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Strengthening rice crop insurance for sustainable rural development: Addressing farmers' needs and policy challenges

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Abstract

Effective risk management is essential for ensuring agricultural sustainability and rural economic stability, particularly for smallholder farmers who are vulnerable to climate risks. To address these challenges, the Indonesian government launched the *Asuransi Usaha Tani Padi* (AUTP) scheme, which provides financial protection for rice farmers. However, its effectiveness is undermined by low farmer participation, inefficient claims processing and policy constraints. This study uses a SWOT-TOWS framework and AHP to evaluate the factors that influence AUTP's performance. It identifies farmers' needs, policy support, budget feasibility and human resource availability as critical determinants. Based on these insights, three priority strategies are proposed: (1) developing new insurance models while maintaining subsidies; (2) strengthening socialisation and farmer awareness; and (3) integrating premium payments with farmer cards to improve accessibility. These findings provide a practical approach to improving agricultural insurance programmes, promoting financial resilience and advancing sustainable rural development.

Keywords: agricultural risk management, food security, rice crop insurance, rural development, strategic decision-making

1 Introduction

Indonesia, one of the world's largest agricultural economies, continues to face persistent challenges in maintaining the resilience of its rice sector (Rachman *et al*., 2022; Sartika *et al*., 2023). Rice is a staple food and a critical economic driver, particularly for smallholders who depend on it for their livelihoods (Maertens & Vande Velde, 2017). However, climate variability, pests, and natural disasters frequently disrupt rice production, undermining food security and farmer income (Yasir *et al*., 2022; Joseph *et al*., 2023). In this context, agricultural insurance plays a vital role in offering financial protection and stabilising farm incomes (Kusuma *et al*., 2018; Kshetri, 2021; Gu *et al*., 2024).

To address these challenges, the Indonesian government introduced *Asuransi Usaha Tani Padi* (AUTP) in 2015, a subsidised crop insurance scheme to protect rice farmers from losses arising from floods, droughts, and pest outbreaks (Pasaribu & Sudiyanto, 2016; Anugrah *et al*., 2024). Under this scheme, the government provides an 80 % subsidy on the premium, while farmers pay the remaining 20 %, making it one of Southeast Asia's most affordable crop insurance programmes (Pasaribu & Sudiyanto, 2016; Yanuarti *et al*., 2019). Nonetheless, AUTP faces persistent issues such as low farmer participation, inefficient claims processing, and administrative bottlenecks, raising concerns over its long-term sustainability (Yanuarti *et al*., 2019; Pane *et al*., 2021; Rachman *et al*., 2021). These challenges suggest reviewing and redesigning its implementation and policy framework.

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International models provide valuable insights for strengthening agricultural insurance in Indonesia. In the United States, extensive adoption has been achieved through sustained subsidies, although this model brings considerable fiscal implications and highlights the need for long-term planning (Azzam *et al*., 2021). India's Pradhan Mantri Fasal Bima Yojana (PMFBY) scheme increased enrolment through streamlined procedures and full premium subsidies, although challenges remain regarding delays and claim settlement (Kaur *et al*., 2021). In China, the integration of digital technologies, such as remote sensing and satellite imagery, has improved accuracy and efficiency in loss verification (Wang *et al*., 2023). Kenya, meanwhile, demonstrates the success of public–private partnerships (PPPs) in sharing risk, fostering innovation, and reducing administrative costs (Călin & Izvoranu, 2018; Agarwal *et al*., 2023). In contrast, Indonesia's insurance landscape remains largely state dominated. The heavy subsidy level discourages private-sector involvement and raises concerns over fiscal dependency (Pasaribu & Sudiyanto, 2016; Yusuf *et al*., 2021). Manual claim processing has also undermined trust and efficiency, contrasting China's AI-supported verification system (Cherlyn *et al*., 2024). Nigeria's experience similarly underlines the importance of strong institutional backing to ensure timely payouts and transparency (Madaki *et al*., 2023). These cases suggest that a shift towards digitalisation, financial innovation, and adaptive policy design could help revitalise Indonesia's crop insurance system.

