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Knowledge-Based Approaches to Adaptive Agriculture: An Ethnoecological Case Study of Indigenous Communities in Climate Change Adaptation

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Abstract. The research aims to understand how the local implementation of ethnoecological knowledge is integrated with adaptive farming practices to enhance agricultural resilience and environmental sustainability amidst climate change and identify factors influencing the successful adoption of these practices and their potential for broader adoption within the context of Indigenous community agriculture in similar regions. This study employs a qualitative research approach, specifically a single holistic case study. This approach allows for an in-depth exploration of knowledge-based approaches to adaptive agriculture among vegetable farmers in Dieng, Java. Data analysis technique will follow Miles and Huberman's interactive model, which involves a systematic process of data reduction, data display, and conclusion drawing. Based on the findings in the study, it was concluded that, several key factors greatly influence the successful adoption of indigenous agricultural practices. These include the active involvement of community leaders and elders who have in-depth knowledge of effective traditional practices and government support through subsidies, loans and policies that support customary land rights and sustainable agricultural practices.

Keywords: agriculture; climate change; ethnoecological

INTRODUCTION

Climate change poses a significant challenge to agricultural systems globally, impacting food security, livelihoods, and environmental sustainability. Indigenous communities in Java, Indonesia, have traditionally relied on ethnoecological knowledge to adapt to changing environmental conditions (Kamakaula, 2024). This knowledge, accumulated over generations, plays a crucial role in helping these communities develop adaptive strategies that enhance agricultural resilience and sustainability in the face of climate variability. To address agriculture's vulnerability to climate change, a multifaceted approach is necessary, including developing climate-resilient crop varieties, adopting sustainable farming practices, improving water management strategies, enhancing early warning systems, and promoting diversification of agricultural systems (Pathak, 2023). Sustainable agriculture has emerged as a critical solution to the various environmental, social, and economic challenges faced by the agricultural sector (Ruslan & Khalid, 2023).

Historical statistical studies and integrated assessment models provide evidence that climate change will impact agricultural yields, earnings, food prices, delivery reliability, food quality, and food safety. Furthermore, land degradation increases the vulnerability of agroecological systems to climate change and reduces the effectiveness of adaptation options (Webb et al., 2017). Climate change adaptation in agriculture (CSA) practices, which aim to manage agriculture for food security under climate change, can enhance soil health and carbon storage, contributing to building more climate-resilient agricultural (Dougill et al., 2021) Agricultural biodiversity plays a crucial role in promoting sustainable and resilient food systems by raising output, enhancing soil quality, lowering the risk of pests and diseases, and diversifying crops and livestock.

Climate change adaptation is a crucial aspect of mitigating the adverse effects of climate change, particularly for vulnerable populations like Indigenous communities. Indigenous communities in Java have been utilizing adaptive strategies rooted in their traditional knowledge and cultural heritage to effectively address climatic challenges (Badrudin et al., 2023). These strategies involve practices such as adjusting planting

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schedules, diversifying crops, and implementing soil conservation techniques. By leveraging these traditional practices, Indigenous communities are demonstrating resilience and innovation in the face of environmental changes, ultimately enhancing food security and promoting environmental sustainability (Lam et al., 2019). The incorporation of Indigenous knowledge systems in agriculture has been demonstrated to significantly contribute to low farming costs, high crop yields, and effective environmental management. These local knowledge systems play a critical role in sustainable crop and livestock production, emphasizing the importance of integrating traditional practices with modern agricultural approaches.

Moreover, the sociocultural significance of traditional foods within Indigenous communities is paramount for ensuring food security and overall well-being. Traditional foods not only facilitate knowledge transmission but also serve as fundamental components of Indigenous food systems, playing a crucial role in enhancing food security and promoting community health (McEachern et al., 2022). It is crucial to acknowledge that Indigenous communities globally are increasingly vulnerable to food insecurity due to declines in wildlife and the impacts of climate change (Priadka et al., 2022). These challenges require a comprehensive approach to enhancing food security, which includes integrating food production with community priorities for education, training, health, economic development, and scientific innovation. By revitalizing traditional food systems, Indigenous communities can bolster their food sovereignty, preserve their ways of life, and promote overall well-being (Delormier et al., 2017).

