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Management of Agriculture Scare Water Resources Applying Incremental Adaptation Strategies: A Case of a Developing Nation

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Abstract
Climate change and population increase have the potential to degrade global water resources. In addition, agricultural water supplies are among the most important factors influencing food production in many regions of the world. The same is true in Indonesia, where agriculture is among the five most influential industries. Therefore, the current study has focused on the direct and underlying mechanisms of incremental adaptation techniques that affect agricultural water management. 545 farmers from 12 communities in the province of East Kalimantan, Indonesia, were surveyed to obtain data for this study. Using SmartPLS version 4.0 to analyze the data, it was discovered that psychological elements, such as the farmers' anxieties, attitudes, and knowledge, had a major impact on their incremental adaption tactics. These exhaustive tactics can further result in efficient and successful water resource management. Despite the strong influence of all psychological components of farmers on agricultural water management and incremental adaptation strategies, the researchers discovered that worry and knowledge had a greater impact on dependent and mediating variables than the farmers' perceptions. In addition, the results demonstrated the contingent effect of farmers' self-efficacy and technical skills on their increased usage of incremental methods and efficient and effective water resource management. This study contributes to the existing literature by assessing the impact of farmers' views, attitudes, and behaviors on their water management abilities. It also gives vital policy insights into the sustainable decision-making of farmers to address the basic problem of water scarcity.

Keywords: Farmer's Psychological Factors; Incremental Adaptation Strategies; Agriculture Water Management; Self Efficacy; Technical Skills.

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1. Introduction
One of the greatest issues of the 21st century is the worldwide water crisis, which is exacerbated by climate change and population expansion. Due to dwindling agricultural water resources, global population growth has prompted concerns about food availability (Jagtap et al., 2022). Consequently, agricultural water management is one of the most prevalent socioeconomic issues that must be tackled globally (Yue & Guo, 2021). According to scientific research, the average yearly precipitation in the world is 813mm (Sabzevar, Rezaei, & Khaleghi, 2021). In addition, Asian nations record an average annual precipitation of 217 to 250 millimeters. In contrast, Asian countries are seeing rapid population growth, which could lead to a rise in water demand (Prabhakar, 2021). In addition, because rural residents in developing countries depend heavily on agricultural goods for their livelihoods, water plays a crucial role in rural development (Rasul et al., 2021).

In addition, agricultural water management has become a globally complex topic (Zobeidi, Yaghoubi, & Yazdanpanah, 2022). Farmers are the most significant decision-makers at the local management levels in addressing this issue (Hanson et al., 2022). In addition, the fact that environmental challenges such as water

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scarcity pose a potential threat to society demonstrates that adaptation tactics depend on a variety of individual, societal, and cultural elements (Henchion et al., 2022). For example, Zobeidi et al. (2022) examined the impact of social aspects in terms of societal norms and values on individuals' adaptation techniques to deal with resource shortages. Concurrently, Rokicki et al. (2021) reported the role of cultural values in creating incremental measures to reduce the effects of several factors on protecting environmental resources. However, the individual elements receive the least attention. Previous academics have also focused on the efforts of local communities to manage finite water resources in the context of climate change (Suhartini & Abubakar, 2017; Wheeler, Zuo, & Bjornlund, 2013). In contrast, the importance of farmers' psychological variables in managing water resources efficiently and effectively has received limited attention (Sabzevar et al., 2021). Consequently, the primary objective of this study is to investigate the significance of farmers' psychological aspects in terms of their concerns, attitudes, and knowledge of managing agricultural water in the context of developing nations (Regmi, 2022).

Moreover, from an anthropological standpoint, humans can adapt to numerous environmental pressures (Niedermeier, Emberger- Klein, & Menrad, 2021). Researchers also ascribe this adaptability to people as a sort of adaptation or mitigation response to mitigate the negative impacts of climate change (Smith et al., 2022). The farmers' adaptations to low water supplies represent their adjustments and involuntary measures to lessen the dangers associated with agricultural activity (Scafuto, 2021). Consequently, their capacity to mitigate the negative impact of climate change on the agricultural sector in terms of water shortages can be considered incremental adaptation techniques (Dam et al., 2021). According to their nature, adaptation tactics can be categorized into three categories: defensive, conservative, and gradual (Zobeidi et al., 2022). At the same time, the primary focus of the current work remains incremental adaptation strategies for managing agricultural water resources throughout irrigation procedures. Researchers emphasized the role of psychological elements in farmers' beliefs, attitudes, and perceptions, indirectly analyzing their resource management abilities and behaviors (Mairura et al., 2021; Sabzevar et al., 2021; Zhang et al., 2019). However, the latest study adds to the existing body of research. It investigates the fundamental process of incremental adaptation strategies for transmitting the farmers' psychological aspects regarding their concerns, perceptions, and knowledge to manage agricultural water efficiently (Sun, 2022).

