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Socio-Economic Factors Influencing the Adoption of Integrated Crop Management Technology in Rice for Sustainable Agribusiness Development

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Abstract: Adoption of Integrated Crop Management technology of rice is considered to increase production and income, also expected to be environmentally friendly. The purpose of this study was to determine the level of application of IPM and analyze the influence of socio-economic factors of farmers on the adoption of IPM technology. This research method was a survey, data collection using structured interviews using a measuring scale that is ordinal. Sampling with *simple random sampling* technique, the samples number used as many as 30 rice farmers. The data analysis technique used multiple linear regression method using the SPSS. The results found that the level of adoption of rice PTT technology in three subsystems: subsystem of supplying production facilities, cultivation subsystem, and post-harvest subsystem categorized as moderate. In adopting PTT rice, farmers have not fully considered the recommendations required by PTT rice. Simultaneously, age, education, land area, and length of farming together have a positive and significant effect. But partially that age, and length of farming have a positive and significant effect on rice PTT, while education and land area used do not have a positive and significant effect on the application of rice PTT in Putera Sejahtera Farmer Group.

Keywords: Farmers; Garut; PTT; Rice; Technology Adoption

Introduction

Food issues have always been important in economic development in Indonesia, which is why agricultural development still plays an important role even though its contribution to national income tends to decline. A region must have natural resources that can be processed and used as a source of food for its population because the population continues to increase (Kaledupa et al., 2013). Farmers in Indonesia have cultivated rice as a food crop for generations. Meanwhile, national rice production capacity is experiencing slow growth or tends to stagnate (Nurmalina, 2008). The economic value of this crop is very important to the economy as it provides a means of livelihood and helps fulfill the basic needs of the community. Garut Regency is one of the important sectors that has a major influence on the growth of the agricultural sector in West Java Province. The agricultural sector, which includes subsectors of food crops, plantations, livestock, forestry and fisheries, dominates the economy of Garut Regency. Rice is one of the food crops grown (Saridewi, 2018). Paddy rice is one of the superior commodities whose availability continues to be pursued by the government so that the resulting production continues to increase and stabilize (Nahrisah et al., 2020). The development of cultivation technology, increasing business capital, and partnerships between producers and business actors are expected to increase agricultural output and environmental sustainability (Purnama et al., 2023). Agricultural processes carried out by the Urug community, such as land cultivation and rice planting, are integrated with STEM concepts to provide valuable insights into the development of sustainable agricultural systems (Lathifah et al., 2024). The development of cultivation technology, increasing business capital, and partnerships between producers and business actors are

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expected to increase agricultural output and environmental sustainability (Purnama et al., 2023).

Table 1. Rice Paddy Production by District in West Java Province in 2021.

District	Production (Ton) 2021
Indramayu	1.319.624
Karawang	1.234.134
Subang	959.456
Cianjur	611.773
Bekasi	587.586
Majalengka	534.250
Sukabumi	492.926
Cirebon	464.731
Tasikmalaya	445.909
Garut	443.320
More	2.019.863
West Java	9.113.572,80

Table 1 shows that Garut Regency ranks tenth as a rice producer in West Java Province, meaning that Garut Regency is in a moderate category in producing rice production. Daliani & Nasriati, (2017) stated that technology adoption among farmers is still relatively low, which has a negative impact on production and income. One of the efforts to improve agricultural technology is to improve rice farming technology and systems, especially through improving farmer behavior through increased knowledge, attitudes and abilities. In order for farmers to increase their agricultural productivity and apply technology, knowledge, attitudes and skills are very important. Increasing farmers' understanding of Implementation of Integrated Crop Management (known PTT) technology is expected to foster a positive attitude towards technology and improve their ability to implement the adoption of technology. The Ministry of Agriculture launched the Integrated Crop Management Field School Program (SL-PTT) with the main aim of accelerating technology transfer through training (Balitbangtan, 2008). According to Wongkar et al., (2016) Each farmer's understanding of rice cultivation technology is different in adopting an innovation. One of the locations for the application of PTT technology is in Samarang Village, Samarang Subdistrict, Garut Regency. Several farmer groups, namely Harapan Tani, Karya Tani, Putera Sejahtera, and Mulya Tani, have succeeded in increasing the productivity of their paddy farms.

