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Factors Affecting the Development of Maize *(Zea mays L.)* Farms in South Sulawesi, Indonesia

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Abstract

The study investigates the factors and conditions that influence the development of maize farming in South Sulawesi, Indonesia. In this study, simple random sampling was used for 120 maize farmers. Observations, interviews, and questionnaires were utilized as data-gathering methods. AMOS 24 software was used for quantitative analysis through Structural Equation Modelling (SEM), while Respondent Achievement Level (TCR) criteria were used for statistically descriptive analysis. The results showed that the higher the farmer's education and farming capital, could improve human resources. In contrast, the lower the farmer's farming experience, could reduce the human resource, and the better the human resources could increase the more effective agricultural extension services will be. The factors that influence the development of maize farming in South Sulawesi are farmer education, farming capital, human resources, farmer experience, and the effectiveness of counselling.

Keywords: *Maize, farm development, and effectiveness*

1. Introduction

South Sulawesi can assist the government's program to expand the food supply due to the high carrying capacity of its land. Based on the 2022 Central Statistics Agency (BPS), the maize harvested area is 425,003.7 ha. Specifically, for Maros, Jeneponto and Bone Regencies, their harvested areas are 10,648.4 ha, 65,120.6 ha and 81,994.7 ha, respectively (BPS 2022). Productivity and maize production within five years in the three districts are quite productive because they have increased yearly (Department of Agriculture, Food and Horticulture Maros, Bone and Jenoponto districts).

Maize is one of the food crop commodities that functions as a food ingredient. In addition, maize can also be processed as a feed ingredient for poultry, which contributes to the production of eggs and chicken meat. Maize is always increasing as a consumption need, an ingredient for poultry, livestock, and other food processing industries (Panikkai et al., 2017). Hence, maize is one of the important commodities whose production must be increased to encourage the need for maize feed production.

Expanding planting areas and increasing productivity are two strategies to increase domestic maize production. Area expansion can be directed at potential lands such as irrigated paddy fields, rainfed paddy fields, and dry land that is not utilized for the agricultural sector. Increasing added value, improving market access, establishing joint business units, improving capital systems, building infrastructure, implementing trade regulations, and providing business incentives are other needs in maize development. However, several aspects and issues, including decreasing planted, harvested area, lack of arable land including nutrient deficiencies, water shortages, and pests and weeds, are often barriers to dryland maize farming (Montoeli, 2022). Based on the supply chain, some farmers sell them to middlemen, which results in maximum efficiency not being achieved due to sub-optimal marketing channels (Darmawan, 2018).

Another factor faced by farmers is the frequent occurrence of price changes. This price instability can cause losses to farmers because the low prices of production are inversely proportional to the high production costs (Darmawan, 2018). The price factor of maize is a problem sufficient to hinder the development of maize plants. The problem of previous research revealed that farmers' education which was on average low, was a weak factor in regional development. The level of technical mastery of maize farmers was not optimal (Winarso, 2012), and (Nikmah et al., 2013) In addition, there are problems from the aspect of land resources, including the status of non-owned land, the water/irrigation system generally in poor condition, and decreased soil fertility (Otara et al., 2023).

Maize needs the main service role carried out by the government and other parties in farming. One of the service efforts that can support the success of a business is the ease of obtaining business capital assistance, technology and counseling. The availability of extension workers in the field is very important to provide guidance and knowledge through information or innovation (Jamil et al., 2023). However, the presence of extension workers in the field is very limited. One extension worker has to serve one sub-district. Meanwhile, financial institutions are still limited in providing capital loans to farmers. This is also a problem in the development of maize agribusiness (Aldillah, 2018).

The development of maize commodities at the local and national levels is still experiencing several obstacles, such as the low use of hybrid seeds, scarcity of fertilizers, inadequate adoption of post-harvest and harvest technologies and generally limited arable land (Kifle et al., 2022). Based on the description above, maize farming development factors have a significant impact on the productivity and production of maize farming, so research is needed to determine the impact of maize farming development, with the main objective of determining the current condition of maize farming and factors that influence maize farming development in South Sulawesi.