Despite valuable lessons from global cases, Indonesia's context presents distinct regulatory and institutional limitations. India's PMFBY operates within a relatively cohesive bureaucratic structure, whereas AUTP has struggled with fragmented implementation and limited digital infrastructure (Singh & Agrawal, 2020; Rachman *et al*., 2021). Kenya's PPP model reduces fiscal strain, yet Indonesia's regulatory framework remains less conducive to such partnerships (Osumba & Kaudia, 2020; Yanuarti *et al*., 2019). China's technology-driven insurance is supported by robust state and private sector capacity, which Indonesia has yet to fully develop (Rachman *et al*., 2021; Hou & Wang, 2024).

Previous studies on AUTP have primarily explored subsidy mechanisms, participation constraints, and institutional design (Prabowo *et al*., 2019; Pane *et al*., 2021). However, these studies are descriptive or context-specific, offering limited insight for scalable reform. Critical gaps remain in integrated approaches that address strategic prioritisation and technological feasibility (Rachman *et al*., 2021; Anugrah *et al*., 2024). Although the SWOT and AHP methods have been applied in agricultural studies (Brudermann *et al*., 2015; Nosrati Nigjeh *et al*., 2023), no prior study has integrated SWOT-TOWS-AHP[1] to evaluate agricultural insurance performance in Indonesia. The absence of such a structured, data-driven approach limits the capacity of current research to inform scalable and sustainable interventions aligned with field realities and institutional constraints. This gap is critical given the complexity of agricultural insurance systems, which require multi-dimensional evaluations to support evidence-based improvements. This study addresses this gap by combining SWOT, TOWS, and AHP, offering a data-driven roadmap to enhance AUTP's accessibility, efficiency, and financial sustainability. This study aims to evaluate AUTP's implementation challenges by identifying key limitations that hinder its accessibility, operational efficiency, and farmer participation; and to propose strategic interventions for improving its performance and sustainability. Building on these insights, the study employs SWOT-TOWS analysis to formulate strategic interventions and applies AHP to prioritise them based on stakeholder-driven decision criteria. This integrated approach supports evidence-based policymaking and ensures that recommendations are practical and aligned with long-term sustainability goals. By examining policy frameworks, technological advancements, and farmer perspectives, this research provides actionable recommendations to improve the effectiveness and sustainability of agricultural insurance in Indonesia. The findings enhance food security and farmer resilience while offering valuable insights for other developing countries seeking to implement scalable and sustainable agricultural insurance programmes.

2 Materials and methods

This study employed a mixed-method approach, combining qualitative stakeholders' insights with quantitative prioritisation to assess and enhance AUTP effectiveness. Focus group discussions (FGDs) captured farmers' perspectives, while SWOT and TOWS analyses identify systemic challenges and opportunities. AHP was used to rank strategic interventions and support evidence-based decisions.

2.1 Research framework

The research follows a three-stage approach: SWOT analysis to identify key issues, TOWS matrix to formulate strategies, and AHP to rank strategies using multi-criteria

[1]SWOT: Strengths, Weaknesses, Opportunities, and Threats, while TOWS is a variant that rearranges these to Threats, Opportunities, Weaknesses, and Strengths to emphasise matching external factors (threats, opportunities) with internal factors (weaknesses, strengths) to generate strategic options. AHP is a multi-criteria decision-making method called the Analytical Hierarchy Process.

decision-making. Fig. 1 outlines the research framework, ensuring systematic evaluation of policy and implementation gaps in AUTP.

