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The Impact of Irrigation in Overcome the Scarcity of Water Resources and Increase Farmer's Income and Productivity in Klepek Village, Sukosewu District, Bojonegoro Regency

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Abstract: This research aims to investigate the impact of irrigation in addressing water scarcity, improving productivity, and increasing farmers' income in Klepek Village, Sukosewu Subdistrict, Bojonegoro Regency. Agriculture productivity is influenced by factors such as the efficient use of resources such as water. The availability of irrigation water is crucial to enhance agricultural productivity. Water scarcity can hinder plant growth, reduce crop yields, and negatively impact farmers' economies. Farmers faced serious challenges regarding water availability for agriculture in Klepek Village. In this study, the researcher conducted interviews, observations, and collected data to describe and analyze the impact of irrigation on addressing water scarcity, improving productivity, and increasing farmers' income in Klepek Village, Sukosewu Subdistrict, Bojonegoro Regency. A SWOT analysis was used to set an effective strategy of water management in order to improve the irrigation system. The sample reserach consisted of 30 respondents. A SWOT analysis indicate the position of quadrant I. It implies an aggressive strategy: improving famers skills in both, technical abilities and management skills. The results of the research indicate that irrigation has successfully become an effective solution to address water scarcity, leading to increased agricultural productivity and crop diversification.

Keywords: Irrigation; Productivity; Water scarcity

Introduction

Agriculture as a vital economic sector in Indonesia has a strategic role in providing food, creating jobs, and supporting economic growth in rural areas. Indonesia's food supply chain is rather steady, thanks to farmers' contributions (Syaekhu et al., 2023). Bojonegoro Regency, as one of the agricultural districts in East Java, has great agricultural potential, but is often faced with challenges such as low productivity, lack of knowledge of modern agriculture, and low living standards of farmers. The agricultural sector is one of the pillars that the Indonesian population continues to rely on, given its ability to overcome food crisis situations that often hit the country ('Azhima et al., 2023). This fact indicates that agriculture is not only a reliable sector, but also has great potential in supporting national economic recovery, especially in the context of national food security (Yudhatama et al., 2021). The presence of food security is crucial for Indonesia as food has the status of a primary need that cannot be ignored (Taufiqurrohman & Fahri, 2021). In this context, agriculture plays a central role in meeting food needs and contributing to economic growth. In general, agriculture can be defined in terms of four closely related components: production processes, agricultural actors or individuals involved in agricultural businesses, agricultural land use, and various activities related to agricultural businesses (Walters et al., 2016). The agricultural sector contributes to the country's economic development in fulfilling food needs and economic

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development (Dethier & Effenberger, 2012). This is influenced by several factors. First, the agricultural sector provides food supplies and raw materials needed by the country (Afriyanti et al., 2023). Second, with the significant demographic pressure in developing countries and the increase in income of some of the population, the need for these resources continues to increase (Padafani, 2022). Third, the agricultural sector is able to provide the necessary factors for the expansion of other sectors, especially the industrial sector (Salendu, 2019).

However, there are various obstacles faced by farmers in developing their agricultural businesses, mainly related to limited access to capital, knowledge, and modern agricultural technology (Mulema et al., 2021). Limited agricultural infrastructure also has a significant impact on agricultural cultivation (Sukmawati, 2022). Bojonegoro Regency, particularly Klepek Village is one of the regions in that has considerable agricultural potential. However, the challenges of these limitations are also felt by farmers in this area, affecting their productivity and welfare.

Fluctuations in farmer output and productivity are tied to farmer efficiency in the allocation of production resources (Iskandar et al., 2022). Farmers frequently fail due to improper utilization of production elements, particularly a lack of water availability (Nadiro et al., 2023). Increasing productivity requires efficiency in the use of production factors and an adequate irrigation system in paddy fields (Hernawati et al., 2023). The availability of irrigation water plays a vital role in maintaining the viability and success of agriculture (Lankford & Orr, 2022). It is not only increases agricultural productivity and efficiency, but also reduces dependence on unpredictable rainfall and avoids the threat of drought (Lismawati et al., 2020).

