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IDENTIFICATION OF CONSTRAINTS AND THE ROLE OF EXTENSION WORKERS IN INNOVATION IN WELTH RICE CULTIVATION IN THE RESPONSE TO CLIMATE CHANGE IN NORTH ACEH DISTRICT

Setia Budi[1], Eva Wardah*[2], Nopri Yanto[3]
[1,2,3]Agribusiness Department, Faculty of Agriculture, Universitas Malikussaleh, Indonesia
*Corresponding Author: evawardah@unimal.ac.id.

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Abstract

Climate change has affected rice productivity in North Aceh Regency, characterized by rainfall fluctuations, increased temperatures, and disruption of agricultural ecosystems. This study aims to identify obstacles faced by farmers in implementing innovations in rice cultivation and analyze the role of agricultural extension workers in supporting adaptation to climate change. The method used in this study was a survey method with qualitative descriptive analysis of 80 respondents in North Aceh Regency. The results showed that the main obstacles included limited adaptive superior seeds (86.56%), availability of irrigation water (80.63%), and low climate literacy (78.24%). The role of adaptive extension workers was assessed as "instrumental" with an average index value of 69.71%, the highest score for the extension worker variable as an innovator (78.63%) and extension workers as educators with an index value of (75.08%). The results of this study emphasize the importance of extension workers as agents of change in terms of technology transfer, climate education, and facilitating access to resources. Community-based extension strategies and participatory approaches have proven effective in increasing farmers' adaptive capacity. The importance of strengthening the role of extension workers through training, policy support, and cross-sector collaboration to accelerate the adoption process of innovations in rice cultivation that are resilient to climate change.

Keywords: ***The role of extension,*** **Climate change,** ***Obstacles to agricultural innovation, Paddy Fields,***

INTRODUCTION

Climate change has become a major challenge in the agricultural sector, particularly in lowland rice cultivation, which is highly dependent on environmental conditions. According to research conducted by the Agricultural Research and Development Agency, changing rainfall patterns and rising air temperatures have led to decreased rice productivity and increased the risk of crop failure. According to the Central Statistics Agency (BPS) in 2023, Indonesian rice production has tended to decline over the past 10 years. In 2012, national rice production reached more than 69.05 million tons of dry milled grain (GKG). This figure then increased again to 81.07 million tons of GKG in 2017. However, after this significant increase, national rice production plummeted in 2018 to only 54.64 million tons of GKG, and fell again to 54.41 million tons of GKG in 2021. Most recently, in 2022, rice production experienced a very slight increase, reaching only 54.74 million tons of GKG. This achievement is very small compared to national rice production a decade ago.

Table 1. Rice Production Development in Aceh Province and Indonesia 2018-2022

Province	Production (tons)			
	2019	2020	2021	2022
Aceh	1,861,567.10	1,714,437.60	1,757,313.07	1,634,639.60
Indonesia	59,200,533.72	54,604,033.34	54,649,202.24	54,415,294.22

Source: BPS, 2023

There has been a decline in production results both at the national level and in Aceh province.In 2022, rice production in Aceh decreased by 7.66%, reaching only 1.51 million tons of unhusked rice (GKG). This figure is lower than the 1.63 million tons in 2021. Meanwhile, rice production, which is used to feed the population, decreased by 72,120 tons, from 0.87 million tons in 2021. This figure is lower than the 0.94 million tons in 2021. North Aceh Regency is one of the regions in Aceh Province that serves as a food barn, particularly for paddy rice. The amount of rice produced is a determining factor in food security in Aceh. In 2022, the rice harvested area in North Aceh was 54,723.91 hectares, with a total production of 318,432.63 tons (BPS North Aceh, 2023). Agricultural extension workers play a crucial role in transferring technological innovations to farmers to increase resilience to climate change. Studies show that extension workers who actively provide education and assistance to farmers can increase the adoption of adaptive technologies, such as the use of superior drought-resistant varieties and water-efficient irrigation systems (Budi. S, 2018, Aulia. M et al., 2023). Furthermore, extension workers also play a role in raising farmer awareness of the importance of climate change mitigation through sustainable agricultural practices.

