Factors affecting farmers' decision to use subsidized seeds on hybrid corn farming in Seluma Regency, Bengkulu Province. Indonesia

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Abstract The results indicated that factors such as age, education, land area, seed prices, productivity, and time spent in farmer groups collectively influence farmers' choices between subsidized and non-subsidized hybrid corn seeds. The likelihood test ratio (57.594) exceeded the chi-square value (3.841) at $\alpha = 0.05$, indicating a significant impact. Furthermore, the research variables revealed that farmers had a 50.50% probability of using subsidized corn seeds, as indicated by the R square value 0.505. Meanwhile, a 49.50% probability of using subsidized corn seeds was influenced by factors not accounted for in the model. The analysis showed a negative influence on various variables, including land size and the duration of farmers' membership in the farmer group. Additionally, the price of corn seeds influenced farmers' use of subsidized and non-subsidized hybrid corn seeds. Other variables, such as age, education, and productivity, did not positively influence farmers' decision to utilize hybrid corn seeds. The findings of this study underscored the necessity for further knowledge dissemination and explicited information provision to farmers concerning the implementation of the seed subsidy program in the study area.

Keywords: Subsidized seed, Agricultural input subsidized, Land area, Hybrid corn, Farmers' decision

Introduction

Indonesia is ranked to be the 21st of corn-importing country with an average import volume of around 2.26 million tons annually from 2014 to 2018, equivalent to 1.58% of the total world corn import volume. The growing demand of corn for animal feed as compared to household or industrial use ranged from 2.52 million tonnes to 4.69 million tonnes, with a growth rate of 34.24%. The overall use of corn in this sector has also increased, with dry corn kernels rising by 2.63% every year from 2015 to 2019. Meanwhile, Indonesia's projected need for corn in 2024 reached 17.16 million tons (Pusdatin, 2020). According to

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research conducted by Kasryno *et al.* (2007), it is estimated that more than 55% of corn in Indonesia is used for animal feed, 30% for functional food, and the rest for other industries and seeds. This imbalance between the availability and use of corn has forced the Indonesian government to implement seed subsidies to assist farmers in obtaining certified superior variety seeds. The Indonesian Minister of Agriculture Regulation Number 67/Regulation of the Minister of Agriculture/OT.140/6/2013 provides the guidelines regarding seed subsidies, outlining the criteria for farmer groups who purchase the subsidized hybrid corn seeds, especially in new development areas.

Agricultural subsidies are essential for increasing farm income and reducing poverty. However, their implementation is complicated due to the socio-economic conditions of recipient households. Also, there is a lack of alignment between the results of the subsidies and the goals of agricultural subsidy programs (Wang *et al.*, 2019). In addition, Agricultural input subsidies, mechanization, and market functioning significantly improve productivity and ensure food security's sustainability (Dixon *et al.*, 2021). Furthermore, subsidies for agriculture may improve dietary diversity, not hinder it. A large-scale study in Malawi found that farmers who received government help for seeds and fertilizer grew a wider variety of crops and ate more nutritious food. These findings suggest that subsidies can be a helpful tool (Snapp and Fisher, 2015). Other studies in many countries found that agricultural subsidy programs stimulate green revolution technologies adoption and increase crop yields (Ajefu *et al.*, 2021; Tsiboe *et al.*, 2021; Minah, 2022).

Many studies on using hybrid corn seeds and providing subsidies have shown positive results in increasing production and income compared to non-hybrid corn. Setimela and Kosina (2006) proved that hybrid corn varieties were about 15 % more profitable when compared to open-pollinated varieties. Carter *et al.* (2021) stated that the spillover impact of the temporary subsidy for Mozambique's corn farmers leads to increased corn productivity from increased technology adoption and stimulation of learning about new technology. According to Mason and Smale (2013), providing subsidized hybrid seeds in Zambia led to slight improvements in the well-being of small-scale maize farmers across various indicators during the program's early years. In addition, hybrid corn seeds can increase farmers' income by IDR 4,100 for each use of IDR 1,000 compared to corn seeds. In terms of productivity and average profit obtained, hybrid corn seeds received an excellent response and were adopted by farmers due to their relatively high productivity compared to non-hybrid corn (Subedi *et al.*, 2018; Bahtiar *et al.*, 2020).