Table 2. Comparison of Rice Productivity

Year	Average PTT Productivity in Samarang Sub-district (kw/ha)	Average Productivity of PTT in Garut Regency (kw/ha)
2019	6.2	5.6
2020	6.4	5.9
2021	6.6	6.1

Table 2 shows that the average rice productivity in Samarang Village is higher than the average rice productivity in Garut Regency throughout 2019, 2020 and 2021. Productivity can be interpreted as the addition of results and efforts to achieve certain production. Productivity can occur in 3 (three) conditions, first with the use of the same resources can produce a higher level of productivity, second with the use of lower resources can produce the same productivity and third with the use of relatively few resources can produce relatively large productivity (J (Ravianto, 1986). (Yusmel et al., 2019) stated that the level of adoption of rice PTT technology depends on the socio-economic factors of farmers that make farmers' opinions about new things around them influenced by these socio-economic factors. Agricultural productivity which will be directly related to the rise and fall of farmers' income is influenced by various factors, one of which is socio-economic factors such as age, education level, land area, length or experience of farming (Soekartawi, 2002).

Method

This study uses a survey method with a questionnaire as a data collection tool. The survey method is a research technique used to examine and measure empirical phenomena that occur in the field or research location, usually in sample units that are faced as respondents and not the target population (Fadhilah et al., 2018). The types of data in this study are primary data and secondary data. Primary data were obtained through direct observation and interviews with PTT rice farmers in the Putera Sejahtera Farmer Group of Samarang Village, Samarang District, Garut Regency using a questionnaire instrument. Secondary data is data obtained from the Samarang District Extension Office, literature studies, related agencies, literature studies, journals and various other sources related to this research.

Determination of respondents in this study using *simple random sampling* where all research samples have the same probability to be selected (Sugiyono, 2018). The population in this study were farmers who received training to increase competency capacity including knowledge, skills and attitudes in the implementation of PTT rice in Samarang Village, Samarang District. Most farmers are aged 15 – 64 years, according to (Rusli, 2012), which is included in the productive age category. Data analysis techniques using multiple linear analysis, where this analysis is an analysis used to determine the relationship between two or more independent variables with the dependent variable. Independent variables are age (X1), education (X2), farm size (X3), length of farming (X4), and the dependent variable (Y) is

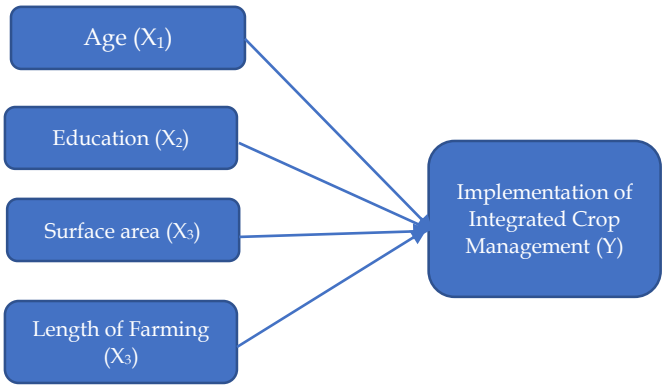
PTT. The multiple linear regression model is as follows:

$$Y = \alpha + b1X1 + b2X2 + 3X3 + b_4X_4 + e \quad (1)$$

Description:

Y	=	Integrated crop management (PTT)
A	=	Constant value
B	=	Regression coefficient
X1	=	Age
X2	=	Education
X3	=	Farm size
X4	=	Length of time in farming
E	=	Standard error

PTT is an effort to increase rice yields, with PTT grain yields and rice quality increase. PTT rice is influenced by socio-economic factors (age, education, land area, and length of farming). Age is one of the benchmarks in seeing the work activities carried out by farmers. Measurement of age factors here is and non-productive age. Education in the study regarding the receipt of information and technology obtained. Factors affecting education are socioeconomic conditions, changes in attitudes, and behavior. Land area is one of the factors that can increase production and productivity. The factor of length of farming or experience is the ability to achieve farming success. The longer the length of time in farming, the more income can be increased in farming. Based on the description above, the framework in this study is as follows:



Gambar 1. Framework for Rice PTT Adoption

Result and Discussion

Integrated Crop Management (PTT)

PTT is one of the approaches taken to restore the level of rice yields as before, because with the application of integrated crop management is expected to increase grain yields and the quality of rice produced, farming cost savings through the use of appropriate technology, sustainability and health of the rice growing environment and the environment of life to be maintained (Bobihoe, 2007). PTT is one of the new innovations with the hope of solving problems in increasing productivity. Intensification technology is location-specific, depending on the problems to be addressed. PTT technology components are determined together with farmers through technology needs analysis (Agricultural Statistics, 2013).

PTT technology is a dynamic technological approach. This PTT model brings together several technological components that synergize with each other so that it is expected to increase the efficiency of inputs used, maintenance and improve soil fertility. The success of PTT implementation can be seen from various indicators including knowledge, skills and attitude changes, cultivation that is applied less well and correctly (Agricultural Statistics, 2013). The implementation of PTT must consider several aspects including the selection of seeds of superior varieties, planting at the right time, fertilizer application, water supply, crop protection, harvest and post-harvest handling. All of these components have a very significant role in increasing rice farming productivity. Each technology and combination of technologies applied in an area can undergo changes along with the development of farming knowledge and experience. The following are the components applied in Integrated Crop Management (ICM). The implementation of PTT requires planned extension methods that are adapted to local needs so that they can contribute to the development of sustainable agriculture (Damanik & Purwoko, 2023).

a) Use of Superior Seeds

Preparing New Superior Varieties (VUB)

Using improved varieties has several advantages, including higher productivity, more resistance to pests and diseases, and better adaptability to climate change. The seed requirement is 25 kg/ha, and if it exceeds this amount, farmers will need additional guidance. Calculating seed requirements can be done by taking into account factors such as spacing, 1000-grain seed weight, and the number of seedlings required. Some superior seed varieties are Mekonga, IR64, Ciherang, Sintanur, Cibogo, Cigeulis, Fatmawati, Inpari 1-13, Situpatenggang, Inpari 14-20, and so on.

Quality and Labeled Seeds

The use of uniform seed, and the right seed according to varietal characteristics. Seed certification results of mixtures of other varieties are less than 1%. Seeds that are healthy (not affected by fungal and pest attacks), clean (not mixed with weed seeds or seeds of other plants), and soaked with 3% salt solution so that they have a growth resistance of more than 90%. The use of quality seeds guarantees the success of farming, namely uniform seed growth, producing healthy seedlings with many roots, faster growth, simultaneous

maturity and harvest, high productivity so as to increase farmers' income.

Seed Treatment

Treatment of seeds involves selection and pest protection. Seed selection is done by adding water and salt mixture. Well-filtered water is mixed with table salt (30 g of table salt per liter of water) or a mixture of 1 kg of ZA fertilizer in 2.7 liters of water. The seeds are put into the mixture in a ratio of twice the volume of the seeds. Then, the seeds that float on the surface are sieved and the damaged seeds are removed.

Making A Seedbed

For planting in an area of 1 ha, ± 20 kg of seeds are required. The sunken seeds are cleaned with clean water and then soaked in water for as long as 24 hours. The sacks are then tended in sacks for 48 hours and kept moist by wetting the sacks. The nursery area should be 400-500 m^2/ha (4-5% of the planting area). The nursery beds should be 1.0-1.2 m wide, with a mixture of manure, sawdust and ash of 2 kg/m^2. This addition can facilitate the uprooting of seedlings, thus reducing root damage. A trench 25-30 cm deep is made between the beds.

b) Land Processing

Success in rice management is by paying attention to the method and time of rice processing. Good land processing is by giving organic materials, husks and others. This organic material is 2 tons/ha of manure or 5 tons/ha of straw compost. The soil that has been mixed with the organic material is allowed to stand for 2 weeks to process naturally. The characteristics of good rice fields are organic C content above 5%, small animals and MOL such as eels, fish, frogs and dragonflies. Soil depth of 25 cm.