In the agricultural sector, water availability plays an important role in ensuring optimal crop growth and production. Most plant species are extremely sensitive to inadequate water availability during vegetative and reproductive growth (Riduan et al., 2022;Nasution & Fitria, 2023; Habeahan et al., 2023). Water sources derived from rainfall are often insufficient, especially during the dry season. In the future, the need for water will increase to increase food production (Santosa & Dharma, 2019). In the agricultural process it is important to carry out appropriate irrigation in order to achieve optimal agricultural yields. This is because water acts as a solvent and transports nutrients from the soil to the plant roots (Gul et al., 2023). Besides increasing productivity, the availability of irrigation water also promotes efficiency in the use of water resources (Li et al., 2019). By carefully managing water flow, farmers can avoid water wastage that often occurs in rain-fed agriculture (Ringler et al., 2022). This not only reduces operational costs, but also maintains the balance of the water ecosystem in the region (Falkenmark & Wang-Erlandsson, 2021). In agricultural irrigation practices, water can be obtained from various sources such as rivers, reservoirs, and boreholes (Gebrehiwet et al., 2021).

Reliable irrigation systems help reduce farmers' dependence on unpredictable rainfall. A lack of adequate rainfall can produce lower soil moisture orgroundwater, diminished streamflow, crop failure, and a general water shortage (Saidah et al., 2023). In an increasingly volatile climate, irrigation reliability provides assurance that crops will continue to get the water they need for growth, without being overly dependent on weather factors. Last, the availability of irrigation water serves as a bulwark against drought. In extreme weather conditions, such as prolonged dry spells, irrigation systems can be a lifesaver for agriculture (Dwiwana et al., 2019). Even in situations when natural water resources are few, farmers can still produce sufficient crops with effective water management (Nugroho et al., 2022). Efforts to adopt sustainable agricultural practices that are more efficient in water use, such as advanced irrigation technologies, soil moisture monitoring, and selection of drought-resistant crop varieties. To address the link between water scarcity and agriculture, a holistic and integrated approach is required. This involves efficient and sustainable water management, protection of water resources, development of infrastructure that supports efficient irrigation, and raising awareness of the importance of water saving among farmers (Wardani, 2022). Irrigation canals are a very important public asset in agriculture, especially in rice farming in Indonesia. Irrigation management is a key supporting sector in the effort to increase food production (Jamil et al., 2022).

Irrigation is the process of flowing water through transport channels to agricultural land. The water is subsequently directed into the river via the sewer after being used as efficiently as possible (Bi et al., 2020). Irrigation can also be interpreted as an effort to provide, organize, and flow irrigation water to support agricultural activities. Types of irrigation include surface irrigation, swamp irrigation, underground water irrigation, pump irrigation, and pond irrigation (Mabui & Paonganan, 2019). The purpose of irrigation is to utilize the available irrigation water efficiently and effectively, so that agricultural productivity can increase as expected (Angelakis et al., 2020).

The availability of irrigation water is very important in agriculture, because water can maintain soil structure, inhibit and suppress weed growth, regulate soil temperature, and carry nutrients needed by rice (Antralina et al., 2019). With a good irrigation system in place, agriculture can increase productivity and water efficiency, reduce dependence on rainfall, and avoid drought (Jarek & Suparno, 2023). This contributes

to increased food production, food security and eradication of hunger. In addition, irrigation development can also open up new economic opportunities, such as the development of agricultural industries, employment in the agricultural sector, and increased farmer income. However, it is important to remember that irrigation development can also have negative impacts, such as population displacement, changes to river ecosystems, and uneven socio-economic impacts. Therefore, sustainable and inclusive planning and management of irrigation is essential to maximize its benefits and mitigate its negative impacts (Naumar et al., 2021).

Irrigation development has impacts on environmental, economic and social aspects. Specifically, in the environmental aspect, the irrigation network consists of building canals and their supporting structures that form an important system for the regulation of irrigation water. This network is responsible for the supply, distribution, delivery, use and discharge of irrigation water. In Indonesia, which is located in the tropical monsoon region, the construction of irrigation networks is very important. Areas with high rainfall during wet months can lead to excess water and potential flooding. Irrigation networks help collect excess water and use it to prevent flooding. In addition, irrigation networks support farmers, especially during the dry season, by providing adequate water supply for crops. Benefits include efficient water management, flood prevention, and adequate water supply during the dry season (S. S. Arif et al., 2007).