The lack of clear policies and regulations between the roles of the government and the private sector in seed production and marketing has

hampered the development of the seed industry (Ubaidillah *et al*., 2023). Research conducted by Oelviani *et al*. (2021) stated that the process involves producing hybrid corn seeds at the farmer level, and the effectiveness of new technology must be achieved because different conditions can cause farmers to make wrong decisions when using hybrid corn seeds. In addition, warmer temperatures can also reduce crop yields because the more extended maturity period for corn can accelerate reproductive development. Therefore, corn farmers in the American Midwest decided to plant hybrid corn, which took longer to extend the grain-filling period (Abendroth *et al*., 2021). Furthermore, environmental and economic issues can influence farmers' decisions to cancel corn protection with herbicides and insecticides (Reboud *et al*., 2016).

Multiple domestic and international obstacles emerged when providing subsidies for corn seeds. Kariyasa (2007), discovered a significant perspective on this issue, stating that the seed subsidy policy through producers is less effective because farmers do not enjoy the subsidy. In addition, Winarso (2014), mentioned that farmers used superior seeds were performed by the farmer due to the high supply cost and limited availability of these superior seeds. Consequently, many farmers still develop local varieties of corn seeds.

On the other hand, inconsistencies in seed certification in Zambia between yield potential and actual yields by farmers were found (Blekking *et al*., 2020). According to Murtaza *et al*. (2020), the basic needs of the determinants of adoption of corn technology in Pakistan is recommended the government provided formal and informal education in addition to facilitating farmers with subsidized prices of hybrid corn technology. Due to the concerns of farmers, they would be less to adopt hybrid corn varieties. To prevent this condition, the Input Subsidy Programs (ISPs) have been implemented in Africa and are one of Sub-Saharan Africa's most hotly debated public policy issues. ISPs have proven effective in raising national food production quickly in one growing season. However, the overall effects of subsidy programs on output and welfare tended to be smaller than initially expected (Jayne *et al*., 2018). Therefore, the research aimed to analyze the factors affecting farmers' decision to use the subsidized seeds in hybrid corn farming and determined that can be used to encourage a wider use of the subsidized seeds among farmers.

Materials and methods

Research location

In this study, Seluma Regency was selected as the sampling location. The region comprises 15 sub-districts, three of which were selected for the specific sampling area: Sukaraja District, Air Periukan District, and South Seluma

District. These districts were selected as most farmers in this region often cultivate hybrid corn plants using subsidized and non-subsidized seeds.

Population and sample

The population in this study consisted of all members of farmer groups totaling 307 people, located in District Sukaraja, with as many as 30 people; Air Periukan Subdistrict, with as many as 61 people; and South Seluma District, with as many as 216 people (Center for Agricultural Data and Information System, 2020). Respondents were taken from as many as 20% of the population, namely as many as 61 farmers.

Method of collecting data

Sampling was done using a cluster random sampling method. Primary data and field information were collected using a questionnaire by conducting direct interviews with 61 corn farmers (46 hybrid corn farmers using subsidized seeds and 15 hybrid corn farmers not using the subsidized seeds). Hybrid corn farmers who use the subsidized seeds have the criteria of planting in the previous two seasons. Meanwhile, secondary data was collected from the Agricultural Field Extension Office, the local Agriculture Service, the Central Statistics Agency, and other relevant agencies.

Research variables

This study examined seven key variables: one dependent variable and six independent variables. The dependent variable measured the likelihood of hybrid corn farmers choosing either subsidized or unsubsidized hybrid corn seeds. Farmers who used subsidized seeds were assigned a score of 1, while those who did not were assigned a score of 0. The independent variables consisted of six factors hypothesized to influence farmers' decisions regarding seed selection. These variables were X1 which represented the price of subsidized and unsubsidized hybrid corn seeds, X2, which represented the total production of dry-shelled corn for an entire growing season, X3 which referred to the area of hybrid corn cultivation land, X4 which represented farmer's age, X5 which referred to a farmer's education level and X6 which represented farming experience.

