjective norm reflects perceived encouragement from family members, neighboring farmers, farmer organizations, extension officers, and local leaders.

Social support can legitimize unfamiliar practices, though its importance varies by context.

Perceived behavioral control concerns whether farmers believe they possess sufficient knowledge, skills, time, input, equipment, and resources to implement a practice successfully. Previous studies consistently identify perceived usefulness and PBC as strong behavioral determinants, while findings on subjective norm vary by context (Li et al., 2021; Phung & Dao, 2024; Swart et al., 2023).

H10: Perceived usefulness positively affects farmers' adoption of climate-resilient agricultural practices.

H11: Subjective norm positively affects farmers' adoption of climate-resilient agricultural practices.

H12: Perceived behavioral control positively affects farmers' adoption of climate-resilient agricultural practices.

RESEARCH METHOD

This study employed a quantitative cross-sectional survey to examine the behavioral determinants of farmers' adoption of climate-resilient agricultural practices. Although the broader project used a mixed-method approach, this article focuses on the quantitative component. We collected data directly from farmers using a structured questionnaire, yielding 200 usable responses. Respondents represented diverse demographic and farming characteristics, including gender, age, education, land ownership, commodities, household income, training experience, and access to agricultural information.

The model comprised seven latent constructs: Training (TR), Information Access (IA), Institutional Support (IS), Perceived Usefulness (PU), Subjective Norm (SN), Perceived Behavioral Control (PBC), and Adoption (ADOP). We measured 34 items on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Data were analyzed using PLS-SEM. We assessed measurement quality using indicator reliability, internal consistency, convergent validity, discriminant validity, and collinearity. We evaluated the structural model using path coefficients, R^2 , Q^2 predict, model fit, and bootstrapping, with statistical significance set at $p < 0.05$.

FINDINGS AND DISCUSSION

Respondent Characteristics

The study obtained 200 usable responses. Male respondents accounted for 58.5% and female respondents for 41.5%. Most participants were relatively senior farmers: 35.1% were aged 60 years or older, and 28.7% were aged 50–59 years. Educational attainment was generally modest, with 64.9% having completed primary school. About 57.4% cultivated their own land, and 56.4% grew vegetables.

Only 28.7% had attended agricultural training during the previous two years, and 38.3% belonged to a farmer group. More than half obtained agricultural information from neighboring farmers. Although only 44.7% explicitly reported knowing the term climate-resilient agricultural practices, 89.4% had implemented at least one relevant practice. This suggests that climate-resilient activities may already be embedded in routine farming even when farmers do not formally identify them using climate-resilience terminology.

Measurement Model Assessment

The measurement model met the required quality criteria. Indicator loadings were generally above 0.84, Cronbach's alpha ranged from 0.910 to 0.937, composite reliability ranged from 0.937 to 0.952, and AVE values ranged from 0.755 to 0.799. All HTMT values were below 0.85, while indicator VIF values remained below 5.0. These results indicate satisfactory indicator reliability, internal consistency, convergent validity, discriminant validity, and acceptable collinearity. Because these statistics are sufficiently reported in the text, the detailed validity and reliability table

is omitted to keep the paper concise.

Model Fit and Explanatory Power

The estimated model demonstrated acceptable fit and meaningful explanatory power. The SRMR was 0.062, and the NFI was 0.982. The model explained 65.5% of the variance in Adoption, while its antecedents explained 40.4% of Perceived Usefulness, 38.8% of Subjective Norm, and 40.3% of Perceived Behavioral Control. All Q^2 predict values for endogenous indicators were positive; values for Adoption ranged from 0.240 to 0.345. These results indicate that the model possesses useful explanatory and predictive relevance.

Table 1. Coefficient of Determination

Construct	R ²	Adjusted R ²
Adoption	0.655	0.649
Perceived Behavioral Control	0.403	0.394
Perceived Usefulness	0.404	0.395
Subjective Norm	0.388	0.379

Source: PLS-SEM results from the study

Structural Model and Hypothesis Testing

We used bootstrapping to test the proposed relationships at the 5% significance level. Eleven of the twelve hypotheses were supported; only Information Access → Perceived Behavioral Control was not statistically significant.

