Application of Simple Multi-Attribute Rating Technique Exploiting Rank (SMARTER) Method In Seed Selection Superior Corn in Silau Mangi Village

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A B S T R A C T

Agriculture is one of the important sectors in Indonesia. Most of Indonesia's population depends on the agricultural sector, one of which is corn farmers. Cultivation of corn plants starts from choosing quality seeds. Determination of quality corn seeds aims to increase productivity and quality of production. Various efforts can be made to increase corn production such as the use of superior corn seeds. Efforts to increase corn production are still experiencing several obstacles, such as the lack of understanding of farmers in determining superior corn seeds. This study aims to apply the SMARTER method in selecting superior maize seeds in order to increase maize production. The Simple Multi Attribute Rating Technique Exploiting Rank (SMARTER) method is one of the methods in a decision support system whose solution is by using Rank Order Centroid (ROC) weighting on each criteria and sub-criteria. The results of the research carried out obtained five criteria that were used as an assessment in the selection of corn seeds, namely resistance to pests, seed size, production yield, environmental adaptation and harvest time

Keywords:

Corn, Rank Order Centroid, Simple Multi Attribute Rating Technique Exploiting Rank

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1. INTRODUCTION

Agriculture is one of the important sectors in Indonesia. Most of Indonesia's population depends on the agricultural sector, one of which is corn farmers. Corn is a potential agricultural commodity and has very good prospects[1] .Corn is also one of the cereals that has economic value andhas the opportunity to be developed because corn is the main source of carbohydrates, protein and feedsources after rice. The potential of corn is not only used as an alternative to staple food, but also as a source of raw materials for making renewable bioenergy[2]. The potential of corn can not be separated from agricultural facilities and infrastructure. One of the means of agricultural production is seeds. Seeds are one of the determinants in the success of corn cultivation. Cultivation of corn plants starts from choosing quality seeds because seeds are the main object to be developed in subsequent cultivation. Determination of quality corn seeds aims to increase productivity and quality of production increases and sometimes decreases. The instability of corn production can be seen in table 1.

Table 1. Corn Production (sumut.bps.go.id)

County/City	Corn Production (Tons)		
	2019	2020	2021
North Sumatra	1960424.00	1965444.00	1724398.00
Pematangsiantar	3561.70	5772.00	5411.00

In table 1 it can be seen that the increase and decrease in corn production will greatly affect export-import level. Currently, Indonesia is still receiving imports of corn from other countries. The Central Statistics Agencyrecorded that there were imports of corn worth Rp. 401.45 billion that entered Indonesia in September 2021.

Various efforts can be made to increase corn production, such as improving cultivation techniques by using superior corn[1][3]. Efforts to increase corn production still face manyobstacles so that corn production has not been able to meet national needs[4][5]. One of the obstacles faced by farmers is the lack of understanding in determining superior corn seeds.

In determining superior corn seeds is not easy. According to[6][4], to determine the seeds. There are five criteria for superior maize, namely environmental adaptation, resistance to pests, seed size, harvest time and production yield. The development of maize commodities in Indonesia is still experiencing several obstacles that can be seenfrom various aspects, such as aspects of narrow land resources, poorly maintained water/irrigation systems. The next problem from the business / production aspect is the high price of fertilizer and the less than optimal in handling cultivation so that the results obtained are not maximized. Problems like this require solutions so that Indonesian farmers are able to choose superior corn seeds that are suitable for the location of farming in the village, especially the village of Silau Mangi.

Silau Mangi Village is a village located in the Siantar Marihat District,Pematangsiantar, North Sumatra Province. This village has an area of 782.5 ha. Most of the people in this village make a living in agriculture. The villagers grow many kinds of crops, especially corn. There areseveral types of corn that are cultivated such as sweet corn (*Sweet corn*), horse tooth corn (*Dent Corn*), glutinous corn (*waxy corn*), corn flour (*Foury corn*), Hybrid maize and composite maize. The maize varieties grown are Bisi, Pioner and NK. The corn planting area in Silau Mangi village is 42 hectares. In 2021 this village will produce 272 tons of corn with a productivity of 63.26 kw/ha. Corn production in this village is still not optimal. Not carelessly in planting corn because it has to pay more attention to corn seeds to be planted. Usually farmers who grow corn on a small scale, they use corn seeds that are selected from their own harvest. The continuous use of harvested seeds will result in growth restrictions *genetic*individuals from a number of plant populations. Farmers also often choose corn seeds that have afast planting time but result in poor yields on fruit size and yields that can even lead to crop failure.Based on the proble In this village, there is a need for a system that provides solutions with a number of criteria and alternatives in a decision support system to choose superior corn seeds.