Research on the climate change adaptation practices of local and indigenous communities, specifically among vegetable farmers in Dieng, provides highly valuable insights. Although these communities are known for effectively implementing climate adaptation strategies, several research gaps remain. First, understanding how local knowledge and modern techniques are integrated and passed down to future generations is essential. Studying the mechanisms through which farmers share knowledge can offer insight into the sustainability of these adaptive practices (Šūmane et al., 2018). Furthermore, while adaptive practices such as climate-resilient crop varieties and technology-based irrigation systems have been well-documented, the specific impacts of these techniques on productivity, soil health, and long-term food security have not been extensively studied. Addressing this gap through detailed research on the effects of these techniques would be beneficial (Ahmed et al., 2022).

In addition, challenges related to scaling and replicability remain. The factors that limit or enable the expansion of Dieng's adaptive practices to other regions with different ecological and socio-economic conditions are not yet fully understood. Investigating these factors is critical to assessing the adaptability of Dieng’s practices in various contexts. Finally, the socio-economic factors influencing farmers’ decisions to adopt adaptive practices also require exploration. Elements such as financial constraints, access to resources, and community support play crucial roles in the adoption process. A comprehensive examination of these factors can provide a deeper understanding of sustainable climate adaptation processes among local communities (Ahmed et al., 2022)

The novelty of this research lies in its focus on the integration of ethnoecological knowledge and adaptive agricultural practices specifically within the context of indigenous communities in Dieng, Java. While numerous studies have addressed climate change adaptation in agriculture, this research uniquely emphasizes the role of indigenous knowledge systems in developing resilient and sustainable agricultural techniques. By documenting and analyzing

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the traditional practices of Dieng's vegetable farmers, the study contributes to a deeper understanding of how local knowledge can inform and enhance modern climate adaptation strategies.

The objectives of this study are to document and analyze knowledge-based approaches to adaptive agriculture practiced by indigenous communities in Dieng, Java, in response to climate change. The research aims to understand how local communities implement ethnoecological knowledge integrated with adaptive farming practices to enhance agricultural resilience and environmental sustainability amidst climate change. Additionally, it seeks to identify factors influencing the successful adoption of these practices and their potential for broader adoption within the context of indigenous community agriculture in similar regions. The significance and contribution of this study will contribute to the understanding of the role of indigenous knowledge in climate change adaptation and provide insights into the potential for integrating traditional practices with modern approaches. The findings will be useful for policymakers and practitioners seeking to enhance the resilience of agricultural systems in Java and other similar regions.

METHODS

Research Approach, this study employs a qualitative research approach, specifically a single holistic case study. This approach allows for an in-depth exploration of knowledge-based approaches to adaptive agriculture among vegetable farmers in Dieng, Java. By focusing on a single case, the research aims to provide a comprehensive understanding of how indigenous knowledge and sustainable farming practices contribute to climate change adaptation (Willig & Rogers, 2017).

Data collection techniques, data collection will utilize semi-structured interviews, observation, and documentation. Semi-structured interviews will be conducted with selected vegetable farmers in Dieng who have maintained traditional farming techniques and prioritize environmental conservation in their adaptation strategies. Observations will supplement interview data by providing insights into daily farming practices and environmental interactions. Additionally, documentation such as farming records and community reports will be reviewed to enrich the data gathered from interviews and observations (*metode penelitian kuantitatif, kualitatif,dan R&D*, 2016).

In research on climate adaptation practices among Dieng's vegetable farmers, the choice of informants is crucial to ensure depth of insight, especially when using a small sample size. Taking only five informants can provide valuable, in-depth qualitative data, particularly if each is carefully chosen for their extensive experience and demonstrated commitment to climate-resilient practices. However, this sample size may limit the representativeness of the findings across the larger farming community in Dieng, especially given that Dieng spans two regencies (Banjarnegara and Wonosobo). This diversity in location might mean variations in local farming conditions, adaptation strategies, or resources, which a sample of five may not fully capture.