Data analysis

Descriptive data analysis consisted of percentages and averages used to describe the respondent farmers' socio-demographic profile (age, formal

education, years of joining farmer groups, and land area) and the practice of corn cultivation technology (the price of corn seeds and corn productivity).

Logit model regression analysis is referred to Gujarati (1999). The logit model was used to estimate the correlation variable between farmers' decision to use the subsidized seeds in hybrid corn farming and the price of corn seed, corn production, land area, age, education, and length of time in the farmer group.

The computation of the logit model in this research was used SPSS V22 to determine the significant variables and to know the probability of predicting farmers' decisions to use the subsidized seeds that affected the independent variable (Greene, 2000). The general formula of the logit model is shown as follows:

$$P_i/(1-P_i) = (1 + e^{(-\alpha - \beta x)}) / (1 + e^{(\alpha + \beta x)})$$

The natural log of the model would be as follows:

$$Ln [P_i/(1-P_i)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + e_i$$

Where:

Y_1	= Farmers using subsidized seeds;
Y_0	= Farmers do not use subsidized seeds;
α	= Constanta;
X_1	= price of corn seed;
X_2	= corn production (kg/ha);
X_3	= land area (ha);
X_4	= age of the head of household (year);
X_5	= formal education of the head of household (year);
X_6	= length of time in farmer groups (year), and
e_i	= error term.

Results

Socio-demographic characteristic

In this study, two groups of farmers were the farmers who used the subsidized hybrid corn seeds and the other who did not use the subsidized hybrid corn seeds. Respondents were 61 people, consisting of 46 farmers who used subsidized corn seeds and 15 farmers who did not use the subsidized corn seeds.

The observed factors included the socio-demographic characteristics of corn farmers, as age, level of formal education, length of time in farmer groups, and ownership of land area, as well as physical factors, as the price of corn seeds and corn productivity. The detailed socio-demographic characteristic data of corn farmers is presented in Table 1.

Table 1. Socio-demographic of corn farmers

No	Characteristics	Corn Farmers		Average	Range
		Number	**(%)**		
1.	**Age (years)**				
	Young (30 – 44)	21	34.43		
	Medium (45 – 58)	27	44.26	48.98	30 - 72
	old (59 – 72)	13	21.31		
2.	**Formal education**				
	Elementary (0-6)	6	9.84		
	Junior high school (7-9)	24	39.34		
	Senior high school (10 – 12)	10	16.39	7.57	0 - 17
	Academy (13-15)	14	22.95		
	College (>16)	7	11.48		
3.	**Length of time in farmer group (years)**				
	New (2 – 11)	34	55.74		
	Medium (12 – 20)	20	32.79	13.09	2 - 30
	Old (21 – 30)	7	11.47		
4.	**Land area (ha)**				
	0.15 – 1.43	55	90.16		
	1.44 – 2.72	5	8.20	0.81	0.15 - 4
	2.73 – 4.00	1	1.64		

The socio-demographic characteristics of respondents in Seluma Regency are described in Table 1. The age of farmers ranged from 30 to 72 years, with the majority (78.79%) falling within the 30 to 58 age group, indicating that most farmers were within the productive age range. Educational attainment among farmers varied; the result showed that 9.84% completed elementary school, 39.34% of farmers had finished junior high school, 16.39% of farmers had finished senior high school, and 34.43% attained education up to the academy or college level. Additionally, most respondents had participated in farmer groups for 2 to 11 years, with an average participation of 13.09 years. Most farmers (90.16%) in the study area cultivated land with sizes ranging from 0.15 to 1.43 hectares, with an average landholding of 0.81 hectares. This finding indicates that corn farming in the region was predominantly small-scale, which may influence farmers' capacity to adopt advanced agricultural practices.