2. Materials And Methods

This study was conducted in three districts in South Sulawesi namely Maros, Bone, and Jeneponto districts. The methods used to collect data were observation, questionnaires, and interviews. The variables measured were farmer education (X1), farming capital (X2), farmer experience (X3), human resources (Y1), and the effectiveness of agricultural extension (Y2), as illustrated in Figure 1. According to data from the Maros, Bone, and Jeneponto districts' agriculture office, the study's sample consisted of all 11307 of the districts' maize producers. We utilized direct random sampling. The sample size was calculated using the Slovin formula:

$$n = \frac{N}{1+N\,(e)2} \ldots\ldots\ldots\ldots\ldots (1)$$

Description:

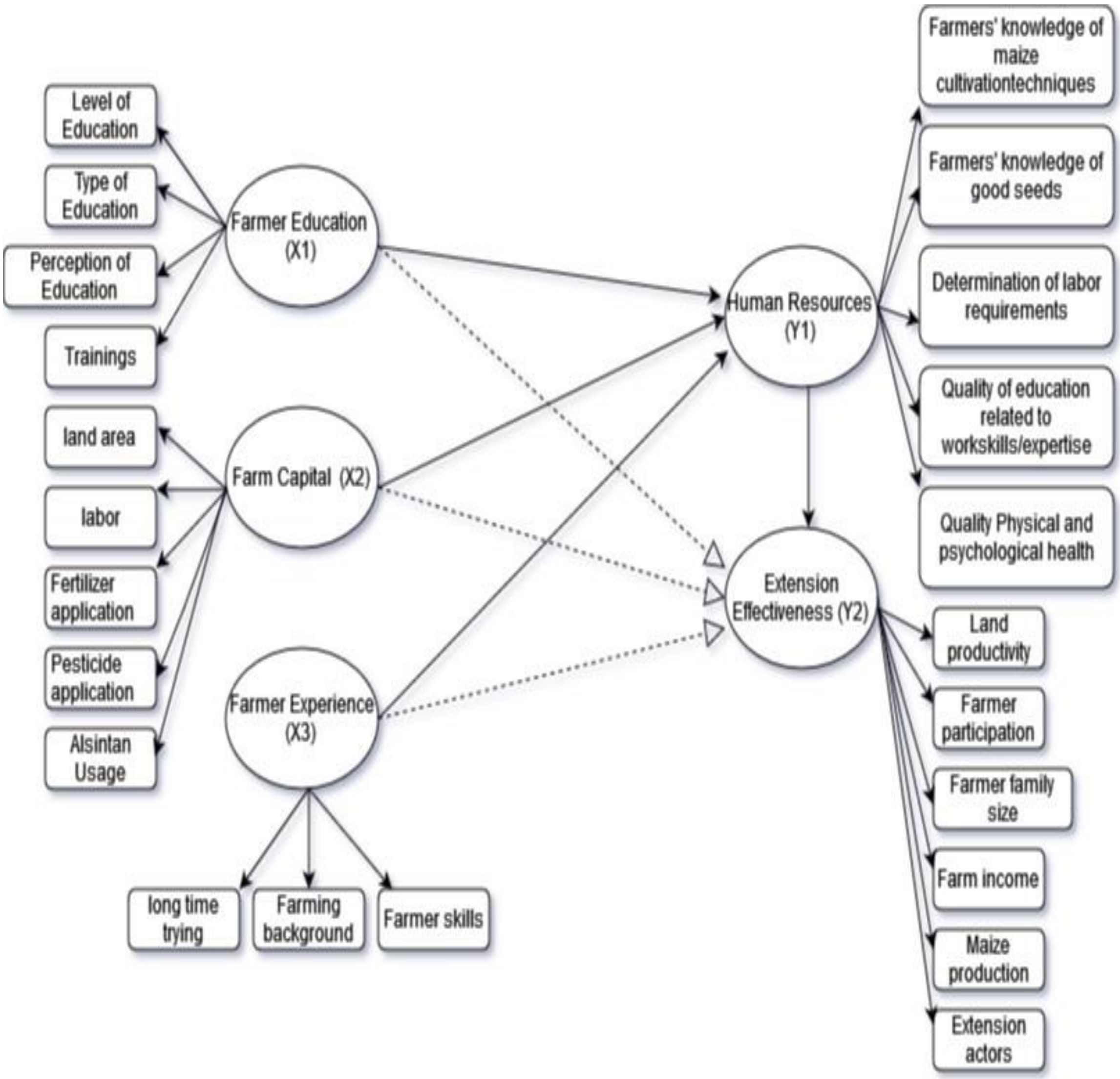
n = sample size; N = population size; e = standardized error

According to the Slovin formula, a sample size of 120 respondents was chosen, with an error rate of 10% or depending on the desired degree of confidence (precision) of 90%. To learn more about the traits and behaviors of respondents, surveys, in-person interviews, and observations were the data-gathering methods utilized in research. The data was examined quantitatively and formally using the Structural Equation Modeling (SEM) technique.

