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Irrigation Management Strategy for Rice–Fish Farming as a Conflict Resolution between Farmers and Pond Owners in Kelingi Tugumulyo

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Abstract: Management of Water Resources in irrigation areas is a vital aspect in supporting food security and community welfare. The Kelingi Tugumulyo Irrigation Area, located in Musi Rawas Regency and Lubuk Linggau City, is one of the important irrigation areas in South Sumatra. This area serves not only as a rice production center, but also as a location for the development of heavy-water pond fish farming. However, differences in interests between rice farmers and fish farmers often trigger water use conflicts. This study aims to identify the dynamics of water use conflicts, assess the role of local institutions, and formulate sustainable policy solutions. The method used is a descriptive qualitative approach with the support of quantitative data from BPS, BBWs Sumatra VIII, and field surveys. The results showed that the conflict was triggered by imbalances in water distribution, weak regulation, low compliance with water utilization permits, and institutional helplessness of farmers (P3A). The impact of the conflict is a decrease in rice harvest area, land conversion to non-rice sector, as well as socio-economic inequality among water user groups. This study recommends strengthening regulation, revitalization of P3A/GP3A institutions, integration of cropping patterns and fish farming, as well as the application of water-efficient irrigation technology.

INTRODUCTION

The use of water in an irrigated area is very important so that existing water resources can be allocated to all irrigated areas efficiently and effectively. The provision of irrigation and rainwater will affect the water balance in the land. If it is known that there is excess water availability to irrigation water needs, then savings can be made and used again for various other purposes. Irrigation water balance system in the land includes rain, water supply, water needs for plants, and excess water needs to be managed properly to determine the amount of parameters in the balance of water in irrigated land by applying koninyu, scheduled, and contoured. The development of Water Resources in the irrigation area is always related to the issue of water availability. The components of water availability include rain and irrigation water provision, which affect the height of inundation in rice fields, surface flow, and subsurface flow (Yendri et al., 2019).

The use of water in agricultural irrigation systems plays a crucial role in ensuring the efficiency and effectiveness of water resource allocation. Rainwater and irrigation water supply have a profound influence on the water balance in the land. In managing the excess availability of water compared to irrigation needs, it is important to note that the use of the Irrigation Performance Index (IPA) can provide insights into efficient discharge. Through IPA simulations in areas with water surplus, efficiency in water use can be achieved, allowing for reallocation to other purposes (Sayekti et al., 2017;Lake et al., 2021). In addition, effective water management is also influenced by the irrigation techniques applied. The use of piped irrigation and sprinkler irrigation is more efficient compared to traditional methods such as flood irrigation, which often results in significant water loss (Hamri et al., 2022); (Rusmayadi et al., 2023).

Conflicts in irrigation water management have become an increasingly pressing issue in many regions, especially in Indonesia. This is due to competition among various stakeholders who need water for agricultural activities, as well as reduced water availability caused by climate change and inefficient management. Research shows that poor irrigation water management can lead to conflicts, particularly in areas with limited water supply (Komarudin, 2010; Ardiansah et al., 2018). In this context, optimizing water use is essential to prevent conflicts and improve the efficiency of water distribution in irrigation networks (Jalaludin & Laksmiati, 2023; Rusmayadi et al., 2023).

One of the main causes of conflicts in irrigation water management is the unequal distribution of water. Studies indicate that in certain irrigation networks, there is an excess of water in the upstream areas and a shortage in the downstream areas, often due to poorly maintained infrastructure (Prasetyo et al., 2023). Dysfunctional irrigation systems can result in water shortages for downstream farmers, which in turn may lead to social jealousy and conflicts among farmers (Adi et al., 2022). To address this issue, several studies recommend the use of modern technologies to improve water distribution efficiency, such as IoT-based automatic irrigation systems that can monitor and adjust water allocation in real-time (Setiadi & Muhaemin, 2018; Sukmono et al., 2020; Tohidin et al., 2023).

Irrigation Area Kelingi Tugumulyo Irrigation Authority of the central government, in its management based on Candy PU No.14/M / 2015, the Raw area in Kelingi Tugu Mulyo 10163 Ha is divided into 8841 Ha in Musi Rawas District and 1322 Ha located in Lubuk Linggau Regency. The authority of the implementation, implemented by the central Sumatra River Region VIII (BBWSS VIII). This Irrigation Area is also one of the mainstays of South Sumatra province, in addition to the Komering irrigation and tidal swamp areas in the eastern part. The production of rice and fish from the Kelingi Irrigation Area is well known and has supplied the needs of districts/cities in South Sumatra and several surrounding provinces (Saleh, 2010).

This area is a highly developed agricultural area, and its irrigation system comes from the Kelingi River, which is one of the tributaries of the Musi River. Data from the Sumatra River Region VIII Center in 2021 states that from the standard area of the Kelingi Tugumulyo Irrigation Area, the functional area is approximately 6,600 ha in the form of rice fields and 117 ha in the form of heavy water fish ponds. The Irrigation Area of Kelingi Tugumulyo, at the beginning of its construction, was intended for rice fields to produce rice. Along the way, since the 1980s, there have been several parts of the potential irrigation area have been developed, in addition to rice production is also used for fish farming in heavy water ponds.

