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The effect of integrated pest management farmer's field school on the use of chemical pesticides and economic feasibility of rice farming system in Siak Regency

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ABSTRACT

Integrated Pest Management Farmer's Field School (IPM-FFS) is a program of human resources improvement which leads to empowering aspects of environmentally sound farming communities. To assess the effect of the implementation of the IPM-FFS, it is necessary to evaluate the changes in knowledge, attitudes and behavior of farmers in applying the four principles of IPM. One of the purposes of the implementation of the IPM-FFS is to reduce the use and application of chemical pesticides appropriately. The study was conducted from January to April 2018 in four districts of rice development centers in Siak Regency, Riau Province. The sampling technique used purposive sampling, with total sample 80 farmers consisted of40 IPM-FFS alumni and 40 non-alumni farmers.The evaluation showed that after IPM-FFS was implemented, the percentage of farmers adopting IPM technology increases, on the application of cultivation of a healthy crop on alumni more than 79 % except for the use of fertilizer with a sufficient applicationdose of only 75 % and non-alumni an average of 65 %.IPM FFS alumni also practiced rice agro ecosystemobservation regularly, and understood the existence of natural enemies and their preservation. In controlling the pests, most farmers applied preventive methods by practicing healthy crop cultivation, chemical pesticides are applied if pest attacks have reached the economic threshold, and this condition causes the use of chemical pesticides to decrease. The calendarsystem of using chemical pesticides regularly without regard topests'existence, for alumni was practiced by 65 % to 0% and non-alumni from 95 % to 40 %. Rice productivity for alumni increased by 18.18% and non-alumni 12 %. Alumni revenue increased by 18, 2 % and net income increased by 29, 7 %, non-alumni of 12, 00 % and net income increased by 22.7 %. The R/C value of alumni also increased by 13, 2 % and non-alumni 11, 27 %.

Keywords: *IPM-FFS, chemical pesticides, economic feasibility, rice farming system*

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INTRODUCTION

The basic concept of Integrated Pest Management Farmer's Field School is the economic threshold, which is using chemical pesticides if there is a pest attack that causes lost yield as much as control costs. If there is no pest attack, then there is no need to use chemical pesticides. To know the pest condition, periodic observations by farmers themselves is needed. The concept is socialized to farmers through activities which is called the Integrated Pest Management Farmer's Field School (IPM-FFS).

In an implementation of the field school, farmers were given materials on healthy crop cultivation, introduction of pest and natural enemies, preservation and utilization of natural enemies, agro ecosystem analysis, pest control based on IPM principles, selection and use of resistant varieties and agricultural environmental sanitation . Integrated pest Management activities are characterized by their existence of human resource development at the level field, which will result in the creation of IPM expert farmers in their own farming fields. Farmers are expected to be able to observe and analyze ecosystem, make decisions and become implementing pest control, also they can disseminate the technology to other farmers around them,and they become partners of extension agents in disseminating IPM technology. After attending IPM-FFS farmers expected to be able to develop themselves to solve various problems they face as a group in the field.

The IPM-FFS implementation begins with the selection of participants through farmer group meetings. Afterwards, 25 farmers who were selected as participants held a meeting once a week for 5-6 hours. The meeting was held 12 times during one planting season. At each meeting, the participants were divided into five groups consist of 5 people. Usually the meeting starts when the plant's age is 2 weeks after planting. Technically IPM technology given to farmers can reduce the use of chemical pesticides with a higher level of productivity (Mariyono, 1998).

Studies on the use of chemical pesticides have been carried out, especially after it is known that chemical pesticides have a negative impact on both humans and the environment (Oka, 1995). Ruhs, et al, (1999), stated that the use of chemical pesticides was caused by uncertainty regarding various components of the ecosystem including the occurrence of pest attacks.

