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EMPOWERING COLLECTIVE MANAGEMENT: HARNESSING TRADITIONAL KNOWLEDGE TO ENHANCE RICE FARMING IRRIGATION PRACTICES IN WEST SUMATRA

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Abstract

In the study area, water flow in rice fields was consistent throughout the year in the last decade, which reduced the urgency for strong institutional frameworks. However, with the onset of climate change, potential water scarcity and conflicts over water allocation are emerging as critical issues. Recent conflicts over water allocation and the disregard for common norms, such as coordinated planting schedules between upstream, midstream, and downstream farmers, highlight the need for stronger institutional arrangements to ensure equitable and sustainable water management. This study aims to facilitate collaborative action with local farmers to integrate traditional knowledge into the existing irrigation system for improved management. Using a qualitative research approach, this study selected key informants purposively, including farmers, traditional leaders, and local government officials, to ensure diverse perspectives. The collaborative action process, executed by researchers and farmers, involves fostering bottom-up initiatives through trust-building, dialogue, and co-producing knowledge to identify irrigation management problems, challenges, and strategies from the perspective of farmers and stakeholders. Through FGDs, farmers are encouraged to identify solutions rooted in traditional values. These solutions include enhancing communal efforts to maintain irrigation facilities through Mufakat (consensus), fostering community unity through Alek Banda (harvest ceremony), and implementing a matrilineal landownership system to bolster participation in collective irrigation management. The study suggests that integrating traditional values and practices, as agreed upon by farmers during FGDs, into the current irrigation management system can significantly improve water governance.

Keywords: *Collective action, water resources management, indigenous knowledge*

INTRODUCTION

In West Sumatra, the management of natural resources, particularly irrigation water, has historically been deeply rooted in the cultural and spiritual beliefs of the Minangkabau community. This traditional system reflects a longstanding ancestral relationship with nature, where the Minangkabau people coexist with their environment rather than seeking to control it. Natural resource management is typically collective, overseen by clan leaders (Penghulu) and gatekeepers (Tuo Banda), and governed by informal rules and the principle of Mufakat (consensus) (Utami & Oue, 2021). This traditional knowledge, transmitted orally across generations, emphasizes communal wisdom and continuity, ensuring sustainable practices in irrigation management.

However, the introduction of government-created institutions, such as Water Users' Associations (P3A), has significantly altered the traditional institutional framework. Since the 1980s, the government has established P3A to formalize irrigation management, often sidelining traditional authorities and practices. While the P3A was intended to improve irrigation governance, its top-down implementation—without meaningful participation from farmers or recognition of local customs—has led to institutional challenges. For instance, the absence of Mufakat in decision-making has resulted in heightened conflicts over water allocation, particularly during dry seasons. Additionally, low participation in the maintenance of irrigation facilities and a growing knowledge gap between farmers and government officials have further undermined the effectiveness of P3A (JICA, 2001; Houterman et al., 2004; Rachman, 2009; Utami & Oue, 2021).

In the Agam District, where this study is conducted, irrigation management has historically been governed by both customary norms and governmental policies. Before the 1980s, water resource management was overseen by traditional authorities under the Adat system. However, with the establishment of P3A, traditional practices were increasingly marginalized. The government imposed standardized guidelines across all irrigation systems, ignoring the considerable variations in local traditions and practices. This shift has led to several institutional problems, including dysfunctional P3A organizations, low farmer participation in communal activities (gotong royong), and conflicts over water use. For example, the common norm of coordinated planting schedules between upstream, midstream, and downstream farmers has been disregarded, leading to disputes over water allocation.

Compounding these challenges is the impact of climate change, which threatens to exacerbate water scarcity and conflicts in the near future. While water flow in rice fields remained stable throughout the year in the past decade, reducing the urgency for strong institutional frameworks, the changing climate now poses significant risks. Recent conflicts over water allocation and the breakdown of traditional norms highlight the need for stronger, more adaptive institutions to ensure equitable and sustainable water management.

Despite these challenges, there is growing recognition of the potential to integrate traditional knowledge into contemporary irrigation management. Previous studies have shown that traditional practices, such as Mufakat and communal decision-making, remain highly relevant and can be effectively combined with modern techniques to address current challenges (Borrini-Feyerabend et al., 2007; Christo et al., 2012; Lepofsky, 2013; Hatfield et al., 2018). Collaborative actions that involve diverse stakeholders—farmers,

local government officials, NGOs, traditional leaders, and researchers—can bridge the gap between traditional and modern systems. Such approaches not only reduce conflicts but also foster learning, build consensus, and ensure that local values are reflected in policy documents (Weible & Sabatier, 2009; Leach et al., 2014; Sato et al., 2018).

