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Accelerating The Adoption of Technological Innovations through of Hybrid Paddy Varieties in Bone District, South Sulawesi

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ABSTRACT

Demonstration Farming is one method of delivering research results and studies to farmer and other users through technology demonstrations to accelerate technology adoption. The purpose of disseminating technological innovation of new superior varieties of hybrid paddy through demonstration farming is to accelerate technology adoption. The activity was carried out in Mandiri Farmer Group, Mallinrung Village, Libureng District, Bone Regency, South Sulawesi. The implementation time started from May to September 2022. The hybrid paddy cultivation technology package was carried out using the Integrated Crop Management (ICM) approach. Variables observed included: 1). Implementation of hybrid paddy demfarm technology innovation, 2). Rice productivity, and 3). Technology dissemination and adoption opportunities. The results of the activity showed that the paddy Demfarm implemented by Mandiri farmer group through the introduction of hybrid varieties combined with ICM approach was able to increase the average productivity of rice by 11.23 tons.ha^{-1} or 106.73% of the average initial productivity of 5.43 tons.ha^{-1}. Technology dissemination through paddy demfarm and farmer field meetings gave a good response to farmers participating in demfarm and other farmers both in implementation location area and farmers outside the area. Farmers and extension workers can witness firsthand and feel confident in the superiority of technology being demonstrated. Demfarm paddy technology innovations that are likely to be adopted based on the result of interviews include: the use of hybrid varieties (92%), integrated pest control according to target pest organism (90%), the use of quality/ certified seeds and seed treatment (88%), Balanced fertilization (84%), and complete tillage system (80%).

· ***Keywords:*** *technology adoption, demonstration farm, technology innovation, hybrid paddy*

INTRODUCTION

Rice is the main staple food in Indonesia. Increased food demand due to population growth requires the government to increase domestic food production. The increasing need for food that continues to increase in line with population growth is a challenge in itself. Indonesia's population in 2020 was recorded at 270.2 million people. The population figure rose again to 272.68 million in 2021. Then, the population of Indonesia is reported to have increased again to 275.77 million people in 2022. That number increased by 1.13% when compared to the same period last year. This population explosion needs to be watched out for because it can gave an impact on the threat of national food security.

The Government's commitment to maintain and improve national food security has been stated in the National Development Agenda for 2022-2024. To enhance food security and boost farmers' livelihoods, the government implements various development initiatives, including the introduction of innovative agricultural technologies. This introduction is accompanied by a socialization phase to speed up adoption, ultimately improving farmers' welfare (Indraningsih 2017). Numerous technological advancements in paddy cultivation have been developed to increase yields and farmers' income, and these technologies continue to evolve to meet the needs of the user community. For instance, Integrated Crop Management (ICM) technology for paddy has been in development since 2008 (Zaini et al. 2009). This innovation incorporates several technological components, such as the use of new high-yielding paddy varieties like Inpari 30, 32, and 33, the application of bio decomposers before tillage to hasten the decomposition of straw, the use of non-pathogenic microbial-based biological fertilizers that are enzymatic to promote plant growth, the application of artificial fertilizers based on the paddy soil test kit (PSTK), the use of organic fertilizers or manure, pest control with pesticides or biopesticides, and the use of jarwo transplants and combined harvesting equipment for planting and harvesting (Sutaryo and Heni, 2014).

The technology demonstration approach is a process of transferring agricultural technology innovations that have been researched and studied by the research team to users (farmers) with the hope that farmers can adopt these technological innovations. Technology demonstration can be done through demonstration plot/technology show activities. It was further explained by Musfal (2019) that through technology demonstration, users will directly see the technology being demonstrated so that it will give a deep impression and faster understanding.

One method to accelerate the adoption of agricultural technology is Demonstration Farm (Demfarm) method. Demfarm is an agricultural extension method that aims to show a way of working or demonstrate a type of technology to farmers or users through agricultural technology demonstration activities (Ibrahim *et al.* 2003). Through Demfarm activities, it is expected that the main actors or cooperators are able to increase their capacity in applying technology to the agricultural business system they develop. This activity aims to clearly show the difference in results between the recommended technology and the one commonly applied, so as to provide confidence to technology users and policy makers in the reliability of agricultural technology packages and accelerate the adoption of technology by users in developing their farming systems.

