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A STUDY ON DIFFERENT CROPPING SYSTEMS ON TWO RENEWED SUPERIOR VARIETIES OF RICE TOWARD RICE GROWTH AND YIELD AT PENGGALAMAN VILLAGE, BANJAR REGENCY

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ABSTRACT

Improved varieties of rice crops play important roles in increasing rice yields. The use of improved varieties and quality seed is one of the basic components in an integrated crop management. This research aims at finding out cropping systems upon two renewed varieties of rice growth and rice yield. The experiment was conducted in Penggalaman Village, District of West Martapura, Banjar Regency from April to September 2013 by using demonstrated plot (demplot) of 65M x 15M in size. The demplot was divided into nine smaller demplots with the size of 11M x 6M for each. A trench of 2M width was made in between of each plot, while a wide elongated trench with the width of 2M was made alongside each plot. The trenches functioned as a way of preventing pest rodents and as a medium to keep fish (simultaneous technique of rice cultivation and pisciculture). Rice varieties Pandanwangi and Ciherang were tested by using 4 different cropping systems that is system of simultaneous rice cultivation and pisciculture Legowo 2.1, Legowo 4.1, System of Rice Intensification (SRI), and tile system.The results indicated that Pandanwangi variety tested by using SRI yielded in 8,713 kg/ha of rice, higher than SRI system for Ciherang variety which yielded 8,308 kg/ha.At the same time, the system of simultaneous rice cultivation and pisciculture Legowo 4.1 tested for Pandanwangi variety yielded 8,779 kg/ha. This yield was considerably higher than Ciherang variety tested with the same system which resulted in 7,367 kg/ha. Compared with conventional tile cropping system, systems of simultaneous rice cultivation and pisciculture Jajar Legowo and SRI in this experiment were proven to be able to increase rice yield. The increase ranged between 150 percent to 200 percent. Rice farmers who utilize SRI and Jajar Legowo cropping systems can reach similar increase in rice yield with one condition that they use right rice seeds, fertilizer, tillage system, and crop pest combating system. The highest rice yields from this research were obtained from tile 9 of Pandanwangi variety (11,563 kg/ha), which provided a net gain of Rp 34,417,000,-.

Keywords: Varieties, growth, rice, cropping system

INTRODUCTION

Rice is the main crop of Indonesia's agriculture which is mostly planted in paddy fields. In an attempt to support the self-sufficiency of food security program, Indonesian Government has launched a program of "Peningkatan Produksi Beras Nasional (P2BN)" (National Rice Production Enhancement Program). This program has been defined as national movement to increase national rice production by 5 percent per year. Therefore, the use of new superior

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varieties of rice cropping system becomes a flag ship technology which is highly recommended since they are lower in cost and more compatible than other advanced cropping technology. Theuse of high yielding varieties is expected to allow Indonesia to achieve self-sufficiency of rice (Arafah, 2006).

A decrease in agricultural production is mainly determined by behavior in the processing of farm land (soil, water and plants). The decrease in the quality of soil structure and texture, which affects biological activity of soil and threatens biodiversity degradation from simple to more complex condition, is more particularly caused by the very less content of organic matter in the soil due to the lack of attention to ecological rules (Yanti and Sri Legowo, 2012). Further, changes of elements in agriculture ecosystem, especially in agro eco systems of field rice, have caused problems in farming. However, the condition is considered normal so that farmers are less aware that it is detrimental to causing rice production increasingly declines (Yanti and Sri Legowo, 2012). By using technology of organic-based agriculture, that is the SRI (System of Rice Intensification) and inorganic-based technology, or *simultaneous rice cultivation and pisci culture* Legowo2.1and Legowo 4.1 systems, farmers can make an evaluation on their agricultural work activities.

