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# The Effect of Fish Type and Variety on Growth and Results Through the Application of Minapadi-SRI

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**Abstract.** National food security must be maintained because the food need of the Indonesian population in the next few years will still continue to increase. Since there is no food diversification for their staple food, rice role will still dominate. More over, the conversion of irrigated rice fields functions is also increasing. This reality must be addressed with policies and the application of efficient lowland rice production technology so that it is still able to meet national food needs while the income of wetland rice farmers increase. This study, combined an experimental production technology and descriptive methods on the farmer income aspect institutional strengthening. The aim of the research is to increase the added value of irrigated rice fields, which area is believed to be increasingly shrinking, while on the other side still produce rice as the main national food and also produce the addition of animal food in the form of fish could. Data obtained in the previous study showed that combination of water dept of a 10 cm with 50 cm width is the best treatment for the development of rice and fish together. This treatment is used as well as basis for testing the MINAPADI-SRI pattern with more varieties and types of fish, which is expected to obtain more practical and profitable combinations. The research was conducted in the Split plot design where fish species (Tawes, Mas, and Nila) as the main plot and the rice varieties (PB42, Batang Piaman, and Beras Merah) as sub plot. The results showed that the PB42 gave higher yield compared to two the other varieties where tilapia and goldfish were which maintained in the technically irrigated rice fields.

**Keywords:** minapadi-SRI, lowland rice, rice variety.

## 1. Introduction

Rice is still the staple food of the Indonesian people and most of the population in the world. National rice needs continue to increase every year as population increases, whereas the area of rice fields continues to decrease due to various interests. Various efforts to increase production have been carried out both through extensification and intensification. One of the last decade's efforts to give hope is the application of SRI (the System of Rice Intensification) in rice cultivation. Various research reports and crop yields of farmers show a one to threefold increase in yield.



The most suitable paddy field for the development of SRI is irrigated rice fields with more guaranteed water availability. Water on SRI does not need to inundate the entire surface of the paddy field, it is enough to guarantee that the soil remains in a wet condition (around field capacity). The results of the research hope for further modifying the SRI pattern [8]. It was reported that the best results on SRI that were tried were the water in the pot about -10 cm above the ground. Thus rice can be planted in parts that are not inundated (plots), enough water is provided in the trenches made between the plots of rice planting. Planting conditions like this provide an opportunity to allow water to remain in the ditch between paddy fields from planting to near harvest. If the age of rice planted is around 100 days, then there will be about 80 days of standing water. Enough time to keep fish.

Farmers in several regions in Indonesia are accustomed to utilizing standing water in paddy fields to maintain fish, either directly between stagnant rice clumps or making special plots in the middle of rice fields, on the edge around paddy fields or alternating with rice planting. This cultivation method is known as Minapadi. West Sumatra is one of the areas where farmers are used to doing it. I Lima Puluh Kota District around 150 ha of rice fields were used for minapadi [9].

Combining SRI with minapadi is very possible. The merger is directly a form of product diversification from irrigated rice fields. However, some issues still need to get answers so that the application at the farmer level is more practical, scientifically accountable and profitable not only for farmers' income, but also nationally beneficial because it can play a role in strengthening food security. Minapadi-SRI in paddy fields with tilapia species and the results can increase farmers' income, but it has not been studied how much water is beneficial for the life of the fish in the ditch [12].

Some of these problems can be formulated as follows: if SRI rice cultivation is combined with fish maintenance it is certainly necessary to ascertain how high the water in the ditch is beneficial for both, what is the most appropriate width of the ditch, what is the most beneficial type of fish, how good the management institution starting from rice and fish cultivation, processing the results and marketing of its products. These questions need to get answers that can be justified. For this reason, this research plan was prepared.

In general, this study aims to increase the added value of irrigated rice fields, whose area is believed to be shrinking further, while still producing rice as the main national food in addition to the addition of animal food products in the form of fish. Although some of the rice fields are used as fish maintenance, the total production will not interfere with the availability of rice because the SRI results are 2-3 times the national average, in fact the additional income from fish will be more profitable for farmers. Especially if the fish they produce make processed foods such as babyfish by adding certain flavors, it might just be a *babyfish balado*, *babyfish flavored with rendang* and so on.

Another advantage of SRI is the reduced use of water. As stated earlier, it shows that the application of SRI to rice cultivation in irrigated rice fields can save around 40% of water needs [15]. This happened because during its growth, rice with the SRI method did not need to be inundated, enough wet conditions even to the ground a little they were still tolerated by rice [3, 10], especially if the fertilizer used came organic matter [4, 11].