In addition, the present study was conducted in a growing nation, Indonesia, where agriculture is one of the top five industries contributing to the country's economic development (Prastiyo & Hardyastuti, 2020). The agriculture industry in Indonesia consumes around 80% of the nation's total water (Bashir & Susetyo, 2018). Nonetheless, nearly 46% of the nation's irrigation system is deemed to be inadequately managed, risking the loss of water supplies (Adebayo et al., 2021). On the other hand, Indonesia is one of the world's top exporters and manufacturers of agricultural goods, exporting goods such as spices, rice, coffee, cocoa, natural rubber, and palm oil. In addition, research undertaken in the Indonesian agricultural industry reveals several irrigation-related concerns (Sekaranom, Nurjani, & Nucifera, 2021). Also, scholars have acknowledged the need to solve water scarcity (Ma'Mun, Loch, & Young, 2021). Researchers have also emphasized the possibility of identifying factors influencing agricultural water management (Ma'Mun et al., 2021; Sekaranom et al., 2021). To address these gaps in the literature, the current study intends to;

- Examine the impact of farmers' psychological factors, including concern, perceptions, and knowledge on the use of incremental adaptation strategies and agricultural water management.

- Examine the influence of incremental adaptation strategies on farmers' agricultural water management.
- Investigate the mediatory role of farmers' incremental adaptation strategies between the association of their concerns, perceptions, and knowledge with agricultural water management.
- Empirically test the contingent role of farmers' self-efficacy in transmitting the significance of their psychological factors to adopt incremental adaptation strategies to manage the water resources.
- Empirically test the contingent role of farmers' technical skills in utilizing incremental adaptation strategies to manage water resources.

2. Literature Review and Hypothesis Development

2.1 Farmers' Psychological Factors, Incremental Adaptation Strategies, and Agricultural Water Management

Concern represents a person's prioritization of issues following their values (Søvold et al., 2021). The farmers are concerned about the availability of water, land, and irrigation methods for crop output (Veissier, Miele, & Mounier, 2021). When farmers are more possessive of their land and production outcomes, they remain watchful in many ways and employ various techniques to increase crop yield (Richardson et al., 2021). Similarly, the present study considered farmers' anxiety to be a fundamental factor in their adoption of incremental techniques. These incremental techniques include purchasing more land with increased water resources or identifying alternatives to address water scarcity challenges (Sabzevar et al., 2021). In addition, farmers' perspectives are considered while establishing incremental adaptation strategies for managing constrained water supplies (Mairura et al., 2021). The individual's views of specific phenomena enable them to plan and organize tactics to address future problems and achieve the desired results (Fierros-Gonzalez & Lopez-Feldman, 2021). Scholars discussed the role of individual perceptions in formulating managerial strategies to boost productivity (Vandersmissen, George, & Voets, 2022). At the same time, the knowledge of individuals has been regarded as a potent instrument for executing particular activities connected to prospective difficulties (Pribadi et al., 2021) Since water scarcity is a possible problem for farmers, their familiarity with dealing with this issue and locating several solutions enables them to manage agricultural water resources efficiently (He et al., 2021). Consequently, based on the literature assessment and rational reasoning, the current study hypothesizes that;

H1: *Farmer psychological factors, i.e., a) concern, b) perceptions, and c) knowledge, positively influence agricultural water management.*

H2: *Farmer psychological factors, i.e., a) concern, b) perceptions, and c) knowledge, positively influence their Incremental adaptation strategies to manage the water resources.*

2.2 Incremental Adaptation Strategies and Agricultural Water Management

Incremental adaptation strategies are important determinants of controlling and arranging specific systems (Zobeidi et al., 2022). Particularly in the context of the present study, the farmers' incremental adaptation tactics are seen as significant predictors of their agricultural water management. Since total adaptation tactics encompass a variety of strategies and behaviors that assist individuals in addressing issues and identifying logical answers (Dam et al., 2021; Sabzevar et al., 2021), consequently, it is anticipated that farmers will be in a better position to manage water scarcity and come up with the most effective solutions if they employ a variety of incremental tactics in addition to their essential resources (Alleluyanatha & Treasure, 2021). It is therefore hypothesized that;

H3: Farmers' incremental adaptation strategies positively affect their agricultural water management.

2.3 Incremental Adaptation Strategies as Mediator

According to research, diverse human, societal, and cultural factors influence the sustainable use of water in agriculture. Ragusa (2021) illustrated the significance of social norms and community forces to safeguard scarce water resources. On the other hand, farmers must have enough possibilities to regulate crop output with accessible water (Ricart & Rico-Amorós, 2021). Therefore, academics and researchers consistently propose alternate methods (Sabzevar et al., 2021; Zhang et al., 2019). To this end, the current study examined the psychological characteristics of farmers as significant predictors of their effective management of water resources in the agricultural sector. In addition to these direct relationships, the current study also examines the underlying mechanisms involved in transmitting the relevance of farmers' psychological characteristics, such as worry, perceptions, and knowledge of agricultural water management. This underlying mechanism may include several incremental adaptation methods in the form of viable alternatives for irrigating the fields. Thus, it is anticipated that;

H4: Incremental adaptation strategies to manage the water resources mediate the association of farmers' psychological factors, i.e., a) concern, b) perceptions, and c) knowledge of agricultural water management.

