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Farmers' Perceptions and The Impact of Agricultural Extension on Rice Productivity in Ciparay Sub-District, Bandung District

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ABSTRACT

Agricultural extension officers are agents of change who play a vital role in transferring technology and knowledge to improve farmers practices. However, the failure rate of traditional extension activities remains quite high in developing countries such as Indonesia. This study examines rice farmers' perceptions of extension officers' performance and the impact of extension services on rice productivity in Ciparay District, Bandung Regency. A quantitative approach was used, with data collected through questionnaires from 80 rice farmers (40 active participants in the extension program and 40 non-participants). Descriptive statistics and Propensity Score Matching (PSM) were applied. Results show that farmers' perceptions of extension officers'performance are moderate in responsiveness, responsibility, accountability, and service quality. Participation in extension programs positively impacted rice productivity, with participating farmers achieving 8.12 tons/ha more than non-participants. To enhance effectiveness, the local government should ensure a balanced ratio of extension officers to farmers, particularly in high-density farming villages. Capacity-building programs should be tailored to Ciparay's agroecological conditions, focusing on water management, adoption of locally suitable high-yield varieties, and integrated pest management. Extension activities should be conducted regularly, aligned with planting seasons, and employ participatory methods such as field schools for hands-on learning. Additionally, improving meeting facilities, providing demonstration tools, and expanding access to digital agricultural information are crucial to strengthening extension services and sustaining productivity gains in Ciparay District.

Keywords: *Extension, Extension Workers, Impact, Productivity, Rice Farmers.*

BACKGROUND

The agricultural sector remains the main source of income for the majority of the population in Indonesia. According to data from the Central Statistics Agency (BPS), in the first quarter of 2024, 28.64% of the total working population, or around 142.18 million people, depended on the agricultural sector for their livelihoods (BPS, 2024). This figure confirms that millions of households in Indonesia still rely on agricultural activities to meet their daily needs. However, the reality on the ground shows vulnerability, with more than 87% of the workforce in

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this sector, particularly rice farmers, being small-scale farmers with fluctuating productivity levels (Jamil et al., 2023). This condition makes farmers highly vulnerable to income fluctuations due to production risks. Several studies show that the success of this sector does not solely depend on natural conditions but is also influenced by the institutions and individuals involved in it (Nandi, 2019).

Data from the Central Statistics Agency (BPS) indicates that the majority of farmers in Indonesia are elderly, while the number of millennial farmers remains relatively small (BPS Provinsi Jawa Barat, 2023). Therefore, efforts to improve the quality and quantity of agricultural human resources are urgently needed, including through training, education, and mentoring, particularly to enhance the performance of their farming businesses (Abhijeet et al., 2023). Practices in several countries show that agricultural extension can have a significant positive impact on farmers' productivity. For example, a study in India found that the participation of rice farmers in agricultural extension programs could enhance their livelihood resilience, with rice production increasing by nearly 70%. This increase is reflected in improved farmer access to seed facilities, credit, appropriate cultivation practices, and innovations in production technology (Akram et al., 2019). These findings reinforce the argument that effective and targeted agricultural extension can promote the sustainability of rice farming in developing countries (Norton, 2020)

Unfortunately, previous studies have also found that the failure rate of extension activities, especially traditional ones, remains quite high in Indonesia. The failures that are commonly encountered occur due to: a lack of technical and communication skills that are important for performing functions efficiently; a lack of definite work plans; too few qualified and trained extension staff; a lack of transportation and logistics resources; poor infrastructure; and organizational and management issues in extension (Whidya Utami, 2019).

The role of agricultural extension workers is crucial. Extension workers serve as key elements in the process of empowering farmers, including efforts to increase productivity. The performance of extension workers is considered good if they are able to carry out their duties and functions in accordance with established criteria and indicators (Takahashi et al., 2020). This performance assessment aims to measure the extent of the extension workers' success in a given period. The main tasks and functions carried out by agricultural extension workers, which involve various performance indicators, are regulated in detail in Law Number 16 of 2006 concerning the Agricultural, Fisheries, and Forestry Extension System.

