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The Influence Of Farmer Characteristics, Farmer Ability, Farmer Opportunity, And Production On Farm Performance Through Avocado Farmer Participation In Baruppu' District, North Toraja Regency

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Abstract
This study examines the influence of farmer characteristics, abilities, opportunities, and production factors on farm performance through farmer participation in avocado farming in Baruppu' District, North Toraja Regency. Avocado farming in this region has significant potential, but its performance is affected by several factors. This study uses a mixed-method approach with Structural Equation Modeling-Partial Least Square (SEM-PLS) to analyze data from 120 avocado farmers in Baruppu' District. The results indicate that farmer characteristics, such as education and experience, significantly affect farm performance. Farmer abilities, including technical skills and managerial capabilities, also play a crucial role in enhancing farm performance. Moreover, farmer opportunities, such as access to markets, resources, and government support, positively influence farm performance. The study found that farmer participation, driven by these factors, is a key mediator between these influences and improved farm performance. The findings suggest that enhancing farmer participation through targeted interventions, such as training programs and better access to resources, can significantly improve the sustainability and productivity of avocado farming in the region. This research provides valuable insights for policymakers and agricultural institutions to develop strategies that support farmer participation and boost avocado farm performance in North Toraja Regency.
Keywords: *farmer characteristics, farmer ability, farmer opportunity, production factors, farm performance.*

1. INTRODUCTION

The avocado commodity is one of the horticultural commodities that has high economic value (Bappenas, 2018) and has great potential to be traded to meet market needs, both domestic and international (Tamalia et al., 2019). Demand for avocados tends to increase along with increasing public awareness of the importance of maintaining a healthy body, where avocados are one of the fruit choices that are rich in benefits (Cahyo, 2019; City, 2021; Fatikhah et al., 2020; Nuryadi & Rahmawati, 2018; Tumbo et al., 2018).

Based on data from (the Statistical Yearbook of Indonesia 2022, n.d.), avocado production in Indonesia in 2019 was recorded at 461,613 tons and increased to 669,260 tons in 2021. This production not only fulfills the domestic market but also for export. In 2021, Indonesia exported 400 tons of avocados. However, this increased demand requires a sustainable increase in productivity through better farm management.

North Toraja Regency, with its favorable geographical and agro-climatic conditions, has significant potential in avocado crop development. Baruppu's sub-district, as one of the Avocado production centers in North Toraja, holds great potential in avocado development, especially the *Persea americana* species, also known as butter avocado. In 2021, avocado production in Baruppu's sub-district was recorded at 2,258 tons (BPS, 2022). The sub-district is located at an altitude of 1,000-1,800 meters above sea level with relatively cool air temperatures, ranging from 15°C-20°C, ideal conditions for avocado growth. The fertile volcanic soil type in this region also supports avocado growth without requiring excessive fertilizer use. Optimization is largely determined by farmer participation. There are several factors that influence farmer participation in avocado farming and the performance of farms managed by farmers, one of which is the level of education and knowledge of farmers, where farmers who have limited knowledge tend to maintain traditional methods, such as not doing routine pruning or balanced fertilization.

Farmer participation in avocado farming covers various aspects, ranging from technological innovation and involvement in farmer groups to access to information and markets (Hayati, 2016). A high level of participation is expected to encourage increased productivity, efficiency, and sustainability of avocado farming. Avocado farming performance, on the other hand, reflects the success of farmers in managing resources and generating optimal profits. This performance can be measured through various indicators, such as crop productivity, efficiency of production input use, farmer income, and environmental sustainability (Rosanti, N., Sinaga, B. M., Daryanto, A., & Kariyasa, 2019).

Various factors are strongly suspected to influence the level of farmer participation and avocado farm performance. Farmer characteristics, such as age, education level, farming experience, and motivation, can influence decision-making and adoption of better farming practices (Putri et al., 2019). Farmers with higher education levels and more experience tend to be more open to new information and innovations. In addition, farmer capabilities, which include knowledge, technical skills, and managerial abilities, also play an important role in farm success (Jamaluddin et al., 2023). Farmers with good capabilities will be more effective in managing their farms, starting from the selection of superior seeds and proper cultivation techniques to quality post-harvest handling.

Farmer opportunities, such as access to market information, government policy support, infrastructure availability, and social networks, can influence farmers' motivation and ability to actively participate and improve their farm performance (Rosanti et al., 2019). Better opportunities will create a conducive environment for avocado farm development. In addition, production factors, which include the availability and quality of land, capital, labor, and agricultural inputs (fertilizers, pesticides), directly affect the productivity and efficiency of avocado farming (Sigit & Nur Aini, 2022). Efficient and appropriate management of production factors will contribute significantly to farm performance.

Although the potential for avocado development in Baruppu's Subdistrict is considerable, an in-depth understanding of how the factors of farmer characteristics, farmer capabilities, farmer opportunities, and production factors jointly influence farmer participation and avocado farm performance is limited. This research is important to identify and analyze the influence of these various factors comprehensively.

Based on the description above, the focus of the research is the influence of the factors of farmer characteristics, farmer abilities, farmer opportunities, and production factors on farmer participation and avocado farming performance in Baruppu District, North Toraja Regency**.** This study also aims to examine the direct and indirect effects of exogenous latent variables, such as farmer characteristics, farmer abilities, farmer opportunities, and production factors, as well as the direct effect of endogenous variables of farmer participation on avocado farming performance in the region.

Thus, the *Structural Equation Modeling - Partial Least Square* (SEM-PLS) approach was used to identify aspects that need to be improved in supporting the sustainability of avocado farming in Baruppu's sub-district. This approach is expected to provide useful recommendations for the government or related parties to improve the productivity and management of avocado farming in Baruppu' Sub-district.

North Toraja has the potential for avocado development, but the increase in the number of plants is not directly proportional to the productivity of the plants; this can be caused by several things, including the farmers' skills in cultivation, while if there is training or counseling farmers are less actively involved, and farmers are not serious about cultivating their avocados, this is what is needed in seeing the participation of farmers in farmer groups. It is also realized that improving farm performance in a commodity is a lot of factors that are considered in meeting market needs and needs to be supported by cooperation between agricultural institutions involved in it, starting from farmers to downstream industries that play a role in processing agricultural commodities before reaching consumers. The purpose of organizing agricultural training programs is none other than an effort to achieve optimal productivity so that market needs for this can be met; a good agricultural cultivation system can be implemented if it has guidelines for implementing supporting activities.