Table 2. Hypothesis Testing Results

Hypothesis/relationship	β (O)	Mean (M)	SD	t	p
H6: Information Access → Perceived Behavioural Control	0.099	0.099	0.056	1.781	0.075
H4: Information Access → Perceived Usefulness	0.281	0.282	0.056	5.039	<.001
H5: Information Access → Subjective Norm	0.315	0.316	0.055	5.702	<.001
H9: Institutional Support → Perceived Behavioural Control	0.412	0.414	0.057	7.256	<.001
H7: Institutional Support → Perceived Usefulness	0.292	0.293	0.060	4.894	<.001
H8: Institutional Support → Subjective Norm	0.261	0.262	0.058	4.476	<.001
H12: Perceived Behavioural Control → Adoption	0.440	0.439	0.057	7.660	<.001
H10: Perceived Usefulness → Adoption	0.345	0.345	0.043	8.044	<.001
H11: Subjective Norm → Adoption	0.199	0.200	0.058	3.435	0.001
H3: Training → Perceived Behavioural Control	0.454	0.454	0.052	8.677	<.001
H1: Training → Perceived Usefulness	0.444	0.443	0.045	9.772	<.001
H2: Training → Subjective Norm	0.420	0.419	0.051	8.204	<.001

Source: PLS-SEM results from the study; O = original sample; M = sample mean; SD = standard deviation.

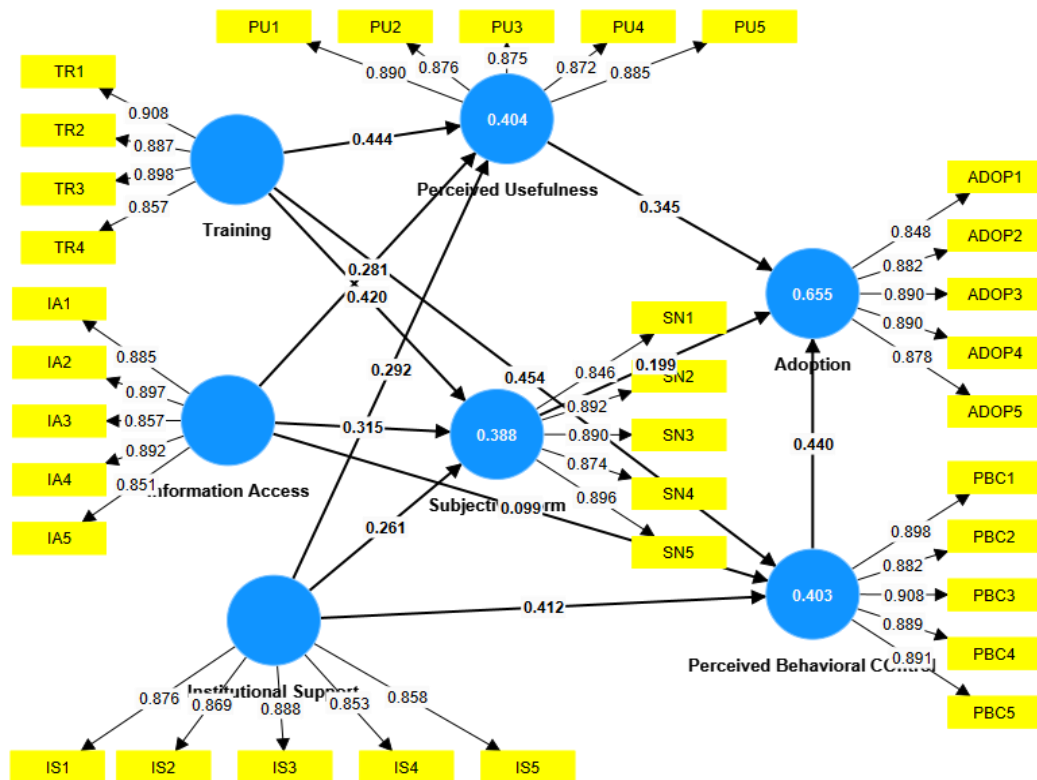


Figure 1. Research model

Bootstrapping showed that eleven of the twelve proposed relationships were statistically significant. H1–H5 and H7–H12 were supported, whereas H6 was not supported. Training exerted strong positive effects on Perceived Behavioral Control ($\beta = 0.454$), Perceived Usefulness ($\beta = 0.444$), and Subjective Norm ($\beta = 0.420$). This pattern shows that training is more than a channel for transferring technical knowledge. It also strengthens farmers' confidence, clarifies the practical value of climate-resilient practices, and reinforces social encouragement toward adoption.

Information Access positively influenced Perceived Usefulness ($\beta = 0.281$) and Subjective Norm ($\beta = 0.315$), but it was not significantly related to Perceived Behavioral Control ($\beta = 0.099$; $p = 0.075$). Thus, access to information can improve understanding and social awareness without necessarily making farmers feel capable of implementation. Information alone does not automatically provide the skills, inputs, finance, equipment, or direct assistance needed to turn knowledge into action.