Bandung Regency is one of the regencies in West Java with a fairly large rice field area of 83,179 hectares. This data indicates that Bandung Regency has significant potential for rice production. Ciparay Subdistrict is the subdistrict with the largest rice-growing area in Bandung Regency, spanning approximately 10,002 hectares. Additionally, Ciparay has a substantial number of rice farmers who are part of farming groups, with 160 farming groups recorded in Ciparay Sub district (BPS Provinsi Jawa Barat, 2023). Despite being relatively close to urban centers and commercial areas, the majority of the population still relies on rice farming as their primary

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livelihood. Unfortunately, rice productivity in Ciparay continues to fluctuate annually (Table 1). This volatility also hinders significant improvements in the economic well-being of farmers in the region.

Table 1. Data on Rice Productivity in Ciparay Sub-District

Year	Rice Productions (ton GKG)
2020	15.211
2021	13.439
2022	14.229
2023	15.436

Source : BPS Kabupaten Bandung, 2024

Some farmers in Ciparay Subdistrict, many of whom are elderly, rely heavily on traditional farming practices passed down through generations. This poses a significant challenge, as agricultural extension officers must strive to stimulate farmers' interest and motivation while developing their knowledge and skills through educational approaches (Nandi, 2019) to enhance rice productivity and maintain the sustainability of the agricultural ecosystem. This study aims to investigate farmers' perceptions of agricultural extension officers' performance in Ciparay Subdistrict, Bandung Regency, and the impact of extension activities on rice farmers' productivity in Ciparay Subdistrict. The hypothesis of this study is that agricultural extension activities have an effect on rice productivity in Ciparay.

RESEARCH METHODS

1. Research Location and Justification
   This research was conducted in Ciparay Subdistrict, Bandung Regency. The reason for choosing this location was based on the consideration that Ciparay is one of the subdistricts with the largest number of rice farmers and the largest area of rice fields in Bandung Regency (BPS Provinsi Jawa Barat, 2023).
2. Sampling Technique and Sample Size
   The population in this study consisted of two groups of rice farmers:
   Treatment group: farmers who participated in the intensive extension program, totaling 205 people; Control group: farmers who did not participate in the extension program, totaling 78 people spread across 14 villages that were the same as the location of the treatment farmers.
   The sampling technique we used was:
   - Treatment Group (205 people)

   Stratified Random Sampling was used to ensure that each stratum (village or farmer group) received a sample proportionate to its population size. Random selection was conducted within each stratum after the sample allocation was determined.

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The sample size for the treatment group was determined using the Slovin formula

$n = N / (1 + N * e^2)$

Population (N) = 205

Margin of Error (e) = 10%

$n = 205 / (1 + 205 * (0.10)^2)$

$n = 205 / (1 + 2.05)$

$n = 205 / 3.05$

$n = 67$

However, in this study, it was decided to use a sample of 40 people from the treatment group. The considerations for this decision were the limited number of farmers willing to be interviewed, time constraints, costs, and enumerator resources. With a sample size of 40 from a population of 205, the resulting margin of error is approximately 14.2%, which is still considered representative of the population for the purposes of this study (Remeikiene, 2021).

- Control Group (78 people)

Purposive Sampling Technique was used with the following criteria: Located in the same village as the treatment farmers; Never participated in intensive training; Have similar agroecosystem conditions. To ensure balance, the number of samples for farmers who did not participate in the training was also set at 40 people.

To take a sample of the population evenly in each village, the number of respondents was divided by the number of villages (14 villages), so that the sample size in each village was 2-3 farmers who participated in the extension program and also those who did not participate in the extension program.

3. Data Collection Methods

Primary data was collected using questionnaires. Secondary data related to the research objectives was collected from relevant government agencies such as the Department of Agriculture, BPS, and previous literature.

4. Variables and Measurement

The variable of Farmers' Perceptions of Agricultural Extension Workers' Performance was measured using the following indicators:

a) Responsiveness is the extension worker's ability to respond to the aspirations, developments, demands, and new knowledge emerging from farmers or the surrounding environment based on farmers' perceptions.
b) Responsibility is a parameter that measures the extent to which the extension worker has fulfilled their duties or moral obligations based on farmers' perceptions.