The study was conducted between 2023 and 2024, during which purposive sampling was employed to select experienced, knowledgeable farmers who could provide rich qualitative insights. While this approach allows for depth in understanding, it also means the findings are more exploratory than representative. To address this limitation, it may be beneficial to consider adding additional informants from both regencies or using a multi-stage sampling approach. This would involve selecting key informants for depth while also incorporating broader sampling to capture any regional differences in adaptation practices. Alternatively, triangulating the findings with secondary data or observations could strengthen the representativeness of the results across Dieng’s diverse farming community.

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Data analysis technique, data analysis will follow Miles and Huberman's interactive model, which involves a systematic process of data reduction, data display, and conclusion drawing. This approach allows for the integration of qualitative data collected through interviews, observations, and documentation. Themes and patterns emerging from the data will be identified, providing insights into the role of indigenous knowledge and sustainable farming practices in climate change adaptation. By employing these methodologies, this study aims to contribute to the understanding of effective adaptive strategies in agriculture, particularly within indigenous communities facing climate variability and environmental challenges in Dieng, Java.

Additionally, the choice of Dieng as the research location adds a distinctive dimension to the study. Dieng's unique agroecological environment, coupled with the region's proactive implementation of climate-resilient crop varieties and sustainable land and water management practices, provides a rich context for examining adaptive agricultural techniques. The combination of these specific variables—indigenous knowledge, adaptive agricultural practices, and the unique geographical and climatic conditions of Dieng—sets this research apart and offers valuable insights that can be applied to similar regions facing the challenges of climate change.

RESULTS AND DISCUSSION

Research Informant

In the context of the research, coding and grouping informants from interview, observation and documentation data collection plays a crucial role in the analysis process. Grouping informants allows researchers to compare and contrast information between different groups or individuals, supporting an understanding of the demographic context that influences informants' perspectives, namely farmers who practiced traditional agriculture in the last 15 years. By selecting informants from different groups, researchers can seek more in-depth information, improve sample selection and increase the generalizability of research findings.

Including detailed information on the characteristics of each informant's farming activities will enhance the relevance and clarity of the data by directly linking it to the research topic on climate-resilient agriculture. The list below can be expanded to show how each informant's farming practices align with adaptive strategies to climate change, adding valuable context for understanding the diversity of methods used in Dieng. The combination of coding and informant grouping ensures that the analysis of interview data is systematic and produces reliable findings, enriching the understanding of the phenomenon under study can be seen in **Table 1.**

Table 1. Research informants

No.	Name (Initial)	Duration of Traditional Farming	Adaptive Practices Related to Climate Resilience
1.	AB	15 years	Uses climate-resilient crop varieties, employs terracing for erosion control
2.	MAK	15 years	Implements mulching to retain soil moisture, uses organic pest control
3.	DAS	16 years	Practices crop rotation to maintain soil health, uses adaptive seed varieties
4.	AP	17 years	Utilizes drip irrigation to optimize water use, engages in soil fertility improvement techniques
5.	SIP	16 years	Employs traditional water management, integrates organic fertilizers

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Table 1 presents the research informants, which are individuals who provided information for the study. The table includes the name of each informant, represented by their initials, and the duration of their traditional farming experience. This information is crucial for understanding the context and perspectives of the indigenous communities involved in the study. The duration of traditional farming experience for each informant ranges from 15 to 17 years, indicating a significant amount of experience and knowledge that can be drawn upon for the research.

This approach highlights how each farmer's methods contribute to climate adaptation and sustainability, showing not only the informants' experience but also specific practices that align with the research's focus on knowledge-based adaptation. This detail improves understanding of each informant's expertise and shows a clear rationale for their inclusion based on their unique approaches to climate-resilient agriculture.

The findings of this study contribute to the understanding of the role of indigenous knowledge in climate change adaptation and provide insights into the potential for integrating traditional practices with modern approaches. The research highlights the importance of ethnoecological knowledge in enhancing agricultural resilience and environmental sustainability amidst climate change.