2.4 Farmers' Self-efficacy as a Moderator

Self-efficacy refers to a person's capacity and belief in their ability to exhibit particular actions necessary to accomplish specific performance standards (Nisar et al., 2022). Self-efficacy denotes the farmers' talents, skills, and capacities to apply various techniques and behave in multiple ways to maximize crop yield (Zobeidi et al., 2021). Additionally, they confront specific problems and crises for this purpose. The water crisis is one of the most significant problems encountered by farmers worldwide (Sabzevar et al., 2021; Wheeler et al., 2013). Therefore, they demand specialized skills to address these difficulties and increase the productive capacity of their properties (Zarei, Karami, & Keshavarz, 2020). Researchers have previously reported the importance of farmers' self-efficacy in achieving higher production and production process performance requirements (Pradhananga & Davenport, 2022). Hanson et al. (2022) revealed that farmer self-efficacy leads to efficient resource utilization. Self-efficacy is theorized to play a moderating function in the current investigation. It is anticipated that when farmers' talents and capacities to execute various actions connect with their psychological elements, such as concern, perception, and knowledge, they will be more likely to employ incremental adaptation strategies to manage constrained water resources effectively (Boni, 2022). This utilization of gradual adaption tactics contributes to effective agricultural water management. Therefore, it is hypothesized that;

H5: Farmers' self-efficacy moderates the association of their psychological factors, i.e., a) concern, b) perceptions, and c) knowledge, with the incremental adaptation strategies such that the association is stronger in the case of higher values of self-efficacy

2.5 Farmers' Technical Skills as a Moderator

The technical skills of farmers show their interpersonal talents to manage and organize the farm and eliminate agricultural process-related issues (Antwi-Agyei & Stringer, 2021). They can utilize their abilities in various ways, including crop maintenance, machinery repair, and communication with farmhands (Odhiambo, Iro Ong'or, & Kanda, 2021; Sabzevar et al., 2021). Destaw and Fenta (2021) also discussed the importance of farmers' technical skills in managing the field's resources. In addition, research demonstrates the importance of farmers' technical expertise in handling irrigation-related challenges (Haryanto, Anwarudin, & Yuniarti, 2021). Similarly, Sabzevar et al. (2021) observed that farmers with greater technical expertise were better able to manage crop output in barren areas in Iran. The latest study expands on prior findings about the agriculture sector's water scarcity. It describes the contingent impact of farmers' technical skills and promotes incremental adaptation tactics to obtain the most advantages from water resources management. It is therefore hypothesized that;

H6: *Farmers' technical skills moderate dissociation of their incremental adaptation strategies with agricultural water management such that the association is stronger in the case of higher values of farmers' technical skills*

2.6 Theoretical Framework

The theoretical framework of the current study is shown in Figure 1.

