ROLE OF STAKEHOLDERS IN THE ADOPTION OF CERTIFIED RICE SEEDS IN RAINFED PADDY FIELDS

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Abstract

Seed certification policies have been in place for more than five decades, but the adoption process still encounters various challenges that need proper solutions. The implementation of certified rice seeds requires a collective approach and cooperation among stakeholders. Performed study aims to analyze the level of adoption of certified rice seeds in rainfed paddy fields and examine the roles of stakeholders in encouraging its sustainable adoption. The quantitative method was used, involving a survey of 137 respondents, through selected use of Lemeshow's formula across five sub-districts in Purworejo District, Indonesia. Additionally, a qualitative approach was included through Focus Group Discussions (FGD), later analyzed with the MACTOR (Matrix of Alliance, Conflicts, Tactics, Objectives, and Recommendations) method. Derived results showed that farmers mainly adopt certified seeds due to government support (71.53%) and irregular plant growth (60.58%). The key stakeholders influencing adoption are seed producers, regulators/facilitators, and end users, all aiming to increase production, productivity, and profits. Despite different roles and goals, no conflicts of interest have been identified among the stakeholders. Policy makers and regional leaders are the most influential stakeholders in promoting the adoption of certified rice seeds.

Key words: Certified rice seeds, rainfed paddy fields, adoption, MACTOR.

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Introduction

The rice seed certification policy in Indonesia has begun in 1971, with the issuance of Presidential Decree no. 72, together with establishing the National Seed Agency within the Ministry of Agriculture. Since then, the government has implemented various regulations and decrees to strengthen seed policies, including Government Regulation no. 22, related to establishment of Perum Sang Hyang Seri and MOA no. 12/Permentan/TP.020/4/2018 regarding the production, certification, and circulation of food crop seeds. The use of certified rice seeds is a top priority in Indonesia's agricultural development, with the government strivings to cover 80% of target (use of certified rice seed) by 2024 (Ministry of Agriculture, 2020). The benefits of using certified rice seeds guarantees not only the quality and durability of the variety, but also assures farmers that they will achieve optimal business results. Research findings have indicated that rice production using certified seeds is better than that linked to non-certified seeds (Prasetyo et al., 2022; Savitri et al., 2024).

Although the certification policy has been in force over the five decades, while the advantages of using certified rice seeds have been proven, the adoption of certified superior rice seeds reached 50.87% in 2015, or only 53% in 2020 (FSA, 2016). Meanwhile, the use of certified rice seeds in rainfed paddy fields is only around 45% (Setiani et al., 2023). This fact indicates that there are still factors that hinder the adoption of certified rice seeds, especially in rainfed paddy fields. Mentioned factors mainly involve limited access to information and required resources, or support from various stakeholders (Kumar et al., 2024).

Previous research on adoption has been focused more on individual farmers, or technical aspects of certified seeds. For example, Vihi and associates (2024) have been conducted a study on the determinants of individual farmers' adoption of rice varieties. Additionally, there has been research towards the factors affecting the acceptance or rejection of certified rice seeds (Acheampong, Dartey, 2024). A review of new variety seeds adoption in developing countries was also performed by Checco and associates (2023). Technology adoption is influenced not only by technical and economic factors, but also emphasizes the importance of involving various parties and stakeholders (Rogers, 2003). Stakeholders usually include farmer's groups, governmental agencies, agricultural extension organizations, and influential individuals in the farming community (Qadir et al., 2024). Their role is crucial in shaping opinions, providing education and transfer of knowledge, facilitating access to certified seeds, or ensuring that adoption can be occured widely and sustainably.

Certain researches, that are specifically discussing about collective contribution and synergy among stakeholders in promoting the adoption of certified rice seeds in rainfed paddy fields, are very limited. Based on the gaps identified in previous research results, this study aims to identify and analyze the role of each stakeholder in the adoption process of certified rice seeds used in rainfed paddy fields, as well as to formulate collaborative strategies that can increase the level of adoption and sustainability of its use.