Social aspects are factors that greatly influence the characteristics and nature of irrigation network systems. This not only involves technical issues, but also relates to traditions and even religious beliefs. For example, in Bali, the Subak irrigation system is well known, where the rules regarding the rights and obligations of members are based on their beliefs and not only related to the distribution of irrigation water (Parti et al., 2023). It also involves traditional ceremonies that have become part of the customs and traditions of the local community. In the planning and construction of irrigation systems, local social aspects are very important. Social factors such as local beliefs, culture and traditions need to be considered to ensure community suitability and acceptance of the irrigation system being built (Narendra et al., 2021).

The economic aspect is an integral factor of the irrigation system, in addition to the social aspect of the local community. Like the social aspect, the economic aspect also emphasizes matters related to the economy, such as the livelihoods of local people, their income, and assessment of land value. Although the fulfillment of irrigation needs has not been able to fully overcome poverty and improve the welfare of farmers, the economic aspect remains an important focus. Since the development of irrigation systems began until today, there has been a failure in efforts to improve the welfare of farmers. Farmers are still considered as a lower economic group and less attractive to the younger generation. Strategic changes in the irrigation system are needed to increase farmers' income as the basis of the economic aspect (Asri et al., 2014; Tirtalistyani et al., 2022).

Method

The research design is a case study, in which the researcher develops and conducts an in-depth analysis of the influence of irrigation on overcoming the scarcity of water resources and increasing the productivity and income of farmers in Klepek Village, Sukosewu District, Bojonegoro Regency. The approach used is a qualitative approach that provides descriptions and categorizations based on the conditions of the research scene (Creswell, 2009). The data sources used in this research consist of primary data sources and secondary data sources (Marendah et al., 2023). Primary data was obtained directly from the field through observation methods and interviews with informants and questionnaires with respondents from the Klepek Village community, most of whom are farmers. Secondary data is in the form of documents from books, web, magazines, journals, documentation, newspapers, and other data sources.

The data collection techniques used include interview techniques, questionnaires, observation techniques, documentation techniques and questionnaires. The sampling method used in this study is purposive sampling Purposive sampling means that respondents are selected by deliberately according to research needs Respondents interviewed were 30 respondents consisting of the government. The research was carried out over a period of 2 months.

Result and Discussion

Research Location

Klepek Village is a village that was originally only located on the banks of the Pacal River. According to village elders, the name Kelepek is taken from the word "iwak nglepek nglepek". Historically, at one time there was a long drought and the Pacal River dried up right in Klepek Village, many fish were lying dead/klepekan. So that the ancestors and tribal leaders at that time, Mbah Madu Renik, named Klepek Village.

Klepek Village is a geographically low-lying area with a river and extensive rice fields. It is located in Klepek Village, Sukosewu Sub-district, so most of its residents also have access to sub-district facilities. The total area of Klepek Village is: 288,365 hectares. Where 168.365 hectares are residential areas and 120 hectares are dry land & rice fields located on the northern boundary of Sukosewu and Semenkidul villages, the

southern boundary is Semawot and Jatitengah villages, the western boundary is Kalicilik and Sukosewu villages, the eastern boundary is Sitiaji and Tegalkodo villages. Topographically, Klepek Village is a lowland village, located around the Pacal River (Klepek Village Profile, 2023).

Data Analysis

Likert Scale

Likert scale is a scale used to measure attitudes, opinions and perceptions of individuals or groups towards social phenomena that are the subject of research (Nurazimi & Hidayat, 2021). The form of assessment or Likert scale score consists of 5 options, namely Strongly Agree (SS), Agree (S), Neutral (N), Disagree (TS), and Strongly Disagree (STS). To analyze the role of irrigation in overcoming the scarcity of water resources and increasing agricultural productivity by using a Likert scale.

The results of data obtained through interviews and distribution of questionnaires to 30 respondents showed that the knowledge of farmers about the benefits of irrigation into the high category. While the attitude and skills of farmers through the utilization of irrigation into the category of medium. The distribution of categories of behavioral characteristics of farmers is presented in Table 1.