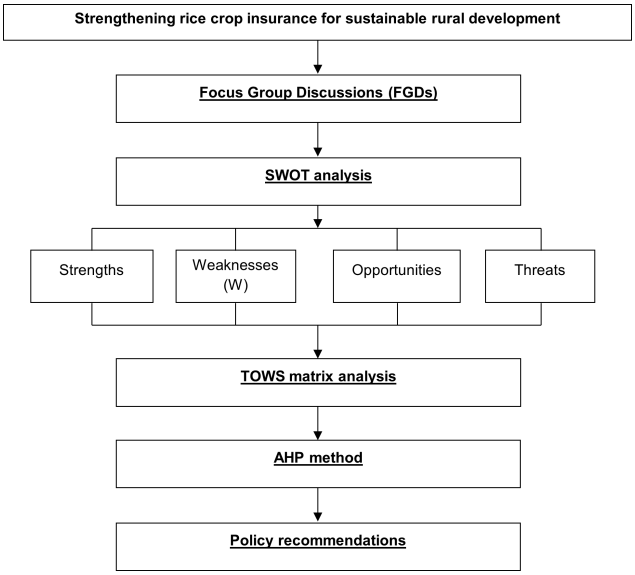

Fig. 1: *Research framework (compiled by the authors).*

2.2 Data collection and sampling

Primary data were obtained through FGDs, structured questionnaires, and expert inputs. FGDs were held in six provinces: West Java, East Java, Central Java, Yogyakarta, West Nusa Tenggara, and North Sumatra, with 414 farmers and 132 field officers. Participants were selected purposively. Regardless of claim status, farmers were eligible if they had joined AUTP within the past three planting seasons. Field officers were selected based on their roles in extension services, insurance facilitation, and claims handling. This ensured that all had direct AUTP experience. Table 1 presents the participant distribution.

FGDs used a semi-structured format, covering risk perception, adoption barriers, claims, and policy supports. Trained facilitators employed a standardised question guide to ensure consistency.

Thematic analysis followed Braun & Clarke's (2006) and Clarke & Braun's (2017) six-phase approach, involving familiarisation, coding, theme identification, theme review, definition, and reporting. Transcripts were coded manually using Microsoft Excel. Codes such as "claim delays", "premium subsidy adequate", or "weak socialisation" were grouped into broader themes, then classified under four domains: product, communication, technology, and mechanism, which reflected systemic aspects of AUTP implementation.

Table 1: *Distribution of focus group discussion participants by province and district.*

Province	*District/City*	*Farmer*	*Field Officer*
West Java	Bandung	38	30
	Cirebon	30	12
East Java	Lamongan	35	14
	Malang	34	15
Central Java	Klaten	49	0
	Sukoharjo	21	0
Yogyakarta	Kulonprogo	20	0
	Sleman	50	0
West Nusa Tenggara	West Lombok	28	13
	Central Lombok	25	18
North Sumatra	Langkat	38	15
	Simalungun	46	15
	Total: 414 Farmers and 132 Field officers		

These domains were not rigid but served as guiding pillars during FGD design, based on prior studies on agricultural insurance that highlight challenges in product features, communication channels, technology adoptions, and operational mechanisms (Ali *et al*., 2020; Ntukamazina *et al*., 2017; Singh & Agrawal, 2020). Inductive coding confirmed that most emerging themes aligned with these four domains, reinforcing their relevance.

To strengthen the credibility and quantifiability of qualitative insights, each FGD included a brief questionnaire capturing participants' agreement levels on key issues. It comprised 20 closed-ended items related to coverage adequacy, claim experiences, communication effectiveness, and technology use. Participants rated their agreement using binary or Likert scales. Aggregated responses were used to calculate support percentages. For example, 93.94 % agreement with "AUTP should provide alternative insurance models" informed Opportunity 1 (O1) weighting in the SWOT matrix.

Out of 546 total FGD participants (414 farmers and 132 field officers), 446 respondents completed valid questionnaires. These responses were used to assign a percentage weight to the SWOT elements. Incomplete responses were excluded to maintain data quality. Ethical considerations were strictly adhered to, with all respondents providing informed consent. Data confidentiality was maintained to reduce bias and uphold research integrity.

2.3 SWOT/TOWS analysis for strategy development

SWOT analysis was developed based on themes emerging from FGDs, with participants' statements categorised

into strengths, weaknesses, opportunities, and threats. Each element was grounded in qualitative data and supported by quantitative agreement levels drawn from structured questionnaires. These proportions were used to assign relative weights to each factor, integrating qualitative and quantitative dimensions in line with established practices in agricultural policy research (Dam *et al*., 2023; Maity *et al*., 2023; Yildiz & Esmer, 2024).

Based on the weighted SWOT elements, a TOWS matrix was constructed to formulate strategic options by combining internal (strengths and weaknesses) and external (opportunities and threats) factors into four strategic quadrants: SO (Strengths-Opportunities), ST (Strengths-Threats), WO (Weaknesses-Opportunities), and WT (Weaknesses-Threats). Each strategy was derived through logical linkages among factors and validated through expert consultation to ensure relevance and feasibility.