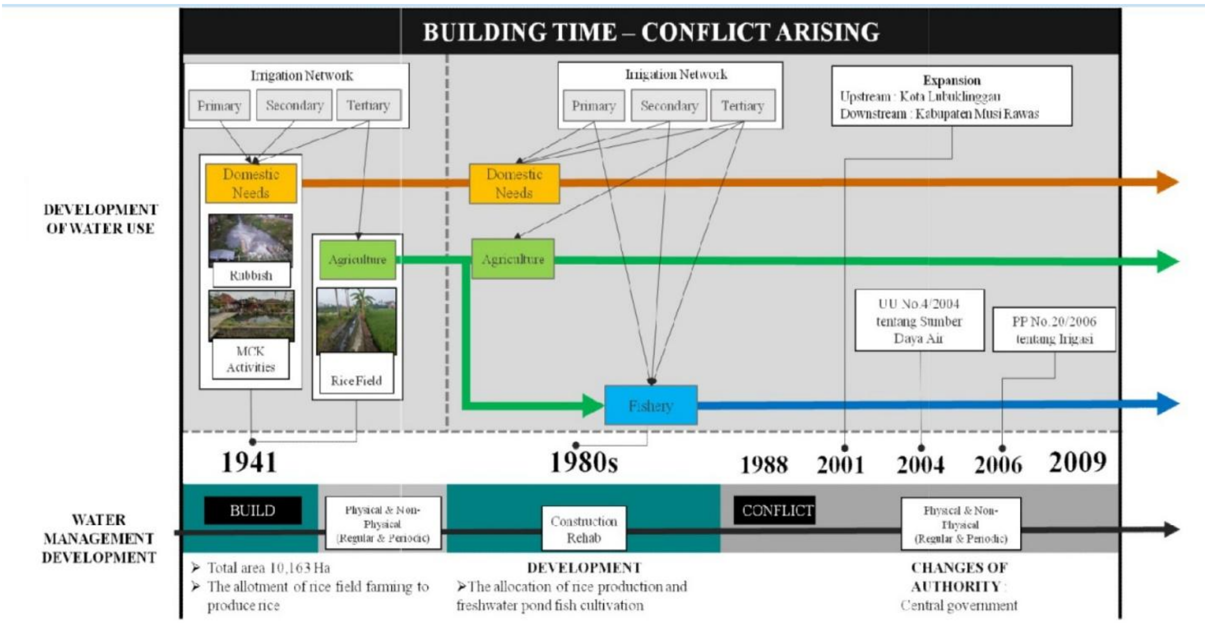
Over the past 20 years, farmers in the Kelingi Tugumulyo Irrigation Area have faced decreasing water discharge, often leading to protests—especially from those farming downstream of the Watervank Dam. During dry seasons, crop yields drop sharply, prompting many farmers to convert their land to plantations. One major cause is the diversion of irrigation water for high-flow fish ponds, where water is dammed and redirected from irrigation channels. However, many of these ponds are built improperly, preventing the used water from being returned to the main channel. This mismanagement disrupts water distribution and has fueled ongoing conflicts over water use in the area.

Based on the inventory that has been carried out by the Sumatra River Region VIII Center, there are more than 400 fish ponds with fast currents that take water from these irrigation channels. In accordance with existing legislation, these activities must obtain permission in advance to cultivate water resources from the irrigation channels. But those who have taken care of new permits, < 5% of the number of existing fish ponds, this will be a problem or a time bomb if there is no further settlement. What's more, the fish farmers already dare to make their own weirs channeled and even break or damage the embankment/ floodgates.

Based on the results of the One Map Policy (Policy one map) functional area in the form of rice fields in D.I Kelingi Tugumulyo is +6,689 Ha, and based on the results of a survey of fish ponds (heavy water ponds and calm water) conducted by PT. Widya Graha Asana (KSO) PT. Sanjaya's partner in D.I Kelingi Tugumulyo through the IPDMIP program is as many as 285 ponds or an area of 336.18 Ha with a debit of 4.03 m3/sec. Of the 285 fish ponds, there are only 4 ponds that have a water use permit (SIPA). Based on South Sumatra BPS data in 2022, Musi Rawas Regency has a rice harvest area of 20,350 ha and a production of 120,025 tons of dry milled grain in 2021. When compared to the harvested area of paddy rice and production in 2020, which was 22,350 ha and 123,933 tons of dry milled grain, there was a decrease in the Harvested Area of

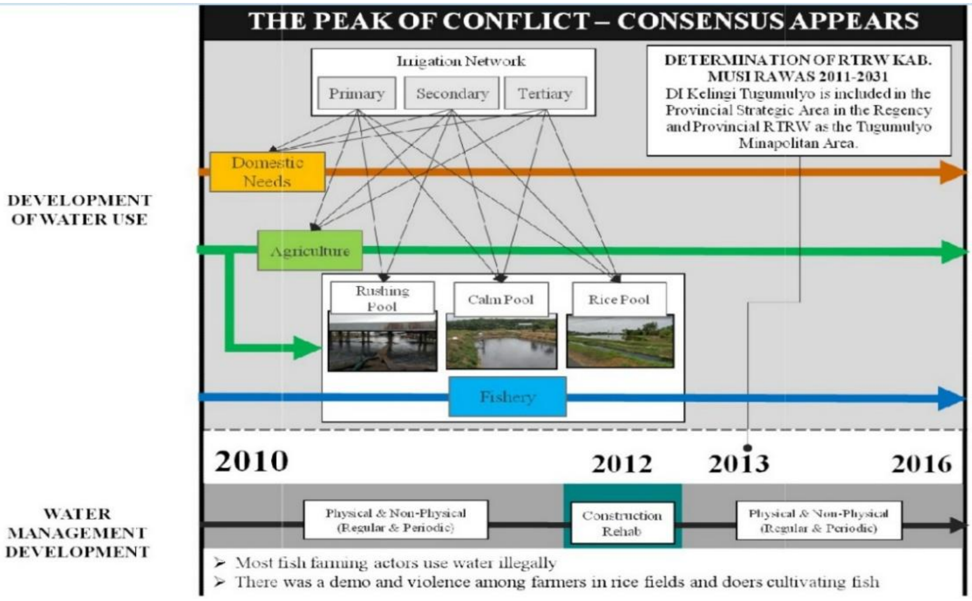
11.06% and a decrease in production of 3.15%. The results of research by Mulyana (2014) identified that one of the important triggers of the decline in the area of paddy fields due to conversion of paddy fields to non-paddy fields, for example, for the development of the fisheries sector.