The main problem identified from the research area is the low rice yield. This condition is caused by factors like low soil fertility level, water shortage during growth period, and crop pest. Based on the identified problem, this research aims at: (i) determining suitable rice varieties which can be planted in rice fields with low soil fertility levels but which can lead to higher rice yield; (ii) finding out cropping systems which can be suited with local conditions, not over priced, but profitable; (iii) finding out the advantages and disadvantages of SRI cropping system, Jajar Legowo cropping system, Tiles 7, 8, 9 cropping systems and conventional tile system. Thereby, this research is designed to result in the evaluation on the advantages and disadvantages of applying SRI cropping system, systems of *simultaneous rice cultivation and pisciculture*Legowo2.1andLegowo4.1comparedwithconventionaltile system, in terms of irrigation systems, cropping procedures, and social and behavioral aquaculture of the farmers. In this way, the cost of rice cultivation can be minimized.

Based on the above explanation, this research examines several different cropping systems employed for two renewed superior varieties of rice towards rice growth and yield. The main objective is to apply appropriate and efficient cropping systems on renewed superior varieties of rice.

MATERIALS AND METHOD

Field experiment was conducted in the field of *Makmur* farming group led by Mr. Mardani, and it was located in Penggalaman village, West Martapura, Banjar Regency, South Kalimantan Province.

The experiment was designed in demonstrated plot (demplot) with the size of 65M x 15M (meter). The demplot was divided into nine smaller experimental plots. Each plot with the size of 11Mx6M was bordered with a trench as wide as 2M. The trench was functioned as boundary divisor between plots as prevention toward the possibility of mutual effect in terms of rice growth and rice yields. In addition, the trenches had another benefit that is as fish farming. The fish harvesting results could help lowering the costs of farming. Renewed varieties of rice in this research were Pandanwangiand Ciherang. Each variety was planted in experimental plot with cropping division as the following:

a. Plot1: SRI cropping system for Pandanwangi rice variety.
b. Plot 2: Jajar Legowo 4.1 cropping system for Pandanwangi rice variety

c. Plot 3: SRI cropping system for Ciherang rice variety.
d. Plot 4: Jajar Legowo 2.1 cropping system for Pandanwangi rice variety
e. Plot 5: Jajar Legowo 4.1 cropping system for Ciherang rice variety
f. Plot 6: Jajar Legowo 2.1 cropping system for Ciherang rice variety
g. Plot 7: Tile cropping system for Pandanwangi rice variety
h. Plot 8: Tile cropping system for Ciherang rice variety
i. Plot 9 : Tile cropping system for Pandanwangi rice variety

Cropping Systems of Jajar Legowoand SRI

*Simultaneous rice cultivation and pisciculture cropping system of J*ajar Legowois the system of rice-fish farming which is designed for the purpose to increase the income of rice farmers. Results of this research reveal that rice cropping system of Legowo 2.1or Legowo 4.1was proven to be able to increase rice production by as much as12 percent to 22 percent.

Legowo is cropping system which suggests the adjustment in the spacing between clumps and inter-row in the rice plots. It highlights the use of vast space (aisle) between plots which are very suitable to be combined with rice fish keeping. Thus, the clumps at the very edge of the plantation area functions as a *border effect.* With this technique, elongated and widened compaction of rice clumps in the spacing between rows could be well-formed. The results showed that the clumps of rice at the very edge of the row yielded one-half to two times (1.5-2.0) rice higher than that of the inside rice clumps.

The stages of *simultaneous rice cultivation and pisciculture cropping system of J*ajar Legowoand SRI were as follows:

a. Preparation. This stage included soil tillage and seed bedding. Soil was cultivated to 15-20 cm in depth. Seed bedding was done to 5% of the cropping area.

b. Planting. OncroppingsystemLegowo2.1, in every two planting rows there was 40 cm wide aisle, 20 cm distance between rows, and the row spacing was 10 cm. On Legowo 4.1, in every four planting rows there was 40 cm wide aisle, 20 cm distance between rows, but the mid row spacing was 20 cm, and the edge row spacing was 10 cm. To set the spacing, a claw of 20 cm in size was used. For Legowo 2.1, the plowing direction was lengthwise, while for Legowo 4.1 it was cut lengthwise and in the direction of cutting.