Theoretical Framework

The diffusion of innovations model (Rogers, 2003) serves as the primary framework for understanding the adoption process of innovation in the agricultural sector. Various authors define adoption in different ways. Some has described it as integration of innovation into farmers' usual farming activities over a long-term period (Feder et al., 2021). Adoption involves the integration of new technologies into existing practices and it is typically preceded by a trial period, or some degree of adaptation (Heard et al., 2013). Process of adoption can be categorized into the two-key metrics, adoption rate and adoption intensity. The adoption rate indicates the relative speed at which farmers adopt certain innovation, while adoption intensity refers to the extent of new technology use (Bonabana Wabbi, 2002). Feder and associates (2021) classify adoption into two types, as individual and aggregate adoption. Individual adoption takes place when farmers have complete information about a new technology and its potential. Aggregate adoption refers to the spread of new technology within a specific area. In performed study, the term „adoption" refers to the use of certified rice seeds in farming activities on rainfed paddy fields.

The ultimate goal of certified rice seed policy is not merely individual adoption. Rather, it requires sustainability and widespread use to ensure its impact observation within the overall community. Although, there is belief that the use of certified rice seeds significantly enhances food security, many developing countries still encounter challenges due to low adoption rates (Bagian et al., 2019).

Rogers (2003) highlights social networks as key channels for dissemination of information. However, in reality, these networks are often fragmented, with presence of institutional actors, such are agencies, producers, and distributors, that form certain barriers or alternative routes. Furthermore, the limited focus on inter-actor dynamics, such as traditional diffusion, accentuates conflicts of interest, power imbalances, and economic stakes of non-farmer actors, are also impacting seed availability and access. Mentioned underscores the need to enrich diffusion theory with stakeholder analysis in order to achieve its more comprehensive understanding.

Stakeholders could be individuals or groups with interest in organization, that are affected by, or could affect, the achievement of certain goals (Kujala et al., 2022). The relationship between stakeholders and benefits they receive is crucial for achieving the presets goal (Hatami, Firoozi, 2019). Therefore, in order to enhance the value of stakeholder benefits through the realization of common goals, good coordination is necessary.

Stakeholders engagement can increase social, economic, political, and cultural outcomes of decision-making (Newig et al., 2023). Stakeholder's involvement in decision-making, promoted through transparent, democratic, and participatory approaches, could be discussed more effective (Syamsu, 2023). As certain disadvantage of stakeholder engagement could be considered that it might be more time-consumed than top-down processes (Lubell, 2004). Furthermore, there is a risk that powerful interest groups may dominate the participatory process (Huwyler et al., 2023). One of the key challenges to stakeholder engagement is establishing a common understanding of needs for technology development due to: 1) heterogeneous stakeholder backgrounds and knowledge, or 2) potential conflict of interests regarding the impact on outputs, resource allocation, and overall costs (Ali, Haapasalo, 2023). Therefore, analysis of stakeholders' role should examine not only the fact who the actors are, but also how power structures, dependencies, and conflicts or coalitions affect the adoption processes.

The MACTOR method (Matrix of Alliance, Conflicts, Tactics, Objectives, and Recommendations) has been applied to examine strategies and relationships among actors in conflict or contexts of alliance (Kadaifci, 2024).

Importance and use of seed adoption studies consider: i) creating a matrix that indicates how much influence each actor has on a specific goal and how dependent are the other actors related to it (mentioned helps to identify the key actors in seed dissemination); ii) identifying actors with aligned goals (potential allies) versus those with conflicting interests, enabling targeted policy interventions for coalition-building; and iii) understanding the network of alliances and conflicts, which allows policymakers to develop measures that reduce resistance and leverage influential nodes.

Research Methods

The research was conducted in 2024, in rainfed paddy fields within the Purworejo District, Central Java, Indonesia. Rainfed paddy fields were chosen as the research site due to their lower utilisation of certified rice seeds compared to irrigated paddy fields. Mentioned allows more in-depth exploration of the specific challenges occurred in

certified seeds adoption. Study used quantitative approach to examine the adoption of certified rice seeds and the roles of stakeholders, which are described as follows:

Adoption - sample criteria in performed study assumes farmers who are managing rainfed paddy fields, cultivate rice crops, and use certified rice seeds. Five sub-districts were chosen that had relatively large areas under rainfed paddy fields. Since the size of overall population was unknown, the Lemeshow formula was used to determine the sample size (Ahmad et al., 2020; Hidayat et al., 2024). The sample involves 137 respondents. Data have been gathered through a survey of 137 respondents using a questionnaire consisted from 5 indicators (Table 1.). The questions were described by 5-point Likert scale, while 1 means "strongly disagree" up to 5 meaning "strongly agree".