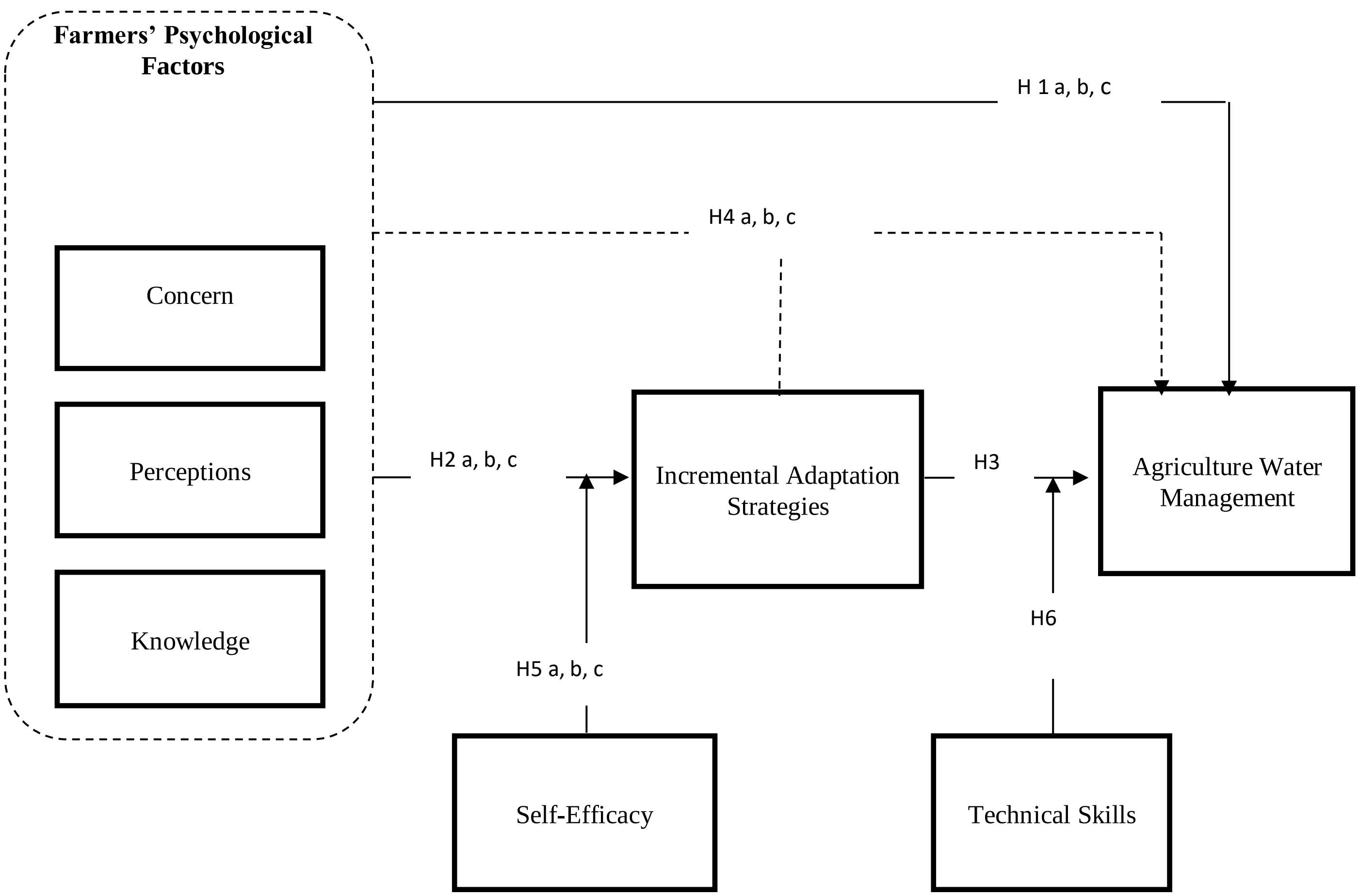

Figure 1: The theoretical framework of the study

3. Research Methodology

The current study's statistical population for data collection consists of all Indonesian farmers. In addition, the authors concentrated on 12 villages in the Indonesian province of East Kalimantan to narrow the general population. The villages were subdivided depending on their population and the local administrative entities. Using a random sample technique, the authors employ 12 data collectors to visit each hamlet at varying administrative levels and conduct interviews with local farmers. Before assigning the task of data collecting, each data collector was briefed on the goal of this investigation. They interacted with the farmers and discussed the nature and purpose of the study after touring various villages. Two-part survey questionnaires were distributed to farmers who consented to participate in the research. The first section comprised the respondents' occupational and personal data, including age, gender, educational level, and agricultural job experience. In addition, the researchers evaluated contextual economic factors such as land ownership, land area, accessible water supplies, and irrigation techniques. The second section of the inquiry consisted of study construct-related items. To increase participation and eliminate biases in the data collection technique, the questionnaire was translated into the farmers' local tongue so they could all easily comprehend it. All questionnaires were retranslated back into English after completion. This entire data-gathering procedure began in January 2022, and researchers were able to acquire 545 possible responses by the end of September 2022.

3.1 Respondents Characteristics

The demographic features of the respondents revealed that 86.3% of respondents were male and 13.7% were female. The mean age of the participants was 49 years (SD = 18). The majority of participants were either students (48.5%) or graduates (39.9%). The remaining 12.6% of participants held graduate degrees or higher. 33.3% of respondents had 1-5 years of agricultural experience, 31.2% had 6-10 years of experience, 23.5% had 11-15 years of experience, and 12.0% had more than 15 years of experience. 51.7 percent of participants were landowners, while 17.3 percent had rented land. At the same time, 31% of previously cultivated land belongs to others. Regarding water supplies for irrigation, 58.5% of farmers relied on deep wells, while 28.7% and 9.8% relied on qanats and rivers, respectively. In addition, 79.3% of farmers employed floodwater as an irrigation system, followed by 20.7% who used drip and furrow.

3.2 Study Measures

The 36-item questionnaire was utilized to collect data for the current investigation. Concern was assessed using a three-item scale derived from Arbuckle et al. (2013). Seven questions from Sabzevar et al. (2021) were used to measure perception. Simultaneously, knowledge was assessed using six items modified from Zarei et al. (2020). In contrast, incremental adaptation techniques were measured using a 6-item scale developed by Zarei et al. (2020). In addition, farm water management was assessed using five items derived from Zhang and Guo (2016), and self-efficacy was assessed using five questions adapted from Wheeler et al. (2013). Four items modified from Zhang et al. (2019) were used to evaluate technical skills. These characteristics were measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with 1 indicating strong disagreement and 5 indicating strong agreement.

4. Data Analysis and Results

Using SmartPLS 4.0, the current study's data analysis was conducted. After examining the descriptive statistics of the study's constructs, kurtosis and skewness were investigated. As advised by academics, the study results demonstrated the normal distribution of all study constructs using the symmetric values of skewness and kurtosis ranging from +1 to -1 and +2 to -2. We conducted a simulated analysis in the second phase to determine the variables influencing agricultural water management. Results indicated that the qualifications of respondents positively influenced agricultural water management; hence, this variable was controlled throughout future research. In the third step, the psychometric qualities of the measures were evaluated. The values of "Cronbach's (CA)" and "Composite Reliability (CR)" were determined for this purpose (Henseler, Ringle, & Sinkovics, 2009; Noor, Mansoor, & Shamim, 2022). As concurrent measures of validity and reliability of the research constructs, factor loadings of the measures and "Average Variance Extracted" (AVE) were employed. The results indicate that the CA and CR values were greater than 0.70. Similarly, the factor loadings for all research items over 0.70 (see Figure 2) and AVE values (i.e., above 0.50) indicate that the study constructs have strong convergent validity and reliability (Hair et al., 2017; Mansoor, Awan, & Paracha, 2022).