A decision support system is a way that can help make a decision by utilizing data and models to solve various unstructured problems. One model that is quite widely used in building a decision support system is MCDM (*Multi Criteria Decision Making*). MCDM is a branch of the operations research model that deals with decision making. This model works by conducting an assessment process of alternatives based on existing criteria. The implementation of this method is used to find the best opinion from several existing alternatives, usually conflicting based on decision criteria. To build the MCDM model, a method is needed. One method that is quite good in carrying out the alternative ranking process is SMARTER.[7] [8]

Simple *Multi Attribute Rating Technique Exploiting Rank*(SMARTER) is a technique or method that *multi-attribute*in the decision-making system. This method is the development of the SMART method. Decision making techniques*multi*This criterion is based on the theory that each alternative consists of a number of criteria that have values and each criterion has a weight that describes how important it is compared to other criteria [5][6]. Weighting criteria by method*Simple Multi Attribute Rating Technique Exploiting Rank*(SMARTER) is calculated using the weighting formula*Rank Order Centroid*(ROC) on each criterion and sub- criteria.*Rank Order Centroid*(ROC) is based on the importance or priority of the criteria. The ROC technique gives weight to each criterion according to the ranking that is assessed based on the priority level. [9][10]

SMARTER is a fairly flexible method. SMARTER is widely used because of its simplicity to respond to the needs of decision makers and how to analyze responses. The analysis is transparent so that the SMARTER method provides a high level of understanding of the problem and can be accepted by decision makers. Basically, each decision-making method has its own advantages and disadvantages, as well as other methods*SimpleMulti Attribute Rating Technique Rank*(SMARTERS). The advantages of using the SMARTER method are that it is easy to modify as the effect of the number of categories increases, changing the number of alternatives will not change the decision of the original number of alternatives and this is useful when new alternatives are added, and the analysis combines various quantitative and qualitative criteria[11] [12]
Based on the problems described above, the researchers chose to use the SMARTER method, in order to help farmers determine the right corn seeds

The system is a collection of entities or components that are interconnected with each other to achieve certain goals. A decision support system is a system that is focused on helping management in overcoming decision-making problems in a company or organization by using data and models [13]

Simple Multi-Attribute Rating Technique Exploiting Rank (SMARTER) is a method multi-criteria in a decision support system. This multi-criteria decision making is based on a theory where each alternative

consists of several criteria that have values. Each criterion has a weight that describes howimportant it is to be compared with other criteria.

SMARTER is a fairly flexible method. SMARTER is widely used because of its simplicity in responding to the needs of decision makers and the way it analyzes responses. The analysis is transparent so that the SMARTER methodprovides a high level of understanding of the problem and can be accepted by decision makers.

In the SMARTER method the weighting of each criterion is calculated using the weighting formula *Rank Order Centroid*(ROC). According to Jeffreys and Cockfield[14], the ROC technique gives weight to each criterion according to the ranking that is assessed based on the priority level. Usually formed with the statement "Criterion 1 is more important than Criterion 2, 2 is more important than Criterion 3 and so on", until it is written $C1 \geq C2 \geq C3 \geq \cdots Cn$.

To determine the weight, the same rule is given, namely $W1 \geq W2 \geq W3 \geq \cdots \geq$ Wn where W1is the weight for the criteria 1. This procedure is formulated:

$$W_1 = \frac{1 + \frac{1}{2} + \frac{1}{3} + \cdots \frac{1}{k}}{k} \quad (1)$$

$$W_2 = \frac{0 + \frac{1}{2} + \frac{1}{3} + \cdots \frac{1}{k}}{k} \quad (2)$$

$$W_3 = \frac{0 + 0 + \frac{1}{3} + \cdots \frac{1}{k}}{k} \quad (3)$$

In general, if K is the number of criteria, then the weight of the criteria to K is:

$$W_k = \left[\frac{1}{k}\right] \sum_{i=k}^{k} \left[\frac{1}{i}\right] \quad (4)$$

Information:
W = Criteria weighting value
k = Number of criteria
i = Alternative value

On the calculation of the value utility, the value is generated from the criteria value and then multiplied by the value from the sub-criteria weighting, then the result are summed.