The TCR (Respondent Achievement Level) criteria were used to analyze statistical data, and the formula below was utilized:

$$TCR = \frac{mean}{skor\ max} \times 100 \ldots\ldots\ldots\ldots\ldots (2)$$

Quantitative analysis in this study using SEM (Structural Equation Modeling) analysis was conducted using AMOS 24 software to answer problems related to variables affecting the development of maize farming in Maros, Bone, and Jeneponto districts. The equation 1 $Y1 = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + e$
The equation 2 $Y1 = \beta 0 + \beta 1Y1 + e$
Description: Y1 = Human resources; Y2 = Effectiveness of agriculture extension;
β = Constant; e = Standardized error; X1 = Farmer's education; X2 = Farming capital; X3 = Experience of farmers



3. Results and Discussion

Table 1: Frequency distribution of farmer education variables (X1)

No	Indicator	N	Max.	Mean	TCR	Category
1	Type of Education	120	15	6.76	45.06	Not good
2	Perception of Education	120	8	4.42	55.21	Less Good

3	Trainings	120	4	1.36	33.96	Not good
	Average			4.18	44.74	Not good

Source: primary data processed 2023

The average farmer education variable had a value of 4.18 and a TCR of 44.74. According to Table 1, it was classified as unfavorable, meaning that the impact of farmer education variables on the growth of maize farming was either unfavorable or had no effect. With a mean value of 4.42 and a TCR value of 55.21, the perception of education indicator fell into the bad category. The other two indicators demonstrated the unfavorable nature of the farmer education variable's indicators.

Table 2: Frequency distribution of farm capital variable (X2)

No	Indicator	N	Max.	Mean	TCR	Category
1	Fertilizer application	120	15	13.15	87.67	Good
2	Pesticide application	120	16	12.28	76.77	Quite Good
3	Alsintan Usage	120	20	15.92	79.58	Quite Good
	Average			13.78	81.34	Good

Source: primary data processed 2023

The farm capital variable's influence on maize farming's growth fell into the Good or influential category according to the average value of the maize farming capital variable, which had a TCR value of 81.34 (Table 2). Compared to the indicator of agricultural machine use, the indicator of pesticide used had a mean value of 12.28 and a TCR value of 76.77 with a quite good category. The indicator of fertilizer used, however, was classified in the "good" category with a mean value of 13.15 and a TCR value of 87.67. If referring to the conditions in the field it proves that the use of fertilizers and pesticides, the doses used by farmers still vary, due to different levels of soil fertility or because of household financial constraints that cannot allocate funds for balanced fertilization (Yulyani et al., 2013). In addition, farmers also spend capital to rent alsintan. Thus, this can have an impact on the development of corn farming because the use of fertilizers and pesticides will determine the high and low yields of corn production obtained.

Table 3: Frequency distribution of farmer experience variables (X3)

No	Indicator	N	Max.	Mean	TCR	Category
1	Farming background	120	25	21.62	86.47	Good
2	Farmer skills	120	52	49.63	95.45	Very good
	Average			35.63	90.96	Very good

Source: primary data processed 2023

According to Table 3, the average of the variable "farming experience" was 35.63, with a TCR value of 90.96, which indicated that the variable had a very good or influential effect. Farmers with longer experience will be more responsive to problems related to their farming and are more able to take risks from every decision they make. Theoretically, the results of this study are in accordance with the opinion of (Rasyid, 2003) stating that farming experience is one of the factors that can be categorized as supporting the success of a farming business. The background indicator for farming has the lowest average value, namely 21.62 with a TCR value of 86.47, indicating that the indicator is in the good category. While the farmers' skills indicator has the highest average value, namely 49.63 with a TCR value of 95.45 and is in the very good category.

Table 4: Frequency distribution of human resource variables (Y1)

No	Indicator	N	Max.	Mean	TCR	Category
1	Farmers' knowledge of maize cultivation techniques	120	15	11.19	74.61	Quite Good
2	Farmers' knowledge of good seeds	120	12	9.15	76.25	Quite Good
3	Determination of labour requirements	120	33	29.03	87.95	Good
4	Quality of education related to work skills/expertise	120	16	9.83	61.41	Less Good
5	Quality Physical and psychological health	120	20	15.91	79.54	Quite Good
	Average			15.02	75.95	Quite Good

Source: primary data processed 2023

The human resource variable had an average value of 15.02 and a TCR value of 75.95, which indicates that it fell into the fair group (Table 4). With a mean value of 9.83 and a TCR value of 61.41, one of the five indicators primarily the level of education associated with work skills fell into the unfavourable group. On the other hand, the other four indicators fell into the sufficient and good categories. Based on the conditions in the field, farmers' knowledge of corn cultivation techniques is quite high. This is marked by land preparation, the use of seeds, fertilizers, pesticides and harvests that are applied by farmers and have been used so far at the right time, the right amount, the right type, the right price, and the right quality. The easier farmers lack experience and skills but the easier farmers are more progressive and willing to take risks. This is in accordance with the statement (Soekartawi, 2002), that older farmers may have conservative farming skills and tire more easily. Meanwhile, young farmers may lack experience and skills but are usually more progressive towards innovations and are relatively stronger.