In the deconcentration fund field school activities, the certified superior rice seeds used are inbred rice seeds. In this Demfarm implementation, rice seeds to be used are hybrid rice seeds. This is associated with the ability to produce food which is quite -threatening due to limited natural and human resources, land conversion for modern industries, and global climate change because of droughts, floods, and others. Given these problems, increasing rice production should be done through increasing rice productivity (satoto *et al*. 2016). Therefore, the development of high yielding varieties (HVY) is a priority policy framework. Conventional technology to develop new HVY using inbred methods becomes more difficult due to limited genetic diversity. Responding to these challenges, hybrid paddy technology needs to be developed as an alternative technology to increase national rice productivity (Widyastuti *et al*. 2015). This is the basis for the development of the logical framework of the Seed Sector Modernization Study conducted by the Directorate of Food and Agriculture – National Development Planning Agency (BAPPENAS). This study views the utilization of hybrid paddy as one of the results of technological engineering. Hybrid paddy is a lever to increase rice production but has not been widely used by farmers. Through this Demfarm, it is expected that the advantages of hybrid paddy can be better recognized by farmers and show real results in the field. For faster technology transfer and technology adoption to farmer users or other farming actors, a Demfarm of hybrid rice development was conducted in 2022 in Bone Regency, South Sulawesi Province.

METHODOLOGY

The activity of adopting technological innovations through the Demfarm of hybrid Paddy - Sembada Variety was carried out in the "Mandiri" Farmer Group, Mallinrung Village, Libureng District, Bone Regency, South Sulawesi Province. The implementation time was held from May to September 2022.

The determination of the location was carried out by looking at the criteria: (1) There is an area of 20 ha, preferably managed by 1 farmer group; (2) Strategic location, it is easily visited and seen by surrounding farmers; (3) The location of the demfarm is not in a pest endemic area; (4) The location of the demfarm is in an irrigated tertiary expanse; and (5) At the demfarm location there are supporting institutions including: production input provider unit, agricultural equipment and machinery service business unit (upja), processing service provider unit, and marketing unit. Farmer identification is carried out with the following criteria: (1) Join a farmer group registered in SIMLUHTAN; (2) Have a commitment to implement, apply, and disseminate the technology recommended in Demfarm; and (3) Actively participate in every stage of Demfarm activities.

The approach used in the implementation of Demfarm activities is a user-oriented participatory approach. With this method farmers together with researchers and extension workers discuss to determine the technology to be applied and discuss various problems that will be faced and look for alternative solutions. With this approach, it is expected that all components involved in technology demonstration activities play an active role in disseminating agricultural technology information.

The procedure for accelerating technology transfer and technology adoption is carried out through the implementation of Demfarm. This activity aims to demonstrate the advantages of technologies that have considerable opportunities that can be developed in the region. The technology package for hybrid rice cultivation was carried out using the Integrated Crop Management (ICM) approach. The observed variables include: 1). Implementation of paddy technology innovation, 2). Rice productivity and 3). The implementation of Demfarm paddy technology innovation was compared with farmers' existing technology by looking at the difference in productivity. While the spread and opportunities for adoption by farmers both inside, outside the group and farmers outside the village of the hybrid paddy Demfarm location through interviews using questionnaires conducted during farm field day. The data obtained were tabulated and analyzed descriptively. The average productivity of existing farmers and demfarm activities was analyzed at the 5% level.

RESULTS AND DISCUSSION

Implementation of Hybrid Paddy Demfarm Technology Innovation

The selection of technology to increase productivity as well as a medium to introduce the technology demonstrated to users is a type of technology that is compatible with the abilities and skills of farmers. Farmers participating in the demonstration use technology based on the Integrated Crop Management (ICM) approach. Participating farmers, together with researchers and extension workers, designed the type of technology to be used in the demfarm activities (Table 1). Table 1 represents the components of technological innovation with the ICM approach. Based on Table 1, there are differences or improvements in technological innovations used in Demfarm activities compared to farmers' existing technology. The involvement of farmers and farmer groups in demfarm activities means that farmers have directly known the new methods or new innovations introduced so that farmers' knowledge is increasing. The types of new technologies introduced include: Hybrid Paddy Sembada Variety, use of certified seeds, seed treatment using 3% salt solution and furadan, young seedling age 10-14 days after planting (DAP), planting system with jajar legowo 4: 1 and balanced fertilization using the Paddy Soil test kit (PSTK) and the use of liquid organic fertilizer (POC).