This study aims to evaluate collaborative efforts to enhance irrigation management in the Agam District, West Sumatra, by integrating traditional knowledge into the current irrigation system. Through a participatory approach, the research seeks to identify strategies for fostering sustainable and adaptive water management that addresses both institutional challenges and the impacts of climate change. By engaging local farmers and stakeholders in dialogue and co-producing knowledge, this study highlights the potential of bottom-up solutions to improve irrigation

governance and ensure the long-term sustainability of water resources.

METHODOLOGY

This study was conducted in West Sumatra, known as the land of the Minangkabau people in Indonesia (Fig. 1), from May to August 2023. The research focused on a Water Users' Association (P3A in Bahasa Indonesia), specifically P3A Namuang Saiyo, located in the Tilatang Kamang sub-district of Agam District. This district is part of the Luhak Nan Tigo region, the highland area of West Sumatra, where the Minangkabau people established the first Nagari (village)—a sociopolitical, economic, and territorial unit in West Sumatra.

Tilatang Kamang sub-district covers a total area of 99.86 km² and consists of three Nagari: Gadut, Kapau, and Koto Tangah. The study was conducted in Nagari Koto Tangah, where rice production is the primary

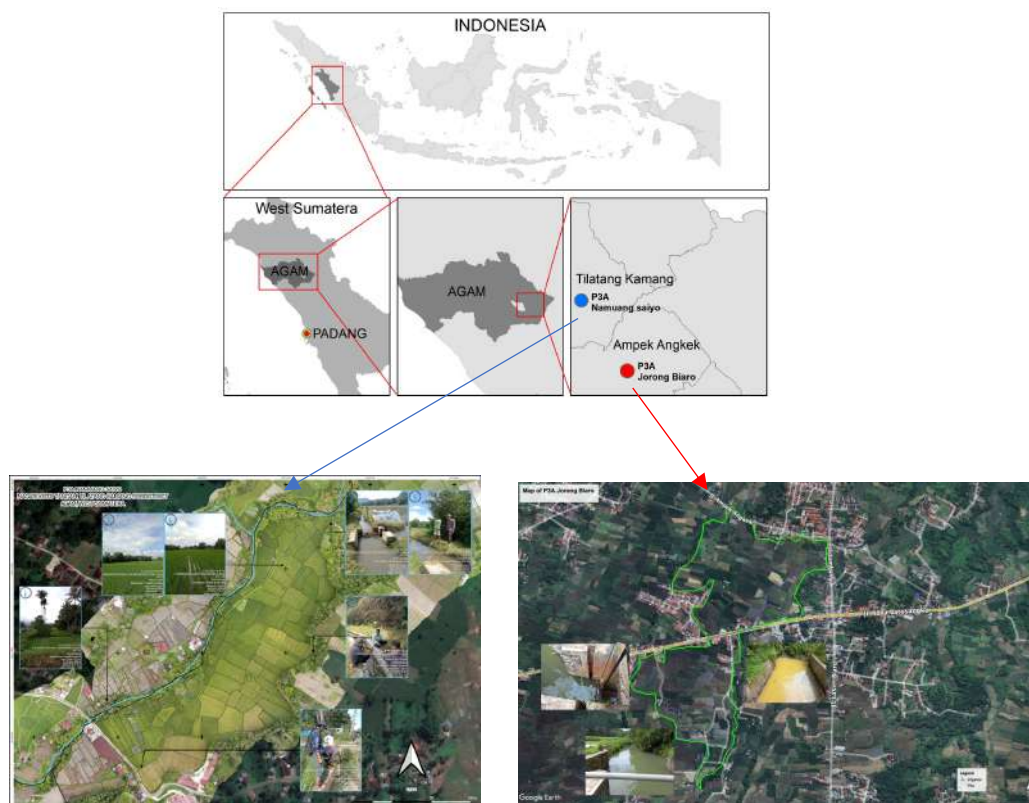


Fig.1 Map of the research area in West Sumatra Indonesia

agricultural activity. The total harvested area for rice in Tilatang Kamang is 5,848 hectares, with an annual production of 37,583 tons. The average rice productivity in this sub-district is 6.43 tons per hectare.