Institutional Support significantly influenced all three behavioral mechanisms. It had its strongest effect on Perceived Behavioral Control ($\beta = 0.412$), followed by Perceived Usefulness ($\beta = 0.292$) and Subjective Norm ($\beta = 0.261$). Among the direct determinants of Adoption, Perceived Behavioral Control was the strongest predictor ($\beta = 0.440$), followed by Perceived Usefulness ($\beta = 0.345$) and Subjective Norm ($\beta = 0.199$). The findings therefore support a clear support–behavior–adoption pathway: training and institutional support strengthen behavioral readiness, information mainly strengthens perceived benefits and social norms, and adoption is most likely when farmers feel practically capable of implementation.

Discussion

The findings confirm that climate-resilient agricultural adoption emerges from the interaction between external support and farmers' behavioral evaluations. Training, information

access, and institutional support matter because they shape whether farmers see a practice as useful, socially supported, and feasible. This supports the broader argument that technological availability alone cannot explain agricultural innovation. Farmers need reasons to value the practice, encouragement from relevant actors, and confidence that they can implement it under their actual farming conditions.

Training was consistently influential across all three behavioral mechanisms. This result is consistent with research showing that training and participatory learning strengthen knowledge, practical competence, and willingness to implement sustainable practices (Martey et al., 2021; Mgendi et al., 2022; Alif et al., 2024). For extension programs, this implies that training should combine explanation with demonstrations, practice, peer learning, and problem-solving. Such approaches can simultaneously increase perceived benefits, social legitimacy, and confidence.

The non-significant relationship between Information Access and Perceived Behavioral Control is especially important. Information can tell farmers what to do and why it matters, but it may not resolve implementation barriers. This finding is consistent with the distinction between knowing and being able to act. Information services should therefore be integrated with demonstrations, technical assistance, access to inputs, farmer networks, and other resources. Institutional support plays this enabling role by reducing constraints and providing both practical assistance and legitimacy for new practices (Tanti et al., 2022; Bahinipati et al., 2024).

Perceived Behavioral Control was the strongest direct predictor of adoption, indicating that capability is central to behavioral change. Farmers are more likely to implement climate-resilient practices when they believe they have sufficient skills, time, inputs, equipment, and resources. Perceived Usefulness also strongly encouraged adoption, confirming that farmers need to recognize concrete benefits such as productivity, risk reduction, resource efficiency, or improved farm sustainability.

Subjective Norm remained significant but weaker, suggesting that social encouragement can reinforce adoption but is unlikely to substitute for tangible benefits and practical capacity. Overall, the results indicate that programs should move beyond information dissemination toward an integrated approach that strengthens farmers' competence, resources, perceived benefits, and supportive social environment.

CONCLUSIONS

This study demonstrates that climate-resilient agricultural adoption depends on both enabling conditions and behavioral mechanisms. Training and institutional support consistently strengthen perceived usefulness, subjective norms, and perceived behavioral control, whereas information access primarily improves perceived usefulness and subjective norms. Information alone is therefore insufficient to strengthen farmers' confidence in implementation. Perceived behavioral control is the strongest direct determinant of adoption, followed by perceived usefulness and subjective norms.

For policy and extension practice, training should be practice-oriented and include demonstrations, farmer-to-farmer learning, mentoring, and direct assistance with practices such as mulching, organic fertilizer, crop rotation, soil conservation, and efficient water management. Institutional support should improve access to inputs, extension services, technical assistance, appropriate incentives, and farmer organizations. Future studies should include more diverse regions and commodity groups and may examine climate-risk perception, financial capability, digital agricultural information, and adoption continuity over time. Longitudinal research would help distinguish initial adoption from sustained, intensified, or discontinued use.