Research on the factors driving farmer participation in a commodity has been widely done, but little research has been found that examines the factors driving farmer participation in horticultural commodities, especially in avocado farming. This study will provide specific and up-to-date information on the factors driving farmer participation in farmer groups to improve business performance through avocado farming participation.

Research (Triguna et al., 2022), (Fangohoi et al., 2022), (Martadona & Elhakim, 2020) both discuss the factors that influence farmer participation, but with different approaches, ojek, and results. This difference in findings is an important basis for research on the influence of the factors of farmer characteristics, farmer opportunities, and production on-farm performance through avocado farmer participation in Baruppu District, North Toraja Regency. To clearly see the differences between this research and similar research conducted can be seen in Table 1:

Table 1. Previous Research

No	Researcher Name	Research Title	Method	Research Result
1	**Triguna,** 2022 (Triguna et al., 2022)	Factors Affecting Farmer Participation in the Maize Special Effort Program in Pandeglang Regency	The data obtained were analyzed by inferential statistics using Structural Equation Modeling-Partial Least Square (SEM-PLS) analysis.	The results showed that the ability of farmers and opportunity factors have a positive and significant effect on the level of farmer participation. This means that the higher the ability of farmers and the greater the opportunities obtained by farmers cause the level of farmer participation in the UPSUS maize program to increase. Farmer characteristics have a positive effect but do not have a significant influence on the level of farmer participation.
2	**Latarus Fangohoi, Yohanis Y Makabori, and Yuliana Ataribaba,** 2023 (Fangohoi et al., 2022)	Factors that Determine the Level of Farmer Participation in Farmer Groups	Rank Spearman test method	Characteristics of farmers in the Mekarsari farmer group are a determining factor in the level of participation of farmers in the planning and implementation stages. Have very high participation (84%), the level of participation of farmers in the evaluation stage is high (82%), and the level of participation of farmers in the stage of enjoying the results is very high (89%). The level of education has no relationship from the characteristics of respondents with participation; on the contrary, the level of participation in agricultural activities has a significant relationship/correlation with the variables of age, length of farming, cosmopolitan land area, and leadership. The results of the interaction of internal and external factor variables have a fairly strong level of relationship, where the relationship between farmer characteristics and the level of participation is unidirectional, so H0 is rejected, and Ha is accepted.
3	**Ilham Martadona, Siti Khairani Elhakim,** 2020 (Martadona & Elhakim, 2020)	F Factors Affecting Farmer Participation Towards the Successful Implementation of Rice Farming Insurance Program (AUTP) in Padang City: SEM-PLS Analysis	Data analysis using quantitative analysis with the Structural Equation Modeling-Partial Least Square (SEM-PLS) approach.	The results of the study show that the variables of age, education level, attitude towards change, farming experience, and land size have a significant effect on the success of the AUTP program in Padang City. The effect of farmer participation on the success of the AUTP program has a negative or opposite relationship, meaning that the stronger the farmer participation, the lower the success of the AUTP program in Padang City.

Based on the above background, the objectives of this study are to examine (1) the direct effect of exogenous latent variables such as farmer characteristics, farmer abilities, farmer opportunities, and production factors on farm performance through avocado farmer participation in Baruppu' District, North Toraja Regency; (2) the indirect effect of these exogenous latent variables on farm performance through avocado farmer participation; and (3) the effect of farmer participation on the farm performance of avocado farmers in Baruppu' District, North Toraja Regency. This research is expected to provide theoretical benefits as a vehicle for applying the knowledge gained in college, especially related to farmer participation in farm performance in the avocado commodity. Practically, this research is expected to contribute as additional literature for academics regarding the determinants of farmer participation, as well as being a recommendation for the government in making policies related to farmer participation in improving avocado farming performance. In addition, this study also aims to provide wider knowledge to the community regarding the factors that determine farmer participation in avocado farming performance.

2. METHOD

2.1 Place and Time

The research was conducted in June-July 2024. The research location is Baruppu District, North Toraja Regency. The selection of the research location was carried out deliberately *(purposive sampling)* with the consideration that based on data from the North Toraja statistical center in 2021, Baruppu 'District is one of the largest avocado centers/production in North Toraja, amounting to 629 tons (35%) (BPS, 2022).

2.2 Population and Sample

The population in this study was 250 avocado farming farmers in Baruppu District, North Toraja Regency. The technique used in sample selection is *simple random sampling.* The number of respondents in this sample was obtained using the following Slovin formula:

$$n = \left(\frac{N}{1 + N\,x\,e^2}\right)$$

$$n = \left(\frac{250}{1+250\,x\,(0{,}10)^2}\right)$$

$$n = \left(\frac{250}{1 + 2{,}5}\right)$$

$$n = \left(\frac{250}{3{,}5}\right)$$

n=71.43; adjusted by the researcher 120.

Notes:

N = the number of samples (souls)s

N = Total population (soul)

e^2 = Error rate (10%)

Therefore, to facilitate data processing and better test results, in this study, the sample to be used was rounded up to 120 Avocado farmer respondents in Baruppu' District, North Toraja Regency.

2.3 Types and Sources of Data

The types and sources of data that will be used in this study are as follows:

1. In this study, primary data will be obtained from the results of interviews conducted with avocado farming farmers using a questionnaire.
2. Secondary data used in this research is obtained from literature that has relevance to this research and related agencies, such as the Central Bureau of Statistics of South Sulawesi and North Toraja Regency. The data to be collected is related to the level of avocado consumption in the last few years in North Toraja Regency.

2.4 Data Collection Method

The method used in collecting data - the data needed is collected by means of:

1. Interview method using a questionnaire guide (list of questions).

In this study, questionnaires were given to Avocado farming farmers, which were closed using ordinal, nominal, and interval measurement scale instruments.

2. Documentation

Documentation in this study was conducted by directly observing the research location.

2.5 Data Analysis Method

In this study, descriptive statistical data analysis was used in calculating the Likert scale on the research questionnaire. Quantitative analysis is used to collect data and numbers obtained and will then be processed in more detail in a data analysis using Structural Equation Modeling (SEM) analysis. The data variables used in this study are farmer characteristics, farmer abilities, farmer opportunities, production factors, farmer participation, and avocado farming performance.