Before the establishment of P3A Namuang Saiyo in the 1980s, irrigation management in the study area was governed by traditional institutions led by Penghulu (clan leaders) and Tuo Banda (gatekeepers). These traditional institutions operated based on customary norms and practices, ensuring collective decision-making and equitable water distribution through Mufakat (consensus). However, in the early 1980s, the government introduced a policy to transform traditional irrigation institutions into formal Water Users' Associations (P3A). This policy aimed to standardize irrigation management across the region, but it often disregarded the existing traditional systems.

P3A Namuang Saiyo was established in the 1980s as part of this policy shift, theoretically based on Mufakat among local farmers. However, since its establishment, the P3A has not functioned effectively. There have been three changes in P3A leadership, and the election process for P3A leaders, which should ideally be conducted through deliberation and consensus involving all farmers, has often excluded many farmers. This lack of inclusivity has led to trust

issues between farmers and P3A leaders, further undermining the effectiveness of the institution.

This study employed a qualitative research method to explore the challenges and opportunities of integrating traditional values into irrigation water management and to identify collaborative actions for implementation. Data were collected through semi-structured interviews with key informants, who were selected based on their knowledge of the study area, Adat Minangkabau (Minangkabau customary law), and the transformation of irrigation management in West Sumatra. The key informants included local government staff, farmers, and indigenous leaders.

Additionally, Focus Group Discussions (FGDs) were conducted to establish collaborative actions for integrating traditional values into current irrigation management. The FGDs involved 20 participants, consisting of farmers who own rice fields in the upstream, midstream, and downstream sections of the irrigation system and others stakeholders. This diverse representation ensured that the perspectives of all stakeholders were considered. The FGD process is detailed in Table 1.

Data were also collected through a review of key articles from scientific literature and governmental reports. The study utilized narrative analysis to describe the collaboration process, outcomes, and potential traditional knowledge that could be

Table 1. Focus group discussion activities

Descriptions	
Date	10 December 2023 and 3 March 2024
Place	P3A meeting room
Participants	Farmers, respected persons in the community, indigenous leaders, and agricultural department officers

integrated into the existing irrigation management system.

Proposed Model of Collaborative Actions to Integrate Traditional Knowledge in West Sumatra

To integrate traditional knowledge into the adaptive transformation of irrigation institutions, a collaborative action model emphasizing bottom-up initiatives is essential. This model involves a structured process (Fig. 2) that fosters trust, dialogue, and knowledge co-production among stakeholders, including farmers, researchers, local leaders, and government officials.

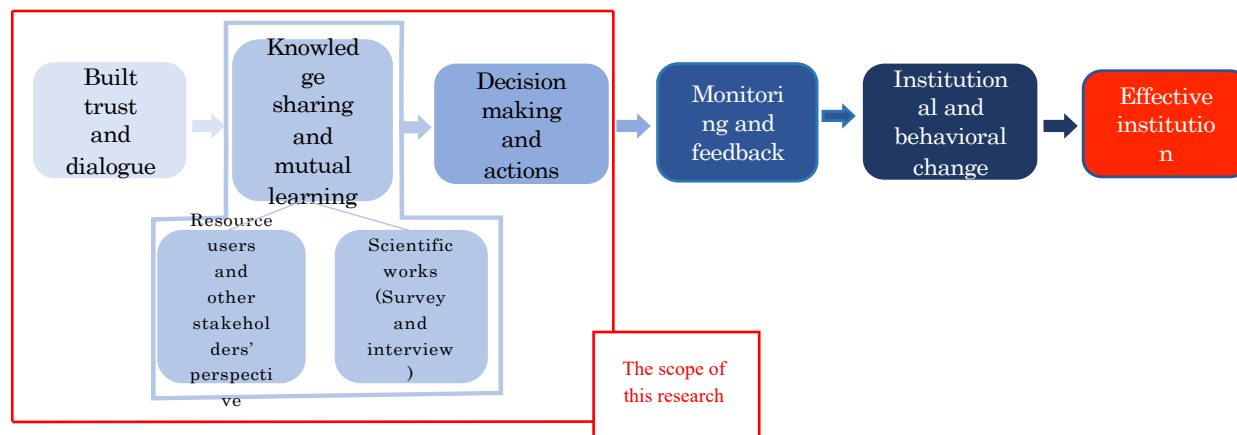


Fig. 2 Diagram Process of collaborative actions

Step 1: Building Trust and Initiating Dialogue

The first step is to establish mutual trust and initiate dialogue with resource users and other stakeholders. Researchers engage with communities in their daily environments, facilitated by local scientists and knowledge translators who act as intermediaries. These trusted local figures help bridge gaps between external researchers and the community, ensuring that dialogues are inclusive and culturally sensitive. Iterative dialogues are crucial for understanding the needs and perspectives of resource users, fostering long-term trust, and gaining their consent to proceed with collaborative actions.