The process of utilizing water from the Irrigation Area of Kelingi Tugumulyo tends to be used exploratively. Most of the use of irrigation water is done illegally by damming or tapping. The diversity of water usage patterns in irrigation areas is motivated by differences in the way each stakeholder views Water Resources. This phenomenon triggers a conflict in the use of irrigation water between rice farmers and fish farmers. On the other hand, agricultural activities are the backbone of the livelihoods of most people who use irrigation water, but fisheries view irrigation water as a potential that can be developed as a profitable business opportunity. After the construction of irrigation in 1941, management resumed regularly and periodically. In the development of forms of water use in irrigation areas and rehabilitation of construction around the 1980s, water use conflicts arose in 1988. Subsequently, construction rehabilitation was carried out in 2012 and realignment. As shown in the following figure :



Picture 1.
Development of pattern and Conflict in Irrigation Area Water Utilization Period of Establishment Until Conflict Appears
Source: Firma Rizki, Doddy Aditya Iskandar ICOSEAT 2023

However, conflicts over the use of water in irrigation areas still resurfaced, triggering even greater conflicts in 2010. The implication is that the pattern of water management for irrigation areas that have been formed is to build and then ignore, then rebuild and ignore, and so on. This shows that there is a pattern of improper management in the water management of the Irrigation Area of Kelingi Tugumulyo. So that conflicts over the use of irrigation water still occur, and the planning and organizing process is not running. As shown in the following figure:



Picture 2.
Pattern and Conflict of Utilization in Irrigation Areas The Peak Period of Conflict Until Consensus Appears
Source: Firma Rizki, Doddy Aditya Iskandar ICOSEAT 2023

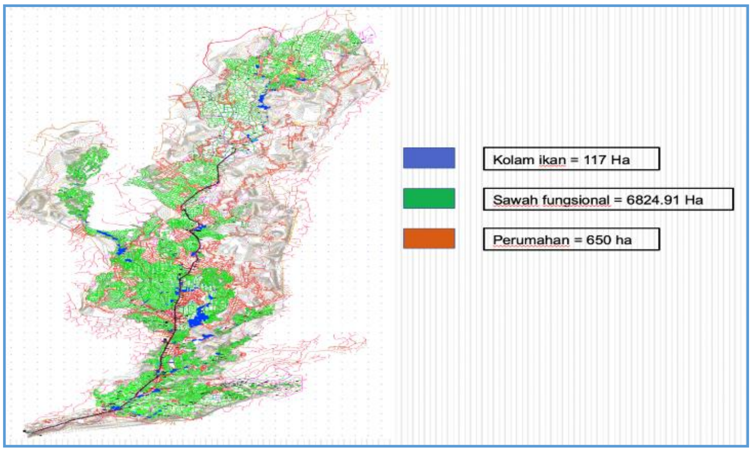
The impact of the conflict resulted in irrigation buildings and irrigation canals becoming unkempt, many sluices do not function, and the distribution of water is only based on estimates. In addition, the silt deposits are channeled beyond the permissible height, since no drainage can be carried out, and the amount of running water cannot meet the needs for irrigation. Water shortages in the lower and middle irrigation fields also occur, especially in the dry season. On the other hand, the conditions in the upstream paddy field often can not control excess water due to the overflow of water from irrigation channels in the dam by the owner of the heavy water pool, as well as from the discharge and heavy water pool that flows continuously. This study aims to identify the dynamics of water use conflicts, assess the role of local institutions, and formulate sustainable policy solutions.

RESEARCH METHODS

Research Approach This study uses a descriptive-analytical approach with a case study method in the Irrigation Area (DI) Kelingi Tugumulyo, Musi Rawas Regency. A descriptive approach was chosen to describe in detail the conditions of water distribution, institutional P3A, as well as the characteristics of rice farmers and fish farmers. Meanwhile, the case study was chosen because the focus of the research lies in one particular location that has distinctive socio-economic and institutional complexities. (Creswell, 2017) emphasizes that case studies are suitable for understanding complex phenomena in real-life contexts. Therefore, this study seeks to explain the conflict patterns of water use holistically by taking into account the technical, social, and institutional dimensions.

RESULTS AND DISCUSSION

Technical Condition of Irrigation Networks. The irrigation network in the Irrigation Area (DI) of Kelingi Tugumulyo was built during the Dutch colonial period and still serves as the backbone of the agricultural system in Musi Rawas Regency and Lubuk Linggau City. The main infrastructure consists of the Watervank Weir, a 25 km primary channel, an 85 km secondary channel, and a tertiary channel serving approximately 10,163 hectares of wetland. The results of the inventory showed that most of the secondary and tertiary channels suffered physical damage in the form of sedimentation, cliff avalanches, and leaks due to community activities. This damage leads to a decrease in the efficiency of water delivery by 30-40%. In addition, sluices in some locations do not function optimally, so that the rotation schedule of water distribution is difficult to run consistently. Field measurements show that the water table height (H) and discharge (Q) fluctuate sharply between the rainy season and the dry season. In the rainy season, the discharge tends to be abundant, so that rice farmers can do simultaneous planting. In contrast, in the dry season, the discharge decreases dramatically, so that the water needs of rice fields can not be met, while fish ponds still demand continuous flow.