2.5.1 Descriptive Statistical Analysis

The following is the formula for determining the value of the Respondent Achievement Rate according to (Sugiyono, 2013) :

$$TCR = \frac{mean}{maximum\ score} X\ 100$$

Table 2. TCR Value Criteria (Respondent Achievement Rate)

TCR	Scale Range
Very good	90% - 100%
Good	80% - 89,99%
Fair	65% - 79,99%
Not so good	55% - 64,99%
Not Good	0% - 54,99%

Source: Sugiyono (2013).

2.5.2 Structural Equation Modeling (SEM) Analysis

In this study, the data collected were analyzed with SEM-PLS. The process includes model identification to ensure a just-identified or over-identified model, parameter estimation to obtain model statistics, and model testing. Evaluation of indicator validity and construct reliability is done by measuring standardized factor loading, construct reliability (CR), average variance extracted (AVE), and Cronbach alpha. Measurement model testing includes a model fit test using the goodness of fit (GFT) measure.

Table 3. Some Measures of Goodness of Fit Test (GFT)

GFT Measure	Description
Probability (P-value)	Maximum likelihood (ML) based model fit test measure. The P (probability) value is expected to exceed 0.05 (model fit) or P = 1 (perfect fit).
CMIN/DF	CMIN/DF value≤ 2 indicates the model fits with the data. That is, the more parsimony the proposed model has compared to alternative models.
Root Mean Square Error of Approximation (RMSEA)	Root mean square error of approximation value. It is expected to be low. RMSEA < 0.08 means the model fits the data.
Tucker-Lewis Index (TLI)	Expected >0.90, then said model fit.
Comparative Fit Index (CFI)	A measure of comparative-based model fit with the null model. CFI values range from 0 - 1.0. CFI > 0.90, the model fits the data.
Normed Fit Index (NFI)	The model is said to be fit if the NFI> 0.90.
Parsimonious Normed Fit Index (PNFI)	The higher the PNFI value produced, the more fit the proposed model is.

Source: Kusnendi (2008).

Furthermore, hybrid model testing is carried out in two stages: first, testing the suitability of the model using the same statistics as in testing the measurement model, and second, testing the meaningfulness of the structural model path coefficients to test the research hypothesis using the t statistic. If t-count ≥ t table at an error rate of 0.05, the null hypothesis is rejected. The model is improved to obtain the simplest one if insignificant path coefficients are found, and the results are interpreted to answer the research problem.

3. RESULT AND DISCUSSION

3.1 Structural Equation Modeling-Partial Least Square (SEM-PLS) Analysis

3.1.1 Measurement Model Testing

Partial Least Square (PLS) uses a bootstrapping method that is not affected by the assumption of normality. This research model consists of 6 constructs: Farmer Characteristics (X1), Farmer Ability (X2), Farmer Opportunity (X3), Production Factors (X4), Farmer Participation (Y1), and Avocado Farm Performance (Y2). Measurement model testing was conducted to test construct validity and reliability through four stages: individual item reliability, internal consistency reliability, average variance extracted, and discriminant validity.

3.1.1.1 Individual Item Reliability

At the initial stage, testing was carried out to validate each indicator against the variable under review based on the outer loading value.

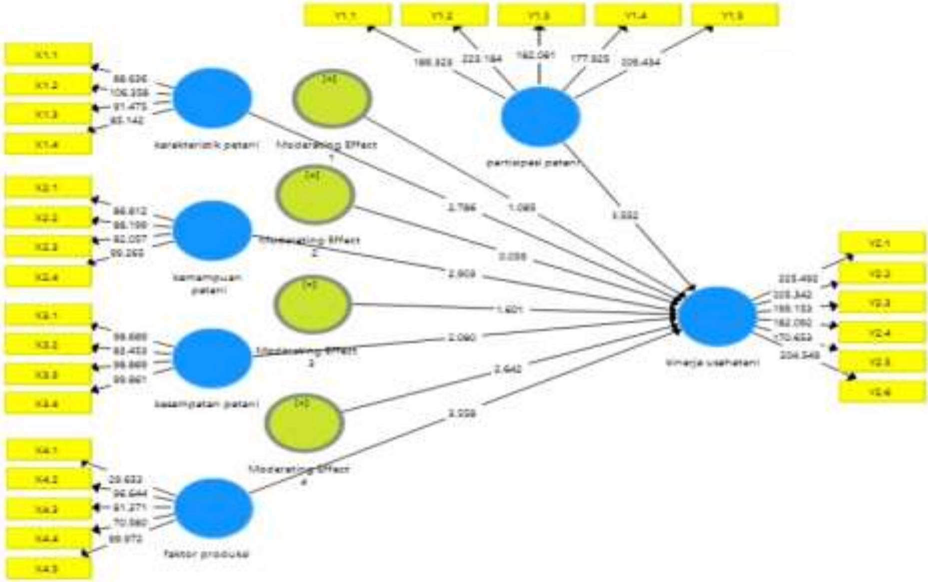

Figure 1. Outer Model Output

The outer model shows the relationship between indicators (manifest variables) and latent variables. The outer loading value of each indicator illustrates its contribution to the latent variable represented. A high outer loading value (>0.7) indicates a strong and valid contribution. Indicators such as X1.1 to X4.5 and Y1.1 to Y2.6 have varying values, reflecting the strength of each indicator in explaining the latent variable. Indicators with low outer loading values may need to be considered for removal from the model.