Step 2: Knowledge Co-Production and Problem-Solving

Once trust is established, the process shifts to knowledge co-production. Resource users are

encouraged to voice their concerns and challenges regarding irrigation management. Researchers, leveraging their expertise, work alongside the community to identify problems and propose visualized solutions. This step involves informal dialogues and adaptive learning, where potential solutions are designed, trialed, and refined in collaboration with the community. Monitoring and evaluating these trials ensure that solutions are practical and effective.

Step 3: Decision-Making and Implementation

The co-produced knowledge leads to decision-

making, where resource users themselves determine the strategies and actions to be implemented. This self-determination ensures ownership and encourages active participation, which is critical for the success of irrigation management improvements. The decisions are shared widely among all stakeholders, fostering collective responsibility and empowerment.

Step 4: Institutional and Behavioral Change

The collaborative process results in changes in individual decision-making and community behavior, which accumulate into adaptive institutional transformations. These changes are supported by the integration of traditional knowledge and modern practices, creating a more resilient and sustainable irrigation management system.

RESULT AND DISCUSSIONS

The Initiations of Collaborative Action with Farmers

To support the transformation of irrigation institutions, collaborative action among relevant stakeholders is essential. This study identified key actors involved in collaborative actions related to irrigation management through focus group discussions (FGDs) with farmers and local government representatives (Table 2). The identified actors include local governments, user groups, indigenous leaders, innovators, and scientists.

Scientists play a crucial role in generating and applying knowledge to sustain effective irrigation management. Their involvement includes theoretical analysis and deliberative research, conducted in collaboration with farmers and other stakeholders, to produce foundational knowledge. The findings of this research must then be disseminated at the local level.

transformation by facilitating cultural education for user groups. This education can be delivered directly through formal organizations, informal organizations, or spontaneous groups relevant to informal education. Local governments can enhance this educational process by collaborating with indigenous leaders to create learning modules based on traditional values. These values can then be transferred through extension activities facilitated by local governments. Additionally, cultural education can be integrated into traditional events such as Alek Banda, where indigenous leaders like Penghulu and Niniak Mamak can impart traditional knowledge during harvest ceremonies. Transferring traditional knowledge across generations is essential for institutional transformation. Moreover, according to Water Resources Law No. 7/2004, traditional knowledge is recognized by the government as long as the local authority formalizes the institution. Therefore, local

Table 2. Relevant actors in collaborative action

No	Relevant actors	Roles
1	Resource users	Initiate the institution's transformation
2	Indigenous leaders	Transferring the traditional value in during harvest ceremony
3	Local government	Supporting and facilitating the institution's transformation
4	Innovator	Acquiring the ideas and skills needed to come up with the effective irrigation institutions
5	Scientist	Producing and utilizing the knowledge to sustain irrigation management

This process involves engaging scientists, local government officials, and indigenous leaders in discussions to translate the knowledge into practical applications for user groups.

On the other hand, local governments play a critical role in supporting and facilitating the transformation of irrigation institutions. They can support this

governments must establish straightforward mechanisms to legalize institutions based on traditional values once user groups have successfully transformed.

Over the past decade, many indigenous irrigation systems, such as those in Paraku, have not been

recognized by the government due to unclear regulations for legalizing traditional institutions in irrigation management. Through collaborative discussions among local government, farmers, and other stakeholders, an adaptive mechanism that can be easily followed by user groups should be established to address this issue.

The most crucial actors in this collaborative action are the farmers, who must take the lead in initiating institutional transformation. Field research indicates that self-initiated groups can effectively transform existing institutions into new ones, establishing irrigation management rules that farmers adhere to. Collaborative action also necessitates the involvement of user groups and a shared interest within the group.

As noted, farmers' values and perspectives have shifted due to the global economy, making it essential to encourage the preservation of traditional values through group initiation. When user groups initiate institutional transformation, traditional knowledge must become collective knowledge recognized by all users, fostering participation in irrigation management. Ostrom (1990) argues that individuals must consider others' choices when making personal decisions, addressing commitment and monitoring issues in irrigation system management.

Since 2019, collaborative actions in the P3As have been initiated through trust-building and open dialogue with farmers in the research area. These activities aim to establish mutual trust between researchers and farmers, encouraging active participation in collaborative efforts. By engaging directly with local farmers, understanding their daily activities, and facilitating discussions on irrigation management challenges, we foster a deeper connection. Additionally, our involvement in both farming and community social activities allows us to comprehend the farmers' environment and mindset, further reinforcing trust. This comprehensive approach has successfully established a foundation of mutual trust, crucial for effective collaborative actions.