Consequently, to control pest attacks, farmers use more chemical pesticides than they should. In addition, there are also uncertainties about the efficacy of chemical pesticides used so farmers tend to want to repeat them to find out the effectiveness of the chemical pesticides used. Rola and Pingali (1993) state that the use of chemical pesticides is a way to reduce risk and

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uncertainty. If the farmer is risk averse, he tends to use more chemical pesticides in order to reduce the risk of loss resultedfrom pests and diseases' attack. Bond (1996) asserts that the use of chemical pesticides is very dependent on certain conditions and plants. Farmers will reduce the use of chemical pesticides when the reduction will not cause a big influence on the profitability of their agricultural business. However, sometimes farmers cannot reduce the use of chemical pesticides because the plants cannot be produced without the use of chemical pesticides, or often because the agricultural business is faced with the goal of maximum yield so that it requires a lot of chemical pesticides.

In the field of agriculture, technology that can reduce the use of chemical pesticides is called Integrated Pest Management (IPM), which is a technology that combines crop cultivation such as crop rotation, planting resistant varieties, healthy crop cultivation and other methods of control. Chemical pesticide applications are carried out if and when the previous methods are not successful. Experience shows that the application of IPM can reduce the use of chemical pesticides by 50% (Pincus, 1991; Kusmayadi, 1999; Soemarwoto, 1999). The application of this concept in crop protection has succeeded in reducing the use of chemical pesticides. This study aims to determine the effect of integrated pest control field schools on the application of IPM technology by farmers, especially in the use of chemical pesticides for their farming, production and economic feasibility of rice farming system they do.

MATERIALS AND METHODS

The study was conducted on four production centers of paddy rice in Siak District, namely Bunga Raya Sub-District, Sabak Auh, Sungai Apit and Sungai Mandau. The data collected consists of primary data and secondary data. Primary data collected included data on wetland farming (production, input, production costs, revenues, prices and application of IPM technology) from January to April 2018. The types of secondary data collected included the performance of wetland areas, harvested area, production, productivity and other data. Primary data collection was carried out through a survey using a structured questionnaire of 80 rice farmers consisting of 40 IPM-FFS alumni farmers (in 2015 and 2016) and 40 non-alumni IPM-FS farmers who were taken randomly using the stratified random sampling method. Secondary data is obtained from the Provincial and District Food Crops Agriculture Service, Field Officers, Regional Planning Agencies, Central Statistics Agency and other agencies. As per the research objectives, several analyzes are used as follows:

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Recognition of IPM technology (Dayan, 1989)

$$r = \frac{1}{n}\sum_{i=1}^{n} Xi$$

Where
r = average value
n = number of examples
Xi = Example parameter value to i

Farming and R/C income is analyzed by *input-output analysis* method (Malian, 2004)

$$\pi = Y.Py - \sum_{i=1}^{n} Xi.Pxi - BL$$

Where :
π = Net income of rice farming (Rp/ha/year)
Y = Total paddy production (kg/ha/year)
Py = Selling price of paddy fields (Rp/kg)
Xi = The level of use of input farming to i (Rp/ha/year)
Pxi = Price of farm inputs to i
BL = Other costs (Rp/ha/year)

Value of Return-Cost Ratio (R/C)

R / C = NPT / BT
Where :
R/C = Revenue and cost ratio
NPT = Total production value (Rp/ha/year)
BT = Total cost (Rp/ha/year)

RESULTS AND DISCUSSION

Application of IPM Technology by Farmers

a. Healthy plant cultivation

IPM-FFS has been done, identified five important events that lead to the cultivation of healthy plants, namely the use of quality seeds, fertilizer applications with sufficient amounts, weeding, planting and spacing

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simultaneously (Legowo system). The results of the implementation study aspects of a healthy crop cultivation are presented in Table 1.