Picture 3.
Layout in Kelingi Tugu Mulyo
Source: BBWS Sumatera VIII

In general, in the irrigation network, there is moderate to severe damage. Some existing floodgates are mostly damaged due to age (corrosion), besides not equipped with a door or roof as a protector on the door itself.

Water distribution and rotation

Water distribution systems that are ideally based on rotation (planting groups) often do not go according to plan. Field Data show that the rotation schedule set by P3A is rarely adhered to, mainly due to illegal damming by fish pond farmers. Under normal conditions, the discharge that flows into the rice fields is around 0.8–1.0 liters/second/ha. However, the measurement results showed that in the dry season, the discharge only reached 0.4–0.5 liters/SEC/ha, far below the needs. Meanwhile, fish farmers use a larger and continuous discharge (0.5-1.2 liters/second per pond) to maintain water quality. This imbalance has caused complaints from rice farmers because their rice fields often experience drought, while water flows heavily in ponds.
The efficiency of irrigation applications at the farm level on average reaches only 50-55%, far from the standard technical efficiency (70-80%). This is exacerbated by the lack of Channel maintenance and weak supervision from field officers.

The situation described in the paragraph has several significant impacts on both agricultural productivity and irrigation management in the Kelingi Tugumulyo Irrigation Area:

1. Water Shortages for Rice Farmers

Because the rotational water distribution system set by P3A (Water User Farmers' Association) is often violated—mainly due to illegal damming by fish pond owners—rice farmers receive far less water than needed. During the dry season, water discharge drops to only 0.4–0.5 liters/second/ha, which is insufficient for optimal rice growth. As a result, rice fields frequently experience drought, leading to reduced yields or crop failure.

2. Unfair Water Allocation
Fish farmers consume a large and continuous amount of water (0.5–1.2 liters/second per pond) to maintain pond conditions, creating an imbalance between agricultural and aquaculture users. This causes tension and conflict between user groups, as one sector (fish farming) benefits at the expense of another (rice cultivation).
3. Low Irrigation Efficiency
The overall irrigation efficiency at the farm level is only about 50–55%, far below the ideal standard of 70–80%. This indicates that a significant portion of available water is lost due to poor infrastructure, leakage, or misuse before reaching the crops.
4. Poor Infrastructure Maintenance and Oversight
The lack of regular maintenance of irrigation channels and weak supervision by field officers further worsens inefficiency. This neglect allows illegal practices and technical losses to continue unchecked.

In summary, these conditions collectively lead to inequitable water distribution, reduced agricultural productivity, resource inefficiency, and persistent social conflict among water users in the irrigation system The described conditions in the Kelingi Tugumulyo Irrigation Area have resulted in a series of serious and interrelated impacts that affect agricultural productivity, water resource management, and social relations among farming communities.

Firstly, the chronic water shortage for rice farmers has become a major issue due to the failure of the rotational water distribution system managed by the P3A (Water User Farmers' Association). Although the system is intended to regulate the fair distribution of irrigation water among planting groups based on a rotation schedule, it is rarely followed in practice. This is primarily caused by illegal damming and water diversion carried out by fish pond owners who seek a continuous flow to sustain their aquaculture activities. Consequently, during the dry season, the amount of water flowing into the rice fields decreases drastically, reaching only 0.4–0.5 liters per second per hectare, far below the ideal 0.8–1.0 liters per second per hectare needed for optimal rice growth. This insufficient water supply leads to repeated drought conditions in rice fields, resulting in a significant decline in agricultural yields and, in some cases, forcing farmers to abandon rice cultivation altogether.

Secondly, there exists a serious imbalance and inequity in water allocation between rice farmers and fish pond operators. While rice farmers receive limited water that barely supports crop survival, fish farmers exploit larger and continuous water discharges, ranging between 0.5 and 1.2 liters per second per pond, to maintain proper water quality and oxygenation levels for fish production. This uneven use of water resources has caused friction and social tension among farmers, as one sector benefits disproportionately at the expense of another. Over time, this situation undermines collective water management agreements and weakens the authority of P3A in enforcing fair distribution practices.

Thirdly, the efficiency of irrigation water application in the Kelingi Tugumulyo Irrigation Area remains alarmingly low, with field measurements showing an average efficiency of only 50–55%. This figure is significantly below the national irrigation efficiency standard, which ranges between 70–80% for well-managed technical irrigation systems in Indonesia. The wide gap indicates that nearly half of the available irrigation water is lost through seepage, evaporation, or unregulated diversion before it reaches the farmlands. Such inefficiency not only leads to water waste but also exacerbates the shortage experienced by downstream users, ultimately reducing the overall productivity and sustainability of the irrigation network.

Finally, this problem is compounded by inadequate maintenance of irrigation infrastructure and weak supervision from field officers. Many primary and secondary channels suffer from sedimentation, vegetation blockage, and structural damage that are rarely repaired due to limited funding and institutional neglect. The lack of active monitoring and enforcement enables illegal damming and technical inefficiencies to persist unchecked, gradually eroding both the physical capacity and the governance integrity of the irrigation system.

In conclusion, the combination of poor compliance with rotational schedules, inequitable water distribution, low irrigation efficiency compared to national standards, and insufficient supervision has led to a cycle of declining agricultural productivity, resource mismanagement, and growing social conflict among farmers in the Kelingi Tugumulyo Irrigation Area. To restore balance and sustainability, urgent improvements in governance, infrastructure maintenance, and enforcement mechanisms are necessary to bring the system closer to the national benchmark of efficient irrigation performance.