The first stage of hybrid paddy Demfarm implementation is the application of balanced fertilization. Balanced fertilization application using PSTK. PSTK is a test kit for measuring soil nutrient content directly in the field so that fertilization recommendations can be obtained. According to Wahyuni *et. al.* 2023, location-specific balanced fertilization needs to be done because it is very useful in determining the right dose, right time, and right type of fertilizer needed according to the fertility status of paddy fields, so that fertilization will be more efficient (Suarjana *et al.* 2015). This balanced fertilization technology is easily applied by farmers because the Libureng Agricultural Extension Center (BPP) in Bone District has been facilitated with PSTK equipment by the Ministry of Agriculture.

Table 1. Technological Innovations with the ICM Approach for Demfarm Implementation in Mallinrung Village, Libureng Subdistrict, Bone Regency.

No	Technology Component	Hybrid Paddy Demfarm Technology	Farmer Existing Technology
1.	New Superior Varieties	Hybrid Paddy Sembada Seeds	Inbred seeds 42
2.	Quality/ Certified Seeds	Yes	Yes
3.	Pre-seedling seed treatment	Salt solution and furadan application	None, just plain water immersion
4.	Seedling System	Wet	No Seedling
5.	Tillage	Complete tillage system	Complate tillage system
6.	Seedling age	14 days after planting (DAP)	No seedling
7.	Planting system	Jajar legowo 4:1 (Figure 1.b)	Scattered sowing system / seeds are scattered directly into the field (Figure 1.a)
8.	Balanced fertilization	Based on PSTK results Urea fertilizer: 200 $Kg.ha^{-1}$ NPK (15:15:15): 280 $Kg.ha^{-1}$	Based on farmer's habit: Urea fertilizer : 100 $Kg.ha^{-1}$ NPK (15:15:15) : 100 $Kg.ha^{-1}$
9.	Pest control	Integrated pest management approach	Integrated pest management approach
10.	Harvest and post-harvest handling	Harvest on time and thresh the grain immedietely	Harvest on time and thresh the grain immedietely

The planting system before and during the hybrid paddy Demfarm activity is presented in Figure 1. Figure 1.b. is an application of jajar legowo 4:1 planting system conducted through the Demfarm activity. Jajar legowo planting system is an engineering technology to obtain a planting population of more than 160,000 per hectare (Sunandar *et al*. 2020). The application of the jajar legowo planting system in addition to increasing the planting population, is also able to add smooth circulation of sunlight and air around the peripheral plants so that plants can photosynthesize better. Supredi *et al*. (2018) and Sholahuddin *et al*. (2023) also argue that the jarwo planting system is thought to have an influence in the form of more effective plant photosynthesis so as to increase grain yield. This happens because plants on the edge are expected to provide high production and good grain quality. The jajar legowo planting system has an open space of 25-50%, so that plants can receive optimal sunlight which is useful in the photosynthesis process. The jarwo planting system is different from the previous application of the planting system of farmers participating in the demfarm, which uses a scattered planting system (Figure 1.a). The scattering planting system is planting seeds directly by sowing them into the field. This scattered planting application causes a high population density so that competition for plants in taking nutrients. Makmur *et al.* (2023) stated that the scattered planting system resulted in lower productivity compared to the jajar legowo planting system. Plant spacing and plant orientation in the field affect six important processes (Hamdani and Murtiani 2014), namely (1) Capture of sunlight by Individual plants,

a b

Figure 1. (a) The scattered cropping system before Demfarm activity; (b) Jajar legowo 4:1 cropping system on the Demfarm farmer's land.

especially leaves for photosynthesis, (2) Effectiveness of nutrient absorption by plant roots, (3) Plant water requirements, (4) Air circulation of CO_2 for photosynthesis and O_2 for photosynthetic products, (5) Availability of space that determines the weed population, and (6) Microclimate (humidity and air temperature) under the canopy, which affects the development of Plant Disturbing Organisms (PDO) (Martina and Asep, 2020; Dahliana *et al.* 2023).

In addition, technological innovations made by cooperator farmers are seed treatment using 3% salt solution and furadan solution with the aim to free seeds from fungi or seed diseases. The types of technological innovations in the use of seedlings aged 10-14 days and the 4:1 jajar legowo planting system introduced in the Demfarm activities are new to cooperator farmers, since in this location technology has not previously been carried out. This type of technology in hybrid paddy Demfarm activities is applied or practiced together by members of the Mandiri farmer group and extension workers and introduces the technology, thus affecting the improvement of farmer's technical skills. Thus, the hybrid paddy demfarm activities became a medium of discussion between farmers, extension workers, and researchers in improving farmer's knowledge, attitudes, and skills.