Table 1: Factor Loadings, Reliability, and Validity

Constructs	Factor loadings							AVE	CR	CA
	1	2	3	4	5	6	7			
Concern								0.618	0.829	0.745
CON1	0.770									
CON2	0.729									
CON3	0.855									
Perception								0.564	0.900	0.821
PER1		0.721								
PER2		0.775								
PER3		0.735								
PER4		0.746								
PER5		0.783								
PER6		0.728								
PER7		0.767								
Knowledge								0.572	0.889	0.802
KNO1			0.758							
KNO2			0.836							
KNO3			0.712							
KNO4			0.767							
KNO5			0.732							
KNO6			0.728							
Incremental Adaptation Strategies								0.628	0.910	0.834
IAS1				0.711						
IAS2				0.823						
IAS3				0.819						
IAS4				0.810						
IAS5				0.792						
IAS6				0.795						
Agriculture Water Management								0.618	0.890	0.811
AWM1					0.792					

AWM2	0.750					
AWM3	0.842					
AWM4	0.716					
AWM5	0.823					
Self-Efficacy				0.584	0.875	0.798
SE1		0.779				
SE2		0.791				
SE3		0.768				
SE4		0.742				
SE5		0.738				
Technical Skills				0.608	0.861	0.787
TS1			0.839			
TS2			0.742			
TS3			0.757			
TS4			0.778			

“Note: CR, Composite Reliability; AVE, Average Variance Extracted; CA= Cronbach’s α.”

In addition to establishing dependabilities and convergent validity, experts advise establishing discriminant validity based on the Heterotrait-Monotrait (HTMT) (Henseler, Ringle, & Sarstedt, 2015). The results demonstrated that all HTMT ratios were less than 0.85 (see table 2). This further confirmed that measurements are differentiated from one another without any multicollinearity concerns, showing discriminant validity across all study domains (Mansoor, Awan, & Paracha, 2021; Sarstedt, Ringle, & Hair, 2021).

Table 2: Heterotrait-Monotrait Ratio

Constructs	Mean	Std	1	2	3	4	5	6	7
Concern	4.03	1.03	**0.786**						
Perception	3.85	1.08	0.461	**0.750**					
Knowledge	3.70	1.12	0.544	0.488	**0.756**				
Incremental Adaptation Strategies	4.12	0.93	0.402	0.423	0.455	**0.792**			
Agriculture Water Management	4.05	1.00	0.600	0.492	0.547	0.453	**0.786**		
Self-Efficacy	3.84	1.15	0.489	0.504	0.444	0.590	0.495	**0.764**	
Technical Skills	4.10	0.99	0.505	0.499	0.518	0.627	0.546	0.513	**0.779**

“Note: the square roots of AVEs of the constructs are shown in bold in diagonal.”

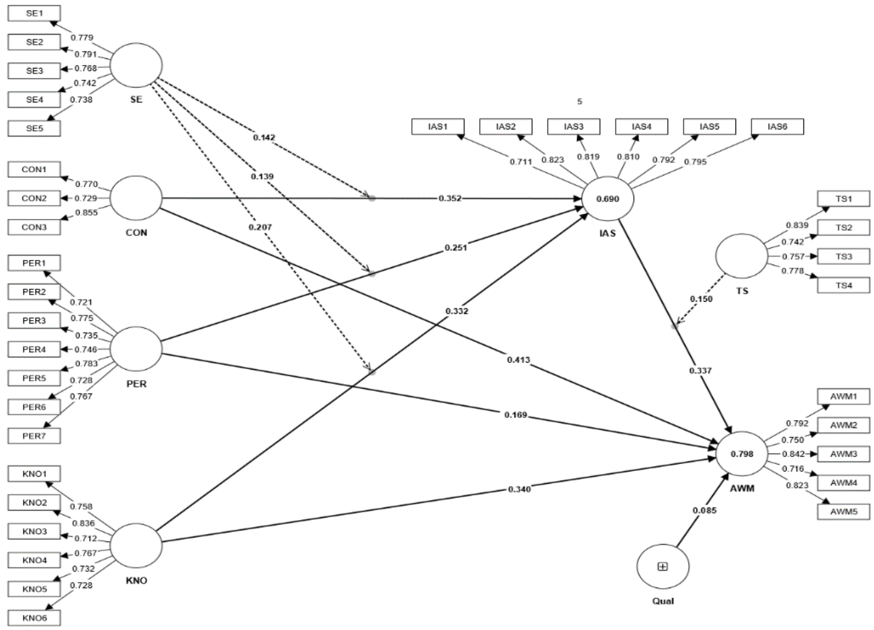

Figure 2: Full measurement model

4.1 Hypotheses Testing

To test the hypothesized relationships, regression analysis was performed. Also, the "coefficient of determination (R^2)" as a significant major of model fitness Was determined. Results showed that the values of R^2 for incremental adaptation strategies as the outcome of concern, perception, and knowledge were 0.690. In contrast, the R^2 joke for agriculture water management was 0.798. Therefore, reflecting a variance of about 69% and 79.8%, respectively, in incremental adaptation strategies and agricultural water management based on all the independent and moderator constructs.

