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Implementation Of Integrated Pest Management And Non-IPM In Rice Plants (Case Study In Kampar Subdistrict, Kampar Regency, Riau Province, Indonesia)

Amalia[1], Yusman Syaukat[2], Dedi Budiman Hakim[3], Dadang[4]

[1]Postgraduate Student of the Department of Agricultural Economics IPB University, Bogor, Indonesia, Corresponding author: Amaliamasjkur@unilak.ac.id

[2]Chairman of the Supervisory Commission, Lecturer of Agricultural Economics Study Program IPB University, Bogor, Indonesia

[3]Member of the Supervisory Commission, Lecturer of Agricultural Economics Study Program IPB University, Bogor, Indonesia

[4]Member of Supervisory Commission, Lecturer of Entomology Study Program IPB University, Bogor, Indonesia

Abstract – The purpose of this study is to descriptively analyze the extent of Integrated Pest Management (IPM) and non-IPM practices in Kampar District, Kampar Regency. This research uses a descriptive method aimed at gathering information through questionnaires, direct observations, and interviews. The subjects of the study consisted of 38 IPM rice farmers and 62 non-IPM rice farmers. The results of the study indicate that both IPM and non-IPM farmers in Kampar District have implemented practices for cultivating healthy crops. The distinguishing factor between IPM and non-IPM farmers lies in pest and disease control. IPM farmers consistently monitor their fields as the basis for making decisions on pest and disease control measures. IPM farmers use superior and locally superior seeds, while non-IPM farmers predominantly use local seeds. IPM farmers prioritize preventive measures in pest and disease control, resorting to the application of chemical pesticides only when the infestation reaches an economic threshold. Non-IPM farmers control pests and diseases using chemical pesticides periodically without considering the level of infestation. The participation of farmers in IPM programs and farmer groups influences their adoption of healthy crop cultivation practices and IPM. Non-IPM farmers perceive pest and disease control using chemical pesticides as more practical and yielding quicker results. However, they are not aware that the indiscriminate use of chemical pesticides increases production costs, poses risks to themselves and the environment. This lack of awareness contributes to the low adoption rate of IPM among farmers.

Keywords – Integrated Pest Management (IPM), non-IPM, Plant Pests, Healthy Crop Cultivation, Monitoring, Economic Threshold.

I. INTRODUCTION

Rice is one of the essential food crops that plays a crucial role in the economic livelihood of Indonesia. Rice, as a staple food, is consumed by almost the entire population of Indonesia, with 95-98% of the population relying on rice as their main source of sustenance (Balitbang 2019). The increasing population growth in Indonesia will have an impact on food availability, necessitating efforts to increase rice production. The Indonesian government is continuously striving to ensure an adequate supply of rice to guarantee national food security.

The level of attack by plant pests significantly affects the productivity of rice farming. Pest infestations can cause severe damage to the crops. The use of pesticides is substantially high in the Asian region compared to other developing countries

(Hossain *et al*., 2000). According to data from the FAO (2020), the total agricultural pesticide use worldwide reached 4 million tons. The Asian continent remains the highest region in terms of agricultural pesticide use, accounting for 2.1 million tons or 52% of the total pesticide used globally.

Pesticides are considered as one of the input factors in agriculture. However, pesticides do not directly contribute to increasing yields but rather help reduce crop damage by controlling plant pests (Weersink, 2001). Unlike other input factors such as fertilizers and seeds, which can directly enhance production (Cooper and Dobson, 2007; Shende and Bagde, 2013), the improper use of pesticide doses by farmers can lead to excessive pesticide use in crop production. This can pose risks to human health and other non-target species (Shende and Bagde, 2013). In fact, the intensive use of pesticides can decrease crop productivity when associated externalities are taken into account (Antle and Pingali, 1994).

Kampar Regency is one of the major rice-producing regions in Riau Province. In 2021, the harvested rice field area in Kampar Regency reached 6.535,8 hectares, with a production of 31.717 tons and a productivity of 4.85 tons/ha (DTPHPR 2022). The estimated population of Kampar Regency in 2022 is 761.567 people, with an average current growth rate of 3,3%. The average rice consumption per capita in the community is 108,74 kg per year, resulting in an average rice demand of 82.812,8 tons per year. Therefore, there is still a rice deficit of 51.096 tons or 60% annually (PPID 2021).

The level of plant pest attacks significantly affects the productivity of rice farming. According to the Survey of Farming Cost Structures (BPS 2011), only 23.13% of households reported that their rice crops did not experience plant pest attacks, while the remaining 76.87% experienced such attacks. To control pest attacks on rice plants, 89.39% of households employed pest control measures, including chemical/pesticide control (79.24%), mechanical control (4.26%), agronomic control (5.03%), and biological control (0.86%).