A structured weighting process was applied to prioritise the strategies. First, individual SWOT element weights were aggregated within each category to obtain category-level weights. These were used to compute TOWS quadrant weights by combining the relevant category pairs (e.g., Strengths and Opportunities for SO) and normalising them across all quadrants.

Each strategy's final score was calculated by summing the weights of its contributing SWOT elements and adjusting by the normalised weight of the relevant TOWS quadrant, using the following formula:

$$S_k = \left(\sum_{i \in E_k} W_{\text{SWOT},i} \right) \times \frac{NW_{\text{TOWS},j}}{100}$$

where:

- S_k: Final weight of strategy k
- E_k: Set of SWOT elements contributing to strategy k
- $W_{\text{SWOT},i}$: Individual weight of SWOT element i
- $NW_{\text{TOWS},j}$: Normalised weight of TOWS quadrant j

This process enabled comparative evaluation of the TOWS-derived strategies by combining factor-level significance and quadrant-level emphasis. AHP was used to rank the strategies to support more structured decision-making. AHP incorporated expert judgments and multiple evaluation criteria, enabling a comprehensive prioritisation of strategic options. The AHP procedure is described in the next section.

2.4 AHP-based prioritisation

The analytical hierarchy process (AHP) is widely recognised in agricultural studies for guiding resource allocation and policy design (Golfam *et al*., 2019; Kunlerd *et al*., 2024; Maulana & Kanai, 2020). In this study, AHP was used to prioritise proposed strategies based on four key evaluation criteria identified from SWOT-TOWS analysis and stakeholder insights: (1) Farmers' needs, (2) Policy support, (3) Budget feasibility, and (4) Human resource availability. These criteria reflect core challenges in improving rice crop insurance (AUTP) performance.

Five experts from academia, government, and the insurance sector were purposively selected for their expertise in agricultural policy, risk financing, and public programme implementation. They conducted pairwise comparisons using Saaty's scale (Table 2), allowing systematic assessment of each criterion's relative importance. A comparison matrix $A = [a_{ij}]$ was constructed, with each a_{ij} representing the relative importance of the criterion i over j, and satisfying the reciprocal rule $a_{ij} = 1/a_{ij}$.

Table 2: *Pairwise comparison scale (after Saaty, 1980).*

Imp.	*Definition*	*Explanation*
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favour one activity over another
5	Strong importance	Experience and judgment strongly favour one activity over another
7	Very strong importance	Criterion is strongly favoured, with dominance shown in practice
9	Extreme importance	The importance of one over another is affirmed in the highest possible order
2, 4, 6, 8	Intermediate values	Used to represent intermediate values between two adjacent values

Weights were derived from the matrix's principal right eigenvector ω, where $A\,\omega = \lambda_{\max}\,\omega$. Consistency was tested using the consistency index (CI) and consistency ratio (CR), calculated as:

$$\text{CI} = \frac{\lambda_{\max} - n}{n - 1}, \quad \text{CR} = \frac{\text{CI}}{RI_n},$$

where n is the number of criteria and RI_n is the average random index. In this study, the final CR values were 0.043 and 0.06, both below the standard threshold of 0.10, indicating acceptable consistency in expert input.

