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Soybean Based Farming System Assessment in Pasuruan East Java Indonesia

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***Abstract*—**The study aims to assess efficient specific-location soybean farming technology assembly by assisting the farmers in applying the suggested technology. Superimposed trial was conducted to know NPK fertilizer effect toward soybean growth and yield and soybean improved variety test for the dissemination of improved variety. The assessment was conducted at the farmers group of Sumber Rejeki, Kepulungan Village, Gempol Sub-district, Pasuruan Regency as the soybean central at Pasuruan area. The number of farmers involved in the study was 38 people with 25 ha soybean area. This study was held from July to October 2012. The recommended technology package agreed at the socialization time and used in this research were: using Argomulyo variety seeds of 40 kg/ha, planting by drilling, planting by distance of 40x10 cm, deciding the seeds amount of 2-3 seeds per hole, and giving fertilization based on recommendation of East Java AIAT of 50 kg Urea, 100 kg SP-36 and 50 kg KCl. Farmers around the research location were used as control group. Assessment on soybean farming system was considered effective because it could increase the production up to 38%. The farming analysis showed that the result collaborator farmers gained were positively higher than non-collaborator farmers with RC ratio of 2.03 and 1.54, respectively. Argomulyo variety has the prospect to be developed due to the high yield of about 2 tons/ha and the larger seeds. The NPK fertilization test at the soybean plants showed that the fertilization had minor effect on the yield.

***Keywords*—**Farming system, soybean, variety, location specific farming.

I. Introduction

FUTURE farming development would be set on the target of improving food production to optimize national food sustainability. One way to achieve this target is through Agribusiness System. Agribusiness is any business related to agricultural production activities which includes the provision of agricultural inputs, production processes and management of agricultural products [1], [2]. Agribusiness system comprises infrastructure system, production system, processing system, and marketing system. All these sub-systems of agribusiness must be supported by all stakeholders to help Indonesia regain self-sufficiency in rice, corn, and soybean.

Improving domestic soybean production is an important program to keep the balance with the continuously increasing demand of this commodity. One of four success programs planned by the Ministry of Agriculture is to achieve soybean self-sufficiency by 2014. The follow-up efforts the government made include increasing productivity by improving the quality of rice field intensification; increasing crop intensity on wet land and dry land; and extending planting area by utilizing idle land and non-optimal land. Directorate General of Crop in 2011 had set a soybean development plan on 1.036 ha with productivity target of 1.5 tons/ha to achieve total national production of 1.56 million tons [3], [4].

Efforts to increase soybean production nationally are expected to reduce imports or even to create self-sufficiency in soybean in the future.

In fact, the imported soybean seed still increases over years. Soybeans import in 2011 was 2.1 million tons and worth about 1.25 billion US dollars, whereas soybean imports in 2009 was 1.3 million tons and worth 621.2 million US dollars [5]. East Java becomes a leading sector for soybean self-sufficiency effort. In 2010, this province has supplied soybean for 37.4% National Production worth 907,031 tons. In this year, East Java's soybean production reaches 339,479 tons. The average soybean production of 1.375 tons/ha is almost similar to average national production of 1,373 tons/ha [6]. To be self-sufficient in soybean, Indonesia should be able to increase soybean production up to 1.8 tons/ha, which means that East Java must increase the soybean productivity to 0.557 ton/ha. Review on soybean farming system with agribusiness perspective was conducted and it was expected that it could increase soybean productivity. The success of review on technological assembly in cooperation with farmers was determined by 5 factors:

1. Environment friendly technological package the farmers understood,
2. The availability of punctual production structure,
3. Direct and continuous technical guidance by farming officers,
4. Participation of the farmers and
5. Support from local government [7].

The success of technological package was determined by the application of technology approved by farmers and authors/counselors [8]. The objective of this review is to assess a comprehensive application of Farming System Technology to obtain more efficient technological assembly for location-specific soybean farming and to accelerate the adoption of new variety of soybean.