In one of the counseling materials from the [2], it was explained that minapadi is a method used by farmers by combining rice cultivation and fish-raising techniques, which are carried out simultaneously in the rice fields. For this business, the construction of rice fields is not necessary, but it is only necessary to make a *caren (kemalir)*, which is a kind of ditch around in a plot of rice fields with a diagonal or crossing a plot of rice fields. This slime serves as a fish shelter and to facilitate harvesting of fish. The wide width of the slime generally ranges from 40 - 60 cm with a water depth of 40 cm. The types of fish that are usually maintained in this way include: Mas, Carp, Tawes, Nilem, Mujair and Nila (tilapia). Carp and tilapia are the types that are best kept in rice fields because they grow well with shallow water and heat resistance.

Meanwhile, the factors that influence the choice of fish are the volume of water, availability of seeds, feed, markets, and habits of farmers [16]. In Minapadi, the inundation water level of rice plants is limited to 10-15 cm, and in the caren part the water level is 20-30 cm. Compared to Tawes, Nilem, Kancra and Carp, gold fish (ikan Mas) is the best type of fish in the Minapadi system [14]. This is reflected in the high yield of rice which reached 5.7 t / ha in the minapadi plot that used goldfish as a treatment, with the highest net profit of Rp 5.15 million / ha / season. Methane gas emissions from minapadi plots that use carp are 51.2 kg CH<sub>4</sub> / ha / season. The strains of tilapia which were maintained in a positive way had an effect on the results obtained, the best strain was larasati tilapia [12].

Other factors that need to be considered are fish populations and feeding. Solid stocking fish that is commonly done on minapadi according to [1] is for 2-3 cm sized fish as much as 2-3 fish / m<sup>2</sup> and for fish measuring 3-5 cm as much as 1-2 fish / m<sup>2</sup>. While the feed dosage and feeding frequency also needs to be considered [6]. In the Minapadi system, fish feed is enough only with fine bran with a dose of 4-5% of the fish's body weight.

Some of the explanations above confirm that the SRI method of rice cultivation has the opportunity to be developed by combining it with the Minapadi system into MINAPADI-SRI. The results of this development are expected to still be able to increase rice yields and be added with fish products which are processed into typical foods which will later increase farmers' income and expand employment. Food security can be maintained and farmers become more prosperous.

## 2. Materials and Methods

This study used an experimental method with field experiments using Split Plot Design in Randomized Block Design with two factors and three groups. The main plot is the type of fish (Tawes, Mas, and Nila) while the subplots are varieties (PB42, Batang Piaman, and Red Rice). The plot area for one experimental unit is 16 m<sup>2</sup>.

The data obtained were then analyzed using ANOVA with the F Test at a real level of 5%. Comparison of the median value of treatment using the Honestly Significance Differences (HSD) at the 5% real level.

This field experiment has been carried out on the farmer's partner member Farmers Group Banda Langik, on the Sungai Bangek, Koto Tengah Subdistrict, Padang City in February-September 2018. The land used is technical irrigated rice fields whose farmers are accustomed to the System of Rice Intensification. Data collected for rice plants are: yield and yield components of rice which includes total and productive tillers, weight of 100 grain, grain yield per clump and per harvest plot. As for fish, the data collected is livelihood, average weight, and yield.

## 3. Results and Discussion

### 3.1 Height of rice plants

Observation data on rice plant height are shown in Table 1. The results of the analysis show that there is no interaction between varieties with fish species on the height of rice plants. The main plot or type of fish is also not significantly different, but subplots or varieties have a significance difference.

**Table 1.** Plant height of three rice varieties in Minapadi-SRI with three types of fish

Treatment	Variety of rice			
Type of fish	PB42	Batang Piaman	Beras Merah	Average
	----- cm-----			
Tawes	80,28	93,73	112,68	95,56 a
Mas	80,42	92,02	106,03	92,82 a
Nila	73,85	85,47	102,87	87,40 a
Average	78,18B	90,41A	107,19A	

Note: The numbers in the lane followed by the same lowercase letters and the numbers in the row followed by the same uppercase letters differ not significantly according to the HSD test 5%.