Table 3: *Summary of focus group discussion (FGD) findings for SWOT analysis.*

Aspects	*Code*	*Issues identified in FGDs*	*% of Respondents*
Product	P1	The 80 % government subsidy was considered adequate, with no significant issues reported regarding premium payment.	61.21
	P2	Farmers expressed strong support for AUTP as a means to reduce crop loss.	84.08
	P3	Farmers proposed alternative insurance models with broader risk coverage and higher claim payouts.	93.94
	P4	The current scheme did not cover natural and environmental risks such as disasters and pollution.	47.05
	P5	Farmers reported irregular weather patterns and unexplained crop failures.	45.06
Communication	C1	Outreach was perceived as weak due to insufficient budget and staffing.	62.63
	C2	Information from agricultural extension officers and the insurer was considered inadequate.	61.63
	C3	Farmers suggested using WhatsApp and farmer groups (poktan) for local-level communication.	87.89
	C4	Issues related to coordination gaps, procedural delays, and unclear responsibilities were commonly cited.	54.78
Technology	T1	Integrating premium payments into the farmer card (kartu tani) was considered adequate and practical.	71.97
	T2	The planting calendar (kartu tanam/KATAM) was known among farmers but remained underutilised.	65.02
	T3	Although widely recognised, the farmer card's potential remains underutilised.	88.78
	T4	Farmers expressed enthusiasm for drone usage and requested related training.	89.91
Mechanism	M1	Many farmers lacked understanding of registration and claims procedures.	45.29
	M2	Delays in claims processing led farmers to request simplified and clearer procedures.	72.88
	M3	Farmers noted a shortage of local staff during claim verification processes.	48.87

3 Results

3.1 Evaluation of AUTP implementation: Insights from focus group discussions

The findings from the FGDs across six provinces provided comprehensive insights into farmers' experiences with AUTP, capturing key issues and recommended improvements. These insights were structured into four critical areas: product, communication, technology, and operational mechanisms. Table 3 summarises the main issues and recommendations arising from these discussions and the proportion of respondents who supported each statement.

3.2 SWOT and TOWS analysis for enhancing AUTP performance

SWOT and TOWS analyses were used to assess internal and external factors affecting AUTP and translate them into actionable strategies. The SWOT analysis identifies key strengths, weaknesses, opportunities, and threats, while the TOWS matrix converts these insights into strategic recommendations.

The SWOT analysis was derived from FGD results with 446 participants across six provinces. Each SWOT item was mapped to specific field issues. Weights were calculated as the percentage contribution of each statement's respondent percentage to the category subtotal. For instance, "High government subsidy (80 %) ensures affordability" (S1) was supported by 61.21 % of respondents, while "Ineffective socialisation limits adoption" (W3) reflected concerns from 61.63 %. To quantify the relative importance of each SWOT statement within its category, weights were calculated as the percentage contribution of each statement's respondent percentage to the category subtotal. This weighting reflects the relative significance of each issue within its category,

Table 4: *Focus group discussion-based SWOT mapping.*

SWOT Code	*SWOT Statement*	*Derived from FGD issues*	*Resp. %*	*Weight %*
Strengths				
S1	High government subsidy (80%) ensures affordability	P1	61.21	5.66
S2	Integration with the farmer card simplifies transactions	T1	71.97	6.66
S3	Utilisation of the planting calendar aids risk management	T2	65.02	6.01
S4	Strong farmer acceptance supports scalability	P2	84.08	7.78
		Sub-total	282.28	26.11
Weaknesses				
W1	Limited operational funding restricts outreach	C1	62.63	5.79
W2	Inadequate human resources hinder program efficiency	M3	48.87	4.52
W3	Ineffective socialisation limits adoption	C2	61.63	5.70
W4	Complex claims processes and delays erode farmer trust	M2	72.88	6.74
		Sub-total	246.01	22.76
Opportunities				
O1	Potential to develop improved insurance models	P3	93.94	8.89
O2	High recognition of the farmer card as a financial tool	T3	88.78	8.21
O3	Drone technology can improve claim verification	T4	89.91	8.32
O4	Potential for socialisation programs using digital tools	C3	87.89	8.13
		Sub-total	360.52	33.35
Threats				
T1	Low awareness and participation rates	M1	45.29	4.19
T2	Uncovered risks (earthquakes, landslides, pollution)	P4	47.05	4.35
T3	Climate change and environmental degradation	P5	45.06	4.17
T4	Unresolved administrative bottlenecks	C4	54.78	5.07
		Sub-total	192.18	17.78
		Total	1080.99	100.00

Table 5: *Consolidated SWOT/TOWS analysis with strategy weights.*

SWOT/TOWS category	*Strategy*	*Contributing elements*	*Combined weight (%)*	*Final weight (%)*
SO (S+O)	New insurance models with subsidies	S1, S4, O1, O3	59.46	9.05
	Integrate premium payments with farmer cards	S2, S3, O2	59.46	6.21
ST (S+T)	Increase AUTP socialisation and awareness	S4, T1	43.89	11.13
	Expand coverage to more disasters	S4, T2, T3	43.89	3.58
WO (W+O)	Re-register farmers for card access	W1, W3, O2	56.11	5.53
	Use drones for claim verification	W1, W4, O3	56.11	5.85
WT (W+T)	Enhance training/support for agents	W2, T4	40.54	3.89