Collaborative Actions: Lesson Learned from P3As in West Sumatra

Social Economic Conditions of P3As in Agam District Indonesia

Through trust-building activities carried out by scientists, valuable information regarding community customs in Agam district has been gathered. This district, one of the original Minangkabau Nagari (villages) in West Sumatra, features a unique system of communal land management known as matrilineal land ownership, or lahan ulayat (Utami and Oue, 2023). This traditional institution ensures the availability and sustainability of productive land, such as rice fields, for the community and future generations (Ifdal and Utami, 2023). Despite the prevalence of communal land ownership, individual land rights are also recognized within the community. The Minangkabau custom classifies land into private land and common land, which includes low ancestral land, high ancestral land, or community land (Beckmann, 1979).

For Minangkabau people in Ampek angkek and Tilatang Kamang, forests, streams, and rice fields belong to communal property (ulayat kaum) organized by Penghulu (clan leader). The ulayat kaum (it is called "ulayat" in this paper) is distributed among the clan member of the village and then administrated by Penghulu (Holleman, 1981). Additionally, the ulayat is inherited from the ancestors and utilized by the present generation but should be conserved for future generations. The rights to use the ulayat (hak ulayat) can be vested in a matrilineage (kaum) or minor lineage (perut) (Oki, 1984). Communal land rights give the highest possible claim to landownership (Saleh 1972), and communal land cannot be sold except for explicitly stated specific reasons. The Minangkabau people are an egalitarian community. Yet, there is a person with authority known as Penghulu (clan leader) (Benda-Beckman, 1984). In addition, the members of a matrilineal descent group are under Penghulu authority, who, in turn, is subject to Mufakat (consensus) among the members of the Adat Council, known as

Kerapatan Adat. Some studies argue that Mufakat is the main guarantee for a just and correct decision (Benda-Beckman, 1984; Blackwood, 200; Naim, 2013) as the Mufakat process requires deliberations and negotiations among all people concerned. Benda-Beckman (1979) argues that Mufakat can only be obtained when people conform to certain abstract values, such as reasonableness, appropriateness, to what is possible, and ultimately to the truth. Furthermore, in the process of Mufakat, a decision must be made by process of joint deliberation by all people concerned, which continues until unanimity is reached (Benda-Beckman, 1984).

In the case of traditional natural resources management, the community implemented Mufakat principles in determining agronomical and irrigation water management and conflict resolutions. The farmers have the right to speak in the consensus process as the farmers have comprehensive rights in clan deliberations. There are some levels at which a decision has to be made in the deliberation process. For instance, in conflict resolutions, the problem has to be solved at the very lowest levels or between people's concerns and Tuo Banda (water master). In the customary law, it states that one should try to make a decision at the lowest possible level, and only if the attempt to reach an agreement has failed may the problem be taken up a step to the next level, where a new effort is made (Benda Beckamn, 1984). Higher levels of decision-making always mean that a Penghulu becomes involved.

In the process of Mufakat, Penghulu is the primary source of leadership roles; Penghulu acts more as a mediator than as a judge and more as an organizer than as a ruler (Dobbin, 1983; Blackwood, 2001; Naim, 2013;). Based on personal interviews with key informants, in some regions in West Sumatra, Penghulu even has more roles in irrigation water management. The roles of Penghulu were to monitor

the irrigation activities such as re-contractions of the canal as found in Paraku irrigation system. In addition, Penghulu as a trustee of irrigation infrastructure, including rice fields, has authority to determine the extension or construction of irrigation facilities. As a result, the community subsequently follows and respects the Penghulu.

The harvest ceremony is an important part of traditional natural resources management. The purpose of the harvest ceremony was a ritual to send gratitude to God. For instance, Alek Banda (the harvest ceremony) in the Paraku irrigation system was to send gratitude to God by cutting buffalo head near the Kapalo Banda (weir). In addition, every region in West Sumatra has different name of the harvest ceremony such as Sadakah Bumi, Manyabik, Bakawua and Turun Kasawah. Besides sending gratitude, the harvest ceremony has an important function that is to strengthen the social relationship between farmers. In addition, the functions of the harvest ceremony are; the occasion was used to forgive the past grievances from all farmers in the last planting season; to determine the next planting season under Mufakat; and to mobilize labor for the task of cleaning the canal.