Institutional aspects of P3A

Ensuring the provision of irrigation water in the area in Kelingi Tugumulyo can be sought through the role of the Association of water-using farmers (P3A), the Association of water-using farmers (GP3A), and the Parent Association of water-using farmers (IP3A). In addition, there is also a role for the three institutions in the existence of farmer groups (Poktan), combined farmer groups (Gapoktan), and supporting institutions such as the farmer women's group (KWT). The following agricultural institutions have been formed in the Irrigation Area of Kelingi Tugumulyo:

Table 1. of agricultural institutions formed DI Kelingi Tugumulyo.

No.	Group	Total
1	Farmer Group	401
2	Farmer Women Group	78
3	Farmer Group Coalition	40
4	Water Consuming Farmers Association	32
5	Coalition of Water Users Farmers Association	15
6	Parent of the Water Users Farmers Association	0

Source : BBWS Sumatera VIII

The current condition, P3A (Association of Water User farmers) in this region has a formal institutional structure, but is still weak in implementation. The number of P3A members is relatively large, but the participation rate is still low. Irrigation dues are rarely paid routinely, while operational funds for O&P (Operations and maintenance) are very limited. At that time, the SOP for water distribution had actually been made, but the sanction rules did not work. For example, illegal damming in secondary channels is often only solved by a reprimand without legal follow-up. This shows the weak position of P3A in enforcing the rules. Community service activities (gotong royong) are still carried out, but participation has decreased from year to year. Farmers ' perception of member compliance is low, and conflicts between members are increasingly common, especially between upstream and downstream rice field groups. Network relationship with the Department of Agriculture and BBWS is still limited, with more administrative than technical assistance.

Condition Of Rice Farmers

Rice farmers in Tugumulyo have an average of 0.5–1.5 hectares of land. The position of the land largely determines access to water: upstream farmers tend to get water supply more easily than downstream. The planting calendar generally follows the IP 200 pattern (twice a year planting), but in the last five years, many farmers can only to afford IP 100 due to a lack of water. Varieties grown include Ciherang, Inpari, and Mekongga, with a puddle irrigation method. The length of the puddle is on average 3-5 cm. The results showed that rice productivity decreased from an average of 6.2 tons/ha (2015) to 4.8 tons/ha (2023). Factors include limited water, decreased soil quality (pH 4.5-5.5), and delays in planting schedules. Meanwhile, farmers ' perceptions of irrigation services tend to be negative. They assess that the distribution of water is unfair, weak institutions, and conflicts are often ignored by the authorities.

The level of farm income is the result of productivity conversion multiplied by the price of rice prevailing during the harvest season. The average production in Kelingi Tugumulyo Irrigation Area is 6.65 tons of GKP per ha per year (2x growing season). The Irrigation Area of Kelingi Tugumulyo covers 7 Sub-Districts, namely Lubuk Linggau Selatan II (3 Villages), Muara Beliti (5 Villages), Tugumulyo (18 Villages), Megang Sakti (1 village), Purwodadi (3 villages), Sumber Harta (6 villages), and STL Ulu Terawas (3 villages). The production process of farming in Kelingi Tugumulyo is quite good by using balanced fertilizer standards. The availability of

fertilizers is always sufficient for the needs of farmers proposed in the RDKK (group needs a definitive plan). According to the recommendation of the Department of Agriculture or Agricultural Extension Center (BPP) itself about setting planting patterns at the beginning of the year is expected to plant up to three seasons, but is often constrained by the availability of fertilizer and remaining because it has not been redeemed at retailers, so that for the needs of fertilizer rations in the next season reduced. This is sometimes a problem because some farmers/poktan have not filed RDKK before the planting season begins.
PPL itself has been trying to help farmers in the preparation of RDKK so that the fertilizer needs of each season can be met. Another obstacle is that the use of chemical fertilizers is still high, because farmers still like instant results compared to the use of organic fertilizers, whereas the use of organic fertilizers can save production costs. From the productivity picture, there is a decrease of 20% caused by pests, floods, and water availability in the second growing season, which has entered the dry season. Some areas even experienced drought as in Lubuk Linggau Selatan II and in Muara Beliti District. This drought is the result of the existence of ponds around rice fields.

Farmers in Kelingi Tugumulyo plant twice a year. The Total cost of production for the Irrigation Area of Kelingi Tugumulyo amounted to Rp 6,091,917/Ha/MT, while the gross income received amounted to Rp 29,4800,000/Ha/MT, so that the net income received amounted to Rp 23,388,083/Ha / MT. Revenue received merupkan konversi from grain to rice. Then the value of the B/C ratio obtained by 3.84. This means that farming can be continued because the value of / C ratio > 1. But conversely, if the value of the / C ratio <1, then this business is not feasible or loss. Another considerable cost incurred in the production process is the cost of soil processing due to the cost of renting a hand tractor, which is generally not owned by all farmer groups.

The average cost of soil treatment in this area is around Rp 500,000 S/d Rp. 1,000,000 for one growing season. The Total cost of corn production for the Irrigation Area of Kelingi Tugumulyo RP. 8.420.000/Ha/MT-II while gross income received Rp. 17,500,000/Ha / MT-II, so that the net income received is Rp. 9,080,000/Ha / MT-II. Then the value of B/C ratio obtained by 1.08 means that this farming can be continued because the value of B/C ratio > 1. But conversely, if the value of B / C ratio <1, then this business is not feasible or a loss. In terms of investment, storage or sale in the form of rice is a little risky, considering the storage system of farmers is still traditional, so PPL recommends storing it in the form of grain because it will be more durable, and will be milled in accordance with the needs of farmers ' households.

