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THE INFLUENCE OF SOCIAL CAPITAL AND THE ROLE OF FARMER GROUPS ON THE PERFORMANCE OF HYDROPONIC FARMING IN KENDARI CITY - INDONESIA

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ABSTRACT

Hydroponic farming has emerged as a promising approach to urban agriculture, yet its success largely depends on the institutional capacity and social dynamics of farmer groups. This study investigated the effects of farmer group social capital and farmer group roles on the performance of hydroponic farming in Kendari City, Indonesia. The research was conducted from March to June 2025 using a census of all 35 hydroponic farmers in the study area. Primary data were collected through structured face-to-face interviews using a validated questionnaire. Descriptive statistics and Structural Equation Modeling–Partial Least Squares (SEM-PLS) were employed to assess the relationships among the study variables. Descriptive analysis indicated that the levels of farmer group social capital, farmer group roles, and hydroponic farming performance were all within the moderate category. The SEM-PLS results demonstrated that both farmer group social capital (β = 0.326, P=0.024) and farmer group roles (β = 0.632, P<0.001) exerted significant positive effects on hydroponic farming performance. The structural model explained 72.8% of the variance in hydroponic farming performance (R^2 = 0.728), indicating strong explanatory power. Furthermore, the interaction between farmer group social capital and farmer group roles was statistically significant (β = 0.341, P=0.006), suggesting that effective farmer groups strengthen the positive contribution of social capital to farming performance. These findings highlight the importance of fostering trust, social networks, collaboration, and institutional capacity within farmer groups to enhance the productivity and sustainability of hydroponic farming. Strengthening farmer organizations through extension services, capacity-building programs, and stakeholder collaboration is therefore recommended to improve the long-term performance of hydroponic farming systems.

Keywords: Hydroponic farming, Farmer groups, Social capital, SEM-PLS, Urban agriculture, Indonesia

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1. INTRODUCTION

Hydroponic farming is a modern agricultural technology that is rapidly developing in Indonesia, including in Kendari City, Indonesia. Hydroponics is known as a soil-less farming method, allowing farmers to maximize limited land and increase the efficiency of water and nutrient use. Kendari City, as a growing urban area, faces challenges related to agricultural land availability and the growing demand for food. In this context, hydroponic farming can be an innovative solution to meet these food needs. Urban agriculture is one way to meet the food needs of urban communities in response to the lack of agricultural land in urban areas. Food needs can be met, among other things, from yards planted with a variety of vegetables (Khan et al., 2020; Ebissa et al., 2024). Yard land has great potential if utilized appropriately and correctly. The potential of yard land is as a provider of family food, reducing household expenses, and increasing family income (Rahman et al., 2024). Su et al. (2020), that farming using a hydroponic system does not require a large area of land for its implementation, but in the agricultural business, hydroponics is worth considering because it can be done in yards, rooftops, or other areas. Thus, farming using a hydroponic system is a solution that should be considered in addressing food problems.

Hydroponics not only overcomes land limitations but also increases the efficiency of water and nutrient use. In various parts of the world, hydroponics has been proven to produce agricultural products more quickly, cleanly, and productively, especially in areas with limited land or infertile soil conditions (Resh, 2022). Hydroponics is agricultural activities using technology allows for up to 90% more efficient water use compared to traditional farming methods. Furthermore, by using a vertical planting system, hydroponics can optimize space usage, allowing farmers to produce more crops in a limited area (Rajaseger et al., 2023).

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Hydroponic farming offers promising economic potential for small- to medium-scale farmers. Analysis of horticultural crop cultivation using hydroponic systems demonstrates that this method is financially viable, with improved production efficiency compared to conventional systems. This makes hydroponic farming a strategic alternative for developing urban agriculture and community empowerment based on modern agribusiness (Sisodia et al., 2021). Hydroponic farming offers advantages such as more practical plant care and better pest control. Plant care through hydroponics is also relatively easy because plants can grow without soil, using only gutters, used plastic bottles, and also reused items such as buckets, basins, and so on (Tuxun et al., 2025). Other advantages include a more beautiful yard, year-round planting without the risk of drought, and lower post-harvest losses compared to conventional farming (Lantarsih & Gupta, 2024).

The development of hydroponic farming in Kendari City is primarily implemented through farmer groups, which serve as an effective institutional mechanism for achieving development objectives. Organizing hydroponic farmers into groups facilitates the dissemination of knowledge, strengthens collaboration, and accelerates the adoption of improved farming practices. Given that hydroponic farmers are widely distributed across urban areas, farmer groups provide a platform for developing shared perspectives and collectively addressing technical, managerial, and marketing challenges. According to Emerick & Dar (2021), farmer groups bring together individuals with common goals, creating opportunities for collective learning and the exchange of agricultural knowledge and experiences. Similarly, Dooley (2020) described groups as forums for collaborative learning where members share knowledge, exchange experiences and strengthen social cohesion and solidarity within the community. Furthermore, group development represents a continuous process of empowering community members with shared objectives to improve their collective capacity and organizational effectiveness. Ma et al. (2023) defined a farmer group as an association established based on shared interests, similar social and economic conditions, common resource availability, and close interpersonal relationships, with the aim of improving and expanding members' farming enterprises. Likewise, Kusnandar et al. (2023) emphasized that farmer groups function as collaborative institutions that facilitate coordinated farming activities, enhance knowledge sharing, and ultimately improve overall farming performance.