Corn seed prices

Most farmers brought the corn seeds from IDR 51,334 to IDR 80,666, with an average price of IDR 74,049 (Figure 1). The price range of corn seeds was between IDR 22,000 and IDR 111,000, both for the cost of the subsidized hybrid corn seeds and the price of non-subsidized corn seeds. The subsidized hybrid corn seed used by farmers in the research area was BC-12 corn seed.
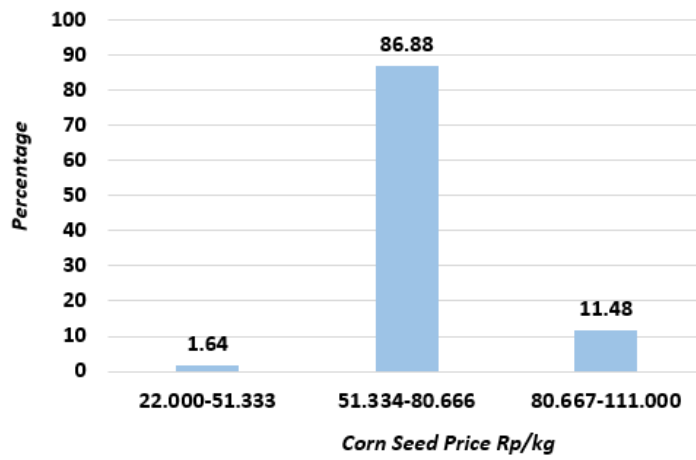
Figure 1. Distribution of corn seed prices in the study area

Corn productivity

Corn productivity that farmers were averaged 4.49 tons per hectare, with production ranged between 2.00 to 8.67 tons per hectare. Most farmers (60.75%) achieved productivity levels ranged from 2.00 to 4.22 tons per hectare. Only 9.84% of farmers achieved productivity from 6.45 to 8.67 tons per hectare (Figure 2).
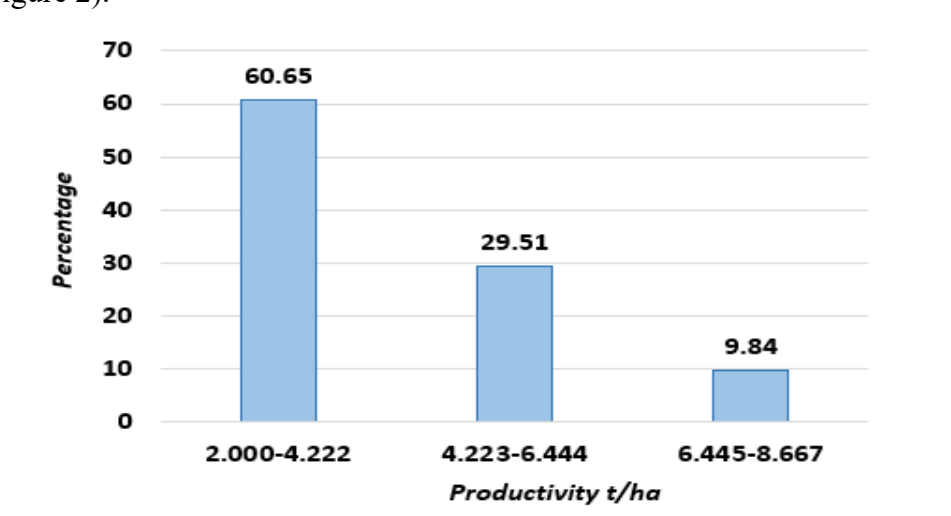

Figure 2. Distribution of Corn Productivity in the Study Area

The estimation of the factors that influence the farmer's decision to use subsidized hybrid corn seeds

The results of the logit regression estimation of factors that influence farmers to use subsidized corn seeds can be seen in Table 2.