There were some indigenous practices in rice farming as well as irrigation water management. For instance, in traditional irrigation water management, there is a traditional rule known as Lamak diawak, katuju diurang (moderating own's needs). It means diverting water from a river and canal only as much as a rice field needs because water is also needed for other rice fields. Therefore, to composite this rule, the indigenous community crated traditional practices in water distribution that can be found in several areas in West Sumatra, which are: regulating Aia Adat (customary water) for protecting irrigation water; adjusting each system's water share, especially in the very dry season; regulating the spacing and location

of the weir; regulating the construction of the weir; irrigation management challenges. The FGD process



regulating planting schedule, especially during the dry season; and gotong royong (communal work) activity to maintain the irrigation facilities under Tuo Banda and Penghulu concern. These traditional rules have been used in most areas in West Sumatra under Tuo banda and Penghulu monitoring. Additionally, to avoid conflicts over water, Penghulu has an important role in maintaining the social relationship between farmers in his clan and between other clan communities. Thus, coordination between Penghulu in each system is important to avoid conflicts.

The Knowledge Sharing and Decision Making of The P3A Irrigation Management

Knowledge sharing and mutual learning with farmers were facilitated through Focus Group Discussions (FGDs). These FGDs, integral to the collaborative actions with local farmers, local government, traditional leaders and the researcher, were conducted twice during the fieldwork at the farmers' homes and the chairman of P3A's residence (Fig. 3). The FGDs encouraged farmers to voice their opinions on their

involved several steps:

1. Farmers were asked to draw the locations and boundaries of their rice fields.
2. They illustrated the upper rice fields from which they share irrigation water.
3. Farmers described the rules and practices for sharing irrigation water.
4. They marked the areas where they participated in communal work (gotong royong).
5. Farmers discussed their problems related to irrigation water management.

During the FGDs, researchers highlighted the challenges and problems faced by the farmers, presenting observations from the field study. This iterative process aims to develop and implement effective solutions, enabling all participants to exchange ideas and learn from one another.

During the knowledge-sharing and mutual learning sessions with the farmers, the study revealed that the P3A Jorong Biaro Irrigation system is managed by a farmers' group. This group, comprising farmers served by the same secondary canal, collaborates to

maintain the irrigation system. The P3A in this area has four weirs serving the rice fields. Gotong royong, or communal work, is typically carried out before land preparation each planting season to maintain irrigation facilities.

The leader of the farmers' group, distinct from the P3A leader, is elected by all farmers within the P3A. This leader's primary responsibility is to mobilize farmers for gotong royong, particularly for cleaning and maintaining the canals.

Socially, rice farming activities have shifted from collective to individual management as the role of indigenous leaders has diminished in agricultural activities. Consequently, rice fields have transitioned from communal to private ownership. This shift has weakened social capital in the area, as farmers now tend to manage irrigation individually rather than collectively.

Based on the FGD results with farmers in P3A Jorong Biaro, there are some problems occurs regarding the irrigation management:

1. The leader of the P3A has not been effectively performing irrigation management tasks, such as managing water distribution, mobilizing labor for irrigation maintenance, and resolving conflicts.
2. There is a lack of common understanding between the P3A and the farmers regarding the division of responsibilities in maintaining the irrigation system. Farmers believe that the P3A, as a government-created institution, should be responsible for tasks such as cleaning and maintaining the canals.
3. Farmers are reluctant to pay an irrigation fee, arguing that a substantial volume of water flows in the river even during the dry season, and no formal rules regarding irrigation fees are in place.

4. Participation in gotong royong (communal work) is low because no sanctions are applied to non-participants, resulting in poorly maintained weirs and canals due to overgrown grass and sedimentation, which hinders the equitable distribution of water.
5. Farmers view the leader of the P3A as an extension of government staff rather than a member of the farming community.

These findings highlight significant gaps in the functioning and perception of the P3A, underscoring the need for better integration of farmer participation and clearer communication of roles and responsibilities.

In P3A Namuang Saiyo, we found that most farmers are hired laborers. These farmers are employed by the rice field owners to cultivate the crops, and the harvested rice is split 50:50 between the owner and the laborer. Additionally, many labor farmers come from outside the P3A village, resulting in weaker social capital within the community.

Regarding the planting schedule, the area is organized with a two-week gap between the upper and lower area. Irrigation water flows from plot to plot, with a single primary canal serving the rice fields. The irrigation rule prioritizes the upper system, granting it first rights to water, while the lower system has only subordinate rights. The results of the focus group discussion (FGD) conducted with farmers revealed several challenges in irrigation management within the area:

1. Inadequate performance by the leader of the P3A in executing essential irrigation management duties, such as regulating water distribution, organizing labor for maintenance activities, and mediating conflicts effectively.