Table 1. Percentage of the application of IPM principles in cultivating healthy plants (before and after implementing of IPM-FFS) in Siak Regency, 2018

No.	Description	Alumni		Non Alumni	
		Before	After	Before	After
1.	Use of superior varieties				
	- yes	70	100	70	85
	- no	25	0	30	15
2.	Use of fertilizer with enough dose				
	- yes	60	75	55	65
	- no	40	25	45	35
3.	Reason no enough				
	- capital less	35	25	40	30
	- fertilizer is not available	5	5	5	5
	- price fertilizer expensive	60	75	55	65
4	weeding plants				
	- yes	95	100	95	100
	- just a little	5	0	5	0
5.	Simultaneous planting				
	- yes	90	100	80	90
	- no	10	0	20	10
6.	Settings distance planting				
	- yes	85	100	80	95
	- no	15	0	20	5

From Table 1, it is known that after the IPM-FFS implementation, the implementation of the principles of healthy crop cultivation, both by alumni and non-alumni farmers, has increased, the use of superior varieties, alumni (70% to 100%) and non-alumni (70% to 85%), at Adequate use of fertilizer, alumni (60% to 75%), non-alumni (55% to 65%), to weeding alumni and non-alumni alike (95% to 100%), to simultaneous planting, alumni (85% to 100%)), non-alumni (80% to 90%), and in setting spacing, alumni (85% to 100%), non-alumni (85% to 95%).

The increase in the percentage of farmers in cultivating healthy crops, of course, shows the improved performance of cultivation which can increase productivity and crop production, so that in the end the farmers' income can also increase. The advantages of using superior varieties, in addition to being resistant to certain pest attacks, can also provide high production (Oka, 1995). According to Fagi (2006), that superior variety is one of the technology components that has a very large role in increasing rice production, especially that a superior variety is supported by other components such as tillage,

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balanced fertilization and intensive care. Of the five main activities of the principle of healthy plant cultivation, the lowest percentage of its application is in the use of fertilizer with a sufficient dose, this is due to the high selling price of fertilizer (not comparable to the price of rice), while for weeding components, controlling the pest with IPM principles, simultaneous planting and spacing arrangement can be seen from the quite high percentage increase, this is because the application of this component does not require a large additional cost, implementing this component is felt by farmers to be very beneficial and have a positive effect on the success of their farming.

b. Preservation and utilization of natural enemies

The kinds of natural enemies found in rice fields for the four sub-districts is quite diverse, as we found a lot of predators such as frogs, gray ladybirds, spiders, red ants, bottle beetles, swallow birds, praying mantis, ordinary dragonflies, lesser dragonflies, coccinelidae, paederus, and others. After implementing IPM-FFS, farmers' knowledge about the existence and benefits of natural enemies is increasing and farmers have been able to distinguish between insect pests and natural enemy insects. Knowledge of natural enemies of alumni farmers increased from (30% to 100%) and non-alumni increased (20% to 40%). The role of natural enemies, alumni farmers increased (30% to 100%) and non-alumni increased (20% to 45%). Preserving natural enemies, alumni increase (25% to 100%) and non-alumni increase (0% to 20%). Pest control with prevention, using non-chemical pesticides increased (30% to 90%) and non-alumni (10% to 40%) (Table 2).

Table 2. Percentage of application of preservation aspects and utilization of natural enemies (before and after implementation of IPM-FFS) in Siak Regency, 2018

No.	Description	Alumni		Non Alumni	
		Before	After	Before	After
1.	Knowing enemy natural				
	- yes	30	100	20	40
	- no	70	0	80	60
2.	Knowing role enemy natural				
	- yes	30	100	20	45
	- no	70	0	80	55
3.	Conserve enemy natural				
	- yes	25	100	0	20
	- no	75	0	100	80
4	Pest and diseaseas control				
	- use it pesticide chemistry	70	10	90	60
	- physical / mechanical method	25	60	10	35
	- biological control, botanical pesticides and biology (enemy natural)	5	30	0	5

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The increasing number of farmers who understand and conserve natural enemies, has implications for increasing production efficiency due to a decrease in the cost of using chemical pesticides and at the same time minimizing the occurrence of pollution to the rice products produced and the environment. Some efforts to preserve natural enemies are carried out in various ways, namely avoiding the use of chemical pesticides, maintaining natural enemy habitats and planting trap plants around rice fields such as refugia plants.