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II. Materials and Method

A. Location, Timing, and Technology

The location of soybean Agricultural Business System (ABS) review was determined with the guidance from the Agricultural Official of Pasuruan Regency. The selected subject was the farmers group of Sumber Rejeki in Kepulungan Village, Gempol Sub-district, Pasuruan Regency. It covered a range of technical rice field with 25 hectares width and 35 members of the farmers group. The study was done in Dry Season II started from July to October 2012.

ABS Assessment was preceded by PRA (Participatory Rural Appraisal). This appraisal aimed to identify problems, challenges, opportunities and potentials the farmers group had in order to set strategy to implement ABS (*on farm*) and non-ABS (*off farm*). The appraisal was supported with group-based discussion to arrange the application of technological assembly based on agreement between additional officers/counselors and farmers as the implementer. The technology agreement explains several items such as: (1) Variety: Argomulyo; Seed = 40 kg/ha; 2-3 seeds/hole; (2) Planting Interval: 40x10 cm in row; (3) Fertilizer Quantity: 50 kg Urea + 100 kg SP-36 + 100 kg KCl/ha, with simultaneous planting time; (4) Use of straw mulch; and (5) Control implementation of plant-disturbing organisms with Integrated pest management Control IPM Concept (Integrated pest management Control) [9].

B. Data Collection

The collected data were primary and secondary data. Data of agronomy and socio-economic conditions were also considered. Field observation emphasized crop visual performance, crop growth, pests and diseases disturbance, and tilled production yield. Data were analyzed with Analysis of Variance and BNT Test. Profit and efficiency were analyzed using Input-Output Analysis with R/C Ratio [10].

C. Superimposed Trial

Besides technology the farmers used, a study on superimposed trial was conducted to support ABS activity. This activity would provide more complete information about ABS Assessment and deliver more information to the farmers. Superimposed trial involved two activities. First activity was related to NPK fertilizer effect on soybean growth and yield. Table I presents the treatment in this activity. The plot size in every treatment was 3x4m and each treatment involved three replications. Crop maintenance was set to optimum. The observed data were crop height, number of branch, number of legume, damaged legume, biomass weight, ton of yield per ha, and weight per 100 seeds. The collected data were analyzed with Analysis of Variance.

Second activity of superimposed trial was the testing of soybean varieties at the irrigated wet land. Eight soybean varieties were tested, including: (1). Burangrang; (2). Baluran; (3). Panderman; (4). Anjasmoro; (5). Slamet; (6). Kaba; (7). Argomulyo; and (8). Wilis (control variety). The plot size was 3x4 meters. Each treatment was replicated 3 times. Crop maintenance was optimum and managed using technology borrowed from BPTP East Java. Planting interval was 40x10 cm in row. Fertilization used was 50kg Urea+100kg SP-36+100kg KCl/ha. These fertilizers were given simultaneously during planting season and supplemented by straw mulch. The control of plant-disturbing organisms referred to IPM concept. The observed components were similar to superimposed trial 1. The collected data were analyzed with Analysis of Variance.

TABLE I
NPK Fertilizer Treatment to Soybean at Irrigated Wet Land dry season two, in KepulunganVillage, Gempol Sub-District, Pasuruan Regency, 2012

Treatment/	Dose of Fertilizer (kg/ha)			
	Urea	SP-36	KCl	ZA
1	0	0	0	0
2	50	0	0	0
3	100	0	0	0
4	25	0	0	50
5	75	0	0	50
6	50	50	0	0
7	50	75	0	0
8	50	100	0	0
9	50	100	50	0
10	50	0	100	0
11	50	0	50	0
12	50	50	50	0
13	50	75	50	0
14	50	100	100	0
15	50	50	100	0
16	50	75	100	0

III. Results and Discussion

A. Characteristic of Review Location

This research was conducted in Kepulungan Village, Gempol Sub-district, Pasuruan Regency. The village has 11 hamlets in approximately 363 km2 village area with the population of 10,245 people, and an elevation about 55 m ASL. This village is a new area for soybean development in Pasuruan Regency. Common cropping pattern of the farmers is three planting seasons of rice, and small area (± 10%) with two planting seasons of rice and one planting seasons of mung beans. Soil topography is 85% flat lands and 15% slightly bumpy ramps. Table II presents the average rainfall in 5 years (2007-2011). The highest rainfall occurred in 2007, which was 1,337.5mm with 133.7 rainy days, while the lowest rainfall occurred in 2010, which was 510 mm with 72.9 rainy days [11].