2. Farmers exhibit reluctance towards paying irrigation fees, citing the perceived abundance of water in the river even during the dry season and the absence of formal regulations governing fee imposition.
3. Participation in communal work (*gotong royong*) is lacking due to the absence of sanctions for non-participation. Consequently, weirs and canals suffer from neglect, characterized by overgrowth of vegetation and sedimentation, thereby impeding the equitable distribution of water resources.

Based on the FGD results, the irrigation management activities for both P3A are presented in the below table.

The decision-making must be determined by the farmers themselves as it will encourage participation and would have a major impact on the improvement of irrigation management. In addition, the self-determination actions will ensure that all resource users would have follows the decisions. Also, during the FGD processes, the empowerment and sharing of responsibility from all actors are conducted to

Table 4. Irrigation activities rules in P3A Jorong Biaro and P3A Namuang Saiyo (based on FGD results)

Irrigation categories	P3A Jorong Biaro	P3A Namuang Saiyo
Water distribution	• No rule	• No rule
Maintenance of irrigation facilities	• There is no common understanding both by the P3A and the farmers regarding job division in maintaining the irrigation system. The farmers think that the P3A, as a government-created institution, should be responsible for maintaining the system, such as cleaning and maintaining the canal. • Weir and secondary canal maintenance is organized by farmers' groups (Not P3A).	• There is a common understanding by farmers regarding job division in maintaining the irrigation system, but the farmers participation of <i>gotong royong</i> to maintain the irrigation facilities is very low. • Weir is organized by farmers whose rice field located near the weir. These farmers worked voluntary to clean the weir. In addition, the maintenance for canal often done by voluntary work by farmers who are location near the canal and served by the canal. Thus, the farmers whose rice field located near the canal claim that the water is belong to them, as they work to clean the canal.
Labour mobilization	• The leader of the P3A has not been performing irrigation management tasks, especially for mobilizing the farmers to maintain the irrigation facilities.	• The leader of the P3A has tried to perform irrigation management tasks, especially to mobilize labour for <i>gotong royong</i> activities but not successfully to encourage farmers to do irrigation maintenance activities.
Financial resource	• The farmers think they should not have to pay an irrigation fee because quite a large volume of water flows in the river even in the dry season, and no rules are applied for an irrigation fee.	• The farmers are no longer pay the irrigation fee from 2015. The farmers think they should not have to pay an irrigation fee as the government is already made the permanent primary canal in the area. Thus, quite a large volume of water flows in the river even in the dry season.
Conflict resolution	• No rule is set for conflict resolution.	• No rule is set for conflict resolution.

Table 3. Logical Framework Analysis Based on FGD results with farmers.

	Narrative summary	Objectively Variable Indicators	Mean of verification	Important assumption
GOAL	Improve farmers' participation in irrigation management (communal work) for maintaining irrigation facilities	- Improvement in farmers participation in gotong royong - Improvement in irrigation water distribution	Observation and survey of showing good maintained of irrigation facilities.	Good maintenance in irrigation facilities
PURPOSE	- Increase social capital of farmers by re implementing traditional knowledge in irrigation management. - Increase farmers' participation in irrigation management.	Improvement of cooperation in irrigation management within farmers in the P3A	The number of farmers participate in maintaining irrigation facilities.	Effective irrigation management
OUTPUTS	- Improving irrigation management in the P3A. - Re-implementing traditional knowledge in agriculture. - Higher participation in gotong royong - Improving in interaction between farmers so that good communication is established.	- Good practices of irrigation management in the P3A - Re-implementation of traditional knowledge in irrigation management	Observation and survey showing the number of farmers participate in maintaining irrigation facilities. Observation to show the function of Penghulu in irrigation management.	Re-implementation of traditional knowledge in agronomical and irrigation management
INPUTS	- P3A regular meeting - Implementing <i>mufakat</i> principle in determining irrigation management. - Implementing Alek Banda (harvest ceremony) - Re-implementing the role of <i>Penghulu</i> (clan leader) in irrigation management	Continuation of gotong royong activities Implementation of regular P3A meeting for all farmers Re-implementation the role of <i>Penghulu</i> in irrigation management such as encouraging farmers participation in gotong royong activities.	Observation and survey showing the number of farmers participate in maintaining irrigation facilities. Observation to show the function of <i>Penghulu</i> in irrigation management.	Higher participation in gotong royongRegular meeting for P3A members

encourage bottom-up initiation. FGDs with stakeholders both in P3A Jorong Biaro and P3A Namuang Saiyo resulted in several actions offered analyzed by the Logical Framework Analysis (LFA) as shown in Table 3.