Farmer group development is directed at implementing an agribusiness system, increasing the role and participation of farmers and other members of rural communities, by fostering cooperation between farmers and other related parties to develop their farming businesses. In addition, farmer group development is expected to help explore potential, solve problems in its members' farming businesses more effectively, and facilitate access to information, markets, technology, capital, and other resources (Hanggana et al., 2022). The development of hydroponic farming through farmer groups in Kendari City is aimed at achieving better hydroponic farming performance. The purpose of establishing farmer groups is to further improve and develop the abilities of farmers and their families in developing farming businesses. Improved farm performance can be seen in higher farm productivity, which in turn will increase farmers' incomes, thereby supporting better welfare for farmers and their families. The performance of hydroponic farming in Kendari City still faces challenges, especially in achieving farm yield quantities and the accuracy of harvest timing. Some hydroponic farmers in Kendari City still fluctuate in the amount of hydroponic farm production they cultivate. Similarly, many hydroponic farms harvest times are still not in accordance with the planned harvest schedule. The performance of hydroponic farming businesses is determined by various factors. In particular, social capital and the role of farmer groups are two crucial factors that substantially influence the success rate and productivity of hydroponic farming systems.

Social capital is a set of informal values and norms shared among members of a group that demonstrates the cooperation between them (Wan & Du, 2022). Social capital in farming is a crucial factor that increases productivity, independence, and farmer income, especially through farmer groups (Upe et al., 2021). Social capital has a significant influence on the success of natural resource management (Przybyła, 2020). Social capital also plays a crucial role in supporting the survival strategies of migrant workers in the informal sector (Wojciechowska, 2021). Social capital has a strategic role as a social glue that supports the maintenance and development of social integration in the community (Thomas & Gupta, 2021). Research on social capital related to farmer group activities has not been widely studied. Thus, by building social capital among farmer groups, it will be able to form networks and support increased business for farming communities in rural areas as well as improve family welfare and income.

Farmer groups, which are farmer institutions with social capital, are closely related to improving farm performance. In addition to social capital factors, another factor that influences the development of farmer groups in achieving better farm performance in this study is the role of farmer groups. Molina et al. (2021) that the role of farmer groups is the activities of farmer groups that are managed based on the agreement of their members, so that they are able to change or shape insights, understanding, thoughts, interests, determination and the ability to innovate behavior to create an advanced agricultural system. Ma et al. (2023) that the role of farmer groups as a place to learn means that farmers will gain experience and skills that they have never had before. The role of farmer groups can provide solutions for farmers to increase their income.

The existence of farmer groups that have social capital and play a good role in the development of hydroponic farmers can improve the performance of hydroponic farming businesses. The existence of farmer groups that have

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social capital and play a good role is a potential that has an important role in shaping changes in the behavior of its members and fostering the ability of their group members to cooperate. Through farmer groups, the process of implementing activities involving group members in various joint activities will be able to change or shape insights, understanding, thoughts, interests, determination and the ability to innovate behavior to create an advanced agricultural system. With farmer groups, it will be easier to achieve the desired goals, compared to working alone. This research is very important, namely research on the Influence of Social Capital and the Role of Farmer Groups on the Performance of Hydroponic Farming Businesses in Kendari City, Indonesia.

2. MATERIALS AND METHODS

This research was conducted in Kendari City, Southeast Sulawesi Province, Indonesia (Fig. 1). Data collection took place from March to June 2025. The study population consisted of all hydroponic farmers actively engaged in hydroponic farming in Kendari City, with a total population of 35 individuals. This study used a census sampling technique, thus selecting the entire population of 35 hydroponic farmers as the sample. The following is a map of the location of Kendari City - Indonesia, which is the location where the research was carried out.