Table 4. Outer Loadings

Variable	Indicator	Factor loadings	Criteria	Test result
Production factor	X4.1	0.842	> 0.7	VALID
	X4.2	0.908	> 0.7	VALID
	X4.3	0.904	> 0.7	VALID
	X4.4	0.891	> 0.7	VALID
	X4.5	0.924	> 0.7	VALID
Farmer characteristics	X1.1	0.916	> 0.7	VALID
	X1.2	0.930	> 0.7	VALID
	X1.3	0.920	> 0.7	VALID
	X1.4	0.909	> 0.7	VALID
Farmer's ability	X2.1	0.911	> 0.7	VALID
	X2.2	0.911	> 0.7	VALID
	X2.3	0.893	> 0.7	VALID
	X2.4	0.910	> 0.7	VALID
Farmer opportunity	X3.1	0.930	> 0.7	VALID
	X3.2	0.909	> 0.7	VALID
	X3.3	0.916	> 0.7	VALID
	X3.4	0.920	> 0.7	VALID
Farm business performance	Y2.1	0.957	> 0.7	VALID
	Y2.2	0.958	> 0.7	VALID
	Y2.3	0.954	> 0.7	VALID
	Y2.4	0.954	> 0.7	VALID
	Y2.5	0.945	> 0.7	VALID
	Y2.6	0.951	> 0.7	VALID
	Y1.1	0.955	> 0.7	VALID

Variable	Indicator	Factor loadings	Criteria	Test result
Farmer participation	Y1.2	0.958	> 0.7	VALID
	Y1.3	0.950	> 0.7	VALID
	Y1.4	0.956	> 0.7	VALID
	Y1.5	0.956	> 0.7	VALID

The results of the outer loading analysis show that all latent variable indicators meet the validity criteria with a loading factor value above 0.7. The variables of production factors, farmer characteristics, farmer abilities, farmer opportunities, farm performance, and farmer participation have indicators with loading factor values between 0.842 and 0.958, which indicates a very good contribution and representation of the respective latent variables.

3.1.1.2 Internal Consistency Reliability

The test was conducted by utilizing the composite reliability (CR) value. This internal consistency refers to the level of conformity or reliability between observers or measurement instruments used in research.

Table 5. Cronbach's Alpha and Rho A

	Cronbach's Alpha	rho_A	Criterion	Test Result
Production Factor	0.937	0.938	0.70	VALID
Farmer Characteristics	0.938	0.938	0.70	VALID
Farmer Capability	0.927	0.928	0.70	VALID
Farmer Opportunities	0.938	0.938	0.70	VALID
Farm Performance	0.980	0.980	0.70	VALID
Farmer Participation	0.976	0.976	0.70	VALID

The reliability test results show that all variables meet the criteria of high reliability and validity. Cronbach's Alpha and rho_A values for all variables are above 0.7, indicating excellent internal consistency. Composite Reliability (CR) values exceeded 0.7, with the highest values in farm performance (0.983) and farmer participation (0.981). The Average Variance Extracted (AVE) value is also more than 0.5, with the highest values in farmer participation (0.912) and farm performance (0.908), indicating convergent validity is met.

3.1.1.3 Average Variance Extracted (AVE)

In testing at this stage, by looking at the average variance extracted value, a value is declared valid if the AVE test value is above 0.5.

Table 6. Average Variance Extracted (AVE)

	Average Variance Extracted (AVE)	Criteria	Test Results
Production Factor	0.800	0.50	VALID
Farmer Characteristics	0.844	0.50	VALID
Farmer Capability	0.821	0.50	VALID
Farmer Opportunities	0.844	0.50	VALID
Farm Performance	0.908	0.50	VALID
Farmer Participation	0.912	0.50	VALID

Average Variance Extracted (AVE) test results show that all variables meet the criteria of convergent validity, with an AVE value of more than 0.50. Production factor variables (0.800), farmer characteristics (0.844), farmer abilities (0.821), farmer opportunities (0.844), farm performance (0.908), and farmer participation (0.912) show that each construct is able to explain more than 50% of the variance of its indicators. This indicates that all indicators are valid and the measurements in this study are reliable.

3.1.1.4 Discriminant Validity

Discriminant validity testing is done with two methods, namely looking at the cross-loading value between indicators, as well as Fornell-Lacker's cross-loading.

Table 7. Cross Loading

	Production Factors	Farmer Characteristics	Farmer Ability	Farmer Opportunities	Farm Performance	Farmer Participation
X1.1	0.805	0.916	0.856	0.862	0.872	0.879
X1.2	0.814	0.930	0.853	0.859	0.881	0.874
X1.3	0.806	0.920	0.871	0.873	0.880	0.891

	Production Factors	Farmer Characteristics	Farmer Ability	Farmer Opportunities	Farm Performance	Farmer Participation
X1.4	0.783	0.909	0.857	0.851	0.888	0.880
X2.1	0.799	0.866	0.911	0.861	0.890	0.891
X2.2	0.818	0.845	0.911	0.846	0.873	0.868
X2.3	0.801	0.842	0.893	0.844	0.854	0.861
X2.4	0.817	0.837	0.910	0.836	0.862	0.854
X3.1	0.824	0.892	0.882	0.930	0.891	0.895
X3.2	0.814	0.839	0.864	0.909	0.877	0.879
X3.3	0.801	0.859	0.842	0.916	0.866	0.865
X3.4	0.799	0.854	0.846	0.920	0.880	0.877
X4.1	0.842	0.854	0.861	0.848	0.880	0.862
X4.2	0.908	0.775	0.776	0.792	0.803	0.773
X4.3	0.904	0.749	0.786	0.763	0.787	0.780
X4.4	0.891	0.746	0.774	0.751	0.765	0.765
X4.5	0.924	0.762	0.780	0.771	0.788	0.782
Y1.1	0.840	0.919	0.906	0.919	0.932	0.955
Y1.2	0.849	0.912	0.916	0.913	0.925	0.958
Y1.3	0.875	0.909	0.916	0.915	0.932	0.950
Y1.4	0.863	0.920	0.916	0.918	0.933	0.956
Y1.5	0.820	0.919	0.924	0.904	0.929	0.956
Y2.1	0.846	0.918	0.916	0.911	0.957	0.925
Y2.2	0.870	0.914	0.922	0.927	0.958	0.928
Y2.3	0.868	0.916	0.913	0.897	0.954	0.929
Y2.4	0.848	0.915	0.920	0.914	0.954	0.933
Y2.5	0.860	0.913	0.902	0.913	0.945	0.922
Y2.6	0.874	0.903	0.919	0.909	0.951	0.931

The results of the analysis of cross-loading values show that most indicators have higher loading on the corresponding constructs than on other constructs, which indicates good discrimination between constructs. For example, indicator X1.1 has the highest loading on farmer characteristics (0.916), and Y1.1 shows the highest loading on farmer participation (0.955). However, some indicators, such as X4.2 to X4.5, have high loading values on both the main construct and other constructs, which needs to be considered to ensure construct validity.