Until now, pest control by the majority of farmers has been based on the presence or absence of pest attacks, and the only available and readily accessible control tool is pesticides. Pesticide control is carried out periodically, from the early stages of plant growth until nearing harvest, with a two-week interval, and using doses according to the recommendations stated on the packaging (Marwoto, 1992). This approach can have negative impacts, including excessively high production costs and environmental sustainability disruption. To mitigate these negative effects, pest control using pesticides should be based on the concept of Integrated Pest Management (IPM).

In the concept of Integrated Pest Management (IPM), pest control is seen as an integral part of agroecosystem management, with an emphasis on integrating appropriate control technologies and promoting the functioning of natural control processes to maintain pest populations at low equilibrium levels. The objectives of IPM are: (a) reducing pest status, (b) ensuring farmers' income benefits, (c) preserving environmental quality, and (d) solving pest problems sustainably (Pedigo and Higley, 1992).

The use of pesticides as a means of control is justified when the economic benefits obtained are at least equal to the cost of pest control, and ecologically, when ecosystem components, both physical and biological, are unable to suppress pest populations and maintain them at low equilibrium levels. Socialization through Agricultural Extension Officers (PPL) and the implementation of Integrated Pest Management (IPM) starting with IPM Field Schools in Kampar Regency have been carried out since 2001. However, only a few farmers are willing to adopt IPM in managing rice cultivation. According to interviews, farmers find chemical pesticide control more practical and immediately visible in its results, but they are not aware of the long-term impacts of unsustainable pesticide use. Based on the aforementioned background, the objective of this study is to descriptively analyze the extent of IPM and Non-IPM implementation in Kampar Subdistrict, Kampar Regency.

II. METHODOLOGY

The research was conducted in Kampar Subdistrict, Kampar Regency, Riau Province. The location was purposively selected based on the following considerations: 1. Kampar Regency is one of the major rice producers in Riau. According to data from the Riau Province Department of Food Crops and Horticulture (2019), the harvested rice field area in Kampar Regency reached 8.147 hectares in 2018, with a production of 31.717 tons. 2. Kampar Subdistrict is included in the Riau Farming Movement 2021-2024, particularly with the implementation of the IPM program. 3. The agricultural land conditions in the research area are relatively similar between rice farming practices that apply IPM and non-IPM. This criterion is intended to capture the diversity of information regarding land area and land ownership status in the research location and avoid productivity differences caused by variations in soil fertility levels.

The selected subdistrict in Kampar Regency that meets these criteria is Kampar Subdistrict. The types of data used in this study are primary and secondary data. The sampling method employed in this research is purposive sampling. The research sample consists of farmers practicing rice farming using IPM and non-IPM methods, deliberately selected through purposive sampling. Respondent farmers, both those implementing IPM and non-IPM methods, were chosen from farmer groups in several villages in Kampar Subdistrict. Farmers practicing IPM were identified based on their membership in IPM Field Schools and/or their implementation of IPM principles in rice cultivation.

The number of IPM farmers in Kampar Subdistrict is 127 farmers (BPP 2020). During the observation period, there were 38 farmers practicing IPM rice farming. Therefore, the sampling for IPM farmers was conducted through a census, including all 38 farmers. For comparison, 62 non-IPM farmers were purposively selected as respondents through purposive sampling. Thus, a total of 100 farmers were included in the study sample. The research was conducted from October 2021 to March 2022.

The data used in this study are primary data obtained through direct interviews with respondents, namely rice farmers, using a structured questionnaire. Data collection was conducted through systematic observation and recording of the research subjects. The primary data collected include the characteristics of farmers and rice farming in a single season. The data collected include land ownership, input usage (seeds, conventional fertilizers, organic fertilizers, pesticides, labor, and other inputs), input and output prices, rice farming revenue, and problems faced by farmers. To support and enhance the analysis in this study, secondary data were also collected from the Riau Province and Kampar Regency Department of Food Crops and Horticulture, Annual Reports of Farmer Groups, and the Subdistrict Office.

This study utilizes a descriptive research method. Descriptive research, literally translated, aims to create descriptions of situations or events (Suryabrata, 2013). The sampling technique employed in this research is non-probability sampling, specifically purposive sampling. To obtain data in the field to describe and address the research problems, data collection methods such as observation, questionnaires, interviews, document analysis, and literature review were employed.

After data collection, the researcher proceeds to analyze the data to address the research questions. To gain an understanding of participation, the data is processed using percentage techniques and presented in descriptive tables. Data obtained through questionnaires are further tabulated into graphs. This analysis aims to depict the research findings based on a sample and provides a general overview of the studied problem. According to Sudjono (2010), the formula for obtaining percentages (relative frequencies) is used as follows:

$$P = \frac{F}{N} X\ 100\%$$

Explanation:

P = Percentage

F = Frequency for which the percentage is being calculated

N = Number of Cases (Total Frequency/Number of Individuals)

100% = Constant value

III. Results And Discussion

Kampar Regency is located astronomically between 01000'40" North Latitude and 00027'00" South Latitude, and between 100028'30" - 101014'30" East Longitude. It is crossed by the equator or the equator line located at 00 degrees latitude. The total area of the regency is 11,289.28 square kilometers, which is 11.62% of the total area of Riau Province (94,561.60 square kilometers). The region has a tropical climate with an annual rainfall of 200-300 mm.