c) Nursery Land

In 1 ha the nursery land requirement is 4-5% (400-500m^2). The recommendation is to make plots facing east-west. The width is 1-1.2 m and the length is adjusted to the rice field area. For the nursery, 1000-2000 kg of manure, ash or straw and 10 g/m^2 of NPK are applied. The young seedlings are planted around 10-15 days after spreading and allow more seedlings to grow. If they are less than 15 days old, they are not ready for transplanting because the roots and stems are not strong enough. Before transplanting 3-5 days old seedlings are sprayed with insecticide. Young seedlings have better adaptability than older seedlings that are more than 20 days old.

d) Planting System

A good planting system is from tandur jajar improved to legowo system or commonly called a mixture of tandur jajar and legowo. The number of seedlings is 1-3 stems per hole. The jajar legowo planting system has two or more rows of rice plants and is interspersed by one vacated row. When there are two rows of planting per legowo unit, it is called legowo 2:1 with a spacing of 20 x 15 x 40 cm and 25 x 15 x 50 cm. Three rows are called legowo 3:1, four rows are called legowo 4:1 with a spacing of 25 x 12.5 x 50 cm and 20 x 10 x 40 cm. The benefit gained from applying the jajar legowo planting system is that all rows of crops are located on the edge, which tends to result in higher yields. In addition, it becomes easier to control pests, diseases and weeds.

e) Intermittent Irrigation

Plants will grow well if the water cycle is well regulated during the growth phase until post-harvest. During the Plant becomes fertile if the water rotation is intermittent from the planting phase until the maximum tillering (50 days after planting) the recommendation is 4 days wet 3 days dry, the growth phase phase, which lasts until the tillers reach the maximum age of 50 days after planting, it is recommended to maintain the water pattern by flooding the rice field for 4 days and giving a rest for 3 days. During the panicle formation and seed filling phases, lasting from 50 to 85 days after sowing, the fields should be flooded. About 14-15 days before harvest time, the paddy should be drained. To avoid drying less than 14 days before harvesting, as this may result in non-uniformity of panicle maturity.

f) Balanced Fertilization and Weeding

Fertilization technology based on nitrogen fertilization crop needs with Leaf Color Chart (BWD), nutrient status map of the study plot to determine the needs of P and K. One method to overcome weeds is by weeding, which is done by pulling weeds manually, using a gasrok or hedgehog tool, or using herbicides. Weeding using a gosrok or hedgehog is done when the plants are 10-15 days after planting, recommended to be done twice and repeated periodically 10-25 days later. Weeds that are too close to the plant are pulled out by hand and done in both directions in the plant row. Increasing the use of adaptive rice varieties and proper fertilization can be an agricultural intensification strategy to meet food needs (Sihaloho et al., 2023). The proper and optimal use of fertilizers can increase agricultural yields. Efficient and measurable fertilizer management can support sustainable agriculture, where the use of agricultural inputs such as fertilizers can be optimized to maximize yields without damaging the environment. Implementing this strategy on a wider scale can help realize a more productive and environmentally agricultural system (Suparno & Wulandari, 2023).

g) Management of Plant Disturbing Organisms

Pests and diseases of rice plants include stem borers, brown planthoppers, crackers, bacterial leaf blight, walang sangit and rats. Preventive measures that can be taken are by preparing rat control materials with a bubu trap system, increasing coordination between farmers and related officials so that production facilities are available on time.

h) Harvest and Post-Harvest

To determine the harvesting of rice plants, it falls on 30-35 days after flowering or coming out of panicles, 90% of the grain turns yellow, the water content is around 21-26%. In the early harvest usually for seed, good grain is selected from rice plants that are flat in height. The location of the plants used as seeds is about 2 m from the galangan or the edge of the rice field. Seed needs are adjusted to the land, if 1 ha then the seeds needed are about 25 kg. The grain is threshed by using a thresher machine (thresher) usually takes 1 day. Improving the capacity of agricultural human resources can be done through innovative and skills-based education. Inquiry-based learning that encourages creativity and process skills can be applied in the context of agricultural extension, where farmers are encouraged to explore, analyze problems, and find innovative solutions to agricultural challenges. This supports the development of critical thinking skills and creative solutions that are essential in agricultural development. In this case, the implementation of PTT will produce better outcomes if synergized with its field schools (Sinuraya et al., 2024).