During the FGD activities the farmers were encouraged to overcome their own problem and determine good practices or possible solutions based on traditional value to the irrigation management problems, especially to improve gotong royong

activities to maintain the irrigation facilities, as follows:

1. Involving Mufakat (consensus) in determining irrigation and agronomical management.
2. Including characteristics of Indigenous leaders in P3A leadership.
3. Implementing Alek Banda (harvest ceremony) to unite the community.
4. Implementing matrilineal landownership system as the monitoring system to increase participation in gotong royong activities.

Ideal Conditions for Integrating Traditional Knowledge into Modern Irrigation Management

A critical question in contemporary irrigation management is whether the traditional knowledge identified for integration can be effectively applied under current conditions. Previous studies indicate that much of this traditional knowledge has either disappeared or is no longer in use, particularly within agricultural activities (Utami and Oue, 2023). Despite the decline of traditional agricultural practices in the Agam region, Minangkabau customs persist in social contexts, such as wedding ceremonies, traditional rituals, and other cultural events. Consequently, the five core traditional values previously mentioned continue to be observed in everyday life.

Mufakat (consensus) remains a vital aspect of decision-making processes, particularly during traditional ceremonies such as the appointment of clan leaders (PENGHULU) and other significant events. Implementing *mufakat* in irrigation management can enhance farmers' participation in irrigation activities and mitigate conflicts over water resources.

The PENGHULU continues to play a crucial role in community mobilization, and their characteristics remain influential among community members. This influence results in the emergence of respected individuals within farmer groups who can offer guidance and support. It is also essential for the leaders of farmer water user associations (P3A) to possess indigenous characteristics that enable them to effectively organize and provide irrigation services to farmers. Such characteristics ensure that farmers

respect the irrigation committee as their leaders.

Alek Banda, a traditional ceremony, continues to be significant in reinforcing the social capital of farmers, although it is now conducted on a smaller scale. The harvest ceremony is an important aspect of traditional natural resources management, serving as a ritual to express gratitude to God. Beyond gratitude, the harvest ceremony plays a crucial role in strengthening social relationships among farmers.

Matrilineal land ownership persists in the research area, with communal land, including rice fields, managed by the PENGHULU. This system serves as a mechanism for encouraging farmer participation in irrigation activities. In addition to securing agricultural land, the matrilineal land ownership system fosters strong kinship relationships within the community, thereby generating robust social capital. This enables the community to engage in collective work efficiently and ensures that the benefits are equitably shared among its members.

In the cases of P3A Jorong Biaro and P3A Namuang Saiyo, where most farmers are hired laborers from other villages, the rice field owners can be involved in irrigation management. The PENGHULU can encourage these owners to monitor gotong royong (mutual cooperation) activities and ensure that all hired laborers participate in these communal efforts.

CONCLUSIONS

Collaborative action is essential to support bottom-up solutions to diverse irrigation water problems. Based on the arguments above, this study aims to assess the collaborative action to integrate traditional knowledge into the current irrigation system. By observing the irrigation management from the viewpoint of the irrigation institution in two P3As in Agam District, it was found that an institutional problem has happened in the P3A Jorong Biaro and P3A Namuang Saiyo. To encourage farmers' participation in collaborative action, this study conducted knowledge sharing and mutual learning through Focus Group Discussion (FGD) to generate irrigation problems and find possible irrigation management solutions. Based on the FGD activities, this study found that both P3As

have been experiencing low participation in gotong royong for maintaining irrigation facilities. This study evaluated that the problems in both P3A have happened because these P3A were established without mufakat (consensus) by all farmers in the area. In addition, the Minangkabau traditional value has been excluded in the agricultural activities, resulting in low social capital in the research area.

This study is also encouraging farmers to determine the possible solutions for their irrigation problem as it will encourage participation and would have a major impact on the improvement of irrigation management. Based on the FGD activities, the farmers found some possible solutions for their irrigation problems as follows: involving mufakat (consensus) in determining irrigation management; including characteristics of Indigenous leaders in P3A leadership; implementing Alek Banda (harvest ceremony) to unite the community; and, implementing matrilineal landownership system as the monitoring system to increase participation in gotong royong activities.

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