The capital of Kampar Regency is located in Bangkinang, approximately 60 kilometers away from the city of Pekanbaru. It is divided into 21 sub-districts, consisting of 242 villages and 8 urban villages. The 21 sub-districts are Kampar Kiri, Kampar Kiri Hulu, Kampar Kiri Hilir, Gunung Sahilan, Kampar Kiri Tengah, XIII Koto Kampar, Koto Kampar Hulu, Kuok, Salo, Tapung, Tapung Hulu, Tapung Hilir, Bangkinang Kota, Bangkinang, Kampar, Kampa, Rumbio Jaya, Kampar Utara, Tambang, Siak Hulu, and Perhentian Raja. The population of Kampar Regency is 857,750 people. The following are the boundaries of Kampar Regency.

Table 1 Administrative boundaries of Kampar Regency

No	Boundary	Regency/City
1	East	Pelalawan Regency and Siak Regency
2	West	Rokan Hulu Regency and West Sumatra Province
3	North	Pekanbaru City and Siak Regency
4	South	Kuantan Singingi Regency

Kampar Regency is traversed by two major rivers, namely the Kampar River, which has a length of approximately 413.5 km, an average depth of 7.7 m, and a width of 143 m. In the upper part of the river, it branches into two, namely the Kampar Kanan River and the Kampar Kiri River. In the upper part of the Kampar Kanan River, there is the Koto Panjang Hydroelectric Power Plant (PLTA) with a reservoir area of 12,000 hectares. It serves as a source of hydroelectric power generation, supplying an electricity demand of 114 Kwt. In addition, Kampar Regency is also home to the Tapung Kiri River, which has a length of approximately 90 km and a depth of 8-12 m. This river is utilized as a source of livelihood for the community, particularly in the field of fisheries.

Kampar District is one of the districts located in Kampar Regency, Riau Province, with a total area of 143.66 km2 and an elevation ranging from 30 to 50 meters above sea level. The district capital is located in Air Tiris and consists of 18 villages/urban villages, namely Batu Belah, Tanjung Berulak, Air Tiris, Ranah, Penyasawan, Rumbio, Padang Mutung, Simpang Kubu, Tanjung Rambutan, Pulau Jambu, Limau Manis, Naumbai, Ranah Singkuang, Pulau Tinggi, Koto Tibun, Bukit Ranah, Ranah Baru, and Pulau Sarak. The distance from Air Tiris Village to the capital of Kampar Regency, Bangkinang, is approximately 10 km. The boundaries of Kampar District are as follows.

Table 2 Administrative boundaries of Kampar District

No	Administrative Boundary	District/City
1	East	Kampar Kiri District
2	West	Bangkinang District
3	North	Kampar Timur District
4	South	Tambang District

Description and Characteristics of Responding Farmers

The characteristics of IPM and non-IPM rice farmers in the research area can be described through information about age, education, farming experience, membership in farmer groups, participation in extension activities, and land ownership status. The diversity of farming characteristics influences farmers' decision-making in rice farming. The description of the characteristics of respondent farmers is presented in Table 3.

Table 3. Characteristics of IPM and Non-IPM Rice Farmers in Kecamatan Kampar, Kabupaten Kampar, 2022

No	Characteristic	IPM Farmers		Non IPM Farmers	
		Number (people)	Percentage (%)	Number (people)	Percentage (%)
1	Age (Years)				
	a. 15-24	0	0	0	0
	b. 25-34	0	0	1	1,6
	c. 35-44	4	10,52	9	14,5
	d. 45-54	17	44,73	17	27,41
	e. 55-64	11	28,94	29	46,77
	f. >64	6	15,78	6	9,6
Total		38	100	62	100
2	Education (Years)				
	a. No School (0)	3	7,9	4	6,4
	b. Elementary School (1-6)				
	c. Junior High School (7-9)	14	36,8	32	51,6
	d. Senior High School (10-12)	6	15,7	11	17,7
	e. College (>12)	13	34,2	15	24,1
		2	5,2	0	0
				0	0
Total		38	100	62	100
3	Gender				
	a. Male	8	21,05	9	14,5
	b. Female	30	78,94	53	85,4
Total		38	100	62	100
4	Land Ownership Status				
	a. Own	18	47,3	8	12,9
	b. Lease	17	44,7	25	40,3
	c. Borrow	3	7,8	29	46,77
Total		38	100	62	100
5	Rice Farming Experience (Years)				
	a. 1-10	10	26,3	25	40,3
	b. 11-20				

