



## Adoption Of Sugarcane Cultivation Technology In Sandy Soil, Purworejo District, Central Java

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### ABSTRACT

The efforts to increase agricultural production are expected to year-over-year increase. The aims of this study were 1) to determine the characteristics of farmers in cultivating sugarcane in sandy soil, 2) to determine farmers' adoption of sugarcane plantation cultivation in sandy soil, and 3) to determine the productivity of sugar cane plantations in sandy soil. The research applied descriptive method. The total sample taken was 30 samples who were sugarcane farmers from the sandy soil, Purworejo Regency by purposive sampling. The instrument used was using a Likert scale ranging from strongly agree, agree, undecided, disagree, and strongly disagree. To answer the first objective used descriptive analysis, second, and the third objective used class intervals (low, medium, and high). The results of this study are 1) characteristics of sugarcane farmers on sandy soil in Purworejo Regency are classified as productive, the highest level of education of the farmers is junior high school, the experience of farmers in cultivating sugarcane on sandy soil are > 15 years, the total production of sugarcane are 5- 6 ton, the area of farmer's land are 2-4 Ha, and the productivity level of farmers are 3 - 4 ton/Ha. 2) the adoption rate of sugarcane farmers on the sandy soil of Purworejo Regency are medium, and 3) the level of productivity of sugarcane farmers on the sandy soil of Purworejo Regency is classified as medium productivity. The utilization of coastal land should add compost to increase soil moisture. The seeds that have been certified and have SNI.

### INTRODUCTION

The aim of agricultural development is to create land resource-efficient agriculture achieving national food security through location-specific technology (Nurhayati et al., 2015). An alternative that can be done is the expansion of agricultural areas

towards marginal land, namely coastal sand (Sasongko and Soejono, 2021). Sandy soils in Indonesia with an area of  $\pm 1,060,000$  ha (Kertonegoro, 2009) cit (Nurhayati, et al., 2015) is extremely beneficial for optimizing the increase in agricultural production. According to Airawati, dkk (2021), Purworejo Regency is one

of the coastal areas located in the southern coastal area of Java Island has a coastline of 21 km. Purworejo Regency have a coastal areas along Purwodadi District, Ngombol District, and Grabag District.

Marginal land is basically not appropriate for development in agriculture in case of having various limitations that prevent plants from growing optimally (Hasibuan, 2017). According to Budiyanto, dkk (2020), marginal land is land that has potential fertility because the land has several limiting factors that must be overcome first before being utilized. The characteristics of marginal land could be categorised as less nutrient, biological activity, and organic matter content. The impacts of worst salinity or pollution or erosion to the land were low water holding capacity, degraded and loses its hydrological function (Suharta, 2010) *cit* Bintang, et al. (6459). The potential of marginal lands to improve food security, support bioenergy production or ecosystem services has globally got a lot of attention (Csikós and Tóth, 2023). Marginal land is one of the priorities for utilization of cultivation areas, especially food production. As regards marginal land ecosystems, trees were responsible for the overall physical structure of the habitat as a form of survival, as they also defined the place fundamentally for structural complexity and environmental heterogeneity (Malik et al. 2016) *cit* (Zulfikar, dkk., 2021).

Kusumaningrum and Widiyantono (2018) stated that sandy

soil is the marginal land because the structure of coastal sand land consists more of sand elements than the soil itself. Sari, et al (2020), in the other hand, stated that marginal land is dry land that has limited nutrient content. Marginal land is a nutrient-poor terrestrial ecosystem so that the use of this land is not optimal because the soil organic matter content is minimal. The optimization of marginal land use is relatively unknown to many people because of unfavorable soil conditions, namely dry and poor nutrients resulting in less fertile and unfavorable for agriculture (Suharta 2010) *cit* Mutammimah, et al (2020).

The important to study the role of agricultural extension in adoption innovations because this works as a link between research and farmers, where the problems of farmers are transferred to the research authorities, and here the technology becomes the result of scientific research in solving farmers' problems, as they are the recipients and users of the technology (Omar, 1992) *cit* Mohamed, dkk (2021).