From Table 1 above, it can be seen that the Red Rice varieties are higher in plants than the Batang Piaman and PB42 varieties. The average height of Red Rice plants is more than 100cm while the average plant height of PB42 and Batang Piaman is below 100 cm. Plant height is more influenced by genetic factors than the plant itself. Red rice includes local rice so that the height of the Red Rice plant is higher. Unlike the case with superior varieties that have been assembled into rice plants whose plant height is lower with early maturity such as PB42 and Batang Piaman varieties. The following shows the morphology of the three rice varieties (Figure 1).



**Figure 1.** Varieties of PB42, Batang Piaman and Beras Merah (Red Rice) varieties

From the three rice plants in Figure 4 above, it can be seen that the Red Rice is higher in plants than the Batang Piaman and PB42 varieties which are observed at 105 days after planting. Plant height is more influenced by genetic factors, so it appears that there is a difference between superior varieties and local rice.

### 3.2 Total Number of Tillers

Data on the total number of tillers of three rice varieties with different types of fish in Minapadi-SRI cultivation are shown in Table 2. The results of the variance analysis on the total number of tillers showed significant interactions, as well as the main plot and subplot gave a significant effect on the total.

**Table 2.** The total number of tillers of three rice varieties with three species of fish in Minapadi-SRI

Treatment	Variety of rice			
Type of fish	PB42	Batang Piaman	Beras Merah	Average
	----- batang -----			
Tawes	34,57Aa	31,77Aa	23,25Bb	29,86
Mas	34,57Aa	32,70Aa	28,43Bb	31,90
Nila	30,05Aa	28,63Bb	21,70Bb	26,79
Average	33,06	31,03	24,46	

Note: numbers in the lane followed by the same lowercase letters and the numbers in the row followed by the same uppercase letters differ not significantly according to the HSD test 5%.

From the data in Table 2 above it can be seen that there are interactions between varieties with fish species, as well as the main plot (fish species) and subplot (variety) showing the number of tillers that are significantly different. In Tawes fish the total number of saplings of PB42 and Batang Piaman varieties is higher than Red Rice. Likewise in the type of carp, but for tilapia, PB42 varieties are better planted.

Different types of fish give different numbers of tillers, as well as varieties that show more different effects due to different genetic factors. National superior varieties will have more tillers so that the grain will be more numerous with longer panicles, but local rice is usually less formed tillers. The data obtained shows that the number of tillers formed is more than the conventional method which is an average of more than 20 sticks, this is due to the SRI method, the formed tillers multiply. As stated by Sato and Uphoff (2007) shows an average yield increase of 78% and a reduction in water use of 40%, a reduction in the application of fertilizer to 50% and a reduction in production costs of 20%.

### 3.3 Number of Productive Tillers

Furthermore, the data on the number of productive tillers are displayed after being analyzed by variance, which shows that there is no significant interaction between varieties with fish species, the main plot is also not significantly different, but subplots have a significant effect. The number of productive tillers is shown in Table 3 below.

**Table 3.** Number of productive tillers of three varieties of rice plants with different types of fish

Treatment	Variety of rice			
Type of fish	PB42	Batang Piaman	Beras Merah	Average
	----- cm-----			
Tawes	24,28	34,56	17,80	25,55a
Mas	22,56	31,60	16,76	23,64a
Nila	27,96	26,44	16,24	23,55a
Average	24,93A	30,87A	16,94B	

Note: The numbers in the lane followed by the same lowercase letters and the numbers in the row followed by the same uppercase letters differ not significantly according to the HSD test 5%.

Based on the table above, it can be seen that the number of productive tillers is more influenced by varieties, this is due to productive tillers according to plant genetics. National superior varieties are more productive than local rice, as are the Batang Piaman and PB42 varieties, while Red Rice has fewer productive tillers.

### 3.4 Long panicles

The following table shows panicle length of three rice varieties with different types of fish in Minapadi-SRI cultivation. From the results of the variance analysis, it can be seen that there is a real interaction between varieties with fish species on panicle length, as well as varieties, but the type of fish is not significant. The panicle length is shown in Table 4 below.

**Table 4.** Panicle length of three rice varieties with different types of fish

Treatment	Variety of rice			
Type of fish	PB42	Batang Piaman	Beras Merah	Average
	----- cm-----			
Tawes	26,74 Ba	31,47Aa	31,51Aa	29,91
Mas	27,90 Ba	27,37 Bb	31,86Aa	29,04

Nila	27,32 Ba	25,96 Bb	30,76Aa	28,01
Average	27,32	28,27	31,38	

Note: The numbers in the lane followed by the same lowercase letters and the numbers in the row followed by the same uppercase letters differ not significantly according to the HSD test 5%.