Table 5: Frequency distribution of agricultural extension effectiveness variables Y2

No	Indicator	N	Max.	Mean	TCR	Category
1	Land productivity	120	30	21.19	70.64	Quite Good
2	Farmer participation	120	32	18.81	58.78	Good
3	Farmer family size	120	4	1.96	48.96	Not Good
4	Farm income	120	5	2.72	45.28	Not Good
5	Maize production	120	7	2.68	53.50	Not Good
6	Extension actors	120	41	27.49	67.05	Quite Good
	Average			12.47	57.37	Less Good

Source: primary data processed 2023

The average value of the extension effectiveness variable was 12.47 with a TCR value of 57.37, so it was categorized as a poor category. Similarly, it was reported that extension workers are less active in disseminating weed and pest control information to help farmers cope with increased attacks due to weather/climate changes (Hilda et al., 2022). The agricultural extension effectiveness variable had six indicators. However, three of the six indicators were in the poor category, mainly the indicator of the number of farmer families, farm income, and maize production. Then two indicators were in the sufficient category, namely indicators of land productivity and extension actors. Then followed by the indicator of farmer participation which was in the unfavorable category.

The Results of SEM Data Analysis

The evaluation of the measurement model is to assess the construct's reliability and validity. The construct validity test seeks to establish the reliability of the latent variable indicators. The amount of the loading factor (standardized weight) indicates the reliability of each indicator in measuring latent variables. If an indicator's loading factor is positive and higher than 0.5, it is deemed legitimate.

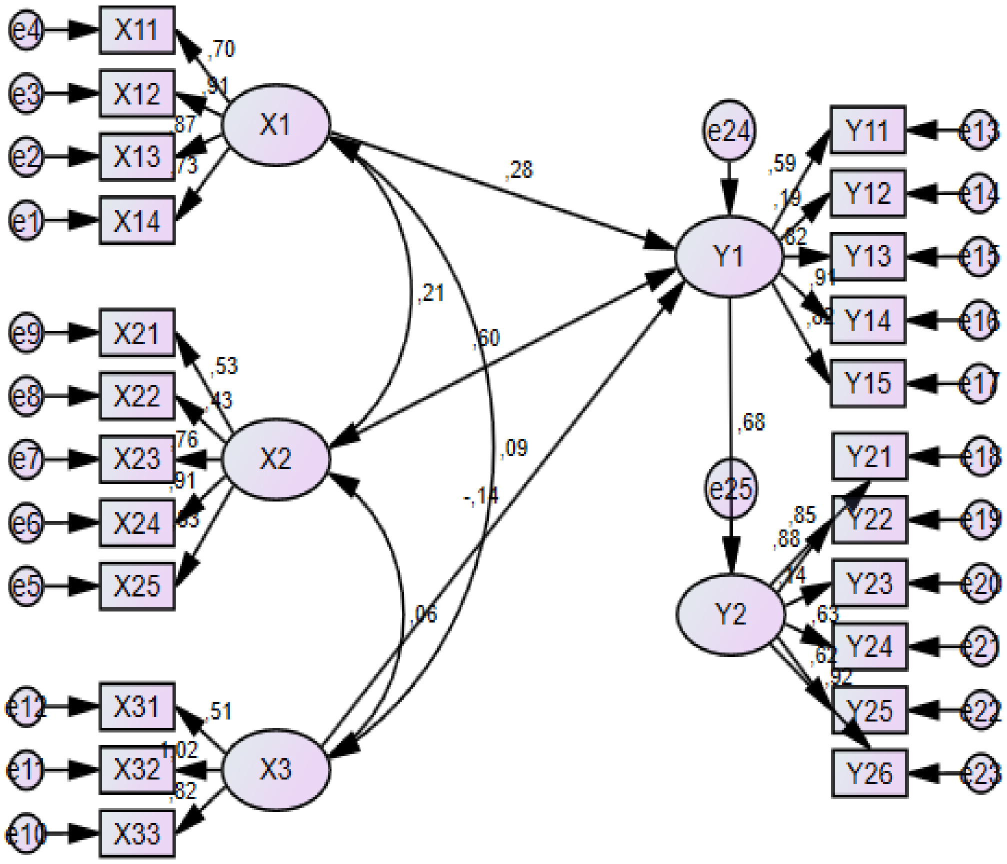


Figure 2. Path diagram

Table 6 provides the concept and validity test results. The usage of the labor question indicator (X22), which assesses the agricultural capital variable (X2), has been disqualified since it generates a loading factor value that is less than 0.5. If associated with conditions in the field, this invalidity was due to the lack of labor used. Then the harvest season was carried out simultaneously (harvest) so that farmers were difficult to get labor, and farmers strongly considered labor wages; the more labor used, the higher the capital spent. Then, because it generates a loading factor that is less than 0.5, the question of farmer knowledge about seeds (Y12), which assesses the human resources variable, was deemed invalid. Then the question indicator farmer knowledge about seeds (Y12), which measures the human resources variable, was declared invalid because it produces a loading factor of less than 0.5. This invalidation was due to the lack of capital owned by farmers, which prevented them from purchasing high-quality maize seeds.