TABLE II
Data of Rainfall from 2007 to 2011 in Gempol Sub-District, Pasuruan Regency

Year's	3 Months				RF/ 3 month	Average/ 3 month
	1	2	3	4		
2007	675	356	65	241	1337	334,25
2008	516	368	0	140	1024	256
2009	407	306	74	127	914	228,5
2010	287	89	0	134	510	127,5
2011	335	82	0	130	547	136,75

The population of Gempol District is ± 80,687 people, consisting of 36,310 men and 44,377 women. Employments in Gempol Sub-district include 46.38% farmers; 31.35% laborers; 5.77% merchants; 11.16% artisans; and only 1.94% civil servants. The remaining 20.93% are builders.

Cropping patterns implemented by the farmers group were 60% farmers used rice-rice-rice pattern and 40% farmers used rice-rice-soybean/green pea pattern. The target of soybean intensification the local government achieved in 2011 was 1,441 ha area width with production average of 18.50 kw/ha. The working capital for the farming was self-dependent, and it was applied to rice, soybean and others. During Soybean ABS Assessment, the farmers implemented the suggested technology. The cost sharing was applied in which AIAT for East Java provided soybean seeds while the other cost was paid by the farmers. However, in reality, not all farmers implemented the suggested technology. Of 38 farmers who were ABS members, ± 60% farmers did not implement the suggested technology. Obviously, soybean could not be well managed and tended to be dense and less distributed. The seedling was quite abundant with 5-7 seeds/hole or 50 kg/ha. Clearing was often late, resulting in plenty of weeds to clean. Many farmers did not fertilize the plant, causing the plant growth was not good enough.

B. Soil Tillage

Planting system was without *tillage*. Land preparation before planting involved several activities. The previously rice field was managed by slashing straws. Ditches were made around the field with rice plot in the middle. Such arrangement was used to facilitate watering.

C. Planting

During planting, seed was dibbled with interval 40 x 10 cm at dibble depth of 2.5-3 cm. The farmers used plastic rope to obtain straight row of planting. Planting timing for soybean immediately started after the rice harvest, or maximally a week after the harvest. This timing had set in such a way because the fields had not dried and the weeds had not grown yet. Before planting, seed was immersed for 2 hours overnight and thawed for 7 hours. In the morning, soybean seeds enlarged and mixed with insecticide to reduce the attack of flies in the early growing period.

D. Crop Maintenance

Farmers still used manual weeding and rarely used herbicide. Weeding was done twice in several days after planting, especially at 15-20-day age and 35-40-day age after planting. In some occasions, the farmers were too late for weeding, and thus early growth of soybean became distorted and required higher cost of weeding. In the second weeding, the soybean leaf had covered the soil and the weeds were minimal. Therefore, weeding cost was rather low.

E. Fertilization

The dose of fertilizers used in this review was arranged into: 50kg Urea+100kg SP-36+100kg KCl/ha. These fertilizers were applied simultaneously to the soybean plantation. Before treatment, fertilizers were mixed well, dibbled into seed hole, and covered with straws.

F. Watering

Watering was given once a week or depended on field situation and condition. In general, watering from planting to harvest was done 4-5 times by inundation. After 2-3-hour inundation, water release was conducted. All of these processes are called as *drowning system*.

G. Pest and Disease

Pest attacking soybean in the review location was *leaf caterpillar* (*spodoptera sp*) that assailed vegetative growth. Farmers were mostly late to control this pest and thus many leaves were perforated. In the generative stage, the pest was *legume borer* (*Etiela sinkinila*). This pest caused difficult moment for the farmers. Late control might result in great loss because the harvest came with perforated seeds and lower seed quality. Field observation showed that farmers' negligence to anticipate pest and disease, mainly legume borer, was quite obvious. Therefore, more intensive guidance from extension officers was needed to ensure that farmers were always punctual in controlling pest and disease by referring to IPM Concept.