4.2 Direct Hypotheses

The hypothesis testing results revealed that farmers' psychological factors, including concern (ß = .413**, t = 7.452), perceptions (ß = .169**, t = 2.675), and knowledge (ß = .340***, t = 5.924) significantly influence the agricultural water management. Simultaneously, results also showed that farmers' psychological factors, including concern (ß = .352**, t = 6.334), perceptions (ß = .251**, t = 4.768), and knowledge (ß = .332***, t = 5.458), significantly influence their incremental adaptation strategies towards agricultural water management. Also, farmers' incremental adaptation strategies toward agricultural water management positively impacted actual agricultural water management (ß = .337***, t = 5.894). Hence, proving all direct hypotheses, i.e., H1a, b, c; H2a, b, c, and H3.

4.3 Mediating Hypotheses

Following the direct hypothesis, mediation hypotheses H 4a, b, and c are supported by the current study results. For instance, farmers' psychological factors, including concern (ß = .249**, t = 4.669), perceptions (ß = .211**, t = 4.300), and knowledge (ß = .325***, t = 5.576), significantly influence the agricultural water management via the mediatory role of incremental adaptation strategies.

4.4 Moderating Hypotheses

To assess the contingent role of regime self-efficacy, authors developed interaction terms between farmers' psychological factors, including concern, perceptions, and knowledge, with self-efficacy using a product indicator approach in SmartPLS 4.0 (Mansoor et al., 2021). The findings revealed that when farmers' self-efficacy interacts with their concerns, perceptions, and knowledge resulting in a high level of incremental adaptation strategies to manage agricultural water. The R^2 for the main influence of farmers' concerns, perceptions, and knowledge on incremental adaptation strategies was 0.530. In contrast, after including the contingent rule of farmers' self-efficacy, this effect reached 0.690. This increased R^2 value further reflects a variance of approximately 16% in enhanced incremental adaptation strategies based on including the interaction terms reflecting the study's acceptance of H 5a, b, and c. Likewise, the interaction term between technical skills and incremental adaptation strategies was used to determine their interactive effect on farmers' agriculture water management. The R^2 change of 13.5% reflects acceptance of H6 of the study.

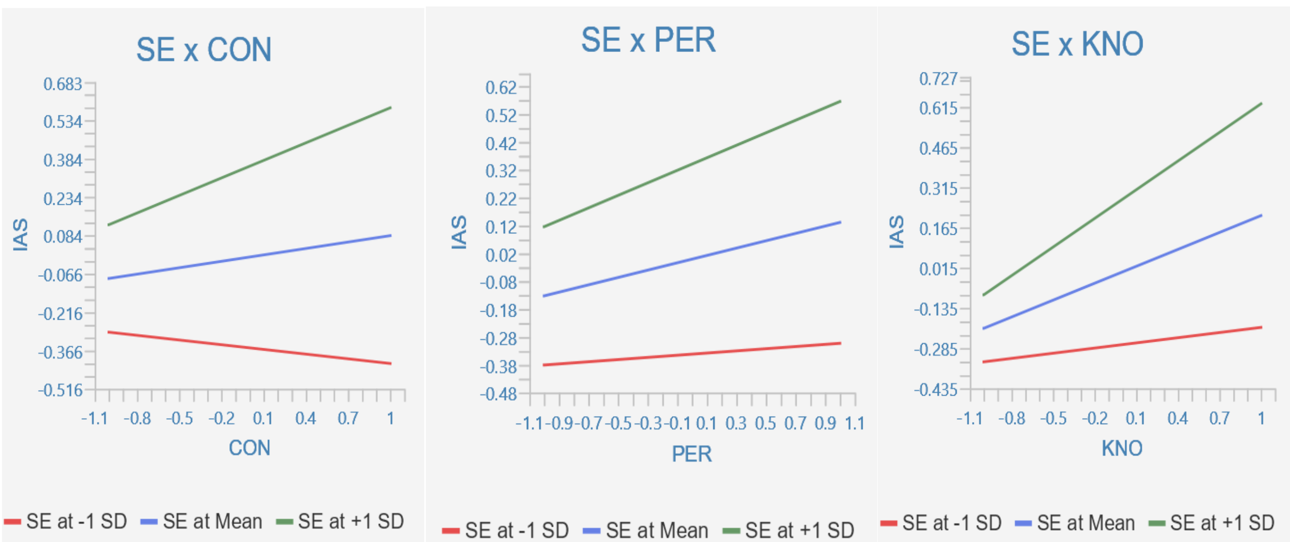

Figure 3: a, b, c: Interaction plot for moderating effects of self-efficacy

In addition, the moderation results are displayed in Figures 3a, b, and c via interaction plot. Higher values of self-efficacy for the association of farmers' psychological factors, including concerns, perceptions, and knowledge, with the use of incremental adaptation strategies to efficiently and effectively utilize their scarce water resources result in a steeper gradient on the interaction plot. These results indicate that when farmers are more self-reliant, they employ their ability to implement incremental water conservation methods during irrigation.