Table 8. Fornell-Larcker

	Production Factors	Farmer Characteristics	Farmer Ability	Farmer Opportunity	Farm Performance	Farmer Participation
Production Factors	0.894					
Farmer Characteristics	0.873	0.919				
Farmer Ability	0.893	0.935	0.906			
Farmer Opportunity	0.881	0.938	0.935	0.919		
Farm Performance	0.904	0.958	0.960	0.957	0.953	
Farmer Participation	0.890	0.959	0.959	0.957	0.974	0.955

In this table, the diagonal shows the AVE value for each construct, while the numbers outside the diagonal show the correlation between constructs. All the AVE values on the diagonal are greater than the inter-construct correlation values, indicating that each construct has more variation explained by its own indicators. For example, the farm performance construct has an AVE of 0.953, which is greater than the correlation with production factors (0.904) and farmer participation (0.974). Likewise, farmer participation has an AVE of 0.955, which is higher than the correlation with other constructs. This indicates good discrimination between constructs.

3.1.2 Testing the Inner Model (Structural Model)

3.1.2.1 R-Square

R square is between 0 and 1.00, provided that the closer to 1.00 (one), the better.

Table 9. R-square value

	R Square	R Square Adjusted
farm performance	0.969	0.967

The R^2 value for farm performance in this study is 0.969, which indicates that 96.9% of the variation in farm performance can be explained by the independent variables in the model. This signifies a strong relationship and an excellent model. The Adjusted R-squared value of 0.967 indicates that the model not only explains the variation well but also takes into consideration the number of independent variables without becoming too complex, so the contribution of the independent variables is significant.

3.1.2.2 Q-Square

The predictive relevant value is used to see how well the observation value is done to assess the fit of the structural relevance of the model.

Table 10. Q-Square

	SSO	SSE	Q^2 (=1-SSE/SSO)
Production Factor	258	258	0.02
Farmer Characteristics	516	305.766	0.307
Farmer Capability	387	251.953	0.319
Farmer Opportunity	516	516	0.042
Farm Performance	387	387	0.032

Based on the test results, the Q^2 value for production factors of 0.02 indicates very low predictive ability. Farmer characteristics had a Q^2 value of 0.307, indicating moderate predictive relevance. Similarly, farmer ability showed a Q^2 value of 0.319, indicating moderate predictive relevance. For farmer opportunities, the Q^2 value of 0.042 indicates the low predictive ability of the model. Finally, farm performance had a Q^2 value of 0.032, indicating the ineffectiveness of the model in predicting this variable.

3.1.3 Goodness of Fit Index (GoF Index)

Goodness of Fit (GoF) values range from 0 to 1, where the recommended communality value is 0.50, and the R square value is used for interpretation. GoF values below 0.10 fall into the small category, 0.25 for the medium category, and 0.36 for the large category. The Tenenhaus GoF calculation is done as follows:

Table 11. Goodness of Fit Index

	Saturated Model	Estimated Model
SRMR	0.036	0.041
d_ULS	0.541	0.680
d_G	0.930	1.326
Chi-Square	550.394	993.224
NFI	0.902	0.823

Based on the Goodness of Fit (GoF) criteria, the analysis results show several indicators to assess the fit of the model to the data. The SRMR value (0.041) indicates a low average error and is considered good (below 0.08). However, the d_ULS value (0.680) indicates a significant difference between the estimated model and the expected model, indicating the need for refinement. The d_G value (1.326) is greater than the saturated model (0.930), indicating a considerable discrepancy and the need for improvement. The Chi-Square value (993.224) is higher than the saturated model (550.394), indicating that the model may not be fully adequate. The NFI value (0.823) is still below 0.90, indicating that the model is quite good, but there is still room for improvement. Overall, while the SRMR and NFI indicators indicate sufficient model fit, other indicators such as d_ULS, d_G, and Chi-Square indicate the need for refinement to improve the fit of the model to the observed data.

3.1.4 Hypothesis Test

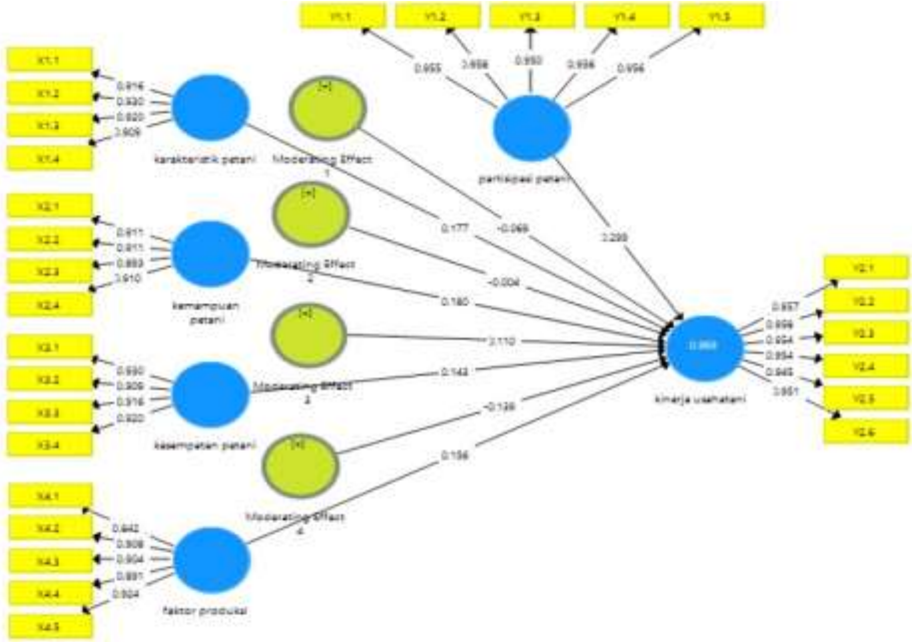

Figure 2. Inner Model

3.1.4.1 Direct Effect

Direct effect analysis is useful for testing the hypothesis of the direct effect of an influencing variable (exogenous) on the influenced variable (endogenous).

Table 12. Direct Effect

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Production Factors→ Farm Performance	0.156	0.155	0.044	3.558	**0.000**
Farmer Characteristics→ Farm Performance	0.177	0.172	0.063	2.786	**0.006**
Farmer Ability→ Farm Performance	0.180	0.183	0.062	2.903	**0.004**
Farmer Opportunities→ Farm Performance	0.143	0.132	0.069	2.080	**0.038**
Farmer Participation→ Farm Performance	0.299	0.291	0.084	3.552	**0.000**

The results of the direct effect analysis show that all independent variables have a significant influence on farm performance. Production factors have a coefficient of 0.156 with a T-statistic value of 3.558 and a P value of 0.000, indicating a significant influence at the 99% confidence level. Farmer characteristics had a coefficient of 0.177 with a T-statistic value of 2.786 and a P of 0.006, which was also significant at the 95% confidence level.