As for the SRI, the cultivation was done by clawing the rice field into the size of 20cm x 20cm, and then planting one seed per hole in condition in which the soil was not water logged.

c. Maintenance: This stageincluded the processes of weeding, fertilizing, feeding the fish, and managing water. Number of farmed fish was 5000fish/ha with the length of each fish 5-8cm.Fertilization was done three times, namely during tillage, when rice was 15days, and when the rice was 45days.Manureusedas fertilizers were Mutiara, SP36, Urea and Phonska. Weeding was done when the ricewas10-15days, or prior to the second phase of fertilization.

d. The activity of cutting and collecting crops was done when the rice paddy reached the age of95 to 100days. At the same time, farmed fish was harvested 10daysprior to rice harvest.

The difference between the SRI and Legowo cropping systems lies on the type of fertilizer and number of seeds. SRI used organic fertilizer, while Legowo used in organic fertilizers

when seeds were still in7 to 9 nursery days. As for the difference in terms of rice seed, SRI required just one seed to plant, while Legowo needed 3 to4seeds to plant.

The observational data collected in this research encompassed length of stems, length of panicle, height of plant, number of seeds/panicle, number of empty seeds/panicle, weight of 1000seeds, percentage of empty grain, dry grain yield, and economic value of SRI and Legowo cropping systems.

RESULTS AND DISCUSSION

The Effects of Cropping System and Variety on Growth

Results of the observation towards growth and yield component softwo tested varieties revealed that Pandanwangi (PW) variety was superior to Ciherang (CH) variety (see Table 1). Results of observations towards average length of stem per clump suggested that Pandanwangi clumps were longer than Ciherang clumps, while the length of panicles was not significantly distinct.

From the results of observation towards 125stemclumps of average productive rice seedlings, it was found that SRI system for Pandanwangi variety resulted more productive stem clumps (22.50 stems) than that of Ciherang variety (17.04 stems). The results of observation towards cropping systems of Legowo 2.1 and 4.1 showed that Pandanwangi variety yielded more number of average productive stems than that of Ciherang variety. Nonetheless, for the same rice varieties, Legowo 2.1 and Legowo 4.1 produced fewer number of stems compared to tile system 7, tile system 8, and tile system 9. From the results of observation on the cropping system Legowo 4.1, it was indicated that the average number of productive stem clumps of Pandanwangi was tangible by the number of productive stems clump of Ciherang. Meanwhile, the results of observation towards tile system for Ciherang variety showed that the productive stems of Tile 8 and 9 (14.86 – 17.46) were higher than that of Tile 11 (8.34).

The Effects of Cropping System and Variety on Rice Yield

From the observation of the results of milled dry grain (Table 2), it is shown that four cropping systems, namely SRI, Legowo 2.1, Legowo 4.1, dan tile resulted in different amount of rice yield which is determined by cropping system, rice varieties, and the treatment to the plant. This can be seen on SRI Pandanwangi which yielded in dry grain 14% (8,713 kg/ha) higher than SRI Ciherang (8,303 kg/ha). Meanwhile, Legowo 2.1 which was used to plant Pandanwangi variety yielded in 7,775 kg/ha, and it was higher than Ciherang yielding 7,150 kg/ha. Legowo 4.1 system for Pandanwangi variety yielded 8,779 kg/ha, which was higher than Ciherang yielding7,367 kg/ha. From the observation of Tile 9, Pandanwangi variety yielded in11,563 kg/ha, andit was higher than the yield of Tile 8 system for Ciherang variety (6,854 kg/ha) dan conventional(4,037 kg/ha).

From the observation of the cropping system and rice varieties, the rice yields of Legowo 4.1 and Tile 11 using the system of simultaneous rice cultivation and pisciculture were higher than that of neighboring paddy field (Legowo 4.1 with 5,292 kg/ha and conventional tile with 4,037 kg/ha).

The Effects of Pandanwangi Rice Variety Interaction on the Cropping System

Observations on the height of the rice varieties cultivated using 4 (four) cropping systems (Table 1) indicated that Pandanwangi SRI showed the highest average growth of 105.26 cm, compared to Pandanwangi Legowo 2.1 (88.08 cm), Legowo 4.1 (81.16 cm), and Tile 9 (86.16 cm). Yet, the average growth did not differ significantly from that of tile 7 (101.76 cm).