	c. 21-30	11	28,9	18	29
	d. 31-40	6	15,7	7	11,3
	e. >40	4	10,5	8	12,9
		7	18,4	4	6,4
Total		38	100	62	100
6	Farmer Group Membership				
	a. Yes	38	100	55	88,7
	b. No	0	0	7	11,3
Total		38	100	62	100
7	Participation in IPM Field Schools				
	a. Yes	18	47,3	0	0
	b. No	20	52,6	0	0
Total		38	100	0	0
8	Input Production	0,38	-	0,29	-
	Land Area (Ha)	65,27	-	115,00	-
	Seed Quantity (Kg)	240,53	-	83,11	-
	Organic Fertilizer(Kg)	198,05	-	175,20	-
	Inorganic Fertilizer (Kg)	10,54	-	-	-
	Natural Pesticide(Ltr/Ha)	0,68	-	1,78	-
	Chemical Pesticide (Ltr/Ha)	52,61	-	44,74	-
	Labor				
	Output				
	Produksi Padi (Kg)	1413,39	-	747,24	-

The age of the respondent farmers is one of the factors closely related to their work ability in carrying out agricultural activities. Many farmers have expressed that age is a significant factor in conducting rice farming activities, especially in IPM (Integrated Crop Management) system, as they require meticulous management compared to non-IPM rice farming. The average age of rice farmers in the research area is still within the productive age range according to the definition of productive age by BPS (Statistics Indonesia) and BKKBN (National Family Planning Coordinating Board), which is between 15 and 64 years old. Physically, individuals within the productive age range have more energy compared to older individuals. Moreover, farmers in the productive age range are more receptive to innovations compared to older farmers. This condition allows farmers to continuously improve their farming performance to increase production and achieve higher profits. The highest percentage of age among the IPM rice farmer respondents falls within the 45-54 years old range, accounting for 44.73 percent. On the other hand, the non-IPM rice farmer respondents are predominantly within the 55-56 years old range. This indicates that rice farmers in Kampar District, in terms of physical condition, are still within an age range where their work ability can be further improved to increase rice production. As mentioned by Nurhapsa (2013) in their study, an individual's work ability tends to increase with age, but eventually declines at a certain age due to the influence of age on cognitive maturity and physical abilities in managing a business.

Education plays a role in changing attitudes, behaviors, and thought patterns, both through formal and non-formal education. Through education, individuals can acquire information and new technological innovations that influence the quality of decision-making. Table 3 shows that 36.8 percent of IPM farmers have completed education up to the elementary school level, which is lower than the 51.6 percent of non-IPM farmers. The highest level of formal education attained by the respondent IPM farmers is at the university level, accounting for 5.2 percent, followed by the high school level at 34.2 percent. On the other hand, for non-IPM farmers, the highest level of education is at the high school level, which is 24.1 percent. This indicates that the education level of IPM farmers is higher compared to non-IPM farmers. The level of education influences farmers' willingness to adopt IPM technology, which is considered a good system. According to Natawidjaja et al. (2008), the level of formal education affects labor productivity and the adoption of technology. Low levels of education can result in low literacy rates and productivity. Additionally, according to Rizal (2014), the level of education is also a factor that can reduce inefficiency in farming. The higher the level of education a farmer has, the easier it is for them to understand and accept new innovations presented to them.

Another characteristic of farmers is their experience in rice farming. Experience is the knowledge accumulated by humans through the use of their reasoning, which is then organized into patterns. Experience is one of the determining factors in the success of farming. In this study, farming experience in rice farming is measured by the number of years the respondents have been engaged in rice farming, both under IPM and non-IPM practices. IPM farmers are those who have participated in the Integrated Pest Management Field School (SL-IPM) and have implemented IPM principles for more than four cropping seasons, while non-IPM farmers are those who use synthetic fertilizers and pesticides in their rice fields or have used synthetic fertilizers and pesticides for three cropping seasons, even if they have previously participated in SL-IPM.

The experience of IPM rice farmers in rice farming for more than 20 years is 44.6%, while for non-IPM farmers it is 30.6%. IPM rice farmers with farming experience of less than 20 years account for 55%, while non-IPM farmers account for 69.3%. This means that IPM rice farmers have gained significant experience in rice farming and have generally participated in SL-IPM, which has equipped them with knowledge and experience that makes them more receptive to new innovations and technologies due to the proven results they have witnessed. On the other hand, among non-IPM rice farmers with farming experience of more than 20 years, which is relatively high at 69.3%, it can be inferred that they have not participated in SL-IPM and their physical capabilities may have declined, making it difficult for them to adopt new practices beyond their usual habits. Rizal (2014) and Nurhapsa (2013) have stated that with sufficient experience, farmers are more likely to accept and choose innovations or technologies that are suitable and appropriate for their farming practices. There is a tendency that the longer a farmer has been engaged in a particular farming activity, the more they will learn about its pros and cons, as well as whether it is suitable or not, and they will also adopt technologies used in their farming practices (Rizal 2014).