Next calculated the final value. At this stage it is obtained by multiplying the value utility and the weight of the criteria. So that the results of this final value will be obtained from the ranking of each alternative and the result will be used as input for decision makers

$$n_i = \sum_{j=1}^{K} W_j U_{ij} \quad (5)$$

Information:
n_i = Final value
W_j = Weight of the 1 st criterion
U_{ij} = Value utility criteria

Corn is one of the most important food crops besides wheat and rice. Apart from being a source carbohydrates, corn is also grown as animal feed, made flour from seeds known as corn flour or cornstarch and industrial raw materials [10].

2. RESEARCH METHOD

The stages carried out in this study are shown in Figure 1

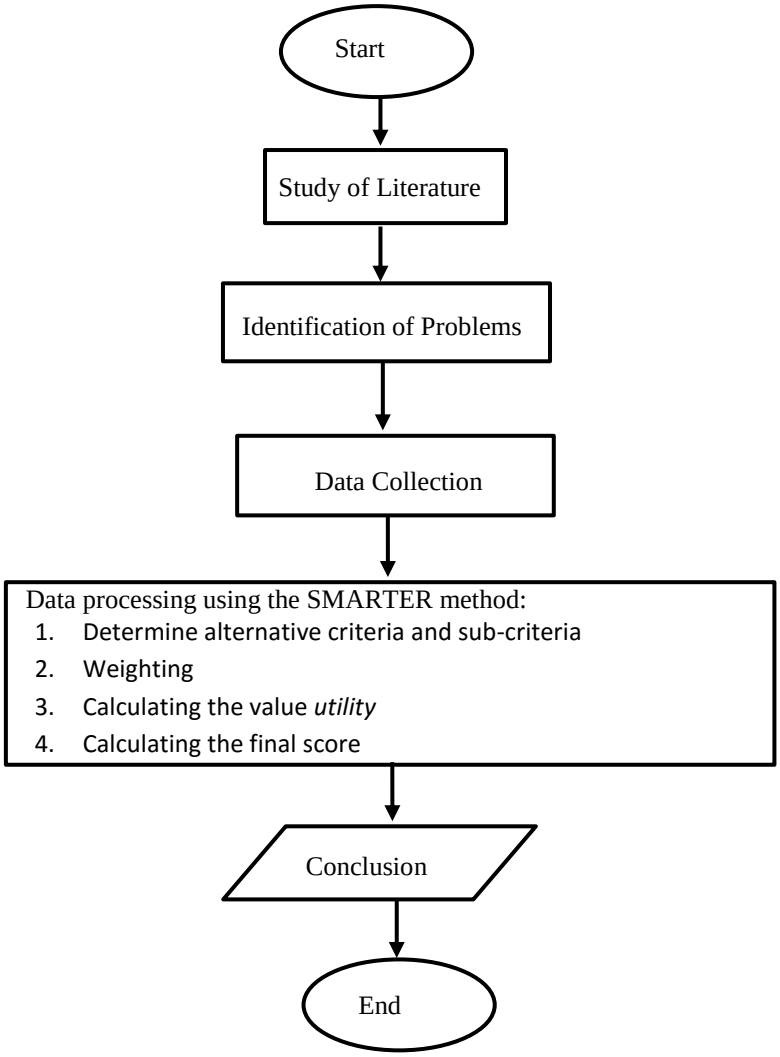

Figure 1. Reseacrh Flowchart

1.1 Research Prosedure

The procedure to be carried out in this study as:

1. Study of Literature
   Researchers understand the literature on the SMARTER method and ROC weighting through the internet, journals or books that can support this research.
2. Identification of Problems
   Identify and describe farmers' problems in selecting superior corn seeds with criteria such as environmental adaptation, resistance to pests, seed size, harvest time and production yield.
3. Data Collection
   Collecting data by distributing questionnaires to 50 respondents according to criteria such as environmental adaptation, resistance to pests, seed size, harvest time and production yield. Data processing
4. Processing
   1. Determine alternative criteria and sub criteria
      Collecting data by distributing questionnaires to 50 respondents in order to get what are the priorities in considering the selection of superior corn seeds. Then arrange the questionnaire data from the most important order. The value of this criterion refers to the Scale *Likert*.

$$Criteria\ Value = \frac{(SS.5) + (S.4) + (KS.3) + (TS.2) + (STS.1)}{5} x\ 100\%$$

      Information :
      SS = Strongly Agree
      S =Agree
      KS = Disagree
      TS = Disagree

STS= Strongly Disagree

2. Weighting
   At this stage the researchers calculated the weights using the weighting*Rank Order Centroid* (ROC) for each criterion. In general the weighting*Rank Order Centroid*(ROC) can be formulatedas follows:

$$W_k = \left[\frac{1}{k}\right] \sum_{i=k}^{k} \left[\frac{1}{i}\right]$$

   Information:
   W=Criteria weighting value k
   k =Number of criteria
   i =Alternative value
3. Utility
   On the calculation of the value utility, the value is generated from the criteria value and then multiplied by the value from the sub-criteria weighting, then the results are summed.
4. Final Value
   The final value at this stage is obtained by multiplying the value of*utility*and the weight of the criteria. So that the final value results will be obtained from each alternative ranking and these results can be used as input for decisionmakers.

$$n_i = \sum_{j=1}^{K} W_j U_{ij}$$

Information:
n_i = Final Value
W_j = Weight of the 1 st criterion
U_{ij} = Value utility criteria

3. RESULT AND DISCUSSION

1. Reseacrh Data Result

Based on the results of data collection by distributing questionnaires to 50 farmers to get what are the priorities in considering the selection of superior corn seeds. The results of the questionnaire data can be seen in table 1 below:

Table 1. Results of Corn Seed Selection Criteria Data (Research, 2022)

Criteria	Respondent					Result
	SS	S	KS	TS	STS	
Pest Resistance	58%	36%	6%	0%	0%	90,4
Harvest Time	42%	44%	14%	0%	0%	85,6
Environmental Adaptation	30%	64%	6%	0%	0%	84,8
Seed Size	34%	54%	12%	0%	0%	84,4
Production result	22%	58%	16%	4%	0%	79,6

2. Calculation Simple Multi Attribute Rating Technique Exploiting Rank (SMARTER) Method

a) **Criteria Weight Value**

The value of the weight of the criteria by using weighting*Rank Order Centroid*(ROC) on each criterion and sub criteria. With the following equation 2.4 formula:

$$W_k = \left[\frac{1}{k}\right] \sum_{i=k}^{k} \left[\frac{1}{i}\right]$$

Information:
W = Criteria weighting value k
K = Numver of criteria
i = Alternative value

Based on the results of the questionnaire data recapitulation, the assessment criteria or weights are made for each of the following criteria:

Table 2. Criteria Weighting (Research, 2022)

No	Kriteria	ROC	Bobot
C_1	Pest Resistance	$W_1 = \frac{1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}}{5}$	0,45
C_2	Harvest Time	$W_2 = \frac{0+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}}{5}$	0,26
C_3	Environmental Adaptation	$W_3 = \frac{0+0+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}}{5}$	0,15
C_4	Seed Size	$W_4 = \frac{0+0+0+\frac{1}{4}+\frac{1}{5}}{5}$	0,09
C_5	Production result	$W_5 = \frac{0+0+0+0+\frac{1}{5}}{5}$	0,04

b) **Sub-Criteria Weight Value**

The sub-criteria weight value is calculated using the ROC weighting in equation 1. The sub-criteria weightingwith ROC can be seen in table 3 below:

Table 3. Weight Value of Sub Criteria (Research, 2022)