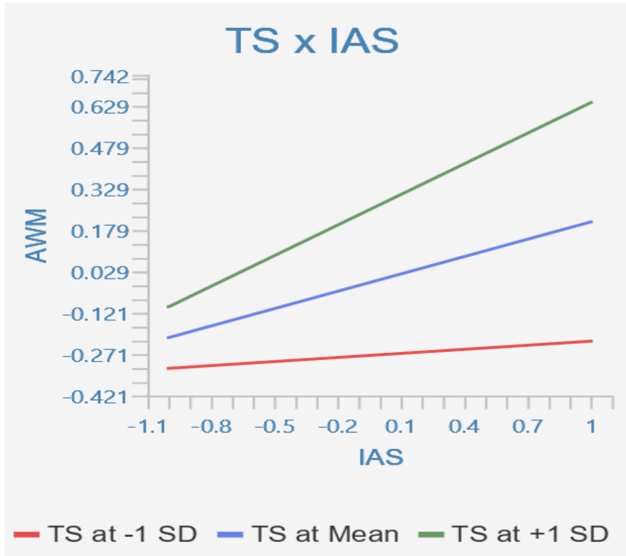

Figure 4: Interaction plot for moderating effects of self-efficacy

As illustrated in Figure 4, the moderation results demonstrate a steeper gradient for greater values of farmers' technical abilities in the association between farmers' adoption of incremental adaptation strategies and effective agricultural water management. Consequently, this demonstrates the necessity of the farmers' technical skills in incremental adaptation techniques for either increasing land area or locating alternatives to irrigate the fields to manage the precious water resources.

5. Discussion and Conclusion

5.1 Findings

For effective water resource management and sustainable development, gradual adaptation measures are crucial. Consequently, it is essential to determine the elements that influence incremental adaptation techniques. To address this gap in the research, the current study investigated the role of farmers' psychological aspects, including their worry perceptions and understanding of their incremental adaptation techniques for managing agricultural water resources. For this objective, the cross-sectional research approach was utilized, and data were collected from farmers in 12 East Kalimantan Province, Indonesia, communities. After analyzing the data with the SmartPLS v.4.0 software, the results demonstrated the favorable influence of farmers' worries on their incremental adaptation tactics for coping with water scarcity during the irrigation of the cultivated field. It also indicates that when farmers are concerned about water scarcity and recognize that their irrigation practices had a significant impact on sustainable development and use of water resources, they employ incremental adaptation strategies and look for alternative ways to irrigate their crops to conserve the existing water resources. This contributes further to effective water management.

Table 3: Hypothesis Testing Results

	Hypothesized Relationships	Std. Beta	T-value	P-value	Supported
H1a	CON → AWM	0.413	7.452	0.000	Yes
H1b	PER → AWM	0.169	2.675	0.011	Yes

H1c	KNO → AWM	0.340	5.924	0.000	Yes
H2a	CON → IAS	0.352	6.334	0.000	Yes
H2b	PER → IAS	0.251	4.768	0.000	Yes
H2c	KNO → IAS	0.332	5.458	0.000	Yes
H3	IAS →AWM	0.337	5.894	0.000	Yes
H4a	CON → IAS → AWM	0.249	4.699	0.003	Yes
H4b	PER → IAS → AWM	0.211	4.300	0.007	Yes
H4c	KNO → IAS → AWM	0.325	5.576	0.000	Yes
H5a	SE*CON → IAS	0.142	2.823	0.011	Yes
H5b	SE*PER → IAS	0.139	2.761	0.011	Yes
H5c	SE*KNO → IAS	0.207	3.950	0.007	Yes
H6	TS*IAS → AWM	0.150	3.014	0.009	Yes

Where: CON=Concern; PER=Perception; KNO=Knowledge; IAS=Incremental Adaptation Strategies; AWM=Agriculture Water Management; SE=Self Efficacy; TS= Technical Skills

The data also indicate that farmers' attitudes have a beneficial effect on their usage of incremental measures to manage agricultural water supplies. The findings are consistent with the results of researchers who highlighted the impact of perceptions and attitudes in affecting the conduct of our farmers over the use of limited resources (Basuki et al., 2022; Sabzevar et al., 2021). When farmers think their activities are crucial for the long-term viability of the land they cultivate and rely on for their livelihood, they are more likely to utilize incremental tactics to safeguard the available resources (Haryani, 2021). Simultaneously, these favorable opinions of managing the resources with care and attention enable them to manage agricultural water resources more efficiently and effectively for sustainable usage.

Results also demonstrated a considerable impact of farmers' knowledge on their incremental adaptation techniques to utilize water resources efficiently and effectively. These results are consistent with previous studies findings, which emphasized the significance of farmers' concerns and knowledge in using various techniques (Zobeidi et al., 2021). Furthermore, research demonstrates that to utilize limited water resources successfully, and farmers employed a variety of defensive, offensive, and incremental methods (Dam et al., 2021). Among these incremental efforts, developing alternative land-water availability options is the most notable. Farmers sometimes expand their cultivated areas to compensate for limited water resources (Sabzevar et al., 2021). Among the farmer's concerns, perceptions, and knowledge, the current study revealed that their concerns had the biggest influence on their adoption of incremental techniques, followed by their expertise. Perceptions were also positively connected to the employment of incremental adaptation strategies, but to a lesser amount than knowledge and concern. It demonstrates that farmers are better positioned to adopt incremental tactics to manage constrained water supplies when they are worried about the irrigated area and are aware of alternative strategies.