The formation of farmer groups provides a platform for farmers to share knowledge, experience, skills, and plan farming activities among themselves (Tanjung, 2003). Through farmer groups, farmers ideally gain additional knowledge and skills in farming, both through discussions among themselves and through technology transfer provided by field agricultural extension workers (PPL). All IPM farmers are members of farmer groups, but among non-IPM farmers, there are some respondents who are not part of farmer groups.

The participation in SL-IPM or non-participation serves as one of the criteria for categorizing farmers into IPM or non-IPM farmers. About 47.3% of IPM farmers have participated in SL-IPM, while 52% have never participated in SL-IPM. From the interviews conducted, it was found that IPM farmers participated in SL-IPM 1-4 times, specifically in the years 2001, 2002, 2003, 2014, 2015, and 2018. Furthermore, it is expected that the IPM alumni farmers will disseminate their knowledge to other farmers. Farmers who consistently implement IPM usually engage in discussions within their farmer groups and collectively plan their actions before the rice planting season begins.

In addition to the socio-economic characteristics of farmers' households, it is also important to know the characteristics of the farming enterprise itself. These enterprise characteristics include the land area cultivated by farmers and land ownership status. Land is one of the main factors of production that plays a crucial and strategic role in efforts to increase agricultural production and income. On average, IPM rice farmers cultivate a land area of 0.38 hectares, while non-IPM rice farmers have a smaller average land area of 0.29 hectares. When it comes to land ownership, the results show that, on average, 47.3% of IPM rice farmers own their land, while the remaining 52.5% are farmers who cultivate land through renting or borrowing arrangements.

For non-IPM farmers, on average, 12.9% own their land, while the majority, 87.07%, cultivate land through renting or borrowing arrangements.

Rice Farming Performance

Rice farming performance at the farmer level

Rice farming in the research location is predominantly conducted in paddy fields. The rice planting season in the research location consists of two planting periods, namely Planting Season 1 (PS1) from April to September, and Planting Season 2 (PS2) from October to March. Rice farmers in Kampar District generally rely on rainwater or water from nearby rivers for irrigation. The table below (Table 4) illustrates the extent to which IPM and non-IPM farmers apply healthy crop cultivation practices.

Table 4. Components of Healthy Crop Cultivation Technology for IPM and non-IPM Rice Farmers in Kampar District, 2022

No	Component	IPM Farmers	Non IPM Farmers
1	Proper Rice Cultivation Technology		
	a. Use of superior quality and labeled seeds	Used labeled and local seeds	Used local seeds
	b. Soil management	No tillage	No tillage
	c. Seedling transplantation (<21 days)	Done	Done
	d. Planting 1-3 seedlings per hole	More than 3 seedlings	More than 3 seedlings
	e. Application of organic materials	Already done	Already done
	f. Legowo planting system	Not implemented	Not implemented
	g. Fertilization based on soil conditions and crop needs	Implemented	ImplementedPupuk
	h. Effective and efficient irrigation	Done between rows and plants	Done between rows and plants
	i. Weed control	Herbicides and manual weeding	Herbicides
2.	Monitoring	Done	Not done
3.	Utilization of natural enemies (biological control)	Done	Not done
4.	Mechanical and physical control	Done	Not Done
5.	Use of botanical pesticides	Done	Not Done
6.	Wise use of synthetic pesticides	Done	Control of pests done with chemical pesticides

Rice farming has been practiced by farmers in the research location for a long time, as evident from the average farming experience of the respondent farmers, which is below 30 years. In the case of IPM farmers, the largest percentage falls within the range of 11-20 years, accounting for 28.9%, while for non-IPM farmers, the majority falls within the range of 1-10 years, accounting for 40.3%. In relation to rice cultivation technology, farmers have long been familiar with and understand how to cultivate rice due to the inherited experience and knowledge passed down through generations in their families. In addition to the internal knowledge and experience gained, farmers also acquire knowledge from external sources such as agricultural extension services and training provided by the Department of Agriculture or other relevant government agencies. One of the activities implemented by the government is the Integrated Pest Management (IPM) program for rice and the IPM Field School, which has been implemented in Kampar District since 2001.

In general, rice cultivation in Kampar District includes activities such as land preparation, planting, fertilization, pest control, weeding, irrigation, and harvesting. The types of inputs used in rice production include the cultivated land area, seeds, inorganic fertilizers, organic fertilizers, chemical pesticides, natural pesticides, and labor. Based on the results of the research conducted on the respondent farmers and extension workers, it was found that there are still several components of IPM technology that have not been fully implemented by IPM farmers due to limited capital and environmental constraints. Additionally, non-IPM farmers have also implemented some components of IPM technology, even though they did not participate in the IPM program. However, they are also members of farmer groups, and 88.7% of them participate in agricultural extension services.