From Table 2, it is also known that the pest control method carried out by alumni farmers is now in accordance with IPM principles, namely by prioritizing prevention by cultivating healthy plants, natural enemies, physical, mechanical and botanical pesticide use, then if not optimal (pests' population are still high) new farmers apply chemical pesticides wisely, both from the selection of pesticides, dosage and method of application, for non-alumni farmers, only about 40% do pest control with IPM principles.

c. Observation of rice field agro ecocytes

Environmental observation of rice fields is prioritized to observe the development or disturbance of plant pests and diseases, fertility of plant growth and the presence of natural enemies. After IPM-FFS, the percentage of farmers who observed rice fields showed an increase, namely alumni farmers increased (30% to 80%) and non-alumni (20% to 60%), Table 3.

The main obstacle of alumni farmers is not observing due to time constraints, this is due to the fact that the average farmer in addition to their fields also has other livelihoods such as oil palm and rubber (60% to 50%) and non-alumni (60% to 55%), because they are not used to, alumni (50% to 25%) and non-alumni (50% to 45%), because they add jobs and costs, alumni (10% to 20%) and non-alumni (0% to 10%). When observations are mostly carried out by alumni farmers, it is once per month (40%) and non-alumni are irregular according to activities in rice fields (50%). The most widely observed observations are combinations (observing pest populations, plant growth and the presence of natural enemies), namely alumni (100%) and non-alumni (20%).

The dominant types of pests found in rice fields are rice bug, yellow stem borer, white-backedplant hopper, green leafhopper, rat, stink bug and false white leaf eater and the dominant disease is blast and bacterial leaf blight.

The impact of IPM-FFS activities on pest control is the reduction of farmers regularly spraying pests (scheduled), namely alumni farmers (from 65% to 0%) and non-alumni (from 95% to 40%). After the IPM-FFS implementation, farmers also realized that regular (scheduled) pest spraying would be

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detrimental, because it sacrificed a number of unnecessary pest control costs, lacked economic impact, and increased the chance of environmental pollution.

Table 3. Percentage of application of rice field agroecosystem observation aspects (before and after implementationof IPM-FFS) in Siak Regency, 2018

No.	Description	Alumni		Non Alumni	
		Before	After	Before	After
1.	Peng observations per paddy's				
	- yes	30	80	20	60
	- no	75	20	80	40
2.	Reason no observe rice fields				
	- there is other jobs (oil palm /livestock)	60	50	55	50
	- not yet get used to	3 0	30	4 0	40
	- add work and cost	10	20	5	10
3.	Time observation				
	- 2 times per month	0	3 5	0	2 0
	- 1 time per month	0	40	0	30
	- No regular	100	2 5	100	50
4	Object observation rice fields				
	- Growth rice	60	0	70	5 0
	- Population pest	30	0	30	25
	- Existence enemy natural	5	0	0	5
	- Combination all	5	100	0	20
5.	Usage pen pesticide chemistry				
	- Scheduled , without lookexistence IPM	65	0	95	4 0
	- Based on level threshold economy	35	100	5	6 0

Economic feasibility of rice farming

From Table 4, it is known that after the implementation of IPM-FFS, the production and income of farmers has increased. The use of biological agents and vegetable pesticides has also increased, but on the contrary the use of chemical pesticides has decreased. The use of organic fertilizers and biological agents and vegetable pesticides is an effort of farmers to produce environmentally friendly rice production, so that farmers are expected to get a higher selling price. For labor use there has been an increase, especially for planting activities using the "jarwo" cropping system, observing rice fields and controlling pests and plant diseases. The increase in the application of farming components led to an increase in rice productivity, namely in alumni farmers increased by 18.18% (5.5 tons / ha to 6.5 tons / ha) and non-alumni farmers 12% (5 tons / ha to 5.6 tons /Ha). Increased labor in planting using "jarwo" planting system, observation of rice fields, and control of plant disease pests by applying the concept of IPM, reduction in the use of chemical pesticides and the use of new improved varieties greatly supports the increase in rice productivity.