On the number of productive rice seedlings, in average Legowo 2.1 system yielded 10.82 seedlings, while Legowo 4.1, Tile 7, and Tile 9 yielded 13.72, 13.38 and 17.46 seedlings respectively. The highest number of seedlings ever produced in each treatment was 20 (Legowo 2.1), 27 (Legowo 4.1), 39 (Tile 7), 44 (Tile 9), and 45 (SRI).

Next, Pandanwangi Legowo 4.1 was observed to have a higher percentage of void husks per panicle, being8.9%, while tile system had 3.3% and Tile 9 5.7%.

Finally, Pandanwangi Tile 9 showed a significantly higher production of milled dry husks than the other systems did. It produced 11,563 kg/ha, while Legowo 2.1, Legowo 4.1, SRI, and Tile 7 produced 7,775 kg/ ha, 8,779 kg/ ha, 8,713 kg/ ha, and 6,796 kg/ ha respectively.

The Effects of Ciherang Rice Variety Interaction on the Cropping System

Observations on the height of the rice varieties cultivated using 4 (four) cultivation systems (Table 1) showed that Ciherang cultivated in Tile 8 system had the highest average growth of 96.95 cm, compared to Ciherang Legowo 2.1 (94.73 cm), Legowo 4.1 (90.53 cm), SRI (88.18 cm), Legowo 4.1 (used in the neighboring rice fields, 86.6 cm), and Tile 11 (73.75 cm), which was significantly different from that of Tile 8 system.

On the average number of productive rice seedlings, Ciherang SRI had 17.04 seedlings, with the highest number of seedlings ever produced of 37. Meanwhile, the average number of productive rice seedlings of Legowo 2.1 was 9.96, Legowo 4.1 10.62, Tile 8 14.86, and Tile 11 10.34. Their highest number of seedlings ever produced was 24 (Legowo 2.1), 18 (Legowo 4.1), 27 (Tile 8), and 10 (Tile 11). These were all significantly lower than that of Ciherang SRI (37 seedlings).

Next, the observations on the percentage of void husks per panicle of Ciherang SRI, Legowo 2.1, Legowo 4.1, and Tile 8 did not show a significant diference, ranging from 3.3% to 5.45%. On the other hand, Tile 11 had 6.3%, which was higher than the cultivation system observed in this study.

Finally, Ciherang SRI showed a significantly higher production of milled dry husks than Ciherang Legowo 2.1, Legowo 4.1, Tile 8, and Tile 11. The highest production was obtained in Ciherang SRI treatment (8,308 kg/ha). This was significantly higher than that of Ciherang Legowo 2.1 (7,150 kg/ha), Legowo 4.1 (7,366 kg/ha), Tile 8 (6,864 kg/ha), and Tile 11 (4,037 kg/ha).

The Economic Benefits of Using New High-Yielding Varieties in the Cropping System

The productions costs in this study covered the costs of land manufacturing, seeds, equipment, organic and non-organic fertilizers, labors, plant maintenance, aclyric sheet, pest trap, and water pump. The expenses spent on paddy fields using SRI, Legowo, and tile systems are presented in Table 3.

Based on Table 3, the highest profit was Rp. 34,417,000,- in Tile 9, while conventional tile experienced Rp. 437,000,-. The combination of aquaculture and rice farming resulted in a Rp. 22,967,000,- profit more than that in the non-combined rice farming system.

CONCLUSION

The research findings suggest that:

1. SRI Pandanwangi cultivation in the research site yielded 8,713 kg/ha and Ciherang 8,308 kg/ha, so there was 405 kg/ha difference. Legowo 4.1 Pandanwangi produced 8,779 kg/ha, 1,380 kg/ha higher than Ciherang (7,366 kg/ha), and there was no

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Vol. 5 No. 1 January 2014

significant difference between the production of Legowo 2.1 Pandanwangi and Ciherang (7,775 kg/ha and 7,150 kg/ha respectively).