Farmer ability shows a coefficient of 0.180 with a T-statistic of 2.903 and a P value of 0.004, so the effect is significant at the 95% confidence level. Farmer opportunity has a coefficient of 0.143 with a T-statistic of 2.080 and a P of 0.038, which is significant at the 95% confidence level. Finally, farmer participation has the largest coefficient, 0.299, with a T-statistic of 3.552 and a P of 0.000, indicating a significant effect at the 99% confidence level.

3.1.4.2 Indirect Effect

This analysis is used to test the hypothesis of the indirect effect of an influencing variable (endogenous) on the influenced variable (endogenous) mediated by an intervening variable (mediator variable).

Table 13. Indirect Effect

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
production factors→ farmer participation→ farm performance	-0.069	-0.071	0.064	1.085	0.279
farmer characteristics → farmer participation → farm performance	-0.004	-0.015	0.070	0.059	0.953
farmer ability→ farmer participation→ farm performance	0.110	0.106	0.069	1.601	0.110
farmer opportunities→ farmer participation→ farm performance	-0.139	-0.142	0.053	2.642	0.009

The results of the indirect effect analysis show that not all moderation has a significant effect on farm performance. Moderating Effect 1 (production factors→, farmer participation→, farm business performance) is not significant with a coefficient of -0.069, T-statistic 1.085, and P-value 0.279. Moderating Effect 2 (farmer characteristics→, farmer participation→, farm business performance) is also insignificant with a coefficient of -0.004, T-statistic of 0.059, and P-value of 0.953. Moderating Effect 3 (farmer ability→, farmer participation→, farm business performance) approached significance with a coefficient of 0.110, T-statistic of 1.601, and P-value of 0.110 but remained insignificant. However, Moderating Effect 4 (farmer opportunity→ farmer participation→ in farm business performance) showed significant results with a coefficient of -0.139, a T-statistic of 2.642, and a P-value of 0.009 at the 95% confidence level.

3.1.4.3 Total Effect

The total effect is the path coefficient of the direct effect summed with the indirect effect.

Table 14. Total Effect

	Direct Effect	Indirect Effect	Total Effect
production factors→ farmer participation→ farm performance	0.156	-0.069	0.087
farmer characteristics→ farmer participation→ farm performance	0.177	-0.004	0.173
farmer ability→ farmer participation→ farm performance	0.180	0.110	180.11
farmer opportunities→ farmer participation→ farm performance	0.143	-0.139	0.004

Based on the total effect analysis, which is the sum of the direct and indirect effects, the following results were found:

a. Production factors provide a total effect of 0.087, with a positive direct effect of 0.156, but a negative indirect effect (-0.069) reduces the total effect.

b. Farmer characteristics provide a total effect of 0.173. Although the indirect effect is very small and negative (-0.004), the larger direct effect (0.177) dominates and results in a positive total effect.

c. Farmer ability provides a highly significant total effect of 0.180, with a large direct effect (0.180) and positive indirect effect (0.110), indicating a large impact on farm performance.

d. Farmer opportunity provides an almost neutral total effect of 0.004, as the positive direct effect (0.143) is almost offset by the negative indirect effect (-0.139).

3.1.4.4 Mediation Effect Test

Testing of mediating variables can also be seen from the value of the allele variance fraction/VAF of each intervening/mediating variable.

Table 15. Mediation Effect Test

	Indirect Effect	Total Effect	VAF
production factors→ farmer participation→ farm performance	-0.069	0.087	-0.79
farmer characteristics → farmer participation → farm performance	-0.004	0.173	-0.023
farmer ability→ farmer participation→ farm performance	0.110	180.11	0.00
farmer opportunities→ farmer participation→ farm performance	-0.139	0.004	-3.47

Based on the calculation of Variance Accounted For (VAF), the indirect effect on the total effect shows significant variation between paths. In the path of production factors→, farmer participation→, and farm performance, the VAF value of -0.79 indicates that the indirect effect has a negative contribution to the total effect, although the overall effect remains small. Furthermore, the farmer characteristics pathway→ farmer participation→ farm performance shows a VAF value of -0.023, indicating that the contribution of indirect effects is almost insignificant and even slightly reduces the total effect.

In contrast, for the pathway farmer ability→, farmer participation→, and farm performance, the VAF of close to 0.00 indicates that almost the entire total effect is dominated by direct effects, while indirect effects barely contribute. In contrast, the farmer opportunity pathway→ farmer participation→ farm performance recorded a VAF of -3.47, which means that indirect effects significantly reduced the total effect, even producing a large negative effect on the overall relationship.

3.2 DISCUSSION

3.2.1 Effect of Production Factors on Farm Performance

The first hypothesis in this study is the effect of production factors on farm performance. Based on the research results, it is known that production factors have a significant influence on farm performance, with a coefficient value of 0.156. The t-count value of 3.558 is greater than the t-table value, and the significance level of 0.000 is below the 0.05 threshold. This indicates that the contribution of production factors to farm performance is real and positive. In other words, an increase in production factors can directly improve farm performance significantly (Ananda & Kristiana, 2017).

Production factors play a crucial role in the success of farming, including land, labor, capital, and technology. Land determines production capacity, where the more fertile and spacious the land, the greater the potential for farm yields. Labor, both family and farm labor, is the main driver in the production process, from land cultivation to harvesting. Labor skills and efficiency affect the productivity and quality of farm produce (Jamaluddin et al., 2023).

Capital and technology play an important role in farming. Sufficient capital allows farmers to acquire production inputs such as improved seeds, fertilizers, and agricultural tools, which can increase the intensity and quality of their farming activities. Modern technology, such as tillage machinery and automatic irrigation, increases efficiency and productivity by reducing time and labor in production and increasing yields. Harmonious interactions between these factors of production can optimize farm performance, improving the quantity and quality of yields, cost efficiency, and product competitiveness. Conversely, the inadequacy of one of the production factors can hamper farming and reduce yields, work efficiency, and profits (Putri et al., 2019).