According to a study by Sudana et al. (2012), the determining factors for farmers in adopting and implementing technology are productivity levels and production costs. Respondent farmers who apply IPM can be more efficient in using agricultural inputs, especially in the steps of implementing healthy crop cultivation. IPM farmers employ preventive measures for pest control through mechanical and physical methods, in addition to using homemade natural pesticides, which helps save costs compared to using chemical pesticides. IPM farmers engage in more production activities than non-IPM farmers, particularly in terms of labor input. IPM farmers carry out pest control measures more frequently, starting from seed selection to harvesting.

Land Preparation and Management

Land is the primary medium for rice cultivation. The activities of land preparation for IPM and non-IPM farmers are carried out after the rice plants are harvested or approximately one week before the rice seed planting period. The preparation of paddy fields for rice cultivation does not require plowing; instead, it involves clearing the fields of weeds and leftover rice straw. After the rice straw is cut and spread out, it is left to dry for about three days. Once the straw has dried, it is burned, and the land is sprayed with herbicides. Subsequently, drainage channels are created at intervals of 3-4 meters, with a depth of 25-30 cm and a width of 20-25 cm. The purpose of creating these drainage channels is to prevent waterlogging, as stagnant water can lead to infestations of golden apple snails (an OPT pest). Both IPM and non-IPM farmers have implemented the construction of drainage channels as part of their land preparation activities.

Planting

The next activity after land preparation is the planting of rice seeds. Both IPM and non-IPM farmers sow rice seeds in seedbeds located near the paddy fields for approximately 21 days. Field observations show that the average seed input used in IPM farming is 65.27 kilograms per hectare, while non-IPM farming averages 113.40 kilograms per hectare. The recommended seed requirement for planting one seed per planting hole is 15 kg, while the norm is 25 kg for a 1-hectare plantation if planting 3-4 seeds per hole. The high seed usage in Kampar District is due to the condition of the land, the environment, and the repeated use of certified or local seeds. The paddy fields in Kampar District are rainfed, which means they can get flooded during the rainy season, leading to pest infestations such as golden apple snails. In the dry season, the issue is typically stem borers. To address these field problems, farmers in Kampar District usually sow more rice seeds than recommended, allowing for replacement in case of pest attacks such as golden apple snails or stem borers. Replacement planting is usually done until the rice reaches 30 days after sowing.

Farmers in Kampar District use various local superior rice varieties, including Suntiang, Anak Daro, Cantik Manis, Bujang Merantau, and Batang Piyaman. Certified seeds used include Ciherang, Inpari 42, Inpari 48, and IR 42. Meanwhile, the local seeds used include Kuriok, Jangguik, Lubuk Coku, Gudang, Padi Kuning, Suntiang Lola, and others. Certified and superior local seeds generally have better germination rates compared to local seeds. Certified seeds are labeled with a blue label and are also known as Extension Seeds (ES/BR). These seeds are the fourth generation of seed class and are directly marketed to consumers or farmers. These seeds are only suitable for one planting cycle. According to Ruskandar (2015), the use of non-labeled seeds is still high in Kampar District. Limited seed distribution centers in certain areas pose a challenge to the timely dissemination of Verified and Uniformed Seeds (VUB), relying mainly on government agencies. In Kampar District, many farmers continue to use local or repeatedly planted seeds, including blue-labeled seeds, despite the regulations specifying that blue-labeled rice seeds should only be used once, which may result in lower production yields.

Irrigation

The paddy fields in Kampar District are generally rainfed. Both IPM and non-IPM farmers create irrigation channels or ditches to supply water to the fields. These channels are usually dug around the fields and directed to the appropriate areas within the agricultural land. Farmers regulate the water flow by controlling or blocking the irrigation channels using water gates or other structures. Irrigation by rice farmers in Kampar District typically occurs twice a year. Irrigation is done during the early growth stage and when the plants start to flower. No irrigation is done towards the harvest period as the soil needs to be dry. Rice plants are not highly dependent on large amounts of water. In order to facilitate irrigation, farmers utilize the drainage systems that have been established during land preparation. However, during the rainy season and periods of high river water levels, farmers' fields are often submerged and flooded, requiring careful timing of rice planting to avoid crop failure.