H. Crop Performance

Crop performance was relatively good and constant because the seed came from one source, specifically Argomulyo variety, contributed by AIAT for East Java. Crops with denser interval of planting tended to grow high with few legumes. Those with rare planting interval grew shorter but with many branches [12]. When farmers implemented the suggestion, crop growth was relatively good and evenly distributed. Crop maintenance became easier, especially in pest and disease control (as shown in Table III.).

TABLE III
PERFORMANCE AND SOYBEAN YIELD FROM SUMBER REJEKI FARMER GROUP

Component of Observation	AIAT's Demo-Plot	Suggested Technology	Farmers' Technology
Height (cm)	54.3	54.4	56.6
∑ of Branch/ Crop	5.4	5.2	6.7
∑ of Legume/ Crop	34.1	32.0	30.5
∑ of Damaged Legume (%)	6.2	10.2	10.4
Yield of tiled seed (t/ha)	2.1	1.8	1.3

Yield of tilled seed from 10 farmers applying the suggested technology was ranging from 1.3 to 2.75 tons/ha or averagely 1.8 tons/ha. Farmers who did not use suggested technology (preferred to use farmers' technology) had their yield about 0.8-1.75 tons/ha or averagely 1.3 tons/ha. The yield increase was around 38.5%. The demonstration plot (demo-plot) for AIAT Technology package was 0.5 ha. Argomulyo variety was tilled five times, and the yield was averagely 2.1 tons/ha.

I. Farming Analysis

The profit of farming must be the most important thing considered by the farmers. Result of review indicated that soybean productivity in collaborator farmers was higher than

non-collaborator farmers. The precise number was 1.8:1.3 tons/ha or increasing by 0.5 ton/ha above non-collaborator farmers. Net income rate reached IDR 5,489,803. - with R/C Ratio of 2.03, while the income of non-collaborator farmers was about IDR 2,507,143. - with R/C Ratio of 1.54. Table IV presents the complete data.

TABLE IV
ANALYSIS ON SOYBEAN FARMING IN RICE FIELD, SUMBER REJEKI FARMER GROUP

No	Soybean Farming Input	Quantity (kg, Lt, HOK)	Price IDR. (000	Input Cost IDR.(000)
1	Land Width	1	1,250.0	1,250.0
2	Seed	40	5.0	200.0
3	Inorganic Fertilizer	400	2.0	800.0
4	Organic Fertilizer	2,000	0.5	1,000.0
5	Pesticide	6.5	60.0	390.2
6	Men Laborer	49	20.0	980.0
7	Women Laborer	40	17.5	700.0
8	Variable Cost	-	-	4,070.2
9	Land Rent	-	-	1,250.0
10	Total Cost	-	-	5,320.2
11	Production	1,800	6.0	10,800.0
12	Profitability			5,479.8
13	R/C Ratio			2.03
No	Soybean Farming Input	Quantity (kg, Lt, HOK)	Price IDR. (000	Input Cost IDR.(000)
1	Land Width	1	1,250	1,250.0
2	Seed	40	5	200.0
3	Inorganic Fertilizer	400	2	800.0
4	Organic Fertilizer	500	0.5	250.0
5	Pesticide	7.0	46.1	322.9
6	Men Laborer	56	20.	1,120.
7	Women Laborer	40	17,5	700.0
8	Variable Cost	1	-	3,392.9
9	Land Rent	1	-	1,250.0
10	Total Cost	1	-	4,642.9
11	Production	1,300	5.5	7,150.0
12	Profitability			2,507,143
13	R/C Ratio			1.54
	Escalated Farming Profitability		2,972.7	117.6%

The increased income among farmers applying suggested technology was IDR 2,972,660. - or increasing by 118.6%. This increasing income was benefited from the increase of soybean productivity and the higher soybean sale price. This promising yield might be related to bigger seed size of Anjasmoro variety which making it popular in tempe industry.