3.2.2 Effect of Farmer Characteristics on Farm Performance

The second hypothesis in this study is the effect of farmer characteristics on farm performance. Based on the results of the study, it is known that farmer characteristics have a significant influence on farm performance, with a coefficient value of 0.177. The t-count value of 2.786 is greater than the t-table value, and the significance level of 0.000 is below the 0.05 threshold. This indicates that the contribution of farmer characteristics to farm performance is real and positive. In other words, an increase in farmer characteristics can directly improve farm performance significantly.

Farmer characteristics have a significant influence on farm performance, as they include personal factors that influence how farmers manage resources and make decisions in farming activities. These characteristics include education level, farming experience, age, access to information, and openness to innovation. The level of education, for example, plays a role in farmers' ability to understand new technologies, access market information, and manage their farms more efficiently. Farmers with higher education tend to adapt more quickly to changes, such as the use of modern technology or the implementation of sustainable agricultural practices.

Farming experience greatly influences farm performance, as farmers who have been managing land for longer have practical knowledge of cropping patterns, variety selection, and how to overcome challenges such as pests and weather. Farmers' age also matters; young farmers are more energetic and open to innovation, while older farmers are more experienced but less flexible to change. Good access to information allows farmers to make more informed and strategic decisions regarding market prices, new technologies, and government policies (Fangohoi et al., 2022).

3.2.3 The Effect of Farmer Ability on Farm Performance

The third hypothesis in this study is the effect of farmers' abilities on farm performance. Based on the results of the study, it is known that the ability of farmers has a significant influence on farm performance, with a coefficient value of 0.180. The t-count value of 2.903 is greater than the t-table value, and the significance level of 0.000 is below the 0.05 threshold. This indicates that the contribution of farmer capability to farm performance is real and positive. In other words, an increase in farmer capability can directly improve farm performance significantly.

Farmer capability is a crucial factor influencing farm performance, as it reflects the extent to which farmers are able to manage their resources and face challenges in the production process. This includes technical, managerial, and adaptive aspects. Technically, farmers' capabilities involve knowledge and skills in applying good cultivation techniques, such as selecting superior seeds, using fertilizers efficiently, managing irrigation, and controlling pests and diseases, which directly impact farm productivity (Zulfajrin et al., 2021).

Managerial skills are critical in efficiently managing farm businesses, including resource allocation, crop rotation, business diversification, and market opportunities. These skills are influenced by education, experience, and access to training. Additionally, the adaptive ability to deal with environmental changes, such as climate change or market price fluctuations, plays a role in farm performance, with adaptive farmers adjusting strategies quickly, such as switching to resistant varieties or adopting efficient technologies for water scarcity (Martadona & Elhakim, 2020).

Farmers with high capabilities in these areas tend to have more productive, efficient, and sustainable farms, optimizing production, reducing costs, and exploiting market opportunities for greater profits, while low capabilities lead to obstacles such as low yields, inefficiency, and lack of competitiveness (Nisita Wuri et al., 2021).

3.2.4 The Effect of Farmer Opportunities on Farm Performance

Farmer opportunities strongly influence farm performance as they reflect access to resources, information, and opportunities that can improve yield and efficiency. External factors such as access to land, capital, technology, markets, education, training, and government policies play an important role in creating these opportunities. The more opportunities available, the greater the potential for farmers to improve productivity, yield quality, and farm sustainability. Access to land and capital allows farmers to optimize farming activities and purchase efficient inputs, while training and agricultural extension provide knowledge and skills to face challenges such as climate change and market needs (Fanani et al., 2023).

Information technology plays an important role in improving farm performance by speeding up work processes and increasing efficiency and crop yields. Access to wider markets, both through local distribution networks and digital platforms, also opens up opportunities for farmers to sell produce at more competitive prices, increasing economic returns and competitiveness. The role of government and other institutions, such as fertilizer subsidies, agricultural equipment assistance, and opening access to credit, provides significant support. Farmer groups or cooperative empowerment programs are also important, as they allow farmers to share information, improve their bargaining position, and take advantage of opportunities together (Fanani et al., 2023). However, if these opportunities are limited, farmers will face various constraints, such as difficulty accessing capital, technology, or markets, which ultimately hampers farm performance. Therefore, creating an enabling environment and expanding opportunities for farmers is a strategic step to increase the productivity, efficiency, and welfare of farmers so that farm businesses can develop sustainably and competitively (Mario Victoria Koampa et al., 2021; Septiadi & Sudjatmiko, 2023).

3.2.5 Effect of Farmer Participation on Farm Performance

The fifth hypothesis in this study is the effect of farmer participation on farm performance. Based on the results of the study, it is known that farmer participation has a significant influence on farm performance, with a coefficient value of 0.299. The t-count value of 3.552 is greater than the t-table value, and the significance level of 0.000 is below the 0.05 threshold. This indicates that the contribution of farmer participation to farm performance is real and positive. In other words, an increase in farmer participation can directly improve farm performance significantly.

Farmer participation in managing the farm greatly influences its performance, including involvement in decision-making, applying new technologies, business planning, and farming community activities. Active farmers, engaged in planning and decision-making, such as selecting crop varieties, setting cropping patterns, and managing fertilizer and pesticide use, tend to perform better. This participation helps identify risks and opportunities, allowing for more effective responses to challenges like weather changes and market price fluctuations . Participation in farmer groups enhances farm performance by facilitating information exchange, access to training, and resources like tools or credit, which strengthens collaboration and efficiency. Adoption of new technologies, supported by government or private sector involvement, boosts productivity. Additionally, farmer input in agricultural policy decisions ensures relevant policies, creating a favorable environment for farm development (Muhlisin, 2021; Putri et al., 2019).

3.2.6 Effect of Production Factors on Farm Performance through Farmer Participation

The sixth hypothesis in this study is the effect of production factors on farm performance through farmer participation. Based on the results of the study, it is known that production factors have a negative influence on farm performance mediated by farmer participation, with a coefficient value of -0.069. The t-count value of 1.085 is smaller than the t-table value, and the significance level of 0.279 is above the 0.05 threshold.

Production factors, which include resources such as labor, capital, land, and technology, play a major role in determining farm performance. However, it is important to understand that farm performance is not only influenced by individual production factors but also by how farmers participate in managing and utilizing these factors. Farmer participation in managing farming affects how effectively these production factors are used and optimized, thus having a direct impact on the productivity and success of the farm (Padang et al., 2024; Ratnasari et al., 2017).