2. Tile 7 and Tile 8 rice cultivation and pisciculture system with the same treatment as Legowo 2.1yielded 6,796 kg/ha rice and Legowo 4.1 did 6,854 kg/ha. Tile 9 produced 11,563 kg/ha; yet, it does not mean that tile 9 system is better than Legowo 2.1, Legowo 4.1, and SRI.
3. Rice cultivation and pisciculture using Legowo and SRI was able to increase the harvest by 150 to 200 % of that using the conventional tile system.

SUGGESTION

To achieve significant improvement in production, the following actions are suggested:

1. Encouraging rice growers to adopt SRI cropping system of simultaneous rice cultivation and pisciculture Jajar Legowo by giving workshops for the rice growers.
2. Based on the study findings, it is suggested that rice growers use Jajar Legowo system, as it has been found easier to use.
3. One factor that causes the decrease in rice productivity is lack of water supply during the growth period. Therefore, cooperation between the Department of Agriculture and the Department of Water Resources and Housing in Banjar Residence is needed.

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ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

APPENDIX

Table 1. The Effect of Cropping Systems on Plant Growth and Productive Number of Rice Seedlings in Penggalaman village, West Martapura Banjar, 2013

Cropping System	*Variety*	*Number of Stem^{-1} (Stems)*	*Average Length of Stem (cm)*	*Average Lengthof Panicle (cm)*	*Average Plant Height (cm)*	*Average Number of Panicle^{-1} (seed)*	*Average Void husks Panicle^{-1} (seed)*	*Average Void husks Panicle^{-1} (%)*	*Number of Productive Rice Seedlings. (Stems)*	*Average Number of Productive Rice Seedlings(stems)*
SRI	Pandan wangi	36	79.06	26.12	105.26	118.75	7.94	6.7	45	22.50
Legowo 2.1	Pandan wangi	25	68.2	19.88	88.08	94.88	6.65	7.0	20	10.82
Legowo 4.1	Pandan wangi	32	59.69	21.47	81.16	93.13	8.34	8.9	27	13.72
Tile 7	Pandan wangi	25	79.68	22.08	101.76	130.16	4.23	3.3	39	17.38
Tile 9	Pandan wangi	23	65.09	21.04	86.13	120.91	6.87	5.7	44	17.46
SRI	Ciherang	22	65.73	22.45	88.18	122.82	6.68	5.4	37	17.04
Legowo 2.1	Ciherang	22	72.05	22.68	94.73	127.09	4.64	3.7	24	9.96
Legowo 4.1	Ciherang	19	58.74	21.79	90.53	107.68	4.37	4.1	18	10.62
Tile 8	Ciherang	20	74.65	22.3	96.95	133.45	4.35	3.3	27	14.86
				Rice Crops Around Research Area						
Legowo 4.1	Ciherang	5	64.4	22.2	86.6	91.4	4.6	5.0	21	10.34
Tile 11	Ciherang	8	53.5	20.25	73.75	111.0	7.0	6.3	10	8.34

Source: Research Result

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

Table 2. The Effects of Cropping System and Variety on Rice Yield in Penggalaman Village, Martapura Barat, Banjar, 2013

Cropping system	*Variety*	*Amount of Grain Panicle^{-1} (gr)*	*Weight of Grain 1000 seedlings (gr)*	*Weight of Grain24 M^2 (kg)*	*Weight of void husks 24M^2 (kg)*	*Weight of void husks 24M^2 (%)*	*Grain yield per 24 M^2 (kg)*	*Grain yield Hectare^{-1} (kg)*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SRI	Pandanwangi	118.75	30	21.60	0.69	3.19	20.91	8,713
Legowo 2.1	Pandanwangi	94.88	31	19.20	0.54	2.81	18.66	7,775
Legowo 4.1	Pandanwangi	93.13	30	21.70	0.63	2.90	21.07	8,779
Tile 7	Pandanwangi	120.41	28	17.50	0.69	3.94	16.31	6,796
Tile 9	Pandanwangi	130.16	30	28.10	0.95	3.30	27.75	11,563
SRI	Ciherang	122.82	30	20.65	0.71	3.44	19.94	8,308
Legowo 2.1	Ciherang	127.09	32	18.00	0.84	4.67	17.16	7,150
Legowo 4.1	Ciherang	107.68	29	18.40	0.72	3.91	17.68	7,367
Tile 8	Ciherang	133.45	32	17.2	0.75	4.36	16.45	6,854
				Rice Crops Around Research Area				
Legowo 4.1	Ciherang	91.4	28	13.2	0.49	3.17	12.71	5,292
Tile 11	Ciherang	86.25	27	10.1	0.41	4.06	9.69	4,037