In Table 4 it can be seen that there is an interaction between varieties with fish species to panicle length. In the PB42 variety, three types of fish can be maintained, as well as Melah Rice, but in the Batang Piaman variety, Tawes fish are better maintained than the other two types of fish. This is because the panicle length is influenced by genetic and environmental interactions. In Tawes fish species are more suitable to be planted with Batang Piaman and Red Rice varieties, but in the type of Goldfish more suitable for Red Rice, as well as the types of Tilapia. The Batang Piaman variety is longer in the treatment of Tawes fish species (31.47 cm), but the Red Rice and PB42 are relatively the same in the three types of fish.

### 3.5 Amount of grain per panicle

The number of grain per panicle of the three rice varieties with different types of fish in Minapadi-SRI is presented in Table 5. The results of data analysis show that there is no interaction between varieties with fish species, as well as main plots or types of fish, but subplots or varieties have a real influence.

**Table 5.** Amount of grain per panicle three rice varieties with different types of fish

Treatment	Variety of rice			
Type of fish	PB42	Batang Piaman	Beras Merah	Average
	----- cm-----			
Tawes	183,68	140,84	250,20	191,57a
Mas	166,68	171,84	273,48	204,00a
Nila	201,00	152,52	303,04	218,85a
Average	183,79B	155,07C	275,57A	

Note: The numbers in the lane followed by the same lowercase letters and the numbers in the row followed by the same uppercase letters differ not significantly according to the HSD test 5%.

In Table 5, it can be seen that the type of fish affects the number of grains per panicle, as well as the varieties grown. The amount of grain per panicle is more influenced by varieties due to genetic factors of the variety itself. In addition, the panicle length is closely related to the amount of grain. Red rice has a longer panicle length compared to PB42 and Batang Piaman varieties so that it has more grain amount.

### 3.6 Amount of rice grain per panicle

The number of pithy rice per panicle after analysis of variance showed that there was no real interaction between varieties with fish species, but the main plot or type of fish and subplots or varieties showed significantly different results. The number of pithy rice per panicle is presented in Table 6.

**Table 6.** Number of pithy rice per panicle three rice varieties with different types of fish

Treatment	Variety of rice			
Type of fish	PB42	Batang Piaman	Beras Merah	Average
	----- cm-----			
Tawes	149,60	96,44	189,08	145,04 b
Mas	174,36	129,84	212,00	172,07 a
Nila	164,80	116,04	247,68	176,17 a
Average	162,92 B	114,11C	216,25 A	

Note: The numbers in the lane followed by the same lowercase letters and the numbers in the row followed by the same uppercase letters differ not significantly according to the HSD test 5%.

Table 6 shows that the variety treatment has a significant effect on the number of rice grain per panicle, as well as the type of fish. Red rice forms more rice grain than the other two varieties. This is because the amount of rice grain is closely related to panicle length and the number of grain per panicle. Red rice gives more number of pithy rice per panicle because the length of the pan is longer so there is also a lot of grain formed. This will also cause a lot of rice grain. In addition, the number of rice grain is also influenced by environmental factors, where the type of fish will affect the rice grain formed as Tilapia is better maintained in the rice fields because it is more resistant and well developed.

### 3.7 100 Grain Weight of Grain

The results of analysis of variance for the weight of 100 grains of rice showed that there was no real interaction between varieties with fish species in Minapadi-SRI, but the main plot or species of fish and subplots or varieties showed significant influence. The weight of 100 grains of grain is shown in Table 7 below.

**Table 7.** Weight of 100 grains of grain

Treatment	Variety of rice			Average
Type of fish	PB42	Batang Piaman	Beras Merah	
	----- gram-----			
Tawes	2,18	2,90	2,32	2,47 b
Mas	2,40	3,08	2,44	2,64 a
Nila	2,18	2,78	2,24	2,40 b
Average	2,25 B	2,92 A	2,33 B	

Note: The numbers in the lane followed by the same lowercase letters and the numbers in the row followed by the same uppercase letters differ not significantly according to the HSD test 5%.