First, farmer participation in planning and decision-making related to the use of production factors will determine the efficiency and effectiveness of farming. Farmers who are involved in making decisions about land allocation, selection of crop varieties, use of fertilizers, and selection of agricultural tools tend to be better able to maximize yield potential. With active participation, farmers can adapt the use of resources such as fertilizers and pesticides more wisely, thereby increasing production yields and reducing wastage (Koper, 2015; Purnamaselfi & Widyasamratri, 2022; Tumbo et al., 2018).

Farmer participation in the utilization of modern technology and in farmer groups significantly affects farm performance. Farmers who actively participate in training and try new technologies such as mechanization tools, smart irrigation systems, or digital-based farming applications can improve work efficiency, reduce production costs, and increase yields. These technologies also help farmers overcome challenges such as climate change or erratic weather. In addition, participation in farmer groups or organizations allows farmers to share knowledge, experiences, and strategies in making optimal use of production factors. They can also access additional resources, such as shared farm tools, business capital, or market information, which strengthens solidarity, increases bargaining power in the market, and eases access to government programs or farm business support institutions (Ita Handayani, 2022; Tumbo et al., 2018).

3.2.7 Effect of Farmer Characteristics on Farm Performance through Farmer Participation

The seventh hypothesis in this study is the effect of farmer characteristics on farm performance through farmer participation. Based on the research results, it is known that farmer characteristics have a negative influence on farm performance mediated by farmer participation, with a coefficient value of -0.004. The t-count value of 0.059 is smaller than the t-table value, and the significance level of 0.953 is above the 0.05 threshold.

Farmer characteristics play an important role in influencing farm performance, especially through their participation in business management. These characteristics include various aspects, such as age, education, experience, knowledge, as well as attitude and motivation towards farming activities. These factors can influence how farmers participate in farming, both in terms of decision-making, application of new technologies, and in farmer group activities. Optimal farmer participation can contribute to increasing the productivity and efficiency of farming, which in turn has an impact on its performance (Anwarudin, 2017; Hayati, 2016).

Farmers' age affects their level of participation in adopting new technologies and attending training. Younger farmers tend to be more open to modern innovations and technologies, while older farmers rely more on traditional experience and tend to be more conservative. Farmer education is also very important; farmers with higher education levels are more likely to understand new information, keep up with agricultural science, and implement this knowledge in their practices. Good education helps farmers manage their farms more efficiently (Erasmus et al., 2017; Rusdiana et al., 2017).

Farmers' experience and knowledge greatly influence their participation in farming. Farmers with more experience tend to be more confident in managing the business and overcoming challenges, and can increase productivity with knowledge of modern farming techniques (Irnawati et al., 2023). Farmers' attitudes and motivation also play an important role; farmers with high motivation and positive attitudes are more active in group activities, adopt new technologies, and improve skills. Good participation, driven by positive factors such as age, education, and experience, improves farm performance, while less favorable characteristics can hinder it (Imas Gandasari et al., 2021).

3.2.8 The Effect of Farmer Ability on Farm Performance Through Farmer Participation

The eighth hypothesis in this study is the effect of farmer ability on farm performance through farmer participation. Based on the results of the study, it is known that the ability of farmers has a negative influence on farm performance mediated by farmer participation, with a coefficient value of -0.110. The t-count value of 1.610 is smaller than the t-table value, and the significance level of 0.110 is above the 0.05 threshold.

Farmers' capabilities have an important influence on farm performance, especially in the context of their participation. Farmers' capabilities include the knowledge, skills, and capacity to apply effective farming techniques and practices. When farmers have adequate capabilities, they can optimally participate in farm management, which in turn can increase productivity and business success. Farmer participation in this context does not only mean physical presence, but also includes involvement in planning, decision-making, application of new technologies, and implementation of activities that improve farming outcomes (Erma A. Tabelak, S.S. Pudjiastuti, 2019).

Farmers' ability to understand agricultural science and practical skills plays a significant role in farm performance. Good knowledge of cultivation, fertilization, and pest control techniques enables farmers to manage farms efficiently, increase yields, and maximize resources. In addition, skills in using modern farming tools such as machinery and irrigation systems help increase productivity and save time. These skills can be acquired through education, training or work experience. (Putri et al., 2019).

3.2.9 The Effect of Farmer Opportunities on Farm Performance Through Farmer Participation

The ninth hypothesis in this study is the effect of farmer opportunities on farm performance through farmer participation. Based on the results of the study, it is known that farmer opportunities have a significant effect on farm performance mediated by farmer participation, with a coefficient value of -0.139. The t-count value of 2.624 is smaller than the t-table value, and the significance level of 0.009 is above the 0.05 threshold.

Farmers' opportunities to access resources and opportunities play an important role in farm performance, especially through active participation. Access to capital, technology, training, market information, as well as support from the government or related institutions increases farmers' potential to manage their farms better. High participation leads to increased productivity and quality of farm produce. Access to capital allows farmers to purchase production inputs, such as improved seeds and agricultural tools, which are important for the adoption of new technologies and scaling up. Financing or farm credit can encourage maximum participation from farmers (Ostuzzi et al., 2016).

Training and education opportunities play an important role in farmers' ability to manage their farms effectively. Training from the government, non-governmental organizations, or agricultural organizations provides new knowledge that helps farmers make better decisions regarding crop care, land management, and adoption of new technologies. Active participation in training improves the quality of farm management. Access to market information is also very important, as it helps farmers plan production based on market prices, product demand, and consumer trends. This minimizes losses and maximizes profits. Farmer participation in farmer communities or associations expands networks and opens up better marketing opportunities (Bissell, 2017).

4. CONCLUSION

Based on the research findings, it can be concluded that production factors, farmer characteristics, farmer abilities, farmer opportunities, and farmer participation all have a positive and significant impact on farm performance. However, the indirect effect analysis shows that some independent variables negatively influence farm performance. Farmer participation is crucial because through their involvement, farmers can gain new information, experiences, and knowledge, which contribute to planning and decision-making. Therefore, it is recommended that farmer capacity be strengthened through accessible training programs, and that farmers actively participate in these programs. The government should also strengthen policy support and provide better access to resources, while the academic sector should play an active role in research that supports sustainable agricultural development and collaborate with the government and farmers to implement research findings.

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