Hypothesis Test (F-test and t-test)

The F statistical test aims to evaluate whether all independent variables in a model simultaneously affect the dependent variable. The f test is performed by comparing the significance level with the α level (5%) and comparing the calculated f value with the f table. If f count is less than f table, then there is no significant impact simultaneously from the independent variable on the dependent variable. Meanwhile, if f count is greater than f table, then there is a significant impact simultaneously from the independent variable on the dependent variable. The hypothesis is as follows: H0 = Socio-economic factors (age, education, land size, length of time in farming) jointly have a positive and significant effect. significant to rice PTT. H1 = Socio-economic factors (age, education, land size, length of tenure) farming) together do not have a positive and significant effect on rice PTT. This simultaneous test uses *SPSS version 26*. The following is the result of the f test can be seen in the following ANOVA output.

Table 3. F Test Results.

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	20837.922	4	5209.481	22.561	.000b
Residual	5772.745	25	230.910		
Total	26610.667	29			

Based on table 26 obtained F value 22.561 > 0.374 and sig 0.000 < 0.05 so it can be concluded that the independent variables include age (X1), education (X2), land area (X3), and length of farming (X4) simultaneously and significantly affect the dependent variable that is PTT (Y). Therefore, the independent variables are able to explain the magnitude of the dependent variable PTT rice. The t-test was conducted to determine how much influence each independent variable, namely age, education, land area, and length of farming individually had on the dependent variable, namely PTT. The significance level used is 5% or 0.05. The research hypothesis that will be tested using the t test is as follows :

H0 = Age has a positive and significant effect on the implementation of PTT.
H1 = Education has a positive and significant effect on the implementation of PTT.
H2 = Land size has a positive and significant effect on PTT.
H3 = Length of time in farming has a positive and significant effect on the application of PTT.

Table 4. Results of the t-test.

Variables	t count	Sig.	Description
Age	3.166	0.004	H0 accepted
Education	-1.083	0.289	H1 rejected
Land area	.562	0.579	H2 rejected
Length of time in farming	-9.402	0.000	H3 accepted

Effect of Age on Integrated Crop Management (ICM) of Rice

Based on the results of the study that the age variable has a positive and significant influence on PTT. The age of farmers partially has a positive and significant impact on the application of PTT in rice crops. This means that the younger the farmer's age, the higher the level of application of PTT in rice farming practices.

Respondents who are included in the old category are respondents who are more than 60 years old, where older farmers tend to have more experience in managing rice plants, and farmers in Samarang Village have faced various problems of integrated rice PTT. This is in accordance with Ismilaili's research (2015) that age has a significant effect on the application of PTT rice because the older the age of farmers, the more mature in thinking

and developing their rice farms, and will more easily accept new innovations to be applied. The average age at the time of the research was in the productive category. This means that the older the age of farmers, the more difficult it is to accept changes. The younger the age of the farmer, the greater the ability to increase production.

In line with what Effendy & Pratiwi, (2020) stated, even though the majority of farmers are in the productive category who allow and are able to accept new technology, because they have been ingrained in carrying out farming activities based on their experience and habits, it will be difficult to accept new technology.

Effect of Education on Rice PTT Implementation

This study shows that the results of the t test on the education variable are rejected. So it can be concluded that the education variable does not have a positive and significant effect on PTT because in general farmers in the Putera Sejahtera Farmer Group have sufficient experience regarding agriculture and also support from the government, training programs and guidance from institutions that have an important role in integrated crop management of rice. The importance of the role of extension workers in improving farmers' knowledge and skills through extension methods such as demonstrations and lectures, farmers are expected to be able to increase their production and welfare (Hamidah et al., 2024). Gradually, farmer empowerment should be carried out through training and providing adequate facilities to adopt new technologies (Irmayani et al., 2024). Farmers who are successful in agriculture, not only depend on formal education alone. Non-formal education provides opportunities for farmers to replace, supplement and complement their formal education (Fauzi et al., 2019). This is in accordance with the research of Sadikin (2013) the level of education has no significant effect, meaning that the level of adoption and application of rice PTT is not determined by the formal education of farmers, because it is not in line with the ineffectiveness of farmer experience factors.