In this study, the researchers focused on sugarcane commodities with high selling value. According to Kurnia (2018), sugarcane (*Saccharum officinarum* Linn) is a plant for raw sugar materials. In 2016, according to data from the Directorate General of Plantations, it was recorded that the total area of sugarcane plantations was 445,520 hectares with a production value of 2.222 million tonne.

Sugarcane is one of the commodities that contribute

significantly to the Indonesian economy. The primary process of sugarcane is to produce sugar as a strategic food commodity. Sugar has an essential role in meeting the needs of society and the food and beverage industry. This value indicates the need for efforts to increase domestic sugar production. One way to increase output is by expanding the plantation area, increasing productivity, and developing farming patterns carried out by sugarcane farmers. The development of dry land sugarcane outside Java Island faces several obstacles, especially the soil's nature, which is unsuitable for the growth of annual crops. The success of sugarcane cultivation on dry land is always limited by natural factors which are difficult to control. The government, through the Ministry of Agriculture, has also established a plantation development policy by increasing the area of sugarcane plantations outside Java Island. The government will also expand the land through community land and *PT Perkebunan Nusantara*. With the raising needs of sugarcane in society, researchers want sugarcane commodities to grow on sandy soil to meet sugar needs locally, regionally, nationally, and even abroad. According to Rogers (2003) *cit* Gandasari, et al (2021), there were five innovation characteristics. Each of which was empirically related to one another but it is conceptually different. Kusumaningrum and Widiyantono (2018) says that, innovation is something new in the form of an idea, thought, opinion or

technology. The five features were a relative advantage, compatibility, complexity, trialability, and observability. Adoption is a decision to use innovation as the best action (Fadhurrahman, et al., 2021). In Aprilia's study, (Aprilia et al. (2018), adoption is the absorption level of new rice farming methods. According to Akbar, et al. (2018), the adoption process must be accompanied by continuous assistance from extension workers. On the other hand, according to Yahya, et al. (2021), a person's change to adopt a new behavior is classified into five stages (awareness, interest, assessing, trying, and adopting). By adopting technology, society can have the ability to take advantage of new technologies that were born in the industrial era 4.0 (Hapsari, et al., 2021). Adoption of innovation can be measured by various benchmarks (indicators), namely relative advantage, suitability, complexity, trialability, and observability (Rogers, 1995) *cit* (Nurmastiti, et al., 2017). Adoption is a mental process of accepting or rejecting an idea and further confirms the acceptance and rejection of the new idea (Rogers, 1983) *cit* (Munawaroh, et al., 2019). Information dissemination activities carried out by extension workers and farmer groups are one of the determining factors for the speed of innovation adoption (Sulastri, et al., 2022). Adoption is determined by various factors, including innovation, communication channels, and extension worker performance (Harta, et al., 2021). Adoption of innovation is a

mental process or behavioral change, whether in the form of knowledge (cognitive), attitudes (affective), and skills (psychomotor) in a person since he knows the innovation until he decides to adopt it after receiving the innovation (Silvestre & Țircă, 2019; Van Oorschot et al., 2018) *cit* (Adianto & Nani., (2022).

Based on stated (Puspitasari dan Winarsih, 2023) Growing Sugarcane on marginal or dry land is an alternative to sugarcane development due to limited irrigated lands. One of some efforts to improve the quality of marginal land, the addition of organic materials and soil conditioners can be given.

The aims of this study were 1) to determine the characteristics of farmers in cultivating sugarcane in sandy soil, 2) to determine farmers' adoption of sugarcane plantation cultivation in sandy soil, and 3) to determine the productivity of sugar cane plantations in sandy soil.

## **METHODS**

This study used a positivistic paradigm with a quantitative research design that is strengthened by a qualitative approach using survey methods or mixed methods with a sequential explanatory strategic approach (Creswell & Creswell, 2018) *cit* (Dharmawan, et al., 2023). Field data collection techniques were carried out through observation, surveys, and interviews.

It was conducted on samples as the target of the research (Dharmawan, et al., 2023). The instrument used was using a Likert

scale ranging from strongly agree, agree, undecided, disagree, and strongly disagree.