Source: Research Result

ISSN-L: 2223-9553, ISSN: 2223-9944
Vol. 5 No. 1 January 2014

Table 3. Production Costs of Farming Using SRI, Jajar Legowo, Tile and Conventional Systems for 1 ha of Land

Program	*Fish-Rice Farming With Pandanwangi (Pw) And Ciherang (Ch) Cropping System :*							*Conventional System*
	SRI		*Jajar Legowo 2.1*		*Jajar Legowo 4.1*		*Tile 9*	*Tile 11*
Expenses	*PWx10^3 (Rp)*	*CHx10^3 (Rp)*	*PWx10^3 (Rp)*	*CH x10^3 (Rp)*	*PWx10^3 (Rp)*	*CH x10^3 (Rp)*	*PWx10^3 (Rp)*	*PWx10^3 (Rp)*
Seeds								
a.SRI (5 kg/ha)	20	20	-	-	-	-	-	-
b.Legowo/Tile (25 kg/ha)	-	-	100	100	100	100	100	100
Fertilizers								
a.Organic: manure 1500 kg	1500	1500	500	500	500	500	500	-
b.Non-organic.								
b1. *Urea*50 kg	-	-	125	125	125	125	125	125
b2.*Poska* 150 kg	-	-	2625	2625	2625	2625	2625	2625
b3.*Mutiara* 100 kg	-	-	1950	1950	1950	1950	1950	1950
b4.SP36:200 kg	-	-	600	600	600	600	600	600
Calcium Supply	450	450	450	450	450	450	450	-
OPT Control with:								
a.Darnabus 20 btl	1000	1000	1000	1000	1000	1000	1000	1000
b.Biopesticide 100 btl	1000	1000	1000	1000	1000	1000	1000	-
Pest Control								
a. Pest Trap 40 pc	3000	3000	3000	3000	3000	3000	3000	-
b. aclyric sheet 40 pc	1000	1000	1000	1000	1000	1000	1000	-
c. *Keong Mas*	630	630	630	630	630	630	630	630
Tractor	1400	1400	1400	1400	1400	1400	1400	1400
Seeding	70	70	70	70	70	70	70	70
Seedling removal	70	70	420	420	420	420	420	420
Planting	1700	1700	4025	4025	4025	4025	4025	4025

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Vol. 5 No. 1 January 2014

Crop replanting	280	280	280	280	280	280	280	280
Weeding	-	-	--	-	-	-	-	-
Harvesting	280	280	280	280	280	280	280	280
Water pump (rent)	750	750	750	750	750	750	750	-
Land rent	3080	3080	3080	3080	3080	3080	3080	3080
Subtotal I	23285	23285	23285	23285	23285	23285	23285	16585
Drainage ditch making	280	280	280	280	280	280	280	-
Fish seeds 5/8: (5000 fish)	2500	2500	2500	2500	2500	2500	2500	-
Fish food (90 days)	2250	2250	2250	2250	2250	2250	2250	-
Employees (90 days)	6300	6300	6300	6300	6300	6300	6300	
Subtotal II	11050	11050	11050	11050	11050	11050	11050	-
Fish harvest (4500 fish)	22500	22500	22500	22500	22500	22500	22500	-
Profit from fish farming	11450	11450	11450	11450	11450	11450	11450	-
Income								
Rice harvest (*GKG* – milled dry husks) kg	8713	8308	8779	7366	7775	7150	11563	4037
Rice sales	34853	33232	35116	29464	31100	28600	46252	16148
Profit (nett)	22618	21397	23281	17644	18865	16765	34417	-437
Profit from the non fish-rice farming	11568	9947	11831	6179	7815	5315	22967	-437

Source: Field observation