In addition, the results demonstrated the remarkable considerable contingent impact of self-efficacy in strengthening the impact of farmers' concern perceptions and knowledge in using established incremental methods in agricultural fields. The findings also indicate that farmers who are more self-reliant and confident in their ability to manage water scarcity concerns are more worried, apply their knowledge, and are viewed favorably for their solution to the problem of inadequate water resources. As a result, when their self-efficient trade interacts with their worry perceptions and information, their ability to employ incremental methods such as locating alternatives, expanding land, infecting existing resources, etc., increases. Previous researchers have demonstrated the importance of farmer self-efficacy in efficiently managing agricultural resources (Hanson et al., 2022; Pradhananga & Davenport, 2022); however, the contingent impact of self-efficacy has not been previously investigated.

Similarly, the results demonstrated the strong contingent impact of the farmers' technical skills in employing their incremental techniques to maximize the advantages of managing agricultural water resources. As confirmed by these findings, farmers are in a better position to manage agricultural water resources when they employ their technical expertise and incremental tactics. Therefore, the combined effect of technical skills and incremental methods effects positively the farmers' agricultural water management habits. Prior research (Zobeidi et al., 2021) associated technical skills with farmers' capacities to manage various workplace resources; however, the current study extends these findings to managing water resources due to the global scarcity of agricultural water. Since agricultural water is crucial to managing a nation's agricultural sector, it also influences its economic growth. Therefore, boosting the technical skills of farmers can tackle water management problems in developing nations.

6. Theoretical Implications

This research contributes to the existing body of knowledge by presenting a unified framework that not only considered the farmer's psychological factors in terms of concerns, perceptions, and expertise but also integrated these psychological traits with farmers' self-efficacy and technical skills to estimate the use of incremental strategies and management of agricultural water resources. Moreover, the focus of the present study has been on the management of agricultural water resources, given the importance of agricultural water to the economic development of a country with a developed agricultural sector (Zhang & Guo, 2016). In addition, these water resources are regarded as the pillars of sustainability (Basuki et al., 2022); therefore, examining the factors that influence the efficient and effective management of restricted agricultural water resources contributes to the current body of knowledge.

In addition, contrary to prior research that emphasized the significance of farmers' self-efficacy and technical skills in managing various resources, the current study has evaluated their contingent function. This indicates that self-efficacy might interact with farmers' knowledge and perceptions to inspire them to employ different incremental tactics to identify alternative water management solutions for agricultural fields with limited water resources. Similarly, the use of formal technical skills to improve the impact of comprehensive adaptation strategies on managing agricultural water resources contributes to the area's existing body of knowledge. In addition to examining the direct influence of farmers' psychological factors on managing water resources, this study also examined the underlying mechanism of incremental strategies to transmit the significance of these farmers' trades in managing agricultural water resources efficiently and effectively.

7. Theoretical Implications

Regulatory authorities, farmers, and government policymakers in the agriculture industry can apply the conclusions of this study. Concerns and expertise of the farmer have the greatest influence on incremental tactics and the agriculture water management system. Therefore, regulatory authorities and government entities can organize a variety of educational programs and awareness campaigns via seminars, workshops, and forming events. It will increase the farmers' understanding of utilizing incremental tactics during emergencies or dealing with these limited resources in the field. In addition, the gradual technique should be incorporated into agricultural studies in the form of a curriculum to increase students' understanding of the problem of water shortage and its potential solutions from an early age.

Moreover, municipal committees and agricultural management units at local and administrative levels should communicate with farmers on an ongoing basis to instill confidence in their ability to find solutions to scarce water issues, given the importance of farmers' self-efficacy in efficiently and effectively utilizing incremental strategies to manage scarce water resources in the agricultural sector. In addition, farmers should be equipped with technical skills. To this end, the competent authorities should establish technical institutions that provide education in agricultural and resource management. This upgrading of technical skills can boost the configuration and capacity of farmers to implement incremental solutions and safeguard agricultural water resources.

8. Limitations and Future Research Directions

In addition to the study's several strengths in giving empirical findings about determinants of agriculture water management and incremental adaptation measures, it also has certain drawbacks that future studies must address. First, the current study has relied solely on quantitative research methods to obtain data from farmers using questionnaires. For this reason, they administered a self-administered survey in which farmers were required to answer questions about incremental techniques, their skills, and their effectiveness exclusively. In contrast, future researchers will be able to engage with farmers and conduct formal interviews to learn more about their perspectives on constrained water supplies and how they employ various incremental tactics to manage those resources. In addition, it will detail the tactics they use during agricultural procedures. This study has only examined the psychological factors of farmers.

Nevertheless, the environmental cues that influence their conduct are disregarded. For example, the social norms and community practices to be considered by future academics in terms of farmers employing incremental measures to safeguard restricted agricultural water resources. Finally, only farmers directly involved in irrigation procedures and exposed to water management challenges have provided information. To gain a better understanding of the actual implementation of different incremental strategies by farmers on the field based on their concerns, perceptions, and knowledge of the scarcity of water and the sustainable use of those resources, future research can also consider the perspective of the agricultural managing authorities in different villages.

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