Table 1. Farmers' statements on the adoption of certified rice seeds

Statement	Score
Every growing season	Strongly disagree (STS) = 1 Disagree (TS) = 2 Undecided (RR) = 3 Agree (S) = 4 Strongly Agree (SS) = 5
Suitability of required varieties	
Plant growth is not uniform	
Not having harvested seeds	
Received assistance/grants	

Source: Koo, Yang, 2025.

Stakeholder Analysis - Focus group discussion (FGD) was conducted to collect qualitative data, as was previously used by Khraisat and associates (2020) and Taherdoost (2021). Discussions have been involved 39 stakeholders, including representatives from the Seed certification supervisory agency (SSCC), (3 persons), Seed producers (SP), (3 persons), Seed traders (SD), (4 persons), Farmers (Farmers), (11 persons), Plant disturbing organism observers (PPCO), (2 persons), Field agricultural extension officers (FAE), (5 persons), Agriculture office (AD), (3 persons), Farmer group heads (FGL), (5 persons), and Village heads (VH), (3 persons). The collected data were quantitatively assessed using the MACTOR method (Matrix of Alliance, Conflicts, Tactics, Objectives, and Recommendations) as was previously used by Jin and associates (2023).

To describe the relationship between stakeholders, the Matrix of Direct Influence (MDI) and Matrix of Valued Position (2MAO) through adequate tables were completed. The MDI matrix shows the influence of stakeholders on one another using a score scale from 0 to 4, where 0 indicates no influence. As higher is the score, the greater is the influence (Table 2.). The 2MAO matrix reflects the stakeholders' attitudes towards the objectives. It is also using a score scale from 0 to 4, where a higher score signifies greater alignment with the objectives (Table 3.). Furthermore,

the data are processed to produce MDI and 2MAO through a computer algorithm process (Fauzi, 2019).

Table 2. MDI Matrix

MDI	SSCC	SP	SD	Farmer	PPCO	FAE	AD	FGL	VH
SSCC	0	4	2	1	4	1	4	1	1
SP	3	0	4	3	1	3	2	2	2
SD	2	4	0	4	2	2	1	1	1
Farmer	1	2	4	0	2	2	2	4	3
PPCO	3	2	2	4	0	4	4	4	2
FAE	2	3	3	4	4	0	4	4	2
AD	4	3	2	2	4	4	0	3	3
FGL	1	3	3	4	3	4	2	0	3
VH	1	2	3	4	3	4	2	4	0

Source: Primary data.

Table 3. 2MAO Matrix

2MAO	Production	Productivy	Profit	Purity
SSCC	3	3	0	4
SP	4	4	4	4
SD	4	4	4	4
Farmer	4	4	4	4
PPCO	4	4	0	1
FAE	4	4	0	4
AD	4	4	0	4
FGL	4	4	0	4
VH	4	4	0	4

Source: Primary data.

Results and Discussion

Overview of research location - potential use of seeds in rainfed paddy fields in Purworejo District (Java, Indonesia) is on area of 2,949 ha. In line to usual rice seed requirement (30 kg/ha), approximately 918,780 kg of rice seeds are required for one planting season. Rainfed wetland farmers heavily depend on rainfalls, while they are limited by difficult adjustment to climate changes (it is very difficult to predict rainfall patterns). The cropping pattern in rainfed paddy fields is paddy-paddy-fallow, or paddy-corn-fallow. With assistance of solar water pumps provided by the Central Java Provincial Government, it is anticipated that farmers can achieve three harvests per season, using either a paddy-paddy-corn or a paddy-corn-corn production scheme.