The study also identifies factors influencing the successful adoption of these practices and their potential for broader adoption within the context of indigenous community agriculture in similar regions. The findings will be useful for policymakers and practitioners seeking to enhance the resilience of agricultural systems in Java and other similar regions.

Implementation of Local Ethnoecological Knowledge Integrated with Adaptive Agriculture Practices

The implementation of local ethnoecological knowledge integrated with adaptive agriculture practices is an approach that combines local communities' traditional knowledge of ecology with modern agricultural techniques that can adapt to environmental changes. Local ethnoecological knowledge includes a deep understanding of biodiversity, climate patterns, and natural resource management practices that have been passed down through generations, as seen in **Table 2.**

Based on the **table 2**, it was found that the implementation of traditional agriculture by Dieng farmers includes the development of climate-resilient crop varieties, sustainable land and water management techniques, information and monitoring systems, farmer education and training, and agricultural diversification. Broadly speaking, efforts to overcome the failure of traditional agriculture in overcoming extreme weather are by conducting crop rotation, terracing, providing superior seeds, and participating in training with other farmers in Dieng.

Traditional agriculture in Dieng refers to long-standing farming practices passed down through generations, developed in response to the unique environmental conditions of the area. These practices include techniques such as terracing to prevent soil erosion on steep slopes, using organic fertilizers, crop rotation, and water conservation methods. The aim is to maintain soil fertility, manage water efficiently, and ensure sustainable land use. Traditional agriculture in Dieng also involves cultivating local vegetable varieties better suited to the specific climate and soil conditions.

The differences between traditional agriculture, Local Ethnoecological Knowledge (LEK), and Indigenous Agricultural Practices lie in their scope and philosophical foundations.

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Traditional agriculture includes region-specific farming techniques that may have evolved in response to local environmental constraints. In contrast, LEK is a broader understanding that local communities have about ecological relationships, plant characteristics, soil conditions, weather patterns, and seasonal cycles. In Dieng, LEK helps farmers recognize shifts in weather patterns and adjust planting cycles or water usage accordingly. LEK encompasses more than just agricultural methods, including insights into ecosystems and biodiversity.

Table 2. Implementation of traditional agriculture in Dieng

Indicators	Findings	Informant
Development of Climate-Resilient Crop Varieties	Using superior seeds that have been proven to be resistant to climate change and in accordance with the land conditions in the Dieng region	AB, DAS, dan AP
	Develop vegetable varieties that are more resistant to changing weather conditions	SIP dan MAK
Sustainable Land and Water Management Techniques	Apply terracing techniques, use of mulch, and efficient water management to maintain the fertility of agricultural land	AB, AP, SIP, dan MAK
	Implementing a drip irrigation system to reduce water loss and increase productivity	MAK dan SIP
Information and Monitoring System	Together with the village government develop an early warning system for farmers in times of extreme weather changes.	AB, DAS, dan AP
Farmer Education and Training	Participate in training programs for farmers on farming techniques, use of technology, and land and crop management practices	SIP, AB, DAS, dan AP
	Form groups so that they can share knowledge and experience with each other.	MAK dan AP
Agricultural Diversification	Implement crop rotation practices to prevent soil degradation and maintain ecosystem balance	AB, DAS, dan AP
	Integrate vegetation in agricultural systems to increase biodiversity	AB, AP, SIP, dan MAK

In the Dieng region, traditional agriculture refers to the farming practices that have been passed down over generations, focusing on methods suited to the local environment, such as terracing and using climate-resilient seeds. While traditional agriculture incorporates local knowledge, Local Ethnoecological Knowledge specifically emphasizes understanding the ecosystem and landscape through a cultural lens, whereas Indigenous Agricultural Practices often encompass deeply rooted cultural, spiritual, and ecological values unique to indigenous communities.