J. Superimposed Trial

1.Testing NPK Fertilizer against Growth and Yield of Soybean at Irrigated Low Land

In superimposed trial 1, the testing of NPK fertilizer against growth and yield of soybean at irrigated wet land is presented in Table V.

Treatment with NPK fertilizer onto soybean at irrigated wet land did not give obvious effect on soybean growth and yield at the reviewed location. Crop height was not obviously different after 28-day age, but at 87-day age, it differed obviously from control treatment. Non-fertilized crops were growing fertile and healthy. The result is consistent with "Suyamto 1999," who states that wet land has adequate nutrient, and thus the yield is quite promising despite less addition of fertilizers [13]. Obvious difference was also shown in term of number of damaged legume and seed. (Table V). The possible cause of the damaged legume/seed was the imperfect technique of pest disinfestation.

TABLE V
THE EFFECT OF NPK FERTILIZER ON SOYBEAN AT IRRIGATED WET LAND, DRY SEASON II, 2012, IN KEPULUNGAN, GEMPOL

Treatment	High of Plants (28 days) (cm)	High of Plants (87 days) (cm)	Number of Branch	Number of Legume
1	39.0 ab	48.7 a	4.2 a	27.0 a
2	42.6 ab	56.1 bcd	4.9 bc	32.7 b
3	42.2 ab	61.0 e	6.9 f	36.1 bc
4	41.5 ab	60.0 e	6.3 ef	43.4 de
5	38.3 ab	58.6 dc	6.5 f	37.8 bc
6	43.3 b	57.2 cde	5.1 bcd	36.4 bc
7	38.7 b	54.5 bcd	5.1 bcd	39.4 cde
8	42.9 a	54.8 bcd	4.9 bc	43.4 de
9	38.9 ab	54.3 bc	4.7 ab	44.0 e
10	40.5 ab	54.8 bcd	5.1 bcd	37.5 bc
11	41.5 ab	54.7 bcd	5.3 bcd	37.9 bc
12	39.1 ab	53.3 bc	5.4 bcd	44.0 e
13	39.5 ab	53.9 bc	5.7 d	38.3 cd
14	38.8 ab	52.3 ab	5.3 bcd	38.5 cd
15	37.0 ab	53.6 bc	5.7 de	34.5 bc
16	40.0 ab	54.3 bc	5.7 de	37.4 b
KK	9.0	4.48	7.0	8.44
BNT	6.05	4.1	0.63	5.35
Treatment	Damaged Legume	Biomass Weight ($7m^2$) (kg)	Yield of ton/ha	Weight of 100 seeds (g)
1	4.0 abc	4.0 a	2.0 a	14.19 a
2	4.4 ab	4.4 ab	2.0 a	14.11 a
3	5.0 bcd	5.0 bcd	2.6 cd	14.37 ab
4	4.5 abc	4.5 abc	2.3 b	14.36 ab
5	4.3 a	4.3 a	2.3 b	14.35 ab
6	5.3 d	5.3 d	2.7 cd	14.45 ab
7	5.4 d	5.4 d	2.6 cd	14.28 ab
8	5.3 d	5.3 d	2.6 cd	14.63 bc
9	5.0 bcd	5.0 bcd	2.4 bc	14.45 ab
10	5.1 cd	5.1 cd	2.6 cd	14.42 bc
11	5.3 d	5.3 d	2.7 cd	14.42 ab
12	5.3 d	5.3 d	2.7 cd	14.46 ab
13	5.0 bcd	5.0 bcd	2.5 bc	14.96 cd
14	5.1 cd	5.1 cd	2.6 cd	14.15 d
15	5.5 d	5.5 d	2.8 d	14.60 bc
16	5.5 d	5.5 d	2.7 cd	14.82 cd
KK	7.0	7.28	5.7	1.56
BNT	1.21	0.61	0.24	0.38

Explanation: Number in same column followed with same letter is not obviously different, based on significance levels at 5 %.