Criteria	Sub Criteria	ROC	Weight
Pest Resistance	Earthworm	$W_1 = \frac{1+\frac{1}{2}+\frac{1}{3}}{3}$	**0,6**
	Seed fly	$W_2 = \frac{0+\frac{1}{2}+\frac{1}{3}}{3}$	**0,27**
	Grub	$W_3 = \frac{0+0+\frac{1}{3}}{3}$	**0,1**
Harvest Time	Harvest age 90-120 days	$W_1 = \frac{1+\frac{1}{2}+\frac{1}{3}}{3}$	**0,6**
	Harvest age 75-90 days	$W_2 = \frac{0+\frac{1}{2}+\frac{1}{3}}{3}$	**0,27**
	>120 days	$W_3 = \frac{0+0+\frac{1}{3}}{3}$	**0,1**
Environmental Adaptation	Soil pH 5,6-7,5	$W_1 = \frac{1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}}{4}$	**0,5**
	Temperature 21-27 C	$W_2 = \frac{0+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}}{4}$	**0,26**
	Soil pH 7,5-7,8	$W_3 = \frac{0+0+\frac{1}{3}+\frac{1}{4}}{4}$	**0,13**
	Temperature 27-34 C	$W_4 = \frac{0+0+0+\frac{1}{4}}{4}$	**0,06**
Seed Size	Diameter 4-5 cm	$W_1 = \frac{1+\frac{1}{2}+\frac{1}{3}}{3}$	**0,6**
	Diameter 1-2 cm	$W_2 = \frac{0+\frac{1}{2}+\frac{1}{3}}{3}$	**0,27**
	Diameter 6 cm	$W_3 = \frac{0+0+\frac{1}{3}}{3}$	**0,1**
Production Result	14 rows/cob	$W_1 = \frac{1+\frac{1}{2}+\frac{1}{3}}{3}$	**0,6**

Criteria	Sub Criteria	ROC	Weight
	13 rows/cob	$W_2 = \frac{0 + \frac{1}{2} + \frac{1}{3}}{3}$	**0,27**
	12 rows/cob	$W_3 = \frac{0 + 0 + \frac{1}{3}}{3}$	**0,1**

c) **Utility Value**

On the calculation of the value*utility*, the value is generated from the criterion value and then multiplied by the value of the sub-criteria weighting, then the results are summed. Then theresults of the calculation of the value of*utility*as follows

Table 4. Score*Utility*Resistance to Pests (Research, 2022)

Criteria / Sub Criteria	Weight	*Utility*
Pest Resistance	0,45	-
Earthworm	0,6	$U_{(1)}$= 0,45 x 0,6 = 0,27
Seed fly	0,27	$U_{(2)}$ = 0,45 x 0,26 = 0,117
Grub	0,1	$U_{(3)}$= 0,45 x 0,1 = 0,045
TOTAL	-	0,432

Table 5. Score *Utility* Harvest Time (Research, 2022)

Criteria / Sub Criteria	Weight	*Utility*
Harvest Time	0,26	-
Harvest age 90-120 days	0,6	$U_{(1)}$= 0,26 x 0,6 = 0,156
Harvest age 75-90 days	0,27	$U_{(2)}$= 0,26 x 0,27 = 0,07
>120 days	0,1	$U_{(3)}$= 0,26 x 0,1 = 0,026
TOTAL	-	0,252

Table 6. Score *Utility* Environmental Adaptation (Research, 2022)

Criteria / Sub Criteria	Weight	*Utility*
Environmental Adaptation	0,15	-
Soil pH 5,6-7,5	0,5	$U_{(1)}$= 0,15 x 0,5 = 0,075
Temperature 21-27 C	0,26	$U_{(2)}$= 0,15 x 0,26 = 0,039
Soil pH 7,5-7,8	0,13	$U_{(3)}$= 0,15 x 0,13 = 0,019
Temperature 27-34 C	0,06	$U_{(4)}$= 0,15 x 0,06 = 0,009
TOTAL	-	0,142

Table 7. Score *Utility* Seed Size (Research, 2022)

Criteria / Sub Criteria	Weight	*Utility*
Seed Size	0,09	-
Diameter 4-5 cm	0,6	$U_{(1)}$= 0,09 x 0,6 = 0,054
Diameter 1-2 cm	0,27	$U_{(2)}$= 0,09 x 0,27 = 0,024
Diameter 6 cm	0,1	$U_{(3)}$= 0,09 x 0,1 = 0,009
TOTAL	-	0,087

Table 8. Score *Utility* Production Result (Research, 2022)

Criteria / Sub Criteria	Weight	*Utility*
Production Result	0,04	-
14 rows/cob	0,6	$U_{(1)}$= 0,04 x 0,6 = 0,024
13 rows/cob	0,27	$U_{(2)}$= 0,04 x 0,27 = 0,010
12 rows/cob	0,1	$U_{(3)}$= 0,04 x 0,1 = 0,004
TOTAL	-	0,038

3 Final Score

The final value is obtained by multiplying the value of*utility*with criterion weights. So the final result . The ranking of each alternative is obtained and the results can be used as input for decision makers.