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c) Accountability is defined as the obligation to demonstrate that extension tasks have been carried out based on established standards and to provide fair and accurate reports on performance results in relation to the roles and plans established based on farmers' perceptions.
d) Service quality is an assessment of the level of service provided by extension workers compared to the level of service expected and needed by farmers based on farmers' perceptions.

Rice productivity is measured using the indicator of harvest yield per unit of land area, namely Tonnes of Dry Harvested Rice (GKP) per Hectare (tonnes/ha), which is the amount of rice at harvest (moisture content ±20–25%).

5. Data Analysis Method

Data on farmers' perceptions of extension performance were analyzed using descriptive statistics in the form of percentages, as follow: First, calculate the scale range using the following formula:

RS = (m-n)/b
RS = Range Score
m = Highest score on the scale
n = Lowest score on the scale
b = Number of classes or categories

The performance evaluation score for agricultural extension workers is calculated using the following formula:
Highest score = Number of questions × highest score
Lowest score = Number of questions × lowest score

The impact of agricultural extension on rice farmers' productivity was analyzed using Propensity Score Matching (PSM) (Benedetto et al., 2018). The data analysis method using PSM and its steps are explained below (Kane et al., 2020)

1. Determining Covariate Variables
   Identify variables that affect the probability of a person receiving treatment. Namely variables: (1) age, (2) education, (3) farming experience, (4) land ownership, (5) membership farmer groups, (6) participation in farmer groups, (7) land type, (8) Use of technology and innovation
2. Estimating Propensity Score
   Use a logistic regression model to model the probability of receiving treatment, based on the covariates that have been determined.

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$e(x) = P(Z = 1 |X)$ (1)

Where e(x) is the propensity score, P is the probability, Z = 1 treatment indicator with values 0 for control and 1 for treatment, and X is the set of observed covariates.

3. Perform Matching Process
Pair treated units with untreated units that have similar propensity scores. Common matching methods: Nearest neighbor matching (one to one); Caliper matching (limiting the maximum distance); Radius matching; Kernel matching; Stratification/subclassification

4. Evaluating Balance (Balance Check)
After matching, check whether the covariate distributions between the treatment and control groups are balanced. Use: Multivariate significance test or t-test or standardized mean differences (SMD). The first step in the analysis is to estimate the potential outcome difference between the treated and untreated groups, formulated as:

$$\Delta i = Yi - Y0 \quad (2)$$

5. Analyzing the Treatment Effect
With the matched data, analyze the treatment effect. Since the data has been "standardized", either linear regression or analysis of mean differences (ATT) can be used. (Average Treatment on the Treated/ATT). In this study, ATT was used to measure the impact of agricultural extension activities on rice productivity, which can be estimated by the following formula:

$$ATT = E[E\{Y1|D = 1, p(X)\} - E\{Y0|D = 0, p(X)\}|D = 1)] \quad (3)$$

$H0$: if the ATT value is negative or zero. Agricultural extension has no impact on increasing rice productivity.
$H1$: if the ATT value is positive. Agricultural extension has an impact on increasing rice productivity.

6. Sensitivity Analysis (Optional)
Check how sensitive your results are to the underlying assumptions of PSM. For example, with the Rosenbaum bounds test to measure potential bias from unobserved confounders.

RESULT AND DISCUSSION

1. Perceptions of Rice Farmers Regarding Agricultural Extension Performance

Ciparay sub-district in Bandung Regency is one of the sub-districts that receives special attention in agricultural extension activities and absorbs many programs and assistance from the

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government. In the preparatory activities, extension officers identify the potential of the area, guide the preparation of the Village Work Plan (RKD) and Village Government Work Plan (RKPD), and prepare an annual work plan for extension. In implementation activities, extension workers develop extension materials, conduct face-to-face visits with farmers, carry out demonstrations of methods and results, plan and guide the implementation of field schools, and hold talks, technology meetings, and business meetings. Extension workers also plan and implement guest speakers and develop farmer institutions. In evaluation and reporting activities, extension workers process implementation data at the subdistrict level. In addition, extension workers also participate in professional development programs organized by the agriculture office or the ministry of agriculture.