Rice seeds that circulate in the community are divided into two categories, formal and informal seeds. Formal seeds are produced through seed system that is officially supported, while it involves various sub-systems including research, legal institutions, seed production, quality control/certification, and distribution. The output of formal seeds category is certified seeds that are ready to be marketed to final users (Westengen et al., 2023). In Indonesia's seed system, seeds are divided into four classes: Breeder Seed (SBS), Foundation Seed (FS), Stock Seed (SS), and Extension Seed (ES), (Ministry of Agriculture, 2020). The seeds that farmers should use are extension seeds, however, many farmers use the stock seeds. The reason is that the quality and yield of SS is better than ES (Qadir et al., 2024). Informal seeds include several components, such are: 1) seeds/planting materials from farmers' production (harvesting, selection, storage); 2) seeds obtained through farmers' social networks; and 3) seeds selected from local markets (Sperling, Almekinders, 2022).

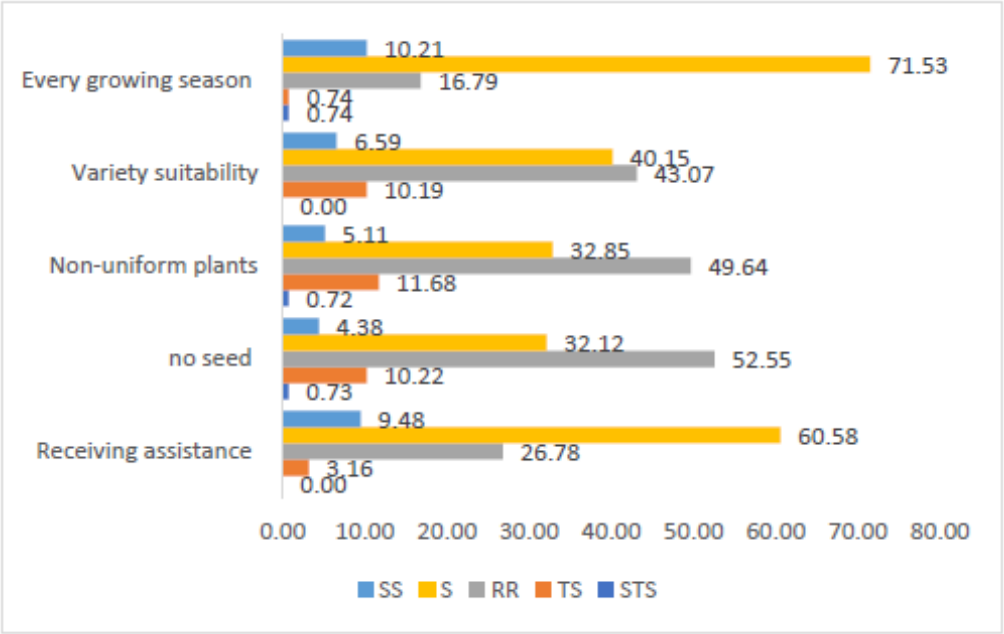
The dominant rice variety used is Ciherang, with average production of 4.2 t/ha, what is much lower than the results derived from research of Agus and associates (2019), (acc. 4.8 t/ha), while the overall variety potential is around 7 t/ha (Ministry of Agriculture, 2020).

Adoption of rice seeds - according to Figure 1., only 1.48% of farmers disagree with using certified rice seeds each planting season. This suggests that farmers are willing to use certified rice seeds for their farming activities in rainfed paddy fields. However, it has to be underlined, that the certified seeds usually represent the varieties required by farmers. Planting conditions in the field can vary, while farmers often lack the access to harvested seeds, or do not receive support or grants from the government or private sector.

The use of certified seeds compared to local seeds can increase productivity by 5-20% (Sarkar et al., 2024). Certified rice seeds are produced through a standardized breeding process, ensuring superior genetic quality. This enables plants to be more resistant to pests and diseases, while to better adapt to diverse environmental conditions (Fornasiero et al., 2022). Additionally, certified rice seeds exhibit better germination and vigor, contributing to stronger and more productive early plant growth (Evamoni et al., 2022). The application of certified seed technology also aligns with efforts to enhance global food security. In the context of climate change and challenges of modern agriculture, the use of quality-tested seeds is becoming increasingly important. Policies that encourage access to, and use of certified seeds, must be strengthened to ensure the sustainability of food production and improve farmers' welfare.