Factors Influencing the Successful Adoption of Indigenous Agricultural Practices

Several key factors influence successful adoption of local agricultural practices. Farmers' knowledge and skills on traditional practices are critical, as a deep understanding of these techniques allows for more effective implementation. Support from the government and relevant institutions, such as the provision of training, access to resources, and supportive policies, can strengthen the adoption of such practices. The involvement of local communities plays an important role in facilitating the exchange of knowledge and practices among farmers can be seen in **Table 3.**

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Table 3. Factors influencing the successful adoption of indigenous agricultural practices

Indicators	Findings	Informant
Integration of Local Knowledge	Collaboration of traditional agricultural practices and local knowledge into modern adaptation strategies	AB, AP, SIP, dan MAK
	Maintain customary knowledge systems and involve community elders in agricultural development	AB, AP, SIP, dan MAK
Access to Resources	Ease of obtaining superior seeds for farmers	AB dan SIP
	Village government provides subsidies or loans to develop agriculture	SIP, AB, DAS, dan AP
Capacity Building	Training programs to improve agricultural skills for farmers	AP, SIP, dan MAK
	Farmer-to-farmer knowledge exchange and field demonstrations are effective methods	SIP dan MAK
Community Engagement	Active participation and support from the community through a participatory approach	SIP, AB, DAS, dan AP
	Involving community leaders and local organizations in planning and implementation ensures cultural relevance and sustainability.	MAK, AP, dan SIP
Market Access and Economic Viability	Ensuring that the practices adopted increase productivity, income, and market access is critical	SIP, AB, DAS, dan AP
	Support initiatives that connect farmers to markets	AB, AP, dan MAK
Policy and Institutional Support	Policies that promote sustainable agriculture, incentivize climate-smart practices, and protect indigenous land rights are crucial	MAK dan AB
	Collaboration with academic institutions to facilitate knowledge transfer and adaptation	SIP, AP, dan MAK
Climate Resilience Education	Increase awareness of climate change impacts to encourage proactive responses in appropriate agricultural land management.	AB, AP, dan SIP

Based on the table 3, integrating traditional agricultural practices and local knowledge into modern adaptation strategies is essential for sustainable development. This approach includes maintaining customary knowledge systems, involving community elders, and ensuring easy access to improved seeds. Village governments play an important role by providing subsidies or loans, while training programs improve agricultural skills. Effective methods such as farmer-to-farmer knowledge exchange and field demonstrations encourage active community participation through participatory approaches. Involving community leaders and local organizations in planning and implementation ensures cultural relevance and sustainability. The practices adopted should increase productivity, income and market access. Policies that promote sustainable agriculture, incentivize climate-smart practices and protect customary land rights, as well as collaboration with academic institutions, facilitate knowledge transfer and adaptation. Raising awareness of climate change impacts encourages proactive farmland management.

The success of Indigenous Agricultural Practices can be measured by indicators such as improved productivity, soil health, climate resilience, and economic viability for farmers. To determine how many vegetable farmers in Dieng have adopted these practices, surveys or interviews can be

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conducted to gather data on the extent and consistency of their use of indigenous techniques, then compared with overall productivity and sustainability metrics across the farming population.

Table format to measure the factors for the successful adoption of Indigenous Agricultural Practices, including indicators and measurement methods can be seen in **Table 4.**