Fertilization

Fertilization is typically carried out twice during a single cropping season by both IPM and non-IPM farmers. IPM farmers apply the first round of fertilization at 7 days after planting (DAP) and the second round at 30 DAP. Non-IPM farmers, on the other hand, apply the first round at 10 DAP and the second round at 30 DAP. The average use of inorganic fertilizers in IPM farming is 198,5 kg per hectare, while in non-IPM farming, it is 175,20 kg per hectare. The composition of fertilizer use in Kampar District, based on the total usage of inorganic fertilizers, is 41% urea, 30,6% NPK, 9,9% TSP, 11,50%, KCl 1,7% ZA, and 4,6% SP36. The utilization of inorganic fertilizers in Kampar District is still not optimal, especially in flood-prone areas and during the rainy season when farmers often do not use fertilizers at all due to the submergence of paddy fields, rendering the function of fertilizers ineffective and wasteful. Farmers in Kampar District also use organic fertilizers, with IPM farmers averaging 240,53 kg/ha and non-IPM farmers using 83,11 kg/ha. The organic fertilizer used is compost made from rice straw, which farmers produce themselves.

The impact of providing less-than-recommended amounts of inorganic fertilizers results in stunted plant growth and reduced harvest yields. Moreover, insufficient fertilizer application can reduce the quality of the harvest, such as smaller and less quality rice grains. However, the use of inorganic fertilizers alone is not sufficient; it needs to be complemented with organic fertilizers to enhance soil and plant productivity sustainably. Therefore, it is advisable to combine organic and inorganic fertilizers in rice cultivation. In line with the findings of a study conducted by Siwanto et al. (2015), it is stated that applying a dose of up to 1.000 kg/ha of organic fertilizer alone leads to low growth and yield. Increasing the dose to 400 kg/ha of inorganic fertilizer enhances the growth and yield of paddy rice. The highest nitrogen efficiency, 89,19%, is achieved with the application of a dose of 500 kg/ha of organic fertilizer + 200 kg/ha of inorganic fertilizer, while the highest phosphorus and potassium efficiencies, 69,55% and 92,52% respectively, are achieved with the application of a dose of 750 kg/ha of organic fertilizer + 300 kg/ha of inorganic fertilizer.

Providing fertilizers below the recommended levels for rice plants can make them more susceptible to pest and disease attacks. This is because of the lack of nutrients needed to strengthen the plant's defense system. Plants that do not receive sufficient fertilization will have a weak defense system and will be less capable of resisting pest and disease attacks. Conversely, plants that receive adequate fertilization will have a stronger defense system and can effectively combat pest and disease attacks.

Unfavorable environmental conditions, such as high humidity and temperature, can also increase the risk of pest and disease attacks on rice plants. Therefore, it is important to provide sufficient nutrients to strengthen the plant's defense system and prevent pest and disease attacks. In order to increase productivity and reduce the risk of pest and disease attacks, it is recommended that farmers follow the recommended fertilizer application guidelines.

Weed Control

Weed control activities carried out by both IPM and non-IPM farmers involve chemical and manual methods. Chemical control is done by spraying herbicides, usually twice during one cropping season. The first spraying is done during the first weeding, which takes place during land preparation. The second weeding is done around 45-65 days after planting when the plants are already flowering. In Kampar District, all farmers use herbicides to control weeds before planting rice in paddy fields because the district employs a no-tillage system. The herbicides used by farmers in Kampar District include Roundup 1 L, Gramoxone 276 SL, and Top Kuat 290 SL for pre-planting weed control. When there are already rice plants in the field, farmers use herbicides such as Lindomin 865 SL and Abolisi 865 SL for weeding. In addition to chemical methods, IPM farmers, in particular, also employ manual methods by manually removing weeds using tools such as sickles and machetes. According to IPM farmers in the research area, regular weed removal and maintaining field cleanliness help prevent diseases such as brown spot and blast.

Control of Plant Pests

During the observation period from October 2021 to March 2022, the plant pests that attacked rice plants were golden apple snails (in the early stages of planting), rats (in mature/tillering plants), brown planthoppers (during flowering), and bird pests (when the rice grains were formed until approaching harvest). There are differences between IPM and non-IPM farmers in controlling plant pests. Non-IPM farmers control pests using chemical pesticides, while IPM farmers adopt preventive control measures starting from seed treatment by soaking the rice seeds in saltwater to select healthy seeds. If there is a potential for specific pests during the planting season, IPM farmers usually begin spraying with biopesticides such as SCBx for brown planthopper control and Corynebacterium for bacterial leaf blight, sheath blight, blast, and leaf spot diseases. IPM farmers also commonly use natural pesticides, such as plant-based pesticides, to control pests. For example, to control golden apple snails, they place young papaya leaves around the rice plants and spray the juice of young betel nut on the young rice plants to reduce their feeding activity. Natural pesticides generally have lower efficacy compared to inorganic pesticides, and their effects may not be immediately apparent like inorganic pesticides. Regular and frequent application is necessary for optimal results.