Table 1. Community Perception

Community Perception	Likert Scale (%)
Knowledge	86
Attitude	78
Action	62

In analyzing the community perception data measured using a Likert scale, there are three important aspects to note. First, on the knowledge aspect, around 86% of respondents had a positive perception of their knowledge level. This indicates that most people have a sufficient understanding of the subject being measured, but there are 14% of respondents who may view their knowledge as inadequate. Therefore, efforts to improve community understanding and knowledge in this regard can be prioritized, such as counseling, education, or information campaigns.

Based on the attitude aspect, it shows that 78% of respondents have a positive attitude towards the subject measured. This is an encouraging result, as the majority of people have a favorable attitude towards the measured topic. About 22% of respondents may have a less positive or neutral attitude. It is important to maintain and strengthen this positive attitude through various means, such as advocacy, or approaches that promote positive attitudes in society.

Third, in terms of actions, the results show that about 62% of respondents reported appropriate or positive actions related to the measured aspects. While most respondents may have had positive attitudes, about 38% of respondents may still have taken inappropriate or even negative actions. This suggests that there is a need for further efforts in stimulating the desired behavioral changes in the community. This could include training programs, advocacy of positive actions, or incentives that support behavior change.

Based on the results of the Likert scale analysis, it provides a comprehensive picture of how people recognize, respond, and act in relation to the subject being measured. These results can serve as an important foundation in designing appropriate strategies and interventions to increase knowledge, maintain positive attitudes, and stimulate appropriate actions in order to achieve desired goals in the community.

Irrigation in Klepek Village, Bojonegoro Regency, plays a key role in overcoming water scarcity, increasing agricultural productivity and community welfare. Previously, water scarcity affected productivity and welfare. With irrigation, scheduled water access enables intensive farming, increased productivity and crop diversification. Irrigation also creates a sustainable environment, reducing the risk of soil erosion. Interviews with Village Heads show that irrigation optimizes water management, significantly reduces water scarcity and opens up opportunities for crop diversification. Villagers experience improved welfare and economic stability. Irrigation also improves food security and supports economic development. Interviews with farmers such as Sugito confirmed that irrigation helps reduce dependence on weather factors and increases agricultural yields. Overall, irrigation in Klepek Village brings holistic positive impacts, not only on agriculture but also on people's lives as a whole.

IFAS and EFAS Analysis

IFAS (Internal Strategic Factors Analysis Summary) is a summary or formulation of internal strategic factors in the context of strengths and weaknesses. EFAS (External Strategic Factors Analysis Summary) is a summary or formulation of external strategic factors in the context of opportunities and threats. Based on the results of the questionnaire obtained from 30 respondents, the following internal and external factors can be identified.

Table 2. Internal Factors

Strategic	Factors	Rating	Score
S1	0.25	3.87	0.95
S2	0.23	3.70	0.84
S3	0.23	3.87	0.90
S4	0.29	4.40	1.29
Total			3.98
W1	0.24	2.233	0.55
W2	0.24	2.333	0.57
W3	0.25	1.833	0.46
W4	0.26	3.4	0.89
Total			-2.46

Table 3. External Factors

Strategic	Factors	Rating	Score
O1	0.27	3.77	1.02
O2	0.24	3.63	0.89
O3	0.22	3.87	0.83
O4	0.27	4.07	1.10
Total			3.84
T1	0.28	1,90	0.54
T2	0.23	2.07	0.47
T3	0.24	1.97	0.48
T4	0.25	3.37	0.83
Total			-2.31

From the results of the strategies that have been made, it can be concluded using the SWOT quadrant as follows (Figure 1).