The indicator question number of farmer families (Y23) measuring the extension effectiveness variable is invalid because it produces a loading factor of less than 0.5. This invalidity was attributed to farmers not attending agricultural extension training organized by the local BPP often or ever. Similarly, it was also reported to emphasize that training creates awareness and provides knowledge to farmers (Otara et al., 2023). The indicator kind of education for schooling that has been followed (X12) contributed the most to the farmer education variable (X1) when factor loading strength (Standardized Weights) on each variable was examined, with a contribution of 91.1%. This might be because the type of education farmers followed greatly influenced maize farming. Then, the variable (X2) was dominated by indicator use of pesticides (X24) at 90.6%. This might be due to farmers consistently using pesticides to eradicate pests and diseases. Even farmers were willing to spend a large budget on preventing all forms of disturbance that caused crop failure. This is in line with research (Fadwiwati and Tahir, 2013) that pesticides do not increase production but save production from pests and diseases.

Furthermore, indicator farmer skills (X33) contributed the most to the farmer experience variable (X3), at 81.7%. This might be because the longer the farming experience a farmer has, the more diverse skills the farmer has, and it causes the farmer to be competent in running his farm. Furthermore, in the human resources variable (Y1), the indicator (quality of education related to work skills (Y14) was dominated by 90.6%. Next, the extension effectiveness variable (Y2) was dominated by indicator Y26 (Extension actors) by 91.8%.

Table 6: Constructs and validity tests

Variables	Indicator	Factor Loading	Criteria	Note	AVE
	X11	0,699	0,5	Valid	
	X12	0,911	0,5	Valid	
Farmer Education (X1)	X13	0,866	0,5	Valid	0.651
	X14	0,731	0,5	Valid	
	X21	0,534	0,5	Valid	
	X22	0,434	0,5	Invalid	
Farm Capital (X2)	X23	0,755	0,5	Valid	0.511
	X24	0,906	0,5	Valid	
	X25	0,830	0,5	Valid	
	X31	0,515	0,5	Valid	
Farmer Experience (X3)	X32	1,017	0,5	Valid	0.656
	X33	0,817	0,5	Valid	
	Y11	0,586	0,5	Valid	
Human Resources (Y1)	Y12	0,192	0,5	Invalid	0.510
	Y13	0,821	0,5	Valid	
	Y14	0,906	0,5	Valid	
	Y15	0,821	0,5	Valid	
	Y21	0,848	0,5	Valid	
	Y22	0,885	0,5	Valid	
Extension Effectiveness (Y2)	Y23	0,136	0,5	Invalid	0.526
	Y24	0,633	0,5	Valid	
	Y25	0,624	0,5	Valid	
	Y26	0,918	0,5	Valid	

Source: primary data processed 2023

The loading factor and Average Variance Extracted (AVE) may be used to determine the validity test, and if the AVE is more than 0.5, the validity test can be satisfied. Based on Table 6, it can be seen that overall indicators on the variables of education (X1), farm capital (X2), farmer experience (X3), human resources (Y1), and extension success (Y2) produce Average Variance Extracted (AVE) values greater than 0.5. Therefore, indicators for these variables were considered valid if they had an Average Variance Extracted (AVE) of more than 0.5. As a result, it was determined that these variable indicators were valid for assessing these variables.

The following results were obtained when the indicators were removed or eliminated due to invalidity:

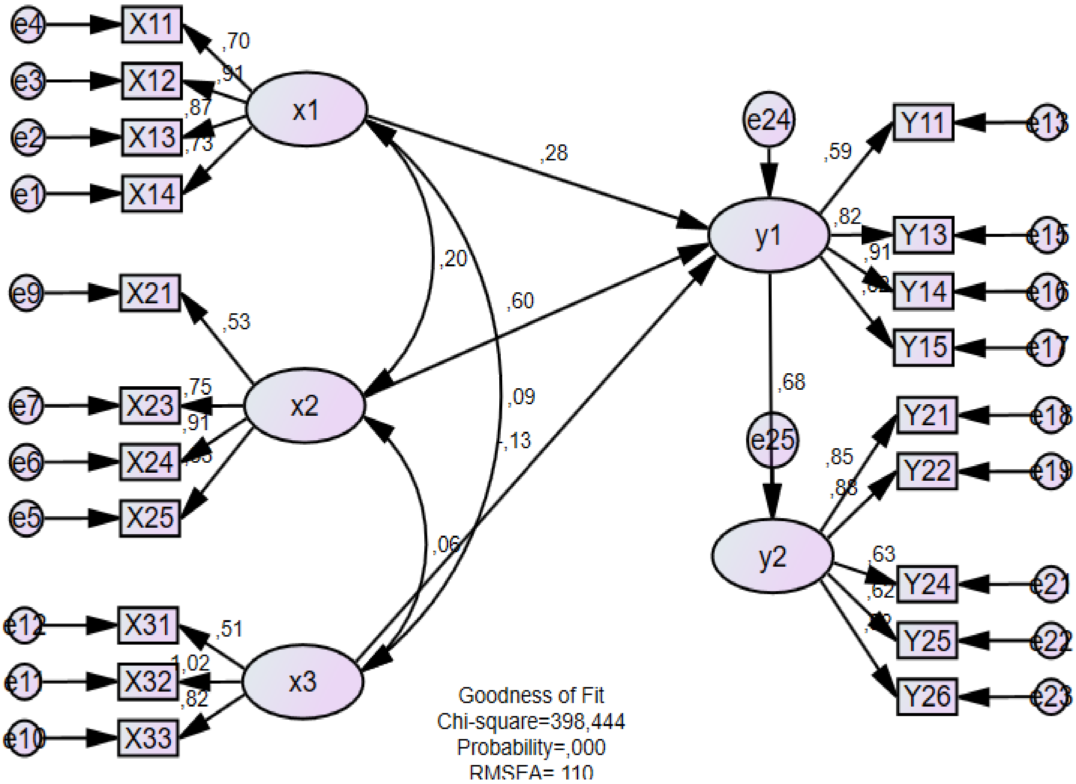


Figure 3. Path Diagram After Dropping Valid Indicators

The amount of the loading factor (Standardized Weights) was used to determine the validity of each indicator in measuring latent variables. If the loading factor of an indication was positive and more than 0.5, it was deemed legitimate. Table 7 lists the outcomes of the validity test.

Table 7: Construct Validity Test After Dropping Invalid Indicators

Variables	Indicator	Factor Loading	Criteria	Note	AVE
	X11	0,699	0,5	Valid	
	X12	0,911	0,5	Valid	
Farmer Education X1	X13	0,866	0,5	Valid	0.651
	X14	0,731	0,5	Valid	
	X21	0,526	0,5	Valid	
Farm Capital X2	X23	0,754	0,5	Valid	
	X24	0,907	0,5	Valid	0.591
	X25	0,834	0,5	Valid	
	X31	0,514	0,5	Valid	
Farmer Experience X3	X32	1,020	0,5	Valid	0.656
	X33	0,815	0,5	Valid	
	Y11	0,589	0,5	Valid	
Human Resources Y1	Y13	0,820	0,5	Valid	0.628
	Y14	0,906	0,5	Valid	
	Y15	0,818	0,5	Valid	
	Y21	0,847	0,5	Valid	
Extension Effectiveness (Y2)	Y22	0,885	0,5	Valid	
	Y24	0,633	0,5	Valid	0.627
	Y25	0,624	0,5	Valid	
	Y26	0,919	0,5	Valid	

Source: primary data processed 2023

Construct Reliability (CR) is a technique used in testing construct reliability. According to the test conditions, a construct can be considered reliable, or its indicators consistently assess the variable it measures if the Construct Reliability (CR) coefficient and Cronbach's alpha are more than 0.6. Table 8 displays an overview of the reliability test findings.

Table 8: Reliability test

Variables	Construct reliability	Cronbach's alpha	Note
Education (X1)	0,846	0,807	Reliable
Farm Capital (X2)	0,885	0,806	Reliable
Farmer Experience (X3)	0,814	0,810	Reliable
Human Resources (Y1)	0,852	0,812	Reliable
Extension Effectiveness (Y2)	0,925	0,811	Reliable

Source: primary data processed 2023

As shown in Table 8, the Construct Reliability (CR) and Cronbach's alpha values of all variables were more than 0.6. These variables were considered reliable based on the calculation of Construct Reliability (CR) and Cronbach's alpha.

A construct's suitability (feasibility) is assessed using a model fit test, fair test, or model (construct) fit. The test indices used in SEM are RMSEA, TLI, and CFI. According to the RMSEA criterion, the construct is appropriate (possible) if the RMSEA value is less than the cut-off value, which is 0.08. In addition, the requirements using TLI and CFI state that the model is appropriate if the goodness of fit value is more than the cut-off value (equivalent to 0.90). Table 9 summarizes the findings of the model feasibility testing.