S: Strengths; O: Opportunities; T: Threats; W: Weaknesses.

ensuring that more frequently cited issues carry greater influence. The overall weights of the categories – Strengths (26.11 %), Weaknesses (22.76 %), Opportunities (33.35 %), and Threats (17.78 %) – indicate their contribution to the total respondent percentage points (1,080.99). Opportunities are dominated, particularly due to frequent calls for technological and procedural improvements. Table 4 integrates the SWOT mapping and analysis, detailing each statement's derivation from FGD issues, respondent percentages, and their respective weights.

Based on the SWOT analysis, strategic options were developed using the TOWS matrix framework, which systematically combines internal and external factors to generate four types of strategies: SO (Strength – Opportunity), WO (Weakness – Opportunity), ST (Strength – Threat), and WT (Weakness – Threat). These strategies address key imple-

mentation challenges of the rice crop insurance program (AUTP) and align with stakeholder-identified priorities.

To prioritise the formulated strategies, a composite scoring approach was applied. First, each TOWS category was weighted based on the combined importance of its underlying SWOT components, as assessed by experts (e.g., SO = Strengths + Opportunities). Then, each strategy's individual score was calculated by summing the weights of its contributing SWOT elements and multiplying it by the weight of the relevant TOWS category. This ensures that the final prioritisation reflects both the strategic relevance and the underlying expert judgment

Table 5 consolidates these results, presenting the strategies, contributing SWOT elements, TOWS weights, and final calculated scores. The results highlight the strategic emphasis on enhanced socialisation and awareness, development of new insurance models with subsidies, and integration of premium payments through farmer cards as critical levers for improving AUTP implementation and increasing farmer participation.

3.3 Prioritisation of strategies using AHP

While the SWOT and TOWS analyses offered insights into AUTP's internal and external dynamics, they lacked a systematic basis for determining which strategies should be prioritized. To address this, the AHP was applied to evaluate strategic options based on multiple criteria. AHP allows structured comparison to ensure prioritisation is data-driven and aligned with stakeholder preferences.

Four evaluation criteria were identified: Farmers' needs, policy support, budget feasibility, and human resource availability. These were derived from thematic insights from SWOT-TOWS analyses and expert discussions. These criteria reflect the most critical enablers and constraints observed in the field. Farmers' needs reflected concern over protection, affordability, and claim reliability. Policy support captured expectations of government continuity and regulatory backing. Budget feasibility addressed financial constraints raised in FGDs, while human resource availability pointed to operational limitations in implementation. Fig. 2 presents the AHP hierarchy. The main objective is to enhance rice crop insurance performance, which is evaluated through the four criteria and used to rank three strategies.

The pairwise comparison was conducted using the Saaty 1–9 scale, where each expert independently assessed the relative importance of each criterion in enhancing rice crop insurance performance. The comparison matrix was constructed and aggregated using the geometric mean method to reflect group consensus. The principal eigenvector of the matrix was then calculated to derive the priority weights,

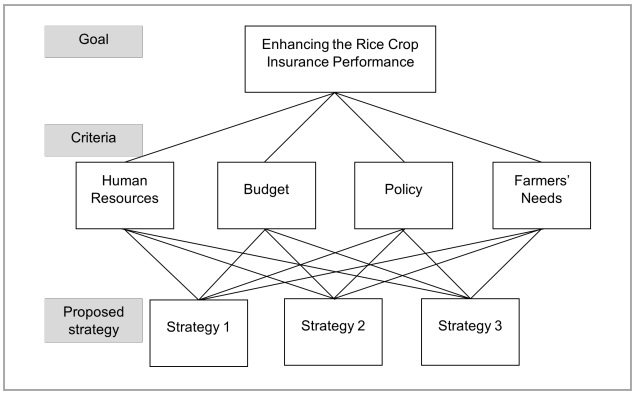

Fig. 2: *Analytical Hierarchy Process (AHP) structure (compiled by the authors).*

while the largest eigenvalue (λ_{max}) was used to compute the Consistency Ratio (CR). The final CR value of 0.043, as presented in Table 6, confirms the logical coherence of expert judgments, ensuring that the prioritisation process is rigorous and reliable.