Table 2. Estimating the factors influencing the farmer's decision to use subsidized corn seeds

Variable	Estimated Coefficient (β)	Se (bi)	Wald	Sig.	Odd Ratio (Expβ)
Seed Price	0.000	0.000	3.482*	0.062	1.000
Productivity	0.000	0.000	0.253	0.615	1.000
Land Area	-1.755	0.999	3.087*	0.079	0.173
Age	0.040	0.038	1.054	0.305	1.040
Formal Education	-0.266	0.319	0.697	0.404	0.766
Length of time in farmer group	-0.173	0.071	5.855**	0.016	0.841
Constanta	9.885	3.550	7.755	0.055	19630.577
Nagelkerke RSquare	0.505				
X^2 table 0.01 (df=6)	12.592				
X^2 table 0.05 (df=1)	3.841				
X^2 table 0.10 (df=1)	2.706				

Note: ***, **, * A significant level of 0.01, 0.05, and 0.10, respectively.

The effect of each variable studied in this study on farmers' decisions to use subsidized hybrid corn seeds or not to use subsidized hybrid corn seeds were investigated.

The R-squared value obtained was 0.505. This value means that the independent variables tested in this study could explain 50.50% of the farmers' decision to use subsidized seeds, while the remaining 49.50% were explained outside the model including farmer experience, belief, and right to use subsidizing seeds.

The corn seed price had significantly affected on the dependent variable at a significant level of 0.10 (Table 2). This result can be seen from the comparison of the significant value obtained with a significance of 0.062 < α at 10%) and the Wald value (3.482 > 2.706) It can be concluded that variable corn seed price had a real influence on the farmers' decision to use subsidized hybrid corn seeds. This indicated that the cheaper price of subsidized corn seed compared to non-subsidized was preferred by farmers to conduct farming activities.

The land area variable had a Wald value compared to its chi-square value. This result informed that land area had a significant influence on the farmers' decision to use subsidized hybrid corn seeds. However, the coefficient value obtained was negative informing an inverse relationship between land area and farmers' decision to use subsidized maize seeds. Thus, the larger the land area owned by farmers, the more they prefer to use non-subsidized seeds. The Odd ratio value was 0.173 indicating that when the land area increases by one unit (for example 1 hectare), the probability of using subsidized corn seeds decreases by about 82.7% (1 - 0.173). In other words, farmers with larger land areas tend to be less likely to use subsidized corn seeds than farmers with smaller land areas. In addition, the results of the analysis can explain that farmers with larger land areas may be more able to purchase non-subsidized seeds compared to farmers with smaller land areas who are more dependent on government assistance.

The results of logit regression analysis showed that the variable X6 (*length of joining the farmer group*) had a negative regression coefficient value, indicating that there was an inverse effect between the participation of farmers joining the farmer group and the decision of farmers to use subsidized corn seeds. The Wald value of 5.855 > Chi-square value (3.841), with a significance value of 0.016 < α 5% (0.05), so it could be said that the variable length of joining the farmer group had significantly affected on the level of farmer decisions to use subsidized corn seeds at the 95% level. The longer farmers join the farmer group, the more likely they will choose not to use subsidized corn seeds. The Odd ratio was 0.841, which means that the longer farmers join the farmer group, the more they reduce the use of subsidized corn seeds by 0.841 times from before.

Classification plot

A simple model explained the accuracy of the use of subsidized corn seeds. Studies showed that respondents are grouped based on whether farmers use subsidized hybrid corn seeds (indicated by the number 1) or do not use subsidized corn seeds (ranked as 0) (Table 3).

Table 3. Frequency of actual and predicted outcomes of the seed corn subsidized model

Observed	Predicted			
	0	**1**	**Total**	**Percentage Correct**
0	10	5	15	24.59
1	0	46	46	75.41
Total	10	51	61	100.00
Percentage	16.39	83.61	100.00	100.00

The use of subsidized corn seeds was analyzed on actual data and predictions from farmers, as presented in Table 3. Of the total respondents, 15 individuals did not participate in the use of subsidized seeds. Of these 15 people, 10 people did not use subsidized seeds, while 5 others, although they should not have used them, still used them. On the other hand, 46 respondents were recorded as using subsidized corn seeds. The total percentage value obtained was $(10 + 46)/61 = 91.80\%$, meaning the accuracy of this logit regression model was 91.80%, which indicated that the model could predict the conditions in the study area, demonstrating a good fit of the model.