Table 9: Goodness of Fit Model

Index	*Goodness Of Fit*	*Cut Off Value*	Note
Chi square	398,444	≥ 0.05 or ≥ 0.10	*Poor of Fit*
Probability	0.000	≥ 0.05 or ≥ 0.10	*Poor of Fit*
RMSEA	0.110	≤ 0.08	*Poor of Fit*
TLI	0.828	≥ 0.90	*Poor of Fit*
CFI	0.852	≥ 0.90	*Poor of Fit*

Source: primary data processed 2023

All five indices-Chi-square, Probability, RMSEA, TLI, and CFI did not meet the requirements, according to the goodness of fit summary in Table 9 of the data. As a result, it was determined that the developed SEM model did not fit. As a result, the model was not applicable, so modifications were made to the index covariance model to produce a suitable model. The structural equation modeling (SEM) model used by AMOS was covariance-based SEM (CB-SEM), which must consider covariance factors. The route diagram resulting from the change in the index covariance model is shown below:

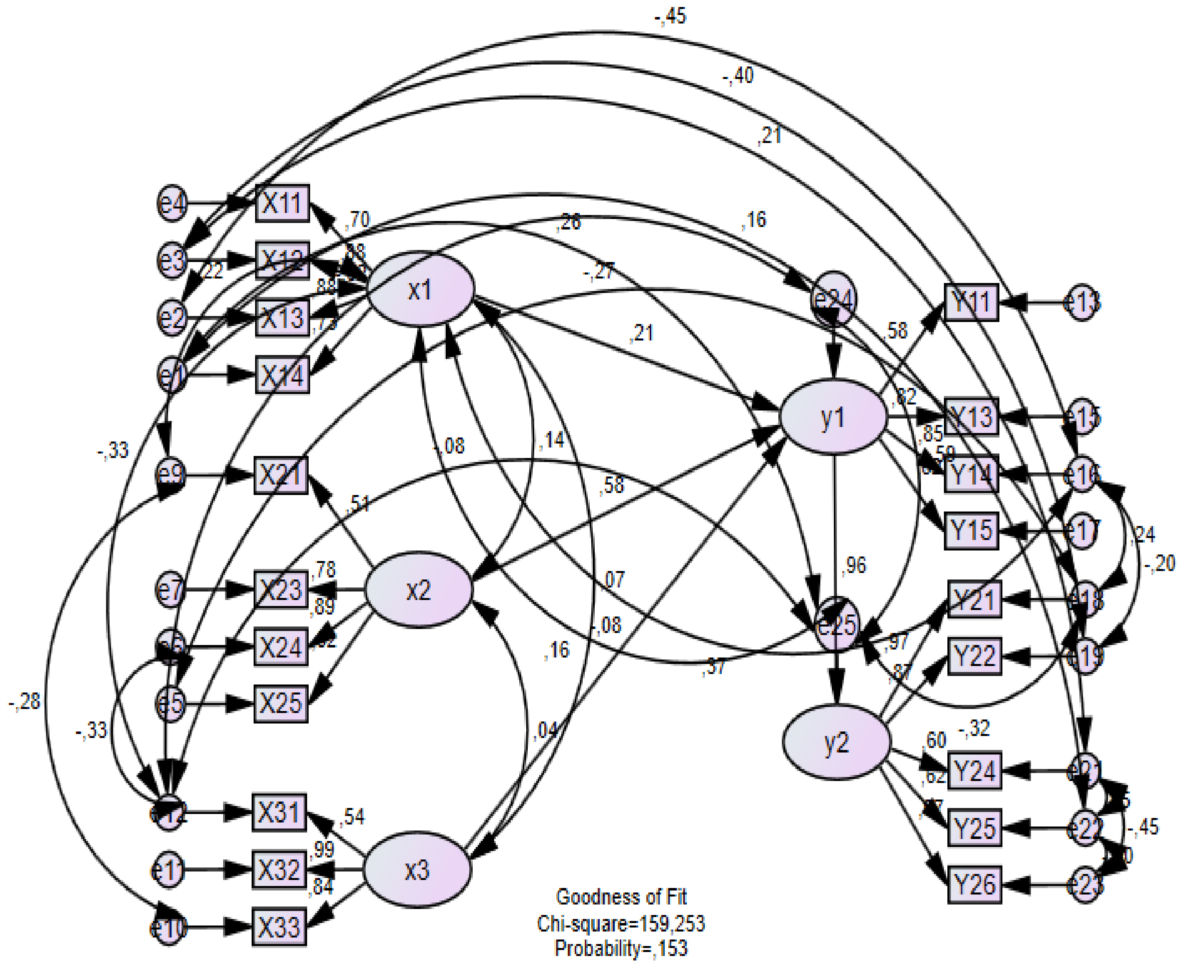


Figure 4. Path Diagram after Index Covariance Modification

Table 10 summarizes the findings of the model fit assessment after changing the covariance index.