Rice Productivity Performance

The productivity of rice farming in Bone Regency is generally still low, ranging from 3.5-5 tons.ha^{-1} (BPS 2020). Several factors contribute to this low productivity, including: 1). farmers still use conventional technology, 2). the use of fertilizers has not used balanced fertilization recommendations, and 3). high yielding paddy varieties have not been used. Bone Regency is the Regency that has the largest harvest area in South Sulawesi Province, which is 164.10 thousand hectares. However, Bone Regency's rice productivity in 2020 was in twelfth position, at 4.8 tons/ha (BPS 2022). This is because the cropping technology in Bone Regency generally still uses a scattered cropping system (Figure 1.a). so that plants experience population density which causes competition for nutrients and low land productivity. In this regard, the implementation of the hybrid paddy demfarm aims to increase the productivity of paddy rice. The production results of paddy rice at the Demfarm location are presented in Table 2.

Table 2. Productivity of Rice Hybrid Paddy Varieties at Rice Demfarm Sites in Mallinrung Village, Libureng Subdistrict, Bone District, South Sulawesi Province.

Varieties	**Average Rice Productivity (ton.ha^{-1} - dray grain harvest)**	
	Hybrid paddy demfarm Technology	Farmer existing technology
Inpari 42 (Inbred)	-	5,43
Sembada 168 (Hybrid)	11,23**	-

t-tab (0.01): 2.06; t-tab (0.01): 2,79

Table 2 shows the average productivity of rice in the existing condition and during the hybrid paddy demonstration. Based on Table 2, it can be seen that the application of technology with an integrated crop management (ICM) approach in Demfarm activities shows higher average productivity compared to farmers's existing technology. Based on ANOVA analysis, the average productivity of farmers applying Demfarm technology is significantly different compared to the average productivity of farmers's existing technology. The average rice productivity of Demfarm technology is 11.23 tons.ha^{-1}, while the rice productivity of existing technology before Demfarm activities is 5.43 tons. ha^{-1}. Thus, the application of recommended introduction of new high yielding varieties with the use of hybrid paddy and the ICM approach in Mallinrung Village, Libureng Subdistrict, Bone District can provide an increase in productivity of 106.73%. This fact shows that the opportunity to increase the productivity of paddy rice can be done with the introduction of new high yielding varieties (HYV), namely using hybrid seed varieties (sembada 168), and it can be combined through the development of cultivation technology with an integrated crop management approach. Hybrid paddy has a yield potential of more than 10-14 tons.ha^{-1}, while inbred rice has a yield potential of 6-8 tons ha^{-1}. Thus, the use of hybrid paddy can increase productivity and farmers's well-being. Roidah (2015); Agustiani *et al*. (2019); Gaesti *et al*. (2019); and Yuliani *et al.* (2023) stated that the income of hybrid paddy farming is more profitable compared to inbred rice farming. This is because the productivity of hybrid paddy is higher than the productivity of inbred rice. Thus, high rice productivity results in high farmer income as well.

Technology Deployment and Adoption Opportunities

Dissemination of technology in order to accelerate the transfer and adoption of technology then at the final stage of the implementation of demonstration farm conducted *Farm Field Day* (FFD). Farm field day is a meeting forum between farmers, researchers, agricultural extension workers, local governments, and other related parties (Effendi *et. al.* 2020) that aims to: 1). provide opportunities for farmers, extension workers and related parties to witness, discuss, and understand the advantages of technology that is demonstrated and ready to be disseminated, 2). explore feedback from farmers, extension workers and other related parties and 3). seek the transfer of knowledge, experience and skills in the application of technology from cooperating farmers to other farmers (Kusumawati *et.al.* 2015; Effendi and Gumelar 2020).

The farmer field meeting was attended by the Regent of Bone Regency, Members of Bone Regency Parliament, Head of South Sulawesi Agricultural Provincial Office, Head of South Sulawesi Provincial Food Security Office, Head of Bone Regency Office, Directorate of Food and Agriculture of BAPPENAS, Head of BPPSDMP Extension Center of Ministry of Agriculture, Commander of Korem (DANREM) Bone Regency, Commander of Kodim (DANDIM) Bone Regency, Researchers of BB Padi, PT Biogen Indonesia, Head of UPTD Bone Regency, and 500 extension workers and farmers of Bone Regency. During the farmer field meeting, farmers participating in the demonstration shared their experiences and assessments of the technologies demonstrated.