Technological innovation in lowland rice cultivation has advanced rapidly in recent years. Research conducted by Wihardjaka et al. (2020) shows that the application of adaptive technologies, such as the use of reservoirs for integrated water resource management and pest control, can increase the productivity of rainfed lowland rice. This technology not only increases yields but also mitigates the negative impacts of climate change on agricultural ecosystems. In addition to technological aspects, social and economic factors also play a role in the success of innovation transfer. A study by Aziz et al. (2021) highlighted that the success of technology adoption by farmers is significantly influenced by education levels, access to information, and government policy support. A holistic approach that combines social, economic, and technological aspects is necessary to ensure the sustainability of innovation in lowland rice cultivation. Climate change adaptation strategies in lowland rice cultivation also include developing superior varieties that are more resilient to extreme conditions. Research shows that selecting rice varieties with high tolerance to drought and salinity can increase productivity and reduce the risk of crop failure. Furthermore, implementing ecologically based farming systems, such as the use of organic fertilizers and crop rotation, can help increase the resilience of agricultural ecosystems to climate change (Mirawati, D et, al, 2023, Ruminta R, 2016).

The role of agricultural extension workers in transferring innovations in climate-resilient rice cultivation has been evident in recent years. Studies show that extension workers act as agents of change in increasing the adoption of adaptive technologies by farmers. Technologies such as the use of superior drought-resistant varieties, water-efficient irrigation systems, and ecologically based agricultural practices have been shown to increase rice productivity. Furthermore, community-based and participatory extension approaches have been shown to be effective in raising farmers' awareness of climate change mitigation. The urgency of this research stems from the problem of declining rice production, one of the causes of which is climate change affecting the rice-rice commodity subsector. Therefore, it is necessary to identify the various obstacles experienced by rice farmers due to climate change. Furthermore, it is necessary to analyze the role of agricultural extension workers in addressing climate change in rice cultivation activities.

METHOD

This research was conducted in North Aceh Regency, specifically in the Kuta Makmur and Banda Baro Districts. The locations were selected based on the presence of active rice farmers within the Agricultural Extension Center (BPP)'s work area and the involvement of agricultural extension workers in innovation transfer activities.

These locations were considered representative for illustrating the dynamics of interactions between farmers and extension workers in addressing the challenges of climate change.

The study population consisted of two main groups: rice farmers and agricultural extension workers within the BPP work area. The sampling technique was purposive, with 80 respondents, 40 from each sub-district. Respondent selection took into account their active involvement in extension activities and direct experience in implementing innovative rice cultivation practices that adapt to climate change. Data collection was conducted through structured interviews using a Likert-scale questionnaire to measure the level of constraints and the role of extension workers. The data obtained were analyzed descriptively and qualitatively to interpret the phenomena occurring in the field (Sugiono, 2013). The analysis was conducted by examining the percentage index of each indicator, then interpreting it based on the category of constraint level and role. This approach enabled researchers to gain a deeper understanding of the relationship between agricultural extension and farmers' adaptive capacity to climate change.

RESULTS AND DISCUSSION

Climate change has become a major challenge in the agricultural sector, particularly in rice cultivation in North Aceh Regency. Fluctuating and shifting rainfall patterns, rising temperatures, and extreme weather events impact the productivity and sustainability of farming. These conditions force farmers to adapt by implementing more efficient and climate-resilient cultivation innovations. However, this adaptation is not always smooth, as farmers still face various technical, environmental, and socio-economic obstacles. Field identification results indicate a number of constraints with varying degrees of impact on the implementation of innovations in lowland rice cultivation. Some are related to natural factors such as drought and pest attacks, while others are related to resource limitations such as superior seeds and irrigation water availability. The following illustrates the level of constraints faced by lowland rice farmers in North Aceh Regency due to climate change, based on the results of constraint index measurements and their interpretation.

Tabel 2. Identification of Constraints in Implementing Innovations in Rice Paddy Cultivation Due to Climate Change

No	Identification of obstacles to implementing innovations in rice cultivation due to climate change	Index (%)	Interpretation
1	Changes in Rainfall and Drought Patterns	45.32	Less constrained
2	Increasing Pest and Disease Attacks	72.44	Constrained
3	Limited Access to Adaptive Superior Seeds	86.56	Very constrained
4	Pest and Disease Attacks	70.39	Constrained
5	Availability of irrigation water	80.63	Constrained
6	Lack of Knowledge and Information on Climate Adaptation	78.24	Constrained
	Average	72.26	Constrained

The average constraint index value was 72.26%, indicating that the majority of climate change adaptation aspects of lowland rice cultivation in the study area still face substantial obstacles at the farmer level. High scores on several indicators also align with research findings on various issues, particularly access to adaptive seeds, water/irrigation availability, and increased pest and disease incidence during uncertain climates. Survey results show that farmers consider changes in rainfall patterns and drought to be relatively minor constraints. This indicates local adaptation through adjustments to the planting calendar, which is continually disseminated by extension workers and the government at the sub-district level, as well as the Keujruen Blang customary institution, in determining the planting season, taking into account keuneunong (rainfall calculations) calculations based on local wisdom. However, in general, rainfall variability remains a significant risk factor affecting critical phases of rice growth. Climate anomalies such as El Niño and La Niña can trigger droughts and floods, which have implications for potential crop losses.