Some of the activities carried out by extension workers are conducting face-to-face visits to farmers' fields, extension workers are also tasked with distributing assistance from the government such as fertilizer distribution and conducting surveys and identification of CPCL. This activity aims to ensure that agricultural programs and assistance can be right on target, given to farmers in locations that really need it. Extension workers also provide guidance on group organization including farmer group membership, group problems, and management of cooperatives in Ciparay.

According to (Maulu et al., 2021), the optimal performance of an agricultural extension worker if they succeed in providing facilities to farmers in all stages of farming, from the cultivation process to the absorption of the final product in the market. This performance assessment aims to see the level of success of agricultural extension workers within a certain period of time. The performance of extension workers can be seen from 4 aspects which include responsiveness, responsibility, accountability and service quality (Kalogiannidis & Syndoukas, 2024).

Based on the formula presented in the Research Method, the following results were obtained: Highest score = 42 × 5 = 210; Lowest score = 42 × 1 = 42. Based on this formula, the performance analysis of agricultural extension workers is as follows: Interval scale = (210-42):3= 56. The performance categories for extension workers are:

42 – 97 = low category
98 – 153 = medium category
154 – 210 = high category

The following are the results of respondents' assessment of the performance of agricultural extension workers in Ciparay District (Table 2).

Table 2. Extension Performance Based on Farmers' Perceptions

No	Description of	Extention Performance (%)		
		High	Medium	Low
1.	Responsiveness	14,21	56,06	29,73
2.	Responsibility	17,02	51,78	31,20
3.	Accountability	15,33	53,64	31,03
4	Service Quality	10,34	50,91	38,75
	Total	14,22	53,09	32,66

Source : Processed Primary Data, 2024

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Based on the data in Table 2, it can be seen that the overall performance of extension workers in Ciparay District according to farmers can be categorized in the medium category (53.09%). In other words, farmers' perceptions of extension workers fall into the neutral category.In the eyes of the majority of farmers, the performance of extension workers is considered “mediocre”, not too good but not bad either. Farmers feel that the performance of extension workers should be better. The farmers realize that the materials delivered by the extension workers are useful for them in running their farms, but the farmers feel that the agricultural extension workers in this village are not active enough. When farmers are in a position to face farming problems, extension workers are not always able to be present and help them, because the number of extension workers is limited and not proportional to the number of farmers.

In terms of responsiveness (which is seen from the indicators: the ability of extension workers to identify community needs, meet expectations, plan programs and priorities on services provided, and develop a variety of public services tailored to community needs and expectations) (Hameed & Sawicka, 2023), the majority of farmers gave medium scores. Farmers felt that the ability of extension workers to respond to anticipate aspirations, developments, demands and newly emerging knowledge from the surrounding environment was good enough.

Similarly, the Responsibility of extension workers (which is seen from the suitability of the moral responsibility of the service process carried out whether in accordance with the regulations set by the government) (Wang, 2014), farmers give a medium value. Farmers feel that the implementation of the service process carried out by extension workers is still not in accordance with administrative and organizational provisions, for example in the provision of services that have not been evenly organized, programs that are run sometimes the time is not right with the planning made.

For the point of accountability (which is a measure to determine the extent to which the services carried out are in accordance with the interests of the community and the implementation of services can be accounted for based on established provisions or procedures) (Hagmann et al., 2014), farmers give a medium score. Extension workers in the eyes of farmers have provided accountability to prove that the work is in accordance with the regulations, but some other things are sometimes still not transparent.

The last indicator is the quality of service which is an assessment of service satisfaction obtained and compared with the standard of service expected and needed (Kadiyala et al., 2016), assessed by farmers is also still standard. The quality of service that has not been good is more due to infrastructure that is less supportive in extension activities. Some extension programs are implemented optimally if supported by sponsors in the procurement of goods or their complement. If there is no sponsor, extension activities become less applicable due to limited supporting facilities. This study is in line with several previous studies that suggest that supporting facilities greatly determine the quality of extension activities (Al-Kaisi et al., 2015).