To control rats and mole crickets, farmers in Kampar District scatter jengkol (Archidendron pauciflorum) skins in the corners or bunds of the paddy fields. Additionally, IPM farmers in Kampar District cultivate refuge plants, such as brightly colored flowers like sunflowers, cosmos, spinach, celosia, Portulaca, and Celosia cristata, along the bunds of the paddy fields. These refuge plants serve as attractants for natural enemies of pests and help maintain the balance of the ecosystem. To control bird pests, IPM farmers install nets around the rice plants to prevent bird attacks. For brown planthopper control, farmers use traps baited with decaying materials like golden apple snail carcasses or shrimp paste, or they manually catch the brown planthoppers once a week and destroy them.

In IPM, controlling plant pests is not solely reliant on natural pesticide applications. Integrated Pest Management (IPM) is a system that combines various control methods into a harmonious program to keep pest populations at levels that do not cause economic losses and are environmentally safe. If IPM farmers have implemented preventive control measures and the pest infestation reaches the economic threshold level, they may resort to the judicious use of chemical pesticides as a last resort.

In Kampar District, IPM rice farmers generally spray chemical pesticides twice during the cropping season, while non-IPM farmers spray 3-4 times. IPM farmers consider the size of the pest population and the intensity of infestation when deciding on pesticide applications, whereas non-IPM farmers schedule their control activities based on the growth stages of the plants. According to farmers, this is done to prevent the emergence and outbreak of pests and diseases that can harm crop production.

Pesticides are considered valuable input in agriculture, as they can control pests and reduce crop damage. However, unlike other inputs such as fertilizers and seeds that directly contribute to increased production, pesticides do not directly enhance yields (Cooper and Dobson, 2007; Shende and Bagde, 2013). During the research period, rice farmers in Kampar District used rodenticides like Klerat 0.005BB to control rats, insecticides like Decis 25 EC, Darmabas 500 EC, and Curater 3GR to control caterpillars, and insecticides like Furadan 3 GR and Spontan 400 SL to control stem borer pests, and only a small number of farmers in Kampar District used fungicides to control plant diseases, specifically blast disease, like Topsin 500 SC. Please note that pesticide brands and formulations may vary among farmers, and the mentioned products are provided as examples.

Harvest and Postharvest

The final activities in rice cultivation are harvesting and post-harvest activities. Rice plants need to be harvested at the right time. Harvesting too early can cause the rice grains to be wrinkled, resulting in increased damage and loss of yield. Rice can be harvested when the leaves of the plants start turning yellow and falling, and the rice pods have dried and about 95 percent of them have turned brown or black. The timing of rice harvest is usually earlier for IPM farmers compared to non-IPM farmers. IPM farmers can harvest rice at around 82 days of age, while non-IPM farmers typically harvest around 90 days of age. Harvesting is done manually, usually by cutting the plants. Both IPM and non-IPM farmers then proceed with the drying process at home. This drying process usually takes about 3-4 days, depending on the weather. Once the rice plants have dried, the grains are manually threshed or threshed using a rice threshing machine. The dried rice is then stored at home for personal consumption or sold to rice mills.

IV. CONCLUSION AND RECOMMENDATIONS

Based on the research conducted, the following conclusions can be drawn:

1. IPM and non-IPM farmers in Kampar District have implemented measures for cultivating healthy crops. The difference lies in the management of pest control, where IPM farmers consistently monitor their fields to make informed decisions regarding pest control measures.

2. In terms of seed selection for healthy crop cultivation, IPM farmers use superior and local superior seeds, while non-IPM farmers mostly rely on local seeds. However, due to limited availability of certified seeds in local agricultural stores, all types of seeds are repeatedly used.

3. IPM farmers, as managers of their own fields, follow the principles of IPM by prioritizing preventive measures. They only resort to the judicious use of chemical pesticides when pest infestations reach the economic threshold.

4. Non-IPM farmers control pests by periodically applying chemical pesticides without considering the level of pest infestation.

5. The participation of farmers in IPM Farmer Groups and cooperative farming has an influence on their adoption of healthy crop cultivation practices and IPM-based pest control.

6. Non-IPM farmers tend to view chemical pesticides as a practical and fast-acting solution, without realizing that their indiscriminate use increases production costs, poses risks to themselves and the environment. This lack of awareness is one of the reasons why few farmers adopt IPM practices.

Based on these conclusions, the following recommendations are proposed:

1. The local government of Kampar District should promote and implement the IPM Rice Farmer Group program to ensure the sustainability of rice cultivation in the region.

2. Extension programs should focus on educating farmers on implementing location-specific healthy crop cultivation practices and IPM-based pest control, emphasizing their impact on production, efficiency, and environmental sustainability.

3. There should be increased promotion and availability of certified and local seeds through government and private sector initiatives, making it easier for farmers to access quality seeds.

By implementing these recommendations, it is expected that farmers in Kampar District can enhance their knowledge and adoption of IPM practices, leading to improved crop productivity, reduced environmental impact, and sustainable agricultural practices.

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