To interpret the data, the researchers used descriptive analysis. Descriptive research aims to provide a description (description) of data in order to make the data easily to understand and informative for those who read it. The researchers used 30 samples who were sugarcane farmers from the sandy soil, Purworejo Regency by purposive sampling.

The data collection techniques used in this research are: 1) Observation, namely data collection techniques by directly observing the object being observed, 2) Interview, namely data collection techniques by communicating directly with sample subjects based on a list of questions prepared beforehand, 3) Recording is a data collection technique implemented by disfiguring all the existing data and is related to the purpose, and Literature study, namely data collection techniques to obtain secondary data related to research objectives.

The types of data used in this research are primary and secondary data. Preliminary data is obtained directly from sample farmers through interviews using a list of questions. Meanwhile, secondary data is obtained from Agriculture Department or Central Statistics Agency (BPS) or Agricultural Extension Center (BPP) related to research, such as an overview of the state of an area, the state of agriculture, etc.

To answer the first objective using descriptive analysis, second, and

the third objective using class intervals (low, medium, and high).

$$I = J/K$$

I = Class interval

J = Score distance between maximum and minimum

K = Number of classes used

## RESULTS AND DISCUSSION

### Characteristic of the Respondents

In this study, the characteristics of the respondents were farmer age, education level, experience level, sugarcane production, land area, and productivity.

Table 1 shows that the unproductive farmers under 15 years is 0, the productive age range between 15 and 64 years are 23

farmers or 76.67%, and unproductive farmers with more than 64 years are 7 farmers or 23.33%. It shows that the productive age of farmers is more than the unproductive age. Farmers in productive age.

Table 2 shows that 15 farmers or 50% has junior high school education level, 14 farmers or 46.67% for senior high school, and 1 farmer or 3.33% has Bachelor degree. It shows that most farmers have finished junior high school education.

Table 3 shows that none of farmers has less than 5 years of experience in adopting sugarcane cultivation technology. Meanwhile, 14 people or 46.67% with 5 - 15 years of experience, and 16 people or 53.33% with more than 15 years experience. It means that the experience farmers

**Table 1.** Composition of the farmers based on age on adopting sugarcane cultivation technology in sandy soil in Purworejo Regency, Central Java.

Age	Amount	Percentage (%)
Unproductive (<15)	0	0
Productive (15 - 64)	23	76.67
Unproductive (>64)	7	23.33
Total	30	100.00

Data Source: Primary Source (2022)

**Table 2.** Composition of the Farmers Based on Education Level in the Adoption of Sugarcane Cultivation Technology in Sandy Soils, Purworejo Regency, Central Java

Level of education (Year)	Amount	Percentage (%)
Elementary Shool	0	0
Junior High School	15	50
Senior High school	14	46.67
Diploma	0	0
Bachelor	1	3.33
Total	30	100.00

Data Source: Primary (2022)

**Table 3.** Composition of the Farmers Based on Level of Experience in Adopting Sugarcane Cultivation Technology in Sandy Soil, Purworejo Regency, Central Java.

Experience Level (Year)	Amount	Percentage (%)
< 5	0	0
5 - 15	14	46,67
> 15	16	53,33
Total	30	100,00

Data Source: Primary Source (2022)

**Table 4.** Composition of the Farmers Based on Sugarcane Production on the Adoption of Sugarcane Cultivation Technology in Sandy Soil Purworejo Regency,

Sugarcane Production(ton)	Amount	Percentage (%)
5 - 6	30	100,00
3 - 4	0	0
1 - 2	0	0
Total	30	100,00

Data Source: Primary (2022)

**Table 5.** Composition of the Farmers Based on Land Area in the Adoption of Sugarcane Cultivation Technology in Sandy Beach, Purworejo Regency, Central Java.

Land area(Ha)	Amount	Percentage (%)
> 4	5	16.67
2 - 4	20	66.66
< 2	5	16.67
Total	30	100,00

Data Source: Primary Source (2022)

in cultivating plants have qualified skills because they have been carrying out sugarcane cultivation activities for a long time in coastal sandy fields.

Table 4 shows the sugarcane production (tons) per planting season in one year. The table shows the overall yield of the farmers in sandy soil is between 5-6 tons. This shows that sugar cane crops can grow and develop well when planted on sandy soil.