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Table 4. Analysis of costs, revenues and income of rice farming for each hectare (before and after implementation of IPM-FFS) in Siak Regency, 2018

Description	Alumni		Non Alumni	
	Before	After	Before	After
cost of production facilities (Rp)				
- Seed / ha	330,000	297,000	330,000	308,000
- Urea	360,000	240,000	360,000	300,000
- SP36	390,000	292,500	390,000	341,250
- Phonska	150,000	300,000	150,000	150,000
- KCl	560,000	560,000	420,000	420,000
- Manure	250,000	500,000	200,000	200,000
- Biological& botanical pesticide	100,000	500,000	0	200,000
- Chemis Pesticide	1,000,000	500,000	1,000,000	800,000
- Liquid organic fertilizer	40,000	75,000	40,000	40,000
- Growth regulator	25,000	50,000	25,000	50,000
total cost of production facilities	3,205,000	3,314,500	2,915,000	2,809,250
labor costs (Rp)				
- Tillage	1,000,000	1,000,000	1,000,000	1,000,000
- Nursery	300,000	300,000	300,000	300,000
- repair of rice fields	300,000	300,000	300,000	300,000
- Plant	1,000,000	1,000,000	1,000,000	1,000,000
- Embroidery	300,000	200,000	300,000	300,000
- Weeding	300,000	300,000	300,000	300,000
- Fertilization 1 and 2	300,000	300,000	300,000	300,000
- Spraying pest & diseaseas	800,000	800,000	800,000	800,000
- Irrigation cost 4x	800,000	800,000	800,000	800,000
- Harvest cost	3,000,000	3,500,000	3,000,000	3,200,000
amount of labor costs	8.1,000,000	8,500,000	8,100,000	8,300,000
Total cost of 1 + 2	11,305,000	11,814,500	11,015,000	11,109,250
Receipt				
- Production (ton/ha)	5.5	6.5	5	5.6
- Price of dry grain harvest (Rp/ha)	4,500	4,500	4,500	4,500
- Value (Rp)	24,750,000	29,250,000	22,500,000	25,200,000
Revenue (Rp)	13,445,000	17,435,500	11,485,000	14,090,750
R/C	2.19	2.48	2.04	2.27

Analysis of wetland rice farming consists of costs for purchasing production facilities (seeds, fertilizers and pesticides) and labor costs. After IPM-FFS, the farm income of alumni farmers increased by 18.2% (Rp. 24,750,000 to Rp. 29,250,000) with net income increasing by 29.7% (Rp. 13,445,000 to Rp. 17,435,500) for non-alumni farmers also experiencing an increase of 12.00% (Rp. 22,500,000 to Rp. 25,200,000) and net income increased by 22.7% (Rp. 11,485,000 to Rp. 14,090,750).

The R/C value of farmers both alumni and non-alumni also increased by 13.2 for alumni farmers (2.19 to 2.48) and non-alumni increased by 11.27 (2.04 to

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2.27). Increased productivity and income of these farmers cannot be separated from the increase in knowledge and skills of farmers in applying the four principles of IPM-FFS which generally develop better.

CONCLUSIONS AND SUGGESTION

Conclusions

From the results of this research, it can be concluded that the percentage of alumni and non-alumni farmers who adopt IPM technology after the implementation of IPM-FFS is increasing, in general farmers prefer to prioritize prevention of plant pests and diseases by combining biological methods (natural enemies), mechanical and use of biological agents and vegetable pesticides. The use of chemical pesticides is the last alternative and applied wisely, after economic analysis there was an increase in production of 18.18%, net income of 29.7% for alumni farmers and non-alumni farmers of 12.00% with net income increasing by 22.7%.

Suggestion

The many advantages that can be felt from the implementation of IPM-FFS, it is recommended that the application of IPM technology can be maintained by socializing and publishing to other regions, especially regions that are the centers of rice development.

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