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2. Impact of Extension on Rice Productivity in Ciparay Sub-District

There were 40 (forty) farmers who actively participated in structured extension activities in Ciparay Sub-district during the last 1 year (2023-2024). Gandhi said based on previous research, there are 7 factors that cause farmers to participate and be active in extension activities, namely: (1) age, (2) education, (3) farming experience, (4) land ownership, (5) membership farmer groups, (6) participation in farmer groups, (7) land type, (8) Use of technology and innovation (Norton, 2020).

To see the impact of extension activities on rice productivity, Propensity Score Matching (PSM) analysis was used. Code =1 for farmer groups that are active in extension, while code=0 for farmer groups that are not active in extension activities. The following are the results of covariate descriptive statistics (Table 3).

Table 3. Descriptive Statistics of Variables Affecting Farmer Participation in Agricultural Extension

		Not participate in agricultural extensions (control group)			Participate in agricultural extensions (treatment group)		
	Variable	S.D.	Freq[a]	Mean	S.D.	Freq[a]	Mean
	Productivity	42			63		
X1	Age (years)	51.77	0.247		48.7	0.476	
X2	Education (years)	5.89	0.079		7.90	0.216	
X3	Farming experience	3.95	0.034		3.99	0.065	
X4	Land are (ha)	0.45	0.039		2.74	0.261	
X5	Membership in farmer groups			14 (35%)			28 (70%)
	Non membership			26 (65%)			12 (30%)
X6	Farmer group Participation			3 (0.08%)			30 (75%)
	No participation			37 (0.92%)			10 (25%)
X7	Land type						
	Low land			24 (60%)			12 (30%)
	Otherwise			16 (40%)			28 (70%)
X8	Use of technology and innovation			12 (30%)			29 (72.5%)
	No Tech			28 (70%)			11 (27.5%)
	Sample size (n)			40			40

Source : Processed Primary Data, 2024

Based on calculations using STATA software, the following results are obtained in Table 4. From the LRM estimation results in Table 4 below, there are six variables that significantly influence farmers' participation decisions in agricultural extension in Ciparay subdistrict (P value <0.05), namely education, land ownership, membership in farmer groups, participation in farmer group, land

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type and use of tech. Thus, this study shows that education, membership in farmer groups, participation in farmer group, land type and use of tech show a positive influence on participation in agricultural extension in Ciparay.

Table 4. Logistic Regression Model estimation (LRM)

Y	Coef.	Std Error.	z	Sig.
Age (years)	0.0003252	0.0063253	0.04	0.973
Education (years)	0.0679122	0.0210709	5.26	0.000
Farming experience	-0.0212871	0.0458484	-0.38	0.811
Land ownership	-0.8332943	0.1549978	-5.83	0.000
Membership in Farmer Group	0.0787675	0.0174378	4.77	0.000
Participation in farmer groups	1.8575461	0.1316293	14.20	0.000
Land Type	0.6912421	0.1417480	5.04	0.000
Use of technology and innovation	0.4712889	0.1267745	4.29	0.000
Constant	-2.725149	0.4197581	-7.68	0.000
Omnibus tests of model coefficients 586.297				
Hosmer and Lemeshow test 0.571				
Pseudo R2 0.24				

Source: Processed Primary Data, 2024

The level of formal education attained by farmers in Ciparay makes it easier for them to understand new information, technology, and agricultural innovations. For example, farmers who have graduated from junior high school tend to be more open to change than farmers who have graduated from elementary school in Ciparay. It has been proven in the field that farmers with higher levels of education participate more in extension activities. Observations in Ciparay also show that farmers with larger plots of land have greater potential to benefit from the application of innovations, so they are more motivated to participate in extension activities than farmers with smaller plots. The larger the plot of land, the higher the level of participation in extension activities.

Farmers who own their own land also appear to be more motivated to invest in knowledge and sustainable agricultural practices, as the results have a direct impact on their personal assets. In general, land-owning farmers are more active in extension activities than tenant farmers. The next variable is participation in farmer groups. It was observed in the field that members of farmer groups tend to participate more frequently in extension activities. Farmer groups serve as the main channel for extension information; members are easier to invite, involve, and benefit from extension activities.