Based on Table 5, the land area

used by 20 farmers or 66.66% for planting sugarcane on sandy soil is between 2 and 4 Ha, < 2 Ha is used by 5 people or 16.67%, and more than 4 Ha with a high category is used by 5 farmers or 16.67%. This shows that the land used for planting sugar cane about 2-4 Ha.

Table 6 shows that 5 people or 16.67% have high productivity (5-6) ton/Ha and 13 people or 43.33% have medium productivity (3-4) ton/ha, and low (1-2) ton/Ha have low productivity or 40%. This shows that

**Table 6.** Composition of the Farmers Based on Productivity in Adopting Sugarcane Cultivation Technology in Sandy Soils, Purworejo Regency, Central Java.

Productivity(ton/Ha)	Amount	Percentage(%)
High (5-6)	5	16.67
Medium (3-4)	13	43.33
Low (1-2)	12	40.00
Total	30	100,00

Data Source: Primary Source (2022)

the productivity produced by sugarcane farmers in coastal sand fields is medium productivity, around 3-4 ton/ha. This is because the utilisation of land in coastal sand needs to be optimized. Sugarcane farmers should add compost to increase soil moisture.

Based on Table 7, the selection of seeds carried out by farmers in providing stubble seeds in the form of SNI-certified seeds reached an average score of 4.30 or 86.00%. Then the farmers grew sugarcane that is 4-6 months old reached an average score of 3.97 or 79.40%. The average score achieved is 8.27 or 82.70%. This is because farmers are aware of the seeds that have been certified and have SNI. The total average score is 8.27 or 82.70%. This

shows that farmers already have the awareness to use certified seeds that already have SNI with a relatively fast harvest time.

Table 8, the farmers carry out plowing for land conversion, it is achieved an average score of 4.61 or 92.20%. Then on the indicator of farmers carrying out land conversion to loosen the soil, an average score of 4.35 or 87.00%. In the indicator of farmers implementing manure in the processing process, it has an average score of 2.65 or reaches 53%. Furthermore, the last indicator is that farmers is that farmers make beds or mounds and, for sugarcane cultivation, achieve an average score of 4.65 or 93%. The total achievement average score on land management is 16.26 or 81.30%. This shows that

**Table 7.** Scoring Selection of Seedlings for Adoption of Sugarcane Cultivation in Sandy Soils, Purworejo Regency, Central Java.

Selection of Seeds	Interval Score	Average score achieved	Percentage (%)
Do farmers provide stump seeds in the form of SNI-certified seeds?	0-5	4.30	86.00
What is the age of 4-6 months-old sugarcane amphibean farmers? (say, how many	0-5	3.97	79.40
Total	0-10	8.27	82.70

Data Source: Primary Source (2022)

**Table 8.** Land Management Scoring Sugarcane Cultivation Adoption in Sandy Soils, Puworejo Regency, Central Java.

Selection of Seeds	Interval Score	Average score achieved	Percentage (%)
Farmers carry out plowing for land conversion.	0-5	4.61	92.20
Farmers implement land conversion to loosen the soil.	0-5	4.35	87.00
Farmers apply manure in the land management process.	0-5	2.65	53.00
Farmers carry out the making of beds or mounds for sugar cane cultivation.	0-5	4.65	93.00
Total	0 - 20	16.26	81.30

Data Source: Primary Source (2022)

**Table 9.** Scoring of Planting Adoption of Sugarcane Cultivation in Sandy Soil, Purworejo Regency, Central Java.

Planting	Interval Score	Average score achieved	Percentage (%)
What is the planting time of 6 months?	0-5	4.37	87.40
Do farmers plant pollen with a planting distance of 100-120 cm?	0-5	2.50	50.00
Total	0-10	6.87	68.70

Data Source: Primary Source (2022)

many farmers have done land processing activities following the procedures for cultivating sugarcane plantations.