Table 3 represents the opportunity to apply the level of technology adoption with the Integrated Crop Management approach. Based on Table 3, the results of interviews using a questionnaire guide to 50 samples of respondents (farmers participating in the demfarm and farmers not participating in the demfarm) to see the opportunity for technology adoption showed that there were several technologies that had the highest percentage to be adopted by farmers after the implementation of hybrid paddy demfarm, including: The use of hybrid varieties (92%), integrated pest control according to target pests with IPM approach (90%), the use of quality/certified seeds and seed treatment (88%), balanced fertilization (84%), and complete tillage system (80%).

Table 3. opportunities for implementation of technology adoption rates with the Integrated Crop Management approach

No	Technology Component	Adoption Rate Oppurtunities	
		Number of Samples	Percentage (%)
1.	New Superior Varieties (Hybrid varieties)	46	92
2.	Quality/ Certified Seeds	44	88
3.	Pre-seedling seed treatment	40	80
4.	Seedling System	28	56
5.	Tillage (Complate tillage system)	36	72
6.	Seedling age	32	64
7.	Planting system (Jajar legowo)	28	56
8.	Balanced fertilization	42	84
9.	Pest control	45	90
10.	Harvest and post-harvest handling	45	90

Source: Primary data (processed)

> *"In the future, we plan to hold trainings or technical guidance related to rice cultivation and the jajar legowo planting system. We hope that with these trainings/ technical guidance, farmers can improve their knowledge, attitudes, and skills so that farmers will get used to and achieve technology adoption." (Ahmadi-Agricultural Extension Officer of South Sulawesi Province, September 28, 2022)*

The application of other technologies according to respondents is rather difficult to do, so the percentage of sustainability to be adopted is relatively lower, including: jajar legowo planting system 4: 1 and young seedlings aged 10-14 HST. This is because farmers are not yet accustomed to applying the jarwo system and transplanting. In addition, the unavailability of jarwo transplanter facilities and the low understanding of farmers about jajar legowo application cause farmers to have difficulties in jarwo application. Rosadillah et. al. 2017 argue that the high application of technology is significantly related

to the support of the availability of production facilities. However, farmers will slowly get used to it and feel the benefits so that technology adoption will be achieved.

Demonstration farming with the application of agricultural technology on group farming. Through demonstration activities, the targets, in this case the implementing farmers, are taught about skills and given examples of how technology works with new innovations including their advantages to improve the old ways that have been applied by implementing farmers. The demfarm method is for agricultural extension workers to accompany the entire series of technology implementation activities with an integrated crop management approach, including field school meetings and field practices. (Khairunnisa et al., 2021)

Field school meetings aimed at providing knowledge to farmers were held in 1 planting season consisting of 6 meetings located at farmers' homes. The material presented by extension workers at the meeting includes new superior varieties, quality and certified seeds, land preparation, planting, fertilization, pest and disease control, harvest and post-harvest (Table 1). Field Practice or farm demonstration is an activity in the paddy field as a place of direct learning for farmers. to see and act directly. Demfarm area is 25 Ha. In the implementation of the demonstration farm, farmers are directed to follow each stage of the activity starting from tillage, planting preparation/selection of superior seeds, planting, maintenance, pest control until harvest. cultivation, harvest and post-harvest handling.

CONCLUSIONS

The hybrid paddy demfarm implemented by Mandiri farmer group through the introduction of hybrid paddy varieties combined with ICM approach was able to increase the average productivity of rice by 11.23 tons.ha^{-1} or 106.73% from the existing average productivity of 5.43 tons.ha^{-1}. Technology dissemination through paddy hybrid demfarm and farmer field meetings gave a good response to farmers participating in demfarm and other farmers both in the implementation location area and farmers outside area. Farmers and extension workers can witness firsthand and feel confident in superiority of the technology being demonstrated. Demfarm paddy technology innovations that are likely to be adopted based on the results of interviews include: the use of hybrid paddy varieties (92%), integrated pest control according to target pest with IPM approach (90%), the use of quality/ certified seeds and seed treatment (88%), balanced fertilization (84%), and complete tillage system (80%).

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