AHP considered four primary criteria based on insights from SWOT-TOWS analysis and stakeholder discussions. Their relative importance was determined through pairwise comparisons, with results shown in Table 6. Farmers' needs (60.9 %) emerged as the most critical, followed by policy support (24.8 %), budget feasibility (10.1 %), and human resource availability (4.1 %). These weights were based on expert judgments from government, academia, and the insurance sector.

Table 6: *Pairwise comparison of key evaluation criteria.*

Evaluation criteria	*Priorities (%)*	*Ranking*
Farmers' needs	60.9	1
Policy	24.8	2
Budget	10.1	3
Human resources	4.1	4

Note: CR = 0.043.

Using AHP, the three most effective strategies (Table 5) were assessed against the four criteria. As shown in Table 7, the top-ranked strategy was developing new insurance models while maintaining subsidies (43 %), due to firm policy and budget alignment. Strengthening socialisation and awareness followed (29 %), reflecting farmer needs but scoring lower on policy and finance. The third was integrating farmer cards for premium payments (28 %), offering administrative benefits but limited policy traction. The final CR of 0.06 confirmed consistent expert judgments.

Table 7: *Final strategy prioritisation in percentages.*

Proposed strategies	*Farmers' needs*	*Policy*	*Budget*	*Human resources*	*Overall goals*	*Ranking*
New insurance models with subsidies	17	43	55	20	43	1
Increase AUTP socialisation and awareness	67	14	24	20	29	2
Integrate premium payments with farmer cards	17	43	21	60	28	3

By incorporating expert judgments across all four criteria, AHP refined the strategy ranking to support effective implementation. While socialisation was the most immediate concern in the field, the results indicate that developing new insurance models offers the most strategic and sustainable solution. This prioritisation ensures AUTP enhancements align with farmer needs and program feasibility, contributing to financial resilience and broader food security objectives.

4 Discussion

This study offers a structured framework to improve Indonesia's rice crop insurance program (AUTP) by integrating SWOT, TOWS, and AHP. Findings highlight that farmers' needs are the most critical success factor, followed by policy support, budget feasibility, and human resource availability. However, low participation, inefficient claims, and limited awareness remain core challenges. Addressing these requires policy reforms, financial sustainability, and digital innovations to improve access, efficiency, and long-term viability.

Developing new insurance models while maintaining subsidies

AUTP must evolve beyond subsidy dependence to ensure long-term sustainability while maintaining affordability for smallholders. AHP results confirm this as the top priority, supported by policy and budget feasibility. While Indonesia's 80 % subsidy makes premiums accessible, it raises fiscal concerns. China's risk-based model adjusts subsidies based on climate risks (Chen *et al*., 2024; Zhao *et al*., 2024), and Kenya's Index-Based Crop Insurance uses parametric tools for faster, cheaper claims (Osumba & Kaudia, 2020; Maina *et al*., 2024). India's Weather-Based Crop Insurance Scheme (WBCIS) expands access through microinsurance (Shirsath *et al*., 2019).

To strengthen AUTP, a hybrid model combining index and indemnity-based insurance can enhance cost efficiency and prevent fraud (Osumba & Kaudia, 2020; Oppong Mensah *et al*., 2023). Additionally, tiered premiums based on farm size and risk levels offer a more sustainable financial model (Li *et al*., 2020; Shi *et al*., 2023). Broader coverage of soil degradation, irrigation failures, and pollution would improve risk protection (Pishbahar *et al*., 2019; Tsay & Paulson, 2024), as seen in Mexico's CADENA program, which integrates environmental risk mitigation (Alcántara-Ayala *et al*., 2020). Public-Private Partnerships (PPPs) can further strengthen financial sustainability by leveraging private expertise in risk modelling, actuarial assessments, and digital payment systems (Călin & Izvoranu, 2018). This approach can reduce government dependency and improve efficiency (Agarwal *et al*., 2023). By adopting hybrid models and PPP-driven solutions, AUTP can enhance coverage, remain affordable, and ensure long-term financial stability.