REFERENCES

- Abe, T., Tsunekawa, A., Haregeweyn, N., Tsubo, M., Fenta, A. A., Nigussie, Z., Tadesse, N., Kassa, S. B., Terefe, Z. T., & Wodaju, A. (2025). Interpersonal information drives intentional change in smallholder farmers' adoption of sustainable land management technologies. *Journal of Environmental Management*, 393, Article 127230. <https://doi.org/10.1016/j.jenvman.2025.127230>
- Alidu, A. F., Man, N., & Ramli, N. N. (2022). Smallholder farmers' access to climate information and climate-smart adaptation practices in the northern region of Ghana. *Heliyon*, 8(5), Article e09513. <https://doi.org/10.1016/j.heliyon.2022.e09513>
- Alif, Ž., Novak, A., Mihelič, R., Juvančič, L., & Šumrada, T. (2024). Can knowledge transfer speed up climate change mitigation in agriculture? A randomized experimental evaluation of participatory workshops. *Environmental Science & Policy*, 152, Article 103662. <https://doi.org/10.1016/j.envsci.2023.103662>
- Asule, P. A., Musafiri, C., Nyabuga, G., Kiai, W., Kiboi, M., Nicolay, G., & Ngetich, F. K. (2024). Awareness and adoption of climate-resilient practices by smallholder farmers in central and upper Eastern Kenya. *Heliyon*, 10, Article e38368. <https://doi.org/10.1016/j.heliyon.2024.e38368>
- Bahinipati, C. S., Viswanathan, P. K., & Singh, A. K. (2024). Do institutions, incentives, and information enhance adoption of climate smart agriculture practices? Empirical evidence from India. *Environmental Development*, 50, Article 100982. <https://doi.org/10.1016/j.envdev.2024.100982>
- Han, G., & Niles, M. T. (2023). An adoption spectrum for sustainable agriculture practices: A new framework applied to cover crop adoption. *Agricultural Systems*, 212, Article 103771. <https://doi.org/10.1016/j.agsy.2023.103771>
- Karbo, R. T. V., Frewer, L. J., Areal, F., Jones, G., & Nurudeen, S. (2024). A systematic review of the efficacy of theories used to understand farmers' technology adoption behavior in lower-to-middle-income countries. *Development Studies Research*, 11(1), Article 2294696. <https://doi.org/10.1080/21665095.2023.2294696>
- Kifle, T., Ayal, D. Y., & Mulugeta, M. (2022). Factors influencing farmers adoption of climate smart agriculture to respond climate variability in Siyadebrina Wayu District, Central highland of Ethiopia. *Climate Services*, 26, Article 100290. <https://doi.org/10.1016/j.cliser.2022.100290>
- Li, F., Ren, J., Li, Z., Qian, L., & Yin, C. (2024). Revealing the role of farmer-to-farmer extension in promoting sustainable agricultural practices in China: A case of rice-green manure rotation system diffusion. *Journal of Cleaner Production*, 485, Article 144365. <https://doi.org/10.1016/j.jclepro.2024.144365>
- Li, F., Zhang, K., Ren, J., Yin, C., Zhang, Y., & Nie, J. (2021). Driving mechanism for farmers to adopt improved agricultural systems in China: The case of rice-green manure crops rotation system. *Agricultural Systems*, 192, Article 103202. <https://doi.org/10.1016/j.agsy.2021.103202>
- Martey, E., Etwire, P. M., & Mockshell, J. (2021). Climate-smart cowpea adoption and welfare effects of comprehensive agricultural training programs. *Technology in Society*, 64, Article 101468. <https://doi.org/10.1016/j.techsoc.2020.101468>
- Mgendi, G., Mao, S., & Qiao, F. (2022). Does agricultural training and demonstration matter in technology adoption? The empirical evidence from small rice farmers in Tanzania. *Technology in Society*, 70, Article 102024. <https://doi.org/10.1016/j.techsoc.2022.102024>
- Musafiri, C. M., Kiboi, M., Macharia, J., Ng'etich, O. K., Kosgei, D. K., Mulianga, B., Okoti, M., & Ngetich, F. K. (2022). Adoption of climate-smart agricultural practices among smallholder farmers in Western Kenya: Do socioeconomic, institutional, and biophysical factors matter? *Heliyon*,

- 8(1), Article e08677. <https://doi.org/10.1016/j.heliyon.2021.e08677>
- Phung, Q. A., & Dao, N. (2024). Farmers' perceptions of sustainable agriculture in the Red River Delta, Vietnam. *Heliyon*, 10(7), Article e28576. <https://doi.org/10.1016/j.heliyon.2024.e28576>
- Shrestha, S., Shrestha, U. B., Shrestha, B. R., Maharjan, S., Udas, E., & Aryal, K. (2024). Determinants of adoption of climate resilient agricultural solutions. *Agricultural Systems*, 221, Article 104139. <https://doi.org/10.1016/j.agsy.2024.104139>
- Swami, D., & Parthasarathy, D. (2024). Role of intrinsic motivation and government policies in adoption of sustainable agriculture practices by farmers in Maharashtra, India. *Farming System*, 2(3), Article 100100. <https://doi.org/10.1016/j.farsys.2024.100100>
- Swart, R., Levers, C., Davis, J. T. M., & Verburg, P. H. (2023). Meta-analyses reveal the importance of socio-psychological factors for farmers' adoption of sustainable agricultural practices. *One Earth*, 6(12), 1771–1783. <https://doi.org/10.1016/j.oneear.2023.10.028>
- Tanti, P. C., Jena, P. R., Aryal, J. P., & Rahut, D. B. (2022). Role of institutional factors in climate-smart technology adoption in agriculture: Evidence from an Eastern Indian state. *Environmental Challenges*, 7, Article 100498. <https://doi.org/10.1016/j.envc.2022.100498>
- Yang, X., Zhou, X., & Deng, X. (2022). Modeling farmers' adoption of low-carbon agricultural technology in Jiangnan Plain, China: An examination of the theory of planned behavior. *Technological Forecasting and Social Change*, 180, Article 121726. <https://doi.org/10.1016/j.techfore.2022.121726>