Table 4. Format to measure the factors

Factor	Indicator	Measurement Method	Informant
Integration of Local Knowledge	Percentage of practices incorporating local knowledge	Interviews/surveys with farmers to identify traditional knowledge in use	AB, AP, SIP, MAK
	Frequency of elder consultation in decision-making	Review of community meeting records for evidence of elder involvement	AB, AP, SIP, MAK
Access to Resources	Availability and frequency of superior seed access	Survey or interview on seed access, assessing ease of procurement	AB, SIP
	Levels of subsidies/loans provided	Record analysis and focus group discussions on subsidy or loan distribution	SIP, AB, DAS, AP
Capacity Building	Number of training sessions conducted; improved skills reported	Collect data on training frequency and post-training reports by farmers	AP, SIP, MAK
	Participation rates in farmer-to-farmer knowledge exchanges	Observe and survey outcomes of knowledge exchanges or field demonstrations	SIP, MAK
Community Engagement	Level of community participation	Survey farmers on community involvement in decision-making	SIP, AB, DAS, AP
	Percentage of initiatives involving local leaders and organizations	Analyze records of leader involvement in program planning and implementation	MAK, AP, SIP
Market Access and Economic Viability	Change in productivity and income levels before and after IAP adoption	Analyze income and yield records, pre- and post-adoption	SIP, AB, DAS, AP
	Frequency of market access and support initiatives	Review sales records and interview informantson market access initiatives	AB, AP, MAK
Policy and Institutional Support	Presence of policies supporting sustainable agriculture	Policy document review and analysis of impacts	MAK, AB
	Frequency of collaborations with academic or other institutions	Documentation of partnership activities and impact assessment	SIP, AP, MAK
Climate Resilience Education	Awareness level of climate impacts	Awareness surveys on climate change impacts and proactive management	AB, AP, SIP
	Adoption rate of climate-resilient practices post-education	Track and record adoption of climate-smart practices after educational initiatives	AB, AP, SIP

Knowledge-based approaches in adaptive agriculture combine traditional knowledge and local ecology to face the challenges of climate change. Ethnoecological case studies of indigenous communities show that knowledge passed down through generations plays an important role in adaptation strategies. Indigenous communities often have a deep understanding of their environment and sustainable agricultural practices, which enables them to adapt to changing climate conditions. Involving community leaders and local organizations in adaptation planning and implementation ensures cultural relevance and sustainability. In addition, this approach

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encourages knowledge exchange among farmers, skills training and collaboration with academic institutions to facilitate knowledge transfer. Thus, this knowledge-based approach not only improves agricultural productivity and resilience but also protects customary land rights and supports environmental sustainability.

Based on the table 4 allows for tracking and analyzing each factor and its indicators, providing a comprehensive framework for evaluating the determinants of successful Indigenous Agricultural Practices adoption.

To measure the success of Indigenous Agricultural Practices (IAP) among vegetable farmers in Dieng, several key indicators can be utilized. Firstly, the adoption rate is crucial, defined as the percentage of farmers implementing IAP compared to the total population of vegetable farmers in the region. For instance, if there are 1,000 vegetable farmers in Dieng and a survey reveals that 300 have adopted these practices, the adoption percentage would be 30%. Additionally, measuring yield improvement by comparing crop yields before and after adopting IAP provides insight into the effectiveness of these practices. Income levels are also important, as analyzing financial records can reveal changes in income due to IAP adoption. Other indicators include assessing soil quality through soil tests, evaluating water management efficiency by measuring water usage rates, and analyzing community engagement levels through participation in related programs. Furthermore, gauging farmers' knowledge of climate change adaptation and reviewing policy support are essential for understanding the broader context of IAP adoption. Collectively, these indicators offer a comprehensive framework for assessing the impact and success of Indigenous Agricultural Practices among vegetable farmers in Dieng.

Implementation of Local Ethnoecological Knowledge Integrated with Adaptive Agriculture Practices

The implementation of local ethnoecological knowledge integrated with adaptive agricultural practices is a very important approach in developing agricultural strategies that are sustainable and responsive to climate change. Indigenous peoples' traditional knowledge, which includes a deep understanding of local ecosystems, conservation practices and farming techniques that have proven effective over the years, is a key cornerstone in this process (Ruminta et al., 2020). By combining this knowledge with modern adaptive practices, such as the use of improved seeds, efficient irrigation techniques and crop diversification, communities can increase agricultural productivity and resilience to climate change (Zainal Arifin et al., 2023).