2. Testing the Adaptation of New Superior Variety of Soybean

The tested soybean varieties included: (1) Burangrang; (2) Baluran; (3) Panderman; (4) Anjasmoro; (5) Slamet; (6) Kaba; (7) Argomulyo; and (8) Wilis (control variety). Result of

analysis of variance indicated that the highest productivity was found in variety no.4 with 2.34 t/ha, followed by variety no.7 with 2.32 t/ha. Both varieties, however, did not show obvious difference. For seed size, the variety with biggest size of seed was preferred more by the farmers because it had wider market share, especially for tofu and tempe industries, as shown by variety no.3, 1 and 2. Other benefit of these varieties if being compared to variety no.8 was shorter age without obvious difference in yield. The weight of 100 seeds of these three leading varieties was higher than others (as shown in Table VI). Argomulyo variety had better prospect because it had big seed size with uniform yellow color [14]. Burangrang variety indeed had bigger seed size but it was vulnerable to fungus disease at root base.

TABLE VI
TESTING THE SOYBEAN VARIETIES AT IRRIGATED LAND DURING MK II IN KEPULUNGAN VILLAGE, GEMPOL DISTRICT, 2012

Treatment of Variety	High of Plants (87 days) (cm)	Number o Branch	Number of Legume	Weight of Lump (14.4 m^2) (kg)
1. Burangrang	58.4 ef	3.4 a	47.3 a	6.9 ba
2. Baluran	43.9 ab	3.3 a	45.1 a	6.6 a
3. Panderman	53.6 cdef	3.9 ab	46.4 a	6.4 a
4. Anjasmoro	49.2 bcd	3.3 a	44.1 a	6.9 c
5. Slamet	58.7 f	3.6 a	47.3 a	7.5 de
6. Kaba	54.2 def	4.1 ab	50.3 a	7.6 ef
7. Argomulyo	43.1 a	3.6 a	58.8 bc	7.8 fg
8. Wilis	40.1 a	4.6 b	65.7 c	8.0 g
Cv	6.6	12.55	8.73	2.35
BNT	5.8	0.82	7.73	0.297

Treatment of Variety	Weight of Size (t/ha)	Weight of 100 seeds (g)	Age of Harvest
1. Burangrang	1.97 a	17.1 g	83 a
2. Baluran	2.06 ab	16.9 fg	80 a
3. Panderman	2.07 abc	18.7 h	85 bc
4. Anjasmoro	2.34 d	15.0 e	91 d
5. Slamet	2.27 bcd	14.8 de	85 bc
6. Kaba	2.14 abcd	13.1 b	85 bc
7. Argomulyo	2.32 cd	14.1 c	83 a
8. Wilis	2.29 bcd	11.8 a	90 d
Cv	6.5	3.04	12.5
BNT	0.25	0.81	0.59

Explanation: Number in same column followed with same letter is not obviously different, based on significance levels at 5%.

IV. CONCLUSION

1. The presented soybean technology applied in the "AIAT's Demo-Plot" and "Suggested Technology have been responded positively by collaborator farmers, because they could increase soybean productivity. However, guidance and counseling from the field officers were still needed because the farmers were still not familiarized with soybean farming.
2. Not all technologies of PRA were applied by farmers. Only 50% farmers were willing to apply the suggested technology, while others still used their traditional technology.
3. The income of collaborator farmers was IDR 1,252,500, while the income of non-collaborator farmers was IDR 629,500. There was 98% increase in the farmers' income. Argomulyo was the soybean variety receiving positive response from the farmers because of the large seed and acceptable to the market.
4. Results of testing superior varieties and AIAT demo plot showed relatively similar results but had another advantage such as shorter and larger seeds, and tolerant to borer pests. Fertilization test showed that the fertile wet land with NPK fertilization had no effect on the growth and yield of soybean.

V. SUGGESTIONS

Further extension should be provided by field officers to ensure that the farmers apply technology suggested by AIAT at the adequate interval (2-3 years). This follow-up is important to make the farmers more understand and believe in this new technology.

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