Farmers are generally resistant to changes, preferring varieties that are well-established and proven to be superior. They can maximize yields and reduce the risk of failure due to varietal incompatibility. However, the variety still in use is Ciherang, which was launched in 2000. This variety, although popular, has certain limitations in confronting climate challenges and new-born pathogens. The adoption of new high-yielding varieties that are more site-specific can provide a more effective solution (Vihi et al., 2024). Locally developed varieties can provide better results in facing specific challenges in individual regions. The rice varieties that have potential to be developed in rainfed paddy fields are Inpari 38, Inpari 39, Inpari 40, and Inpari 41 (Ministry of Agriculture, 2020).

Figure 1. Farmers' statements on the adoption of certified rice seeds in rainfed paddy fields



Source: Primary data

Plants' growth uniformity is priority for farmers while managing their business. Therefore, if the sown plants do not grow uniformly, farmers will use certified rice seeds. Plants grown from certified rice seeds tend to be uniform due to seeds' genetic purity, which is 99%. The growth of other varieties occurred in the mixtures, or decline in agricultural production, approximately 2.6% per cropping generation, have been resulted from using the seeds with lower quality control (John, Babu, 2021). Similar findings are affected by the use of poorly controlled seeds (Pizza et al., 2021). Encouraging the use of certified seeds with high genetic purity is a strategic step to increase overall agricultural productivity. Additionally, mentioned approach will help sustain food production and increase competitiveness in the market.

Farmers are claiming that they are using certified rice seeds when they don't have harvested seeds. Generally, farmers set aside a part of their harvest to use as seed in the next planting season. Although this practice is common, the seeds produced in this way are not guaranteed to be of good quality (Javaid et al., 2023). The use of uncertified (informal) seeds should be reduced in order to fully realize the genetic potential of varieties, resulting in increased productivity. Increased productivity is supported by the use of certified seeds. Farmers require certified rice seeds, so the most of them will plant mentioned seeds. However, some disagreed (3.16%) to plant

the certified seeds obtained from the grant, if they did not match the desired variety, or if the seeds had expired, or had poor performances. Grant programs have to consider farmers' needs and preferences in order to provide more appropriate and effective solutions.

Stakeholders analysis

Role of Stakeholders - stakeholders are a crucial component that determines how goals can be achieved sustainably (Fauzi, 2019). Initial observations identified stakeholders interested in adopting certified rice seeds. There are three groups of certified rice seed stakeholders: seed production (Seed Supervision and Certification Agency, Seed Producers, and Seed Traders), regulation/facilitators (Plant Disturbance Organism Observers, Field Agricultural Extension Officers, Agricultural Offices, Farmer Group Heads, Village Heads), and final users (Farmers). Based on the FGDs, the detailed roles, problems, and objectives of each stakeholder are underlined in Table 4.

Table 4. Roles, issues, and objectives of stakeholders in the adoption of certified rice seeds

No	Stakeholders	Symbol	Role	Problem Issues	Objective
1.	Seed Supervision and Certification Agency	SSCC	Conduct seed supervision and certification	Circulation of certified rice seeds that do not meet seed certification standards	Ensure the availability of quality certified rice seeds
2.	Seed Producer	SP	Producing certified rice seeds	Availability of certified rice seeds is still limited	Provide certified rice seeds - Getting benefits
3.	Seed Trader	SD	Provide seeds	Rice varieties do not always match the needs/ desires of farmers	Providing certified rice seeds that meet the needs and desires of farmers - Getting benefits
4.	Farmers	Farmer	Conducting rice cultivation	Low rice income and production	Increased rice production
5.	Plant Disturbance Organism Observers	PPOC	Technical officers who assist and guide farmers to control Plant Disturbing Organisms and Climate Change Impacts	Too large an area (1 person/sub-district)	Pest and disease control to increase rice production
6.	Field Agricultural Extension Worker	FAE	Technical officers who assist, guide farmers, and provide information related to farming activities	Extension is multidisciplinary	Increase rice production Dissemination of technological innovations

No	Stakeholders	Symbol	Role	Problem Issues	Objective
7.	Agriculture Department	AD	Facilitate farmers in farming activities from policy and technical aspects	The level of use of certified rice seeds and farmers' welfare is still low	Increase the use of certified rice seeds, rice production, and farmers' welfare
8.	Head of Farmer Group	FGL	Provide agricultural information to farmers	Low income and rice production	Increase rice production
9.	Village Head	VH	Region leader Coordinating natural and human resources	Low rice income and production	Increase rice production

Source: Primary data.