Rice farmers in the Tugumulyo region generally manage land areas ranging from 0.5 to 1.5 hectares, and the position of the farmland—whether located upstream or downstream—largely determines their access to irrigation water. Farmers in upstream areas tend to receive sufficient water supplies, while those in downstream regions often experience severe shortages, particularly during the dry season. The planting calendar typically follows the IP 200 pattern (two planting seasons per year), but over the past five years, many farmers have only been able to achieve IP 100 (one planting season per year) due to a declining and unreliable water supply.

The main rice varieties cultivated in Tugumulyo include Ciherang, Inpari, and Mekongga, using a puddle irrigation method with an average water depth of 3–5 cm. However, over time, rice productivity has decreased from an average of 6.2 tons/ha in 2015 to 4.8 tons/ha in 2023, representing a decline of nearly 23%. Several factors contribute to this reduction, including limited water availability, decreased soil fertility (pH 4.5–5.5), and delays in planting schedules caused by late water distribution. Farmers' perceptions of irrigation services have consequently become negative, as many consider the water distribution system to be unfair, with weak institutional management and unresolved conflicts between water users.

The deterioration of irrigation network infrastructure is a crucial underlying factor that directly affects water distribution efficiency and, consequently, rice farmers' productivity. Many of the primary and secondary irrigation channels in the Kelingi Tugumulyo area suffer from physical damage, sedimentation, and vegetation blockages. This degradation reduces the effective carrying capacity of canals, causing significant water loss through leakage, seepage, and overflow before it reaches downstream rice fields. As a result, the actual irrigation efficiency in this area has dropped to an estimated 50–55%, far below the national irrigation efficiency standard of 70–

80% set for well-maintained irrigation systems. The reduced efficiency means that almost half of the available irrigation water fails to reach the intended farmlands, leading to uneven water distribution and persistent drought conditions in lower-lying areas.

This network damage and inefficiency have a direct relationship with the decline in cropping intensity (IP) and reduction in rice yields. Inadequate water delivery limits the number of feasible planting seasons per year and shortens the growing period, thereby reducing both productivity and profitability. Moreover, the weakened irrigation system increases farmers' dependence on rainfall, making them more vulnerable to seasonal variability and climate change impacts. The poor condition of channels also increases maintenance costs and forces farmers to invest additional labor in temporary repairs or alternative water access methods, further reducing their net income.

In terms of farm income, productivity outcomes are determined by multiplying harvested yield by the prevailing rice price during the harvest period. On average, the production in the Kelingi Tugumulyo Irrigation Area reaches 6.65 tons of unhulled rice (GKP) per hectare per year under two growing seasons. The irrigation area covers seven sub-districts, namely: Lubuk Linggau Selatan II (3 villages), Muara Beliti (5 villages), Tugumulyo (18 villages), Megang Sakti (1 village), Purwodadi (3 villages), Sumber Harta (6 villages), and STL Ulu Terawas (3 villages).

Although the production process is generally managed using balanced fertilizer applications according to the Definitive Group Needs Plan (RDKK), delays in fertilizer distribution and unredeemed fertilizer quotas from retailers often disrupt the following planting season. The Agricultural Extension Officers (PPL) continue to assist farmers in preparing RDKK documents to ensure fertilizer needs are met each season. However, the excessive use of chemical fertilizers remains a challenge, as farmers often prefer immediate results rather than adopting organic fertilizers, which could actually reduce production costs and improve long-term soil health.

From the productivity perspective, a 20% yield reduction is also linked to pests, flooding, and limited water availability, particularly in the second planting season that coincides with the dry period. Drought conditions are particularly severe in Lubuk Linggau Selatan II and Muara Beliti, where the diversion of irrigation water for fish ponds has further reduced the flow available to rice fields.

Economically, farmers in Kelingi Tugumulyo who cultivate rice twice per year incur an average production cost of Rp 6,091,917/Ha/MT, while earning a gross income of Rp 29,480,000/Ha/MT, resulting in a net income of Rp 23,388,083/Ha/MT and a B/C ratio of 3.84, indicating that rice farming remains economically feasible. However, the high cost of soil preparation, typically around Rp 500,000–1,000,000 per season, adds to the production burden, particularly for smallholders who must rent tractors. For corn cultivation, total production costs reach Rp 8,420,000/Ha/MT, with gross income of Rp 17,500,000/Ha/MT, producing a net income of Rp 9,080,000/Ha/MT and a B/C ratio of 1.08, which also suggests economic viability.

Nevertheless, despite the profitability, the continuing deterioration of irrigation infrastructure poses a long-term threat to farm sustainability. Unless the irrigation network is rehabilitated to meet national efficiency standards, the gap between water demand and supply will continue to widen, potentially forcing more farmers to reduce their planting frequency or switch to less water-dependent crops. The analysis clearly shows that network damage, decreased water distribution efficiency, and declining rice productivity are directly correlated, forming a cycle of reduced agricultural performance and growing vulnerability among farmers in the Kelingi Tugumulyo Irrigation Area.

Fish Farming Conditions

Fish ponds in their management based on water sources are distinguished into two, namely swift water fish ponds and calm water fish ponds. A quiet water pool is a pool that has a water source in and out of the pool with very limited water, or a pool that is only filled once at the beginning of the stocking until the harvest. The addition of water volume is done occasionally just to maintain a minimum volume of water in the pool. Not always depend on the source of water that flows into the pool, so anyone can make a pool of calm water without having to consider the location close to the river flow or other water sources. The swift water pond is a pond used for fish rearing activities. The heavy flow of water in this pond causes the stocked fish to be larger; for example, they have reached the size of 50 g/head (Gufran and Kurdi, 2008).