Based on Table 9, the indicator for the 6-month planting period of sugarcane is to achieve an average score of 4.37 or 87.40%. Farmers planting sugar cane with a spacing of 100-120 cm have an average score of 2.50 or 50.00%. The total average score achieved is 6.87 or 68.70%. This shows that farmers choose sugarcane plants that have a planting period of about 6 months with a spacing of 100-120 cm.

Based on table 10, maintenance indicators on watering sugarcane plants is carried out using

technical irrigation with the average score 3.73 or 74.60%. In the irrigation of sugarcane plants using rainfed watering, the average score was 2.63 or 52.60%. The farmer irrigation indicator is done by mixing fertilizer nutrients for plants. The average score achieved is 3.03 or 60.60%. In the indicator of farmers doing weeding on sugarcane cultivation, the average score achieved was 4.03 or 80.60%.

The total average score achieved was 13.43, or 67.15%. This shows that the irrigation system carried out by farmers is in the form of technical irrigation, rainfed fields and by mixing nutrients when irrigation.

Table 11 shows on the fertilizer indicators, farmers provide organic



**Table 10.** Scoring of Adoption Maintenance of Sugarcane Cultivation in Sandy Soils, Purworejo Regency, Central Java.

Maintenance	Interval Score	Average score Achieved	Percentage (%)
Is irrigation on sugarcane cultivation carried out using technical irrigation?	0-5	3.73	74.60
Is irrigation on sugarcane cultivation carried out using rainfed watering?	0-5	2.63	52.60
Is irrigation of farmers done by mixing nutrient fertilizers for sugarcane cultivation?	0-5	3.03	60.60
Do farmers do weeding on sugarcane cultivation?	0-5	4.03	80.60
Total	0-20	13.43	67.15

Data Source: Primary Source (2022)

fertilizer to sugarcane plant with an average score of 3.93 or 78.60%. Farmers gave ZA fertilizer at the age of 20-30 hst sugarcane plant achieved an average score of 5 or 100%. Then the farmers gave phonska fertilizer at the age of the sugarcane plant 20-30 hst achieved an average score of 5 or 100%. Farmers gave ZA and Phonska fertilizers on the second fertilization with an average score of 5 or 100%.

The average total score on the adoption of sugarcane cultivation in sandy soil in Purworejo Regency, Central Java, is 18.93 or 94.65%. The fertilizers used by farmers are compost, ZA, and phonska. Based on table 12, eradication of pests on indicators of farmers implementing shoot borer pest control at 2 weeks of plant age has an average score of 4.07 or 81.40%.

**Table 11.** Scoring of Fertilizer Adoption of Sugarcane Cultivation in Beach Sand, Purworejo Regency, Central Java.

Fertilization	Interval Score	Average Score Achieved	Percentage (%)
Do farmers provide organic fertilizer on sugarcane?	0-5	3.93	78.60
Do farmers give ZA fertilizer at the age of the sugarcane plant of 20-30 hst?	0-5	5	100
Do farmers give phonska fertilizer at the of 20-30 hst sugarcane plant?	0-5	5	100
Do farmers provide ZA and Phon-ska fertilizers in the second fertilization?	0-5	5	100
Total	0-20	18.93	94.65

Data Source: Primary Source (2022)

**Table 12.** Scoring for Pest and Disease Eradication Adoption of Sugarcane Cultivation in Sandy Soil, Purworejo Regency, Central Java.

Eradication of Pests and Diseases	Interval Score	Average Score Achieved	Percentage(%)
Farmers carry out pest management of the shoot borer disease at the 2-weeks sugarcane plant.	0-5	4.07	81.40
Farmers carry out mechanical control on the disease.	0-5	4.07	81.40
Farmers carry out technical and cultural controls, for example, using stubble varieties that are resistant to pests and diseases.	0-5	4.87	97.40
Farmers carry out biological pest and disease control? For example, parasitoids and predators such as trichogammachilonis, cotesia flavipes, sturmiopsi sinferens etc.	0-5	2.57	51.40
Farmers carry out chemical pest and disease control? For example, with the application of carbofuran with a microband and spray.	0-5	4.60	92.00
<b>Total</b>	<b>0-25</b>	<b>20.17</b>	<b>80.68</b>

Data Source: Primary Source (2022)

Farmers carrying out mechanical control have an average score of 4.07 or 81.40%. Farmers implementing cultural control have average score of 4.87 or 97.40%. Farmers carrying out biological pest and disease control using parasitoids and predators such as *Trichogamma chilonis*, *Cotesia flavipes*, *Sturmiopsis inferens*, etc., with an average score of 2.57 or 51.40%. In addition, farmers carrying out chemical pest and disease control with the application of carbofuran with microbands and being wasted. sprays have average of 4.60 or 92.00%. The control of these pests and diseases is to increase the productivity of sugar cane plants so that optimal results are produced.