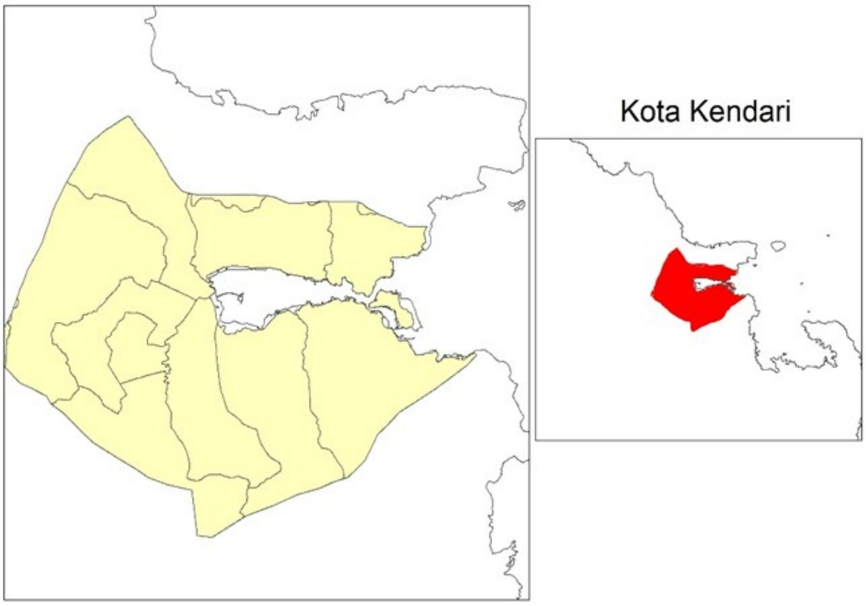

Fig. 1: Map of Kendari City – Indonesia.

Kendari City has a humid tropical climate with maritime characteristics, influenced by monsoon winds. Kendari City has warm daily temperatures, high air humidity levels and varying rainfall with alternating dry and rainy seasons every year. The average annual temperature in Kendari City ranges from 20.00°C (minimum) to 33.5°C (maximum). The highest temperatures usually occur between September and November during the summer. Kendari City has high air humidity, with an annual average ranging from 85 to 93%.

This study involves exogenous and endogenous variables. The exogenous variables consist of the social capital of farmer groups (X_1) which includes three dimensions, namely trust ($X_{1.1}$), social networks ($X_{1.2}$), and norms ($X_{1.3}$), as well as the role of farmer groups (X_2) which includes earning class ($X_{2.1}$), cooperation platform ($X_{2.2}$), and production unit ($X_{2.3}$). Meanwhile, the endogenous variable in this study is the performance of hydroponic farming businesses (Y) which is measured through three indicators, namely the quantity of agricultural produce (Y_1), the quality of agricultural produce (Y_2) and the timeliness of agricultural implementation (Y_3). Measurement of all variables is carried out using a questionnaire in the form of statements using a like scale by assigning scores and weights to each respondent's response. The questionnaire used in this study was validated empirically or through field testing. The statements used in this research questionnaire were those that were found to be valid and reliable based on the validity and reliability tests of the questionnaire statements and the empirical validation tests or field tests. Data analysis used includes descriptive statistics and inferential statistics.

Descriptive statistics are used to provide a description or general overview of the research object using data from samples or populations without conducting comprehensive analysis or drawing conclusions (Kaur et al., 2018). Descriptive statistics are statistics that function to describe or provide an overview of the research object through sample or population data as it is, without conducting analysis and making conclusions that apply to the general public (Franzese & Iuliano, 2025). The descriptive statistics used in this study are class interval analysis, as follows:

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I = J/K, ……… (Yamashita, 2022)
Where:
I: Class interval
J: Highest value – Lowest value
K: Number of classes

The social capital conditions of farmer groups, role of farmer groups, and performance of hydroponic farming in this research area are described in three class categories, namely: (1) low category (1 – 2.3); (2) medium category (2.4 – 3.6); and (3) high category (3.7 – 5).

The inferential statistical analysis used in this study was Partial Least Squares-Structural Equation Modeling (PLS-SEM). The PLS-SEM method was chosen because of its ability to analyze relationships simultaneously in complex models involving multiple constructs, indicator variables, and structural paths (Purwanto & Sudargini, 2021). PLS-SEM is an increasingly popular method for estimating path models involving latent variables and their relationships. According to Hair et al. (2021), PLS-SEM is more oriented towards theory development and theory building, with a primary emphasis on predictive power. Therefore, this method is used to test and identify relationships between latent variables and serves as an effective predictive tool. PLS-SEM analysis consists of two sub-models: a measurement model (external model) and a structural model (internal model). Legate et al. (2023), that PLS-SEM offers several advantages including providing the ability to model many variables and a higher level of significance; overcoming multicollinearity problems in large datasets; robustness in handling incomplete and missing input; and the ability to advance latent causes more forward based on cross-contextualization of the response causes, thus generating stronger hypotheses.

3. RESULTS

3.1. Socio-Demographic Characteristics of Hydroponic Farmers

The socio-demographic characteristics of hydroponic farmers of the respondents is data collected to describe the state of the research respondents. The socio-demographic characteristics of hydroponic farmers variables of the respondents used in this study consisted of age, education level, and length of hydroponic farming. The socio-demographic characteristics of hydroponic farmers in this study can be found in Table 2.

Table 1 