Climate change (increased temperature and humidity) can accelerate pest life cycles and increase the incidence of plant diseases. Suryanto et al. (2021) reported that brown planthopper population explosions and rice blast disease in rice paddies often occur during extreme weather conditions. This phenomenon is frequently experienced by farmers in the research area, necessitating an integrated pest control strategy that adapts to climate dynamics. The availability of adaptive, superior seeds is crucial for rice farmers in the research area, as it is the primary foundation for successful production amidst the challenges of climate change. Seeds tolerant to drought, flooding, and pest and disease attacks can maintain stable crop yields despite uncertain environmental conditions. Furthermore, the use of adaptive seeds can reduce dependence on pesticides and other costly additional inputs,

making them more economically efficient. In the research area of North Aceh Regency, where the main irrigation system in Krueng Pase is still under repair, the irrigation system is not optimal for meeting the water needs of the rice fields. Therefore, the availability of adaptive, superior seeds is not only a technical option but also a regional food security strategy. In addition to increasing intensity, pest and disease attacks generally remain a major problem in lowland rice cultivation. emphasized that pest attack patterns are now increasingly difficult to predict, necessitating a technology-based monitoring system and integrated pest control training for farmers. In North Aceh Regency, climate change, which triggers irregular planting seasons and fluctuating air temperatures, also extends the life cycle of pests and accelerates their reproduction. Humid conditions resulting from unusually high rainfall, or conversely, drought followed by sudden rain, create an ideal environment for the development of plant pests such as brown planthoppers, stem borers, and blast disease. The cumulative impact of these phenomena is increased crop losses and high control costs, which in turn hinder the implementation of sustainable cultivation innovations at the farmer level (Hasanah et al. (2019)).

Irrigation water availability is a serious constraint, particularly during the dry season. Hidayat et al. (2020) noted that decreased water discharge in technical irrigation areas frequently occurs during the second planting season, impacting productivity and the sustainability of farming businesses. Efficient water use strategies and water resource management are adaptation priorities. Research with rice farmers has shown that this situation is exacerbated by the incomplete repairs to the Krueng Pase Main Irrigation network, which is the primary water source for most rice fields in the region. Delays in repairs have resulted in uneven water distribution to rice fields, forcing some farmers to adjust planting schedules or even reduce planting area and opt out of rice cultivation. This situation emphasizes the critical importance of sustainable irrigation water supply for rice farmers in the face of climate change.

Lack of climate literacy limits farmers' ability to respond appropriately to climate change. Nuryanti and Swastika (2018) demonstrated that agricultural extension workers play a crucial role in enhancing adaptive capacity through education and training that integrates local knowledge with modern technology. A collaborative strategy is needed across stakeholders, including local governments, the Meteorology, Climatology, and Geophysics Agency (BMKG), research institutions, universities, and farmer organizations. The government can strengthen climate-based extension programs with applicable and easy-to-understand materials, while research institutions provide detailed climate forecast data to support decision-making at the farmer level. Universities can play a role in developing training modules and adaptation technologies tailored to local conditions. Furthermore, farmer organizations need to be involved as information hubs and facilitators for innovation adoption in the field, so that climate literacy increases equitably and sustainably.

A. The Role of Adaptive Extension Workers in Lowland Rice Cultivation Against Climate Change

Climate change poses a challenge to lowland rice cultivation in North Aceh Regency. Changing rainfall patterns, rising temperatures, and the increasing frequency of extreme climate events impact productivity, cropping patterns, and the sustainability of farming businesses. In addressing these conditions, adaptive agricultural extension workers play a crucial role in helping farmers adjust cultivation strategies, manage risks, and capitalize on opportunities arising from advances in agricultural technology. Adaptive extension workers not only convey information but also respond quickly and appropriately to the dynamics of climate change (Salampessy, YLA, 2018). The role of extension workers in adapting to climate change encompasses various aspects, from facilitating farmer access to technology, introducing relevant innovations, motivating farmers to change their behavior, to providing ongoing education. The success of farmer adaptation efforts to climate change is greatly influenced by the quality of interactions between extension workers and farmers. Based on research results, the level of extension workers' role is measured through several key indicators (as facilitators, innovators, motivators, and educators), summarized in the following Table 3.