Discussion

Three factors affect farmers' decisions to use subsidized corn seeds, including the price of the seeds, land area, and length of time as a member of a farmer group. Meanwhile, this research also found that productivity, age, and education have insignificant influence on adopting subsidized corn seeds. These findings suggested that practical and financial considerations are more important than personal characteristics in this context. These findings also underscore the need for policies that target economic incentives and strengthen farmer groups to promote the effective use of subsidized fertilizers.

The price of the seeds themselves influences farmers' use of subsidized and non-subsidized hybrid corn seeds. The main reason is that farmers want to minimize costs and maximize income. In addition, this finding is reasonable because the majority of farmers always consider input prices in farming, including in adopting technology, as found by Mensah *et al*. (2021); Kabeakan and Manik (2020); and Pal *et al*. (2016). This research concluded that with subsidized seeds, farmers can reduce production costs that must be incurred since price affects the use of seeds and the repurchase of the same seeds.

In many studies, Hu *et al*. (2022); Ojo *et al*. (2019); Nyariki (2011); Martínez-García *et al*. (2015) stated that the area of land owned by farmers is often the primary determinant in adopting or not a new farming technology. However, a dissimilar finding occurred in this study, which found that the land area owned by farmers hurt farmers' ability to use superior corn varieties compared to those with limited land. Farmers with large plots of land can apply the new corn varieties introduced to some of their land without worrying about affecting the yield and income they receive. A contradictory result is found in the research of Harianto *et al*. (2020), which concluded that the land area has a positive and significant effect on farmers' decision to use the input of New Superior Variety rice seeds along with the increase in land owned by farmers.

One of the causes of less agricultural production is the low adoption of technology. Adopting this technology is also often associated with a lack of

information on farmers, especially smallholders, about new and renewable technologies. Therefore, the involvement of farmer groups is an important policy so agricultural innovation information can be conveyed to farmers quickly. This argument is in line with the opinions of Hennessy and Heanue (2012); Ahmed and Anang (2019); and Addai *et al.* (2022); who stated the significance of the existence of farmer groups in accelerating technology adoption. However, the findings of this study have an inversely proportional effect between the length of time they joined the farmer group and the decision of farmers not to use subsidized superior hybrid corn seeds. In other words, the length of time to join a farmer group reasonably influences the non-use of subsidized superior hybrid corn seeds from before. Farmers who have good experience in technical, environmental, economic, and social aspects are still relatively slow in adopting hybrid corn seeds, in contrast to the results of research from (Mau *et al.*, 2022) where farmers who have high knowledge or experience will better understand how to use subsidized fertilizers thoroughly and appropriately compared to farmers who have little or no experience. Furthermore, Saad and Nainggolan (2020) stated that if the farming experience is getting stronger, it is directly proportional to the conversion of land from rice fields to oil palm plantations.

The study results concluded that there was a negative influence on several variables, such as land area and the length of time farmers joined the farmer group. In addition, the variable price of corn seeds positively influences the hybrid corn seed subsidy program. Other variables, such as age, education, and productivity, also did not positively influence farmers' decisions to use hybrid corn seeds. Overall, from this study's results, it seems necessary to provide additional knowledge and clear information to farmers regarding the implementation of the seed subsidy program in the research area. Similar to the statement (Alta *et al.*, 2021), the utilization of agricultural inputs is still not optimal due to the agricultural input subsidy policy. The seed subsidy program has not increased the adoption of hybrid and hybrid rice seed varieties; domestic production capacity is also still low. Nguyen and Tuan (2021), found that farmers who did not get subsidized seeds had higher production than farmers who received subsidized variety seeds. Therefore, the recommendation of this study is for the government to review this subsidy policy. Furthermore, Mastenbroek *et al.* (2021) stated that in the adoption of agricultural technology, there are obstacles for farmers in receiving information related to certified seeds, as shown by only 14% of farmers willing to pay according to market prices. Therefore, this study recommends that the government consider providing additional forms of support, including extension training programs tailored to meet the specific needs of various farmer groups.

Acknowledgements

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