In Table 7 above, it can be seen that the types of fish and varieties affect the weight of 100 grains of grain. The Batang Piaman variety has a weight of 100 grain grain which is heavier than the PB42 and Red Rice varieties. This is because during the vegetative phase, Batang Piaman varieties look healthy with no pest and disease disturbances, but in PB42 varieties there are attacks by stem borer pests so that after the PB42 variety can be produced it can also produce. Most likely, the 100 grains of Red Rice are low due to many being empty, because they last longer so that the nutrients absorbed must also be more, in the case that the fertilizer given is the same, so not all grain is fully filled.

### 3.8 Grain Weight per Clump

The results of analysis of variance on the weight of grain per clump after being analyzed by variance showed a real interaction. The weight of grain per hill is presented in Table 8.

**Table 8.** Grain weight per clump of three rice varieties with different types of fish

Treatment	Variety of rice			Average
Type of fish	PB42	Batang Piaman	Beras Merah	
	----- cm-----			
Tawes	43,44Bb	36,75Cc	63,85Aa	48,01
Mas	43,88Bb	41,12Bb	48,71Bb	44,57
Nila	49,83Bb	40,80Bb	58,70Aa	49,78
Average	45,72	39,56	57,09	



Note: The numbers in the lane followed by the same lowercase letters and the numbers in the row followed by the same uppercase letters differ not significantly according to the HSD test 5%.

In Table 8 it is stated that the types of fish and varieties provide a real interaction with the weight of grain per clump. In the cultivation of Minapadi-SRI for Red Rice, it is more suitable to maintain Tawes and Tilapia fish. For Batang Piaman variety, it is more suitable for carp and tilapia, but for PB42 varieties it is more suitable for tilapia that is maintained. There is an interaction between species of fish and varieties on the weight of grain per clump due to the presence of genetic interactions with the environment. Goldfish and tilapia are more suitable to be maintained in paddy fields because these types of fish are more resistant to rice fields, sometimes the water is hot due to sunny weather. As stated by Sasa and Syahromi, (2006) states that compared to Tawes, Nilem, Kancra and Carp, carp is the best type of fish in the Minapadi system. This is reflected in the high yield of rice which reached 5.7 t / ha in the minapadi plot that used goldfish as a treatment, with the highest net profit of Rp 5.15 million / ha / season. Methane gas emissions from minapadi plots that use carp are 51.2 kg CH<sub>4</sub> / ha / season. The strains of tilapia which were kept in the minapadi effect on the results obtained, the best strain was Larasati Tilapia [13].

### 3.9 Results of Grain per Plot

The results of the variance analysis on the yield of grain per plot provide unrealistic interactions, as well as the main plot, but the subplots provide tangible results. Data from grain per plot results are shown in Table 9 below.

**Table 9.** Grain yield per plot of three rice varieties with different types of fish

Treatment	Variety of rice			
Type of fish	PB42	Batang Piaman	Beras Merah	Average
	----- gram-----			
Tawes	1.040,00	550,00	750,00	780,00a
Mas	1.220,00	550,00	760,00	843,33a
Nila	970,00	562,00	790,00	774,00a
Average	1.076,67A	554, 00B	766,67B	

Note: The numbers in the lane followed by the same lowercase letters and the numbers in the row followed by the same uppercase letters differ not significantly according to the HSD test 5%.

From the table above it can be seen that only the treatment of varieties gave a real effect on the yield of grain per plot. Whereas the interaction is not real as is the type of fish. This is because grain is more closely related to varieties because different varieties will cause differences in results that are influenced by the genetics of the variety itself. Although the yield or grain is influenced by the interaction between genetics and the environment, in this case environmental factors have not affected much. The PB42 variety gave the most severe grain yield (1,076.67 grams) compared to Batang Piaman varieties (554 grams) and Red Rice 766.67 grams). This is related to the number of total tillers where PB42 varieties have more total tillers than other varieties. The more saplings formed, the more grain formed.

## 4. Conclusions

From the results and discussion that has been described, it can be concluded that: the number of tillers formed up to 12<sup>th</sup> phyllochron on PB42 varieties is 33 tillers, Batang Piaman 31tillers and Red Rice is 24 tillers with the highest yields per plot is varieties PB42. The type of fish that is suitable to be maintained in paddy fields is the type of Tilapia and Mas. Those fish are more resistant to life in the rice field environment.

It is recommended to apply the Minapadi-SRI pattern to the cultivation of lowland rice so that the formation of the tillers increases, so the results will increase as well. The application of SRI can be combined with fish (Minapadi-SRI) so that the results obtained will multiply.

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