Table 3. The Role of Adaptive Extension Workers in Lowland Rice Cultivation Against Climate Change

No	The role of extension workers	Index (%)	Interpretation
1	As a Facilitator	70.36	Playing a role
2	As an Innovator	78.63	Playing a role
3	As a Motivator	54.76	Quite a Role
4	As an Educator	75.08	Playing a role
	Average	69.71	Playing a role

Based on the results of research conducted in North Aceh Regency, the role of adaptive agricultural extension workers is measured in four main indicators, namely the role of extension workers as facilitators, the role of extension workers as innovators, the role of extension workers as educators with an average value of 69.71% which is categorized as "involved". This shows that extension workers have carried out their role in supporting the adaptation of lowland rice cultivation to climate change, although there are variations in the level of role in each indicator. The role of agricultural extension workers as facilitators reflects their ability to bridge information, resources, and partnerships between farmers and various stakeholders. An index value of 70.36% indicates that agricultural extension workers in North Aceh Regency are quite effective in facilitating farmers' access to climate adaptation technologies, technical advisory services, and relevant marketing networks. Through this role, extension workers are able to connect farmers with research institutions, agricultural input providers, and other supporting institutions, thus facilitating farmers' access to innovations and adaptation tools such as agricultural insurance and stress-resistant seeds. This is in line with the findings of Nuryanti and Swastika (2018), who stated that the role of agricultural extension workers as facilitators has been shown to directly contribute to increasing farmers' capacity to access innovations and adaptation resources needed to address the risks of climate change.

The highest index in this study was found in the indicator of the role of extension workers as innovators, with an index value of 78.63%. This illustrates the strategic role of extension workers in introducing, adapting, and implementing climate-smart agriculture (CSA) technologies. Several innovations introduced by extension workers include drought-tolerant rice varieties, the implementation of the legowo planting system, and balanced fertilization techniques. This role is not only limited to technology transfer but also includes direct assistance through field demonstrations and technical training, which significantly accelerates the adoption of innovations by farmers. These results align with the findings of Mutiso et al. (2024), which emphasize that extension workers have a crucial contribution in ensuring the effective implementation of climate change adaptation technologies at the field level.

The lowest index was found in the variable of the role of extension workers as motivators, with an index value of 54.76%, indicating that although extension workers have attempted to encourage farmers to adapt to climate change, the resulting level of motivation is not optimal. The role of motivators is crucial because it is related to efforts to overcome psychosocial barriers, increase farmer self-confidence, and build collective awareness in adopting adaptation practices. This low achievement may be caused by limitations in the use of persuasive communication approaches, a lack of motivational reinforcement based on examples of local wisdom, or minimal incentive support for farmers. Tambo et al. (2025) emphasize that strong motivation is a determining factor in the success of adaptation, so increasing the communication capacity and participatory approach of extension workers is something that needs to be prioritized.

The role of extension workers as educators had the second-highest index value, at 75.08%, indicating that extension workers play a significant role in improving farmers' climate literacy. Through activities such as climate field schools (SLI), adaptive cultivation technique training, and the provision of weather forecast-based information, extension workers help farmers understand climate dynamics and risk management strategies. The role of extension workers as educators is crucial because adequate knowledge and skills will facilitate the implementation of new technologies at the farm level. FAO (2021) emphasized that successful adaptation depends heavily on farmers' knowledge capacity, while Aronggear et al. (2023) showed that extension workers who actively act as educators can improve farmers' decision-making abilities based on accurate climate information.

CONCLUSION

The average constraint index for implementing innovations in lowland rice cultivation due to climate change in North Aceh Regency reached 72.26% (constrained), indicating substantial obstacles at the farmer level. The main constraints include limited adaptive superior seeds, irrigation water supply, intensity of pest and disease attacks, and low climate literacy. Although local adaptation through adjustments to planting calendars based on local wisdom can mitigate the impact of changing rainfall patterns, climate variability and weather anomalies remain significant risks to productivity. The role of adaptive extension workers in rice cultivation in North Aceh Regency is reflected in the average score of 69.71% (involved). The highest role is seen in the role of extension workers as innovators (78.63%), which reflects the success of extension workers in introducing and assisting the implementation of climate-smart agricultural technology, followed by the role of extension workers as educators (75.08%) who can improve farmers' climate literacy, as well as the role of extension workers as facilitators (70.36%) who can facilitate access to adaptation resources and the role of extension workers as motivators has a relatively low value (54.76%), which indicates the need to emphasize the need to strengthen persuasive communication strategies and continue to prioritize local wisdom to build farmer motivation.

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