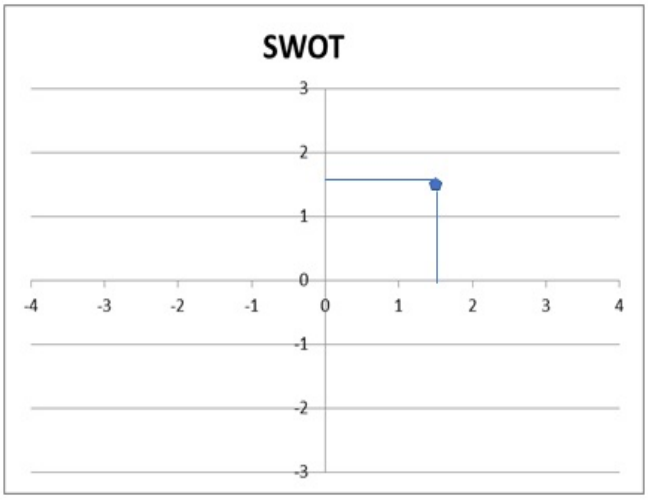

Figure 1. SWOT Analysis Result

Based on the SWOT analysis above is at the coordinate point (1.52; 1.52) where the coordinate point is in quadrant I. So that the opportunities that exist as well as internal strengths owned sehinggu can be concluded that irrigation is in the position of quadrant I, where in that position is the most favorable situation. Position in quadrant I means irrigation has opportunities and strengths. The strategy to be taken in such conditions is to support aggressive growth policies or growth oriented strategy by utilizing existing opportunities and strengths.

The Effect of Irrigation in Increasing Farmer Productivity and Income

Farmers in Klepek Village use irrigation to implement a 3-time rice planting pattern, while on unirrigated land, farmers only plant rice during the first growing season (TM). In the MT II growing season, unirrigated land is used to grow soybeans and tobacco. This shows that irrigation has the ability to change farmers' cropping patterns from one rice growing season per year to three rice growing seasons per year.

Table 4. Cropping Pattern and Intensity

Farmers	Planting Season		
	1	2	3
Irrigation	Rice	Rice	Rice
Non Irrigation	Rice	Rice	Tobacco

Based on Table 4, the rice planting intensity of respondents with irrigation in Klepek Village is 300%, while the value of planting intensity in farmers without irrigation in Klepek is 200%. The cropping system on farms with irrigation involves rice production in all three growing seasons (MT), while in areas without irrigation, the first growing season (MT I) produces rice and MT II produces tobacco. Rice yields on irrigated farms reached 6 tons GKP/ha, while on non-irrigated farms there was no rice production in MT II due to the focus on tobacco production.

Based on interviews with stakeholders, the use of irrigation in Klepek Village has had significant positive impacts. Farmers, such as Jarnawi and Sugianto, report substantial increases in rice yields and crop diversification throughout the year thanks to the irrigation system. Badri, an agricultural expert, highlighted improved water use efficiency and increased yields as key benefits of irrigation. Dwi Puryanto from Bumdesa emphasized the importance of modernization measures and cooperation with the government to improve the efficiency of irrigation systems. Despite challenges, such as infrastructure maintenance and conflicts over water use, Bumdesa actively involves the community in decision-making and conducts training to increase farmers' capacity. Overall, the interview results show that irrigation not only increases agricultural production but also plays a role in improving farmers' welfare and income in Klepek Village.

Conclusion

The irrigation in Klepek Village, Sukosewu Subdistrict, has had a positive impact in increasing the planting intensity (IP) of farmers on paddy fields. Prior to the irrigation network, farmers were only able to plant rice twice a year, namely in the rainy season (MT I) and three-month season (MT IIUI), by trying to grow tobacco or other secondary crops. However, with the irrigation system in place, farmers can plant paddy rice three times a year, namely in MT I, MT II, and MT III. This change in cropping pattern has positive implications for the availability of food, especially rice, in the area. In addition, the availability of irrigation water also encourages the increased use of other production inputs, such as seeds, fertilizers, and pesticides. With the intensification of production input use, there is an increase in production per unit land area or overall agricultural productivity. This conclusion shows that irrigation not only has a positive impact on increasing

rice production, but also contributes to increasing food availability in the region through changes in cropping patterns that are more intensive and efficient. Based on the SWOT analysis at the coordinate point (1.52; 1.52) which is in quadrant I, it can be concluded that irrigation in overcoming water scarcity and increasing farmers' productivity and income is in a very favorable position.

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Author Contribution
Conceptualization, B. S., N. B., H.T.; methodology, B. S., N. B., H.T.; validation, N. B., H.T.; formal analysis, B. S.; writing—original draft preparation, B. S., and F.C.W.; writing—review and editing, F.C.W. All authors have read and agreed to the published version of the manuscript.

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Conflicts of interest
Authors declare that no conflict of interest in this publication.

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