This is in line with research conducted by Haryani, (2009) which shows that the higher the education obtained by farmers, the higher their ability to adopt technology and be able to use input proportionally so that it will improve performance in cultivating lowland rice. Because the government's role is important as a source of information for farmers, so the competence of extension workers in finding and providing information to farmers is something that must be considered. So far, many extension workers have used information sources from Google and YouTube, even though the government itself has developed Cyber Extension (Hayati, 2022).

Effect of Land Area on Rice PTT Implementation

The results showed that the t-test results on the land area variable were rejected because the sig value> α. This means that the land area variable does not have a positive and significant influence on PTT. PTT rice is more focused on sustainable practices and approaches regardless of the land area used either small or large. Where practices are applied both on large land and small land, but with good management can increase yields. Likewise, the land area owned by farmers in Farmer Groups that apply PTT has a variety of land areas. Prayitno & Arsyad, (1987) stated that the area of cultivated land is classified into 3 groups, namely narrow (less than 0.25 hectares), medium (0.25-0.49 hectares), and large (0.5-0.99 hectares). In accordance with the research of Choirotunnisa (2008), that the land area does not significantly affect the application of PTT rice because in applying PTT rice there are no specific provisions on the area of land to be used. In the corporate farming model, which is the merging of small agricultural land owned by farmers to be managed collectively in one integrated management, it can further increase agricultural efficiency and productivity (Iskandar et al., 2022).

The Effect of Length of Farming on the Implementation of Rice PTT

The results showed that the t test on the variable length of farming on the PTT variable was accepted. Significant value <0.05 has a unidirectional relationship with PTT. Then the variable length of farming partially has a significant influence on rice PTT. The longer farmers in doing farming then the level of application of rice PTT will be higher. Length of farming is important in increasing rice farming, as evidenced by the average results obtained by farmers. Farmers who have long enough experience will produce a high amount of rice, when compared to farmers whose experience is still low.

In another study by (Ismilaili et al., 2015), the length of farming had a significant effect on the level of rice PTT implementation. Farmers who are categorized as experienced according to (Manyamsari & Mujiburrahmad, 2024) are farmers who have farming experience for more than 20 years, while those between 10-20 years are categorized as quite experienced and less than 10 years are categorized as less experienced. The longer the farm, the better the level of PTT implementation. This is also in line with research by (Roswida, 2003), agricultural innovation decisions are influenced by the length of farming. Farmers with extensive expertise should consider expanding their business by investigating various technologies that suit the industry and seeking answers to existing problems. Choirotunnisa, (2008) that the variable length of farming has a significant effect on the application of rice PTT,

which means that the higher the level of experience or length of farming, the higher the level of rice PTT application model.

A person will benefit from his experience, because with that experience he will have the opportunity to see, compare and choose, making it easier for him to solve the problems he faces (Room, 2017).

Conclusion

The influence of socio-economic factors of farmers on the application of rice PTT simultaneously significant effect. While partially socio-economic factors on the variable age and length of farming have a positive and significant effect on the application of rice PTT. While education and land area has no effect because the application of rice PTT is not determined by education but because of experience and there is also a training program from the government. The area of land used does not have a positive and significant effect because it is not seen from the size of the land but seen from how to practice it.

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Author Contributions
Conceptualization, T.F. and F.R.; methodology, T.F., F.R and M.K; software, D.S.; validation, T.F., M.K. and D.S.; formal analysis, T.F and F.R.; investigation, D.S.; resources, F.R.; data curation, T.F. and F.R; writing—original draft preparation, T.F.; writing—review and editing, M.K. and D.S; visualization, F.R.; supervision, T.F. and F.R; project administration, D.S.

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The authors declare no conflict of interest.

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