Farmers who use certified seeds are generally more progressive, open to new technologies, and want to increase productivity, so they are more interested in attending extension services. The involvement of farmers in contract farming systems, which is a collaboration between farmers and companies/buyers, is also prominent in the field. Farmers in contract systems are usually required to follow certain standards and receive assistance, including extension services. The type of land also influences the need for technology and cultivation methods. In Ciparay, farmers with more productive

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or more challenging land (rainfed) are more motivated to participate in extension activities to increase their productivity.

In the next step, a balance test was conducted on the difference in means, and we found no significant covariates between the treatment group and the control group. This indicates that the matching algorithm produced relevant groups for comparison. The Average Treatment to Treated (ATT) value was used as an indicator of treatment impact. The ATT score was measured using the nearest neighbor matching method, resulting in a test for the impact of farmer participation in agricultural extension activities, as shown in Table 5 below.

Table 5. Estimated Impact of Participation in Agricultural Extension on the Productivity of Rice in Ciparay District

Matching	Sample	Treated	Controls	Diff	t-stat
NNM	Unmatched	254.21	1723.04	-1467.01	-1.27
	ATT	254.21	246.98	8.126	0.21

Source : Processed Primary Data, 2024

Table 5 shows that agricultural extension has a positive impact on the productivity of rice farmers in Ciparay District. The average land area of rice farmers in Ciparay Subdistrict, both those who participate in extension programs and those who do not, ranges from 0.25 Ha to 0.30 Ha, but there is a difference of 8.126 tons/ha between the group that participates in extension and those that do not, indicating an increase in productivity of 8.126 tons/ha in farmers involved in the activity. who do not participate in agricultural extension in Ciparay. This study is in line with research (Emmanuel et al., 2016) which says that in developing countries, extension activities have a positive impact on farming activities carried out, knowledge and skills provided by extension workers make farmers able to run their farming businesses better. The amount of information farmers receive from extension activities contributes to increasing their competence in managing their farms (Knook et al., 2020). As a result, farmers become more skilled and knowledgeable in managing their farms, which in turn leads to better productivity (Suryana et al., 2024)

Based on the results of interviews with farmers who are active in extension, during the past year many of the extension programs provided were directed at increasing rice production, including: Integrated Land Use Program, Pest Eradication Program, Seed Supply Program, and Sustainable Agriculture Program, which contributed positively to farming in Ciparay sub-district. This research is in line with research (Knook et al., 2018), which states that in the implementation of the extension program there are still some obstacles and problems such as some of the facilities and tools used are still lacking, as well as the number of extension workers who are only two people in Ciparay Sub-district is not comparable to the existing farmers, and the lack of sponsors makes the program carried out some of them hampered. This research still has limitations, other factors outside the model such as government policies need to be considered and studied further in future research.

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CONCLUSION AND SUGGESTION

The results showed that the agricultural extension program has had a positive impact on rice productivity in Ciparay. What needs to be underlined, although the extension program has been able to increase farmers' rice productivity, but the performance of extension workers still needs to be improved, because the farmers' assessment of the performance of extension workers is still not too optimal. Rice farmers' perceptions of the performance of agricultural extension workers are in the medium category. In the eyes of most farmers, the performance of extension workers is considered "mediocre", not very good but not bad either. Farmers feel that the performance of extension workers should be even better. According to farmers, the material delivered by extension workers is useful for them, but when farmers are in a position to face farming problems, extension workers cannot always be present and help, because the number of extension workers is limited and not proportional to the number of farmers. Extension workers must continue to improve their capacity so that their performance can be better in the future.

The agricultural extension program has had a positive impact on rice productivity in Ciparay. However, rice productivity must still be maintained and even improved by considering supporting aspects of extension activities, such as the number of extension workers, facilities, and infrastructure. To improve effectiveness, local governments must ensure a balanced ratio between extension workers and farmers, especially in high-density agricultural villages. Capacity-building programs need to be tailored to Ciparay's agroecological conditions, with a focus on water management, adoption of suitable local high-yielding varieties, and integrated pest management. Extension activities should be conducted regularly, aligned with planting seasons, and utilize participatory methods such as field schools for hands-on learning. Additionally, improving meeting facilities, providing demonstration tools, and expanding access to digital agricultural information are crucial for strengthening extension services and sustaining productivity gains in Ciparay District.

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