Strengthening socialisation and awareness for AUTP adoption

Despite recognising AUTP's benefits, many farmers remain unengaged due to limited outreach and extension capacity. AHP findings show strong alignment with farmer needs, but lower policy and budget feasibility scores reveal implementation hurdles. Lessons from Kenya, China, and India emphasise the role of multi-channel outreach strategies. Kenya's peer-to-peer learning and China's mobile-based education tools (WeChat, SMS alerts) have raised participation (Sibiko *et al*., 2018; Amadu, 2023), while India's cooperative-led model builds trust in insurance programs (Nanda, 2021; Soni, 2022). To improve AUTP adoption, Indonesia should integrate farmer field schools, SMS alerts, WhatsApp groups, and YouTube tutorials (Sharma *et al*., 2021; Kirchner & Musshoff, 2024). Strengthening cooperative and peer networks improves literacy (Wu *et al*., 2022; Sarkar *et al*., 2023). Simplifying registration, reducing paperwork, and lowering the crop failure threshold can increase trust and participation (Alif *et al*., 2022; Regmi *et al*., 2023).

Integrating premium payments with farmer cards for efficiency

AUTP's manual claim causes delays, inefficiencies, and trust issues among farmers. While farmer cards exist, many remain unfamiliar with their full functionality, limiting their

use. Smart card-linked agricultural financing has improved efficiency by linking subsidies to transactions and reducing fraud (Dayana & Kalpana, 2023; Glotova *et al*., 2024). China's satellite-assisted insurance minimises manual verification (CHEN *et al*., 2020; Wang *et al*., 2023). Indonesia's existing e-wallet systems further demonstrate the feasibility of digital financial solutions. To enhance payment efficiency and transparency, Indonesia should expand digital literacy programs to promote farmer card adoption, pilot drone-based claim verification, and link farmer cards to automated premium deductions (Casaburi & Willis, 2018; Zalavadiya, 2024). These initiatives would ensure faster, transparent transactions, reduce administrative delays, and improve accessibility for farmers in remote areas.

5 Conclusions, limitations, and future research

This study highlights that enhancing AUTP's accessibility, efficiency, and sustainability requires a multi-faceted approach, including diversifying insurance models, strengthening public-private partnerships (PPPs), improving socialisation, and embracing digital transformation. Strengthening policy frameworks, engaging the private sector, and leveraging technology are essential to build a more resilient and inclusive rice insurance system. Through hybrid models, digital financial solutions, and improved outreach, AUTP can increase farmer participation, reduce fiscal burden, and support long-term agricultural resilience and rural development.

Despite its contributions, this study has several limitations. First, the analysis is based on qualitative insights from FGDs and expert evaluations, which, while offering rich contextual depth, may introduce subjective biases. FGDs were chosen over large-scale surveys for their methodological suitability for exploring complex implementation issues and stakeholder perspectives. Moreover, this approach was more feasible given the study's time and resource constraints. Future research should complement these findings with larger-scale quantitative surveys to validate farmer preferences and adoption patterns. Second, the study focuses on Indonesia's rice sector, meaning the findings may not be directly generalisable to other agricultural contexts without adaptation. Additionally, the AHP-based prioritisation relied on expert judgment, which, despite rigorous consistency checks, may still be influenced by individual perspectives.

For future research, further exploration of the effectiveness of hybrid insurance models, such as index-based and indemnity-based mechanisms, is needed to optimise risk coverage and cost efficiency. Additionally, integrating AI and blockchain technologies for fraud detection, claims verification, and premium pricing could reduce administrative inefficiencies. Research on farmer adoption behaviour, particularly in response to digital financial inclusion, risk-sharing models, and behavioural incentives, would help refine policies to increase AUTP's reach and impact. Lastly, a cost-benefit analysis of PPP integration in agricultural insurance would provide insights into sustainable risk-sharing mechanisms and their long-term economic viability for Indonesia's rural economy.

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Conflict of interest

The authors declare that they have no conflict of interest.

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