Heavy water pond fish farming has developed rapidly since the 1990s. There are currently more than 400 ponds in the area in Kelingi Tugumulyo, with sizes varying between 200-600 m2 per pond. Ponds generally draw water directly from secondary drains and discharge wastewater back into the grid. Discharge into the pool ranges from 0.5 to 1.2 liters/SEC, with a full 24-hour operating hours. Types of fish that are cultivated include tilapia, catfish, and salmon. Production averages 2-4 tons per cycle (3-4 months). However, water quality is a major problem. The measurement results showed a DO (Dissolved Oxygen) level of 4-6 mg/L, a pH of 6.5–7.5, and a temperature of 27-30 °C, but the content of Nh_2 and nitrites often exceeded the thresholds. Inedible feed waste and fish feces worsen water quality, so wastewater has the potential to contaminate rice fields downstream.

In addition to the potential of Agriculture, local resources that have a great opportunity to be developed are calm water fish ponds and fast water fish ponds. It's just that the pool issue has become a polemic and a cause of conflict in recent years. Fish, as one of the nutritional needs of the community, has indeed become a regional income source. It's just that the management of fish ponds, especially those that use irrigation water, has become a potential problem for a long time in Musi Rawas Regency. In Kelingi Tugumulyo, this issue has been discussed together at every meeting, and until now, the local regulation is the main solution to regulate pond licensing and irrigation water utilization. The potential of this pond also has considerable economic opportunities, considering the need for fish per year is also very high, especially the supply to Lubuk Linggau and Musi Rawas itself, up to Palembang, Bengkulu, and Jambi, reaching 193.78 tons, while fish consumption in Musi Rawas is still relatively low at only 35.84 kg per capita per year. This is a paradox, where the production is high but low consumption, so that the fish became the main supply goods to other cities.

Other Data states that in 2023, fish farming in Musi Rawas Regency amounted to 70,731.86 tons. The potential area reaches 3500 Ha with an existing land area of 792.38 Ha. This should also be a concern of the relevant agencies such as the Department of Fisheries, PUPR and Department of agriculture, including the use of irrigation water as a water supply to the main pool of heavy water ponds because the purpose of the IPDMIP (Integrated Participatory Development & Management of Irrigation Program) program implemented is to improve food security where it is expected that the development or repair of irrigation networks (rehabilitation) can continue to increase agricultural production, especially rice.

Picture 4.
Farmers of calm water fish pond (rice field pond) in Mardiharjo Village
Source: Research Documentation

Along with the results of the Survey Investigation Design (SID) that has been done States that the existence of a good fish pond or fish pond, swift water, calm water, impact on water discharge in irrigation Kelingi Tugumulyo and also on social life among the community, especially users of irrigation water as a source of water for rice fields or the pool itself. The Irrigation Area of Kelingi Tugumulyo community has also utilized the existing water for the fish pond business by taking water such as tapping/damming water from irrigation channels. For a technical solution now in progress, the Hall is preparing a design that will be followed up for construction rehab activities in the Irrigation Area of Kelingi Tugumulyo, because it concerns how much water should be provided by them, and how many areas of services will be served by the network.

Table 2. Inventory Of Fish Pond Irrigation Area Of Kelingi Tugumulyo

Channels	Number Of Fish Ponds		Fish Pond Area (Ha)	
	Heavy Water	Calm Water	Heavy Water (Ha)	Calm Water (Ha)
BK1	5	2	0.281	5.040
BK2	24	7	2.928	6.370
BK3	12	15	3.248	12.797
BK4	3	2	1.280	0.810
BK5	1	26	1.010	24.450
BK6	7	28	1.750	20.566
BK7	-	13	-	9.322
BK8	-	9	-	0.222
BK9	1	3	0.003	0.740
BK10	-	12	-	1.958
BK11	-	-	-	-
BK12	-	9	-	4.496
BK13	-	-	-	-
BK14	-	-	-	-
BK15	-	1	-	0.214
BK16	-	1	-	0.276
BK17	10	30	1.925	17.566
Jumlah	**63**	**158**	**12.425**	**104.827**

Sources : BBWS Sumatera VIII

Based on the results of interviews with several farmers of calm water fish ponds, they generally do not use irrigation water but springs or rivers around the location. Calm water fish ponds are safer in terms of water availability and do not interfere with or reduce the amount of water discharge. It's just that in terms of results, large fish produced are not like fish from heavy water ponds. Technically, heavy water fish ponds require more water that continues to flow because of the greater amount of O2, so that the fish continue to move and make the fish hungry faster and need more feed. One of the interviewee farmers said that the capital for the heavy water fish pond is greater than the cost of feed (pellets) because the fish need large amounts of food. In one production process for 1 pond with the number of fish fry as much as 60,000, the need for fish feed (pellets) is as much as 200 zak or 10 tons, drugs, salt 1 zak, chlorine 2 zak, dolomite 5 zak, urea fertilizer 1 zak. For the harvest obtained 6-7 tons. Selling price Rp17. 000/kg up to. If calculated, the net income obtained is Rp 22,660,0000. Economically, the fish pond business is more profitable felt by some fish pond farmers in Kelingi or in Lakitan; besides that, the treatment is also not as difficult as rice plants that need fertilizer or drugs when pests interfere. The fish pond business only needs the fulfillment of water as a breeding site. On average, for calm water fish ponds, in one production, only change the water three times, while for heavy water fish ponds, water changes are made while maintaining circulation or water circulation in ponds that generally use irrigation water either directly from the primary channel or from secondary channels with a direct tapping System with pipes.