Influence and dependence among stakeholders - stakeholder influences and dependencies are grouped into four quadrants: I) Dominant; II) Dominate; III) Isolated; and IV) Relay (Figure 2.). The positions of the Village Head (VH) and Agriculture Office (AD) in quadrant I indicate that they have a dominant influence over the adoption of certified rice seeds. The VH plays crucial role in the farming community, coordinating local resources and fostering business environment that encourages farmers to adopt certified rice seeds. Agriculture Office has access to agricultural resources that can be optimized to increase the use of certified rice seeds at the regional level. Decisions made by VH and AD can have a long-term impact on overall and sustainable adoption of observed input (Saraswati et al., 2024).

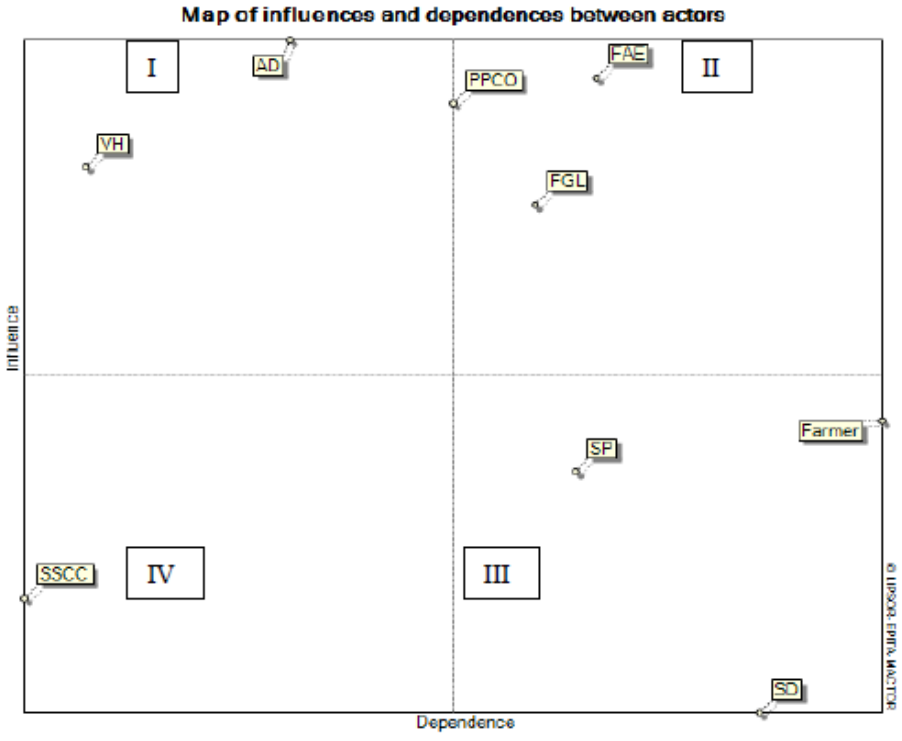
Position of the Farmer Group Leader (FGL), Plant Disturbing Organism Observer Officer (PPCO), and Field Agricultural Extension Officer (FAE) in quadrant II shows that they are dominant stakeholders. However, they influence the system, but depend on decisions or policies from other stakeholders. FGL is influential as a community leader who can motivate belonging group members to adopt certified rice seeds. PPCO is influential as it is related to health aspects of seeds, what is also one of the important parameters linked to certified rice seeds. FAE influences seed adoption by fulfilling its duties and functions as facilitator and assistant to farmers in dissemination of agricultural technology innovations (Becerra Encinales et al., 2024). However, mentioned stakeholders depend on the decisions and policies of AD and VH.

Three stakeholders active in quadrant III are Farmers, Seed Producers (SP), and Seed Traders (SD). Observed quadrant shows that mentioned stakeholders have low-level influence and dependence regarding the adoption of certified rice seeds. So, their activities or decisions tend to be localized or specific, while do not significantly interact with the broader dynamics of certified rice seed development. Farmers use certified rice seeds based on personal experience and local preferences, while not in line to national policies or support from more influential stakeholders. SP only produce certain varieties that suit local market requirements, while SD operates

within a limited distribution network. Local influences towards the decisions in agricultural technology adoption are often more significant than external influences (Ruzzante et al., 2021).