The process of implementing local ethnoecological knowledge also involves various important stages, such as training, knowledge exchange among farmers, and support from the local government in the form of subsidies or loans. Collaboration with academic institutions is also a key factor in ensuring knowledge transfer and adaptation of best practices (Saefullah et al., 2023). This approach aims not only to increase agricultural yields but also to maintain environmental sustainability and preserve the cultural heritage of indigenous communities (Kurniawan & Arisurya, 2021). Agroecology, which emphasizes the integration of ecological principles into agricultural systems, provides a strong theoretical foundation for this approach. Agroecological principles enable the development of more resilient and sustainable food production systems, in line with the demands of modern adaptive agriculture (Yastika et al., 2023). In addition, the application of adaptive technologies is also an integral part of efforts to anticipate the impacts of climate change, especially in the context of rainfed wetland agriculture (Asteriniah & Hestiriniah, 2023)

In the context of cultural heritage preservation and environmental conservation, heritage preservation models that integrate local traditions with modern

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technological innovations are relevant in ensuring a synergistic relationship between tradition and current developments (Sarvina, 2019). This shows the importance of maintaining local cultural values in the development of adaptive agricultural practices that are responsive to climate change. Farmers' strategies to climate change are also a major focus in the implementation of local ethnoecological knowledge. These strategies include agricultural intensification and extensification, diversification of agricultural businesses, and migration as adaptive measures in the face of climate change (Sari & Khairi, 2022). In this context, socialization, training and assistance in strengthening agricultural institutions are key in ensuring the successful implementation of local ethnoecological knowledge (Adiyoga & Basuki, 2019)

Analyzing farmers' responses to climate change is also an important part of understanding the impact of climate change on local agricultural practices. Setting the right cropping pattern and adapting to rainfall are important strategies in increasing optimal agricultural production yields (Alfiandy & Firman Ilahi, 2023). In addition, the collaborative governance approach in the development of chili also shows that cooperation between various parties, including farmers, government, and related institutions, is key in creating a sustainable agricultural model (Harini et al., 2022).

The impact of climate change on fruit and vegetable crop production also requires appropriate adaptation strategies. Climate field schools are one of the effective methods in equalizing perceptions and disseminating adaptation technologies to climate change to farmers. Climate education and literacy are also important factors in ensuring farmers' awareness of climate change and its impact on sustainable agriculture (Ruminta et al., 2020). Increasing agricultural productivity through the adoption of agricultural technology is very relevant in the context of implementing local ethnoecological knowledge. The adoption of agricultural technology is an important resource in increasing crop production in a sustainable manner. In addition, the knowledge and adaptation of vegetable farmers to climate change also shows the importance of shifting planting time, changing cropping patterns, and using adaptive agricultural techniques in the face of climate change (Satria et al., 2023).

Prediction of crop yields using machine learning methods has also become relevant in the context of modern agriculture that is responsive to climate change (Kristiandi et al., 2022). The effect of climate parameters on fruit crop productivity also shows that a deep understanding of environmental factors is key in developing adaptive agricultural strategies. Efforts to empower dryland farmers are also an important part of realizing sustainable agriculture and food security. Thus, the implementation of local ethnoecological knowledge integrated with adaptive agriculture practices is a holistic approach that involves various aspects, from the traditional knowledge of indigenous peoples to the adoption of modern agricultural technology. Collaboration between various stakeholders, training, socialization and mentoring are key in ensuring the success of this implementation. With this approach, it is expected that agriculture can become more productive, sustainable and responsive to climate change, while still maintaining environmental sustainability and preserving the cultural heritage of indigenous communities (Mihiretu et al., 2024).

Factors Influencing the Successful Adoption of Indigenous Agricultural Practices

Factors that influence the successful adoption of indigenous agricultural practices include various social, economic and environmental aspects. One key factor is the presence and involvement of community leaders and elders who have in-depth knowledge of effective traditional practices. Support from the government, such as subsidies, loans and policies that support

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customary land rights and sustainable agricultural practices, is also crucial. In addition, access to good markets and adequate infrastructure can encourage farmers to adopt traditional techniques that increase productivity and income. Ongoing training and education helps farmers understand the benefits of customary practices and how to integrate them with modern technologies. Knowledge exchange between farmers through field demonstrations and community networks also facilitates information dissemination. Awareness of climate change and its impacts encourages the adoption of practices that are more resilient to changing environmental conditions. With a combination of these factors, the adoption of indigenous agricultural practices can be successful and provide long-term benefits to communities and the environment.