Water source analysis and irrigation water availability

There are several main things that are indicated as the cause of the problem of reduced availability of irrigation water or excessive availability of water that results in flooding in the area in Kelingi Tugumulyo. Problems and follow-up efforts are presented in the table below:

Table 3. Description of the problem of sources and availability of water in Kelingi

No	Aspect	Description Of The Problem	Follow-Up Efforts
1	Source and availability of irrigation water	In the 2nd planting season not all rice is irrigated from a functional area of 6800 ha	1. Review the needs / capacity of existing intakes and channels. 2. Normalization of the channel (cleaning garbage, wild plants along the channel) 3. Conservation of forests.
2	Weir	Several main buildings (weirs and taps) suffered minor to severe damage.	Repair/rehab of weirs and auxiliary buildings (mud bags, drain doors, intakes)
3	Channels	Sedimentation in channels and around buildings	Sedimentation dredging
4	Fish Pond	Free harvesting is carried out by Pond farmers along the primary and secondary networks, which has an impact on the lack of water availability to farmers ' fields downstream.	Made regulations related to licensing, usage limits, and technical pool building. Made special tapping building Kola mikan heavy water and calm water.
5	Multipurpose	Use of water for fish ponds and not returned to the channel	Planned irrigation system that accommodates rice farmers and fish pond owners.

Source : BBWS Sumatera VIII

The table above illustrates the sources and availability of irrigation water that are less efficient in regulation and utilization for both agriculture and fisheries in the DI region. Kelingi Tugumulyo. It is expected that follow-up efforts can be implemented so that farmers can feel the benefits of the existence of the irrigation network.

Conflict and its impact

Conflicts between rice farmers and fish farmers arise mainly during the dry season. Farmers are demanding a fairer distribution of water, while fish farmers are resisting a reduction in discharge for fear of fish dying. Conflicts sometimes lead to extreme measures such as illegal demolition of dams, channel closures, and fights between residents. The impact of conflict is very real:

- Rice harvest area decreased by 20% in the dry season.
- Downstream farmers tend to switch to crop crops or leave their fields.
- Economic inequality is increasing because fish farmers earn more profits than rice farmers.
- Social tensions in the village are increasingly felt, weakening community solidarity.

Irrigation Management Strategy

The findings of this study show that conflict is not only a technical problem, but also an institutional and socio-economic problem. Technically, unbalanced water distribution occurs due to limited infrastructure and high pool water requirements. From the institutional aspect, the weak capacity of P3A makes the rules ineffective. From the social aspect, there is an inequality of economic benefits between rice farmers and fish farmers, which increases the sense of injustice. When referring to the Tragedy of the Commons theory (Hardin, 1968), the conflict in Kelingi tugumulyo reflects the struggle for shared resources (water) without strong regulation. Meanwhile, the Institutional Analysis and Development (IAD) approach from (Ostrom, 1990) shows the importance of the role of local institutions in regulating resource utilization. However, local institutions here have not been able to overcome the problem due to weak legitimacy and government support.

Based on the research findings, it is necessary to take several strategic steps, including: revitalization of irrigation networks through channel normalization, repair of sluices, and reinstallation of discharge measuring devices so that water distribution can be managed more accurately and transparently, strengthening P3A institutions by providing training support, operational funds, and clearer authority in regulating water distribution. It is necessary to create a mechanism for strict sanctions against violations, both by rice farmers and fish farmers. Enforcement of water utilization permit rules is required.

The government should require every fish pond to have a SIPA. Ponds that do not comply with technical rules need to be put in order so that the wastewater can return to the irrigation canal. Then the implementation of planting patterns and integrated irrigation schedules, which are mutually agreed upon between rice farmers and fish farmers. For example, synchronize rice planting schedule with fish farming cycle to minimize water struggle. In addition, a collaborative approach (co-management) is required. This is related to a multi-stakeholder forum involving BBWS, local governments, P3A, fish farmers, and the community. This Forum is a forum for Conflict Mediation and the preparation of Fair water distribution rules.

Diversification of the farmer's economy through the development of integrated farming should also be encouraged, such as mina-padi or sawah–ikan collaboration. This Model allows a balance between rice production and fisheries without sacrificing the other. Increasing the role of local government in providing appropriate regulation of development. The government must actively oversee the implementation of irrigation management policies based on the latest Water Resources Law. Environmental Quality Supervision. Fish pond waste must be treated first before being discharged into irrigation canals. The Environment Agency needs to establish quality standards and monitoring mechanisms regularly. Education and public awareness. Education and socialization programs on the importance of efficient use of water, planting patterns in unison, and technical rules of water utilization should be improved. Further research needs to be done related to water balance modeling, the potential efficiency of water-efficient irrigation technology, as well as socio-economic studies of the long-term impact of water use conflicts.

CONCLUSSION

Based on the results of the study, it can be concluded that the main problem in the Irrigation Area (in) Kelingi Tugumulyo lies not in the availability of water alone, but in the management and distribution of water that is not fair and weak institutions in the regulation of irrigation. The imbalance of distribution between the needs of rice farmers and fish farmers has triggered an increasing conflict, aggravated by the declining performance of irrigation networks, low institutional participation, and overlapping policies between levels of government. Social tensions arising from this conflict of interest have disrupted the social and economic stability of the community. Therefore, an integrated, fair, and sustainable environmental and institutional management strategy is needed to create harmony between the various parties that depend on irrigation water resources in the region.

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