Table 9. Final Score (Research, 2022)

Criteria	Weight	*utility*	Final Score	Ranking
Pest Resistance	0,45	0,432	$n_i = \sum_{j=1}^{K} W_j U_{ij}$ = 0,45 x 0,432 = 0,1944	1
Harvest Time	0,26	0,252	$n_i = \sum_{j=1}^{K} W_j U_{ij}$ = 0,26 x 0,252 = 0,0655	2
Environmental Adaptation	0,15	0,142	$n_i = \sum_{j=1}^{K} W_j U_{ij}$ = 0,15 x 0,142 = 0,0213	3
Seed Size	0,09	0,087	$n_i = \sum_{j=1}^{K} W_j U_{ij}$ = 0,09 x 0,087 = 0,0078	4
Production Result	0,04	0,038	$n_i = \sum_{j=1}^{K} W_j U_{ij}$ = 0,04 x 0,038 = 0,0015	5

From table 9, it can be seen that the criteria for resistance to pests are the priority criteria in the selection of superior maize seeds. Criteria for resistance to pests have a final value of 0.1944. In choosing superior corn seeds, themost important thing to consider is seeds that are resistant to attacks by corn plant pests. Then another thing that needs to be considered in choosing superior corn seeds is harvest time. Superior seeds have a fast harvest time but can produce high. In this study, superior maize seeds had a harvest time of 90-120 days. Harvest time has a final value of 0.0655. Then the important thing that needs to be considered in choosing superior corn seeds is adaptation to the environment. Superior seeds are resistant to environmental stresses such as extreme weather, unstable temperatures and unsuitable soil acidity so that corn plants can continue to grow well. Environmental adaptation has a final value of 0.0213. Seed size also needs to be considered in selecting superior corn seeds. Superior seeds will produce quality corn. Quality corn can be seen from the diameter of the seeds. Superior seeds will produce a seed diameter of 4-5 cm. The seed size has a final value of 0.0078. Then the thing that needs to be considered in choosing superior corn seeds is the production. Superior maize can produce large maize fruit with the number of rows of seeds as much as 14 rows/cob. The product has a final value of 0.0015. By taking into account these five criteria, it is expected that the selected corn seeds are superior corn seeds so that they can grow well and produce quality corn and have quality so that they can increase corn production. Superior maize can produce large maize fruit with the number of rows of seeds as much as 14 rows/cob. The product has a final value of 0.0015. By taking into account these five criteria, it is expected that the selected corn seeds are superior corn seeds so that they can grow well and produce quality corn and have quality so that they can increase corn production. Superior maize can produce large maize fruit with the number of rows of seeds as much as 14 rows/cob. The product

has a final value of 0.0015. By taking into account these five criteria, it is expected that the selected corn seeds are superior corn seeds so that they can grow well and produce quality corn and have quality so that they can increase corn production.

4. CONCLUSION

From the results of the study it can be concluded that the application of the SMARTER method can help select superior corn seeds based on the criteria that have been calculated using ROC weighting. The selection of superior corn seeds must pay attention to the criteria that are in accordance with the location of the cultivation so that the selected corn seeds are superior seeds. The main consideration criteria in choosing superior corn seeds is resistance to pests because superior seeds are able to withstand pest attacks. The second consideration criterion is harvest time. Superior seeds have a harvest time of about 90-120 days. Environmental adaptation is the third consideration inchoosing superior corn seeds. The fourth consideration criterion, namely seed size and production yield, is the fifth consideration criterion because superior seeds are capable of high production. By paying attention to these criteria inselecting superior corn seeds, the selected seeds are superior seeds so that they are able to develop well and can increase corn production

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