Based on table 13, farmers carried out knife harvesting activities

with an average score of 5 or 100%. Farmers carried out loading activities with an average score of 2.10 or 42%. The indicator of farmers carrying out transport activities is 2.10 or 42%. The total average score achieved is 9.20 or 61.33%. The need for standards that are carried out in harvesting is to avoid damage to the sugarcane stems and to produce pure cane starch extract. Then it is also necessary to pay attention to the loading and transport activities according to the procedure in order to avoid the load of sugarcane stalks being wasted. Based on table 14, it was found that farmers directly sold their sugarcane crops to middlemen, achieving an average score of 2.10 or 42%. Farmers directly sell sugarcane crops on the market with an average

**Table 13.** Scoring for Sugarcane Cultivation Harvesting Adoption on Sandy Soil, Purworejo Regency, Central Java.

Harvesting	Interval Score	Average Score Achieved	Percentage(%)
Farmers carry out knife harvesting activities.	0-5	5	100
The farmer carry out loading activities.	0-5	2.10	42
Farmers carry out transport activities.	0-5	2.10	42
Total	0-15	9.20	61.33

Data Source: Primary Source (2022)

**Table 14.** Scoring for Post-harvesting of Sugarcane Cultivation Adoption on Sandy Soil, Purworejo Regency, Central Java.

Post-harvest	Interval Score	Average Score Achieved	Percentage(%)
Farmers directly sell their sugarcane crops to middlemen.	0-5	2.10	42
Farmers directly sell their sugarcane crops on the market.	0-5	4.03	80.6
Farmers directly sell their sugarcane crops to sugarcane factories.	0-5	4.63	92.6
Total	0-15	10.77	71.80

Data Source: Primary (2022)

**Table 15.** Farmers Adoption Rate on Sugarcane Cultivation in Sandy Beach in Purworejo Regency.

Category Adoption	Number of Farmer	Percentage(%)
High (27-29)	5	16.67
Medium (24-26)	21	70
Low (21-23)	4	13.33
Total	30	100.00

Source: Primary Data (2022)

score of 4.03 or 80.6%. Moreover, the last indicator that farmers directly sell their sugarcane plants to sugarcane factories have an average score of 4.63 or 92.60%. The total average score achieved is 10.77 or 71.80%. Sales of sugarcane crops can be made directly to middlemen,

to the market and to the sugarcane factories.

Madukismo factory is one of the factories to sell sugarcane crops.

Table 15 shows the adoption rate of farmers on sugarcane cultivation in coastal sandy soil in Purworejo Regency. In the high

category, there were 5 people or 16.67%, then in the medium category with 21 people or 70%, and the low category 4 people or 13.33%. This shows that the level of farmers adoption of sugarcane cultivation on sandy soil in Purworejo Regency is moderate. This shows that the level of the adoption carried out by farmers is in accordance with the procedure.

### CONCLUSION AND SUGGESTION

The first, characteristics of sugarcane farmers in the sandy soil of Purworejo Regency are in the productive age with junior high school graduates as the highest level of education. The average experience of farmers in cultivating sugarcane in the sandy soil is more than 15 years.

The total production of sugarcane by the farmers is 5-6 ton. The area of the farmer's land is in the range of 2-4 Ha and the productivity level is 3-4 ton/Ha, Second, the adoption rate of sugarcane farmers in the sandy soil of Purworejo Regency belongs to medium. And the last, level of productivity of sugarcane farmers in the sandy soil of Purworejo Regency is classified as medium productivity. The utilization of coastal land should add compost to increase soil moisture. The seeds that have been certified and have SNI.

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