The successful adoption of indigenous agricultural practices is influenced by a myriad of factors encompassing social, economic, and environmental dimensions. One pivotal element in this process is the active involvement of community leaders and elders who possess profound knowledge of effective traditional practices (Purba et al., 2020). These elders play a crucial role in fostering relationships within the community, facilitating intergenerational knowledge transfer, and contributing to overall community wellness (Viscogliosi et al., 2020). Moreover, the support from governmental bodies through mechanisms such as subsidies, loans, and policies that uphold customary land rights and sustainable agricultural practices is paramount in ensuring the viability of indigenous agricultural techniques. By providing financial support for infrastructure development in indigenous communities and involving elders in policy-making processes, governments can significantly enhance the adoption of traditional practices (Nguyen et al., 2020)

Furthermore, access to robust markets and adequate infrastructure serves as a catalyst for farmers to embrace indigenous techniques that can bolster productivity and income levels. Additionally, ongoing training and education initiatives are essential in enlightening farmers about the benefits of customary practices and how to seamlessly integrate them with modern technologies. This educational aspect not only empowers farmers but also equips them with the necessary skills to navigate the evolving agricultural landscape effectively. Moreover, knowledge exchange platforms such as field demonstrations and community networks play a pivotal role in disseminating information among farmers, thereby fostering a culture of shared learning and collaboration (Kawung et al., 2024).

Awareness of climate change and its repercussions on agricultural systems is another critical factor that drives the adoption of indigenous practices. Understanding the imminent impacts of climate change encourages farmers to embrace techniques that are more resilient to changing environmental conditions. By integrating climate-smart agricultural practices, farmers can mitigate greenhouse gas emissions, enhance soil health, conserve water, and promote biodiversity. These practices not only contribute to environmental sustainability but also ensure the long-term viability of agricultural systems in the face of a changing climate.

In addition to these factors, the literature underscores the significance of building strong cultural connections and resilience within indigenous communities to support the adoption of traditional agricultural practices (Fitzpatrick et al., 2023). Initiatives such as elder-led mentorship programs and community needs assessments through culturally sensitive methodologies like talking circles play a pivotal role in revitalizing indigenous knowledge systems and promoting community well-being. By leveraging indigenous learning principles, community-led processes, and incorporating indigenous curriculum content, communities can reclaim resilience and strengthen their

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cultural heritage (Yumagulova et al., 2020)

Moreover, the role of indigenous elders in transmitting religious and cultural values through local knowledge systems is instrumental in preserving traditional practices and fostering a sense of communal identity. The holistic and integrated nature of indigenous educational values underscores the profound impact elders have in shaping future leaders and upholding cultural traditions (Gunara et al., 2019). By recognizing and honoring the wisdom of elders, communities can ensure the continuity of indigenous knowledge systems and practices for generations to come.

The successful adoption of indigenous agricultural practices hinges on a multifaceted approach that encompasses the active involvement of community leaders and elders, government support, access to markets and infrastructure, ongoing education and training, knowledge exchange mechanisms, climate change awareness, and the revitalization of cultural connections within indigenous communities. By synergizing these factors and fostering a collaborative environment that values traditional knowledge, communities can enhance agricultural sustainability and promote overall well-being and resilience among their members.

CONCLUSION

Based on the findings in the study, it was concluded that, several key factors greatly influence the successful adoption of indigenous agricultural practices. These include the active involvement of community leaders and elders who have in-depth knowledge of effective traditional practices, as well as government support through subsidies, loans and policies that support customary land rights and sustainable agricultural practices. Access to good markets and adequate infrastructure also encourages farmers to adopt traditional techniques that increase productivity and income. Ongoing training and education initiatives are important to help farmers understand the benefits of traditional practices and how to integrate them with modern technologies. Knowledge exchange platforms such as field demonstrations and community networks also play an important role in disseminating information and enhancing collaborative learning. Climate change awareness also encourages the adoption of practices that are more resilient to environmental changes, while ensuring cultural and environmental sustainability.

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