Seed Supervision and Certification Council (SSCC) occupies quadrant IV, indicating that this stakeholder does not have significant influence on entire system, but it is highly dependent from other stakeholders. SSCC operates as institution responsible for seed certification. However, its influence within the overall system is relatively low. It highly depends from decisions and policies established by other stakeholders, especially the AD located in quadrant I. This reliance encompasses aspects of funding, resources, and policy directions that determine the operational mechanisms of the SSCC. Absence of entirely passive stakeholders regarding both influence and dependency signifies that each stakeholder in the certified rice seed adoption system holds a specific role, although not always equal. Previous presents complexity of interactions between stakeholders, while highlights the importance of understanding relationship between stakeholders towards creation of more effective system (Barari et al., 2022).

Figure 2. Influence and dependency map between stakeholders

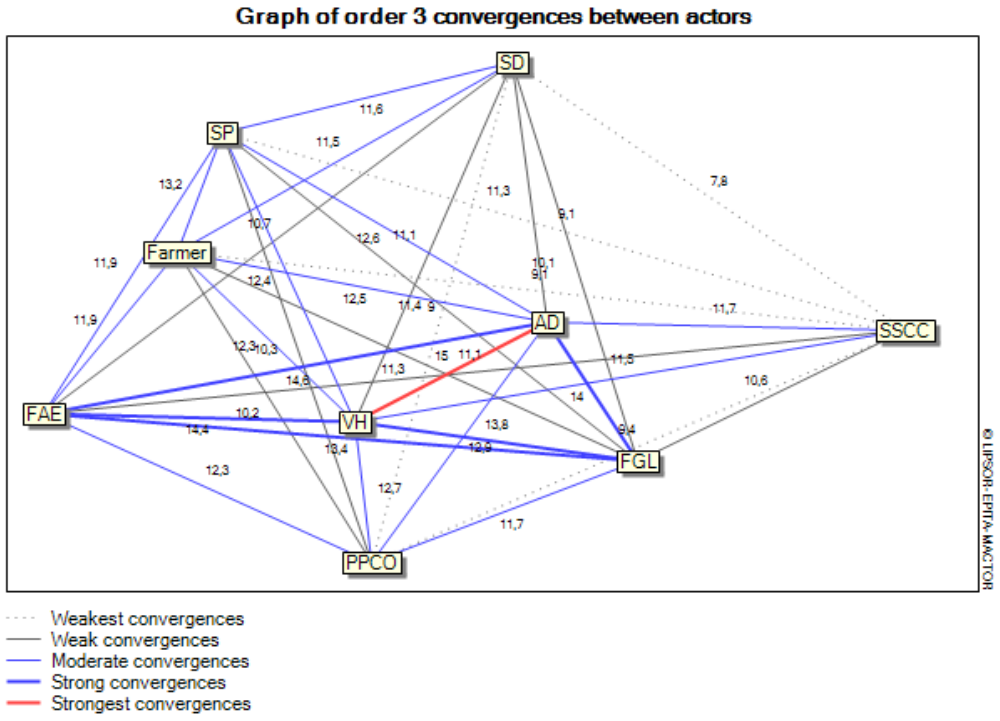


Source: Primary data.

Convergence between stakeholders - in Figure 3., it is clear that the convergence level between AD and VH is extremely high (indicated by the red line). This means that when both stakeholders are focused to building cooperation, there will be an increase in adoption of certified rice seeds in rainfed paddy fields.

It is also necessary to build strong cooperation (thick blue line) between FAE and AD, or VH and FGL. Stakeholders that show a moderate level of convergence (thin blue line), indicate that there are similarities in some areas but also significant differences, such as those between Farmer and FAE, or SP and SD, as well as between FAE, PPCO and AD. Farmers are more focused on achieving optimal crop yields and increasing income, while FAE are primarily concerned to dissemination of technology and promotion of better agricultural practices. Meanwhile, SP and SD have interests focused to product distribution and financial gain.

Figure 3. Collaboration between stakeholders



Source: Primary data.