Table 10: Goodness of Fit Model (after covariance modification)

Index	*Goodness Of Fit*	*Cut Off Value*	Note
Chi square	159.253	≥ 0.05 or ≥ 0.10	*Good of Fit*
Probability	0.153	≥ 0.05 or ≥ 0.10	*Good of Fit*
RMSEA	0.032	≤ 0.08	*Good of Fit*
TLI	0.986	≥ 0.90	*Good of Fit*
CFI	0.989	≥ 0.90	*Good of Fit*

Based on the goodness of fit summary in Table 10, the five indices-Chi-square, Probability, RMSEA, TLI, and CFI-all meet the requirements. From the findings of the index criteria, it can be concluded that the resulting SEM route diagram is declared feasible for application.

Table 11: Hypothesis test

Hypotheses	Path	Standardized Coefficient	S. E	C.R	p-value	Note
H1	X1→Y1	0.215	0.171	2.483	0.013	Significant
H2	X2→Y1	0.582	0.074	5.090	***	Significant
H3	X3→Y1	-0.081	0.054	1.284	0.199	Insignificant
H4	Y1→Y2	0.963	0.538	5.188	***	Significant

Note: ***p value < 0.001

Based on Table 11, the results of the structural equation analysis are presented as follows:
The test of the effect of Farmer Education on Human Resources obtained a statistical value of CR of 2.483 and a p-value of 0.013. The test results show that the p-value (0.013) < alpha 0.05, which means

that there is a significant effect of Farmer Education on the issue of maize farming development (hypothesis accepted). The positive coefficient of 0.215 indicates that farmer education positively impacts Human Resources. This means that the higher the farmer's education (frequent training or counseling on maize farming), the higher the Human Resources.

The test of the effect of Farm Capital on Human Resources resulted in a CR statistical value of 5.090 with a p-value of 0.001. the test results show the statistical significance of p-value (0.001) < alpha 0.05, which means that Farm Capital has a significant effect on Human Resources. The positive coefficient of 0.582 indicates that farm capital positively impacts Human Resources. This means that the higher the farm capital, the higher the human resources.

The findings from the test to determine the impact of farmer experience on human resources were a CR statistical value of -1.284 and a p-value of 0.199. The statement "p-value (0.199) > alpha 0.05" indicates that there was no significant impact of farmer experience on human capital.

The test of the effect of human resources on the effectiveness of counseling showed a statistical value of CR 5.188 with a p-value of 0.001. The test results show the statistical significance of p-value (0.001) < alpha 0.05, which means that human resources have a significant effect on the effectiveness of counseling. The positive coefficient of 0.963 indicates that human resources positively impact the efficacy of counseling. This can be interpreted that better human resources can increase the effectiveness of agricultural extension.

Table 12: Indirect hypothesis testing

Hypotheses	Path	Indirect Coefficient	S. E	p-value	Note
H5	X1→Y1→Y2	1.028	0.201	0.303	Insignificant
H6	X2→Y1→Y2	1.745	0.321	0.080	Insignificant
H7	X3→Y1→Y2	-1.149	0.067	0.250	Insignificant

Source: primary data processed 2023

Based on Table 12, there was no significant impact of farmer experience, capital, or education on the success of agricultural extension mediated by human resources (p>0.05). Hence, the human resource variable could not mediate the effect of farmer education, farming capital, and experienced farmers on the effectiveness of counseling.

Convert Path Diagram into Structural Equation

Structural equations were created by converting route diagrams into mathematical equations to ascertain the type of impact between constructs. Based on the attachment, it can be seen that the mathematical model created is.

The equation: $Y1 = 0.215\ X1 + 0.582\ X2 - 0.081\ X3$
The equation: $Y2 = 0.963\ Y1$

4. Conclusion

From the point of view of farmer education, the existing condition of maize farming development in South Sulawesi, based on the TCR value obtained, is 44.74, which means it is in a bad category. Furthermore, from the point of view of farming capital, the TCR value was 81.34, which means that the existing conditions for corn farming development are in a good category. Then from the point of view of corn farming experience with a TCR value of 90.96, it means that it is in the very good category. From the point of view of human resources and the effectiveness of agricultural extension agents, the TCR values were 75.95 and 57.37, meaning that the two existing conditions were in the sufficient and unfavorable categories. The factors that influence the development of corn farming in South Sulawesi are, firstly, farmer education, meaning that the level of education of farmers in running their farming certainly influences the actions of farmers in taking attitudes in farming. Both farming capital means that farmers need large capital to optimally use existing farming technology. The three experiences of farmers mean that farmers with longer experience will be more responsive to problems related to their farming and are more able to take risks from every decision they make. Furthermore, human resources and the effectiveness of extension, better human resources can increase the effectiveness of agricultural extension. Future researchers are expected to examine the factors that influence the development of maize farming by using variables that have not been studied in this study, and especially using SEM AMOS should pay attention to the number of samples and variables used in the research.

Conflict of interest
The authors declare no conflict of interest.

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