Stakeholders with low convergence are positioned far apart on the map (grey line), indicating that they have significantly different goals and interests. For example, SP focuses on production and provision of quality seeds, whereas PPCO emphasizes pest control and plant health. In situation when each stakeholder has a different focus,

it is challenging to build synergy in programs designed to increase the use of certified rice seeds.

For stakeholders with medium or low convergence, managing differences of interest and seeking common ground is essential. Effective dialogue and negotiation can help to overcome differences and build consensus to achieve broader goals. An inclusive negotiation process can create an environment where all parties are felt respected, while can contribute to the final decision, thereby strengthening the consensus.

Conclusions

The share of farmers within the surveyed group who disagreed with the use of certified rice seeds every planting season was only 1.48%. However, certified rice seeds must be available through the varieties required by farmers. In practice, the cropping conditions are not uniform, while there are no harvested seeds available, nor do the farmers receive assistance or grants from the government or private sector.

Based on the MACTOR analysis, the stakeholders that the most significantly affect the sustainable adoption of certified rice seeds are Department of Agriculture (AD) and Village Head (VH). They are engaged the most actively in promoting the adoption of certified rice seeds, while strong collaboration between them is quite essential. Mentioned cooperation focuses on developing policies and regulations that support the adoption of certified rice seeds, including guidelines related to assistance and grants, as well as their distribution.

At the field level, strong cooperation between the AD and VH, along with Field Agricultural Extension (FAE) and Farmer Group Heads (FGL) is basic for ensuring the widespread and sustainable adoption of certified rice seeds. This will guarantee that seed assistance from the government and private sector is distributed effectively and in accordance with the needs of farmers. Additionally, collaboration between Seed Producers (SP) and Seed Traders (SD) is necessary, while SP can produce seeds that meet the requirements of farmers. AD can facilitate communication between farmers and SP, ensuring that the needs for varieties suitable for rainfed paddy field conditions are met. Cooperation between Seed Certification Supervisory Agency (SSCC) and Plant Disturbing Organism Observers (PPCO) mainly focuses on guaranteeing the seeds quality before it reaches the farmers. AD can establish a mechanism to monitor the level of adoption of certified seeds and evaluate the constraints that farmers face during their usage.

Finally, the goals that stakeholders want to achieve are increased production, enhanced productivity, and greater profits. Although there are differences in the roles and objectives of each stakeholder, there are no conflict of interest between

them. Ultimately, by comprehending the roles of stakeholders, it is expected that the adoption of certified rice seeds will increase, thereby improving the productivity and efficiency of farming in rainfed paddy fields.

Policy implications and recommendations

This research provides a comprehensive understanding of stakeholder interactions and their roles in process of sustainable adoption of certified rice seeds. Practically, gained findings facilitate policy development, planning seed distribution, drafting local regulations, and establishment of monitoring and evaluation systems due to improve the productivity and efficiency in rainfed paddy fields.

Complexity of the certified seed adoption system in rainfed paddy fields requires active involvement of various stakeholder groups. AD and VH need to design local legislation, such as village regulations, or a decree from the regional head. They have to encourage the use of certified seeds according to variety zoning, as well as to regulate the distribution mechanism or grants ensuring that they are well-targeted and sustainable. Furthermore, core issue is to strengthen the collaboration with FAE and FGL to facilitate the dissemination of information regarding the benefits of certified rice seeds.

Development of business model between Farmers and SP to assist farmers in accessing and increasing the adoption of certified rice seeds is also required. AD facilitates regular meetings between farmers and SP to identify more specific variety needs. SSCC and PPCO have to strengthen their role in securing seed quality control before distribution. Established continuous monitoring system by AD has to evaluate the effectiveness of distribution and actual use by farmers, as well as to identify certain constraints, while to develop evidence-based policy responses.

Limitations and further research

This research focuses on stakeholder analysis and does not quantitatively measure the long-term effects of adopting certified seed on farmers' productivity and profitability. Furthermore, the diverse conditions of rainfed rice field agroecosystems restrict the general applicability of such this research.

Future research should establish a more structured collaboration model among stakeholders, particularly between AD, VH, SP, and SSCC. Additional studies could evaluate the effectiveness of monitoring and distribution mechanisms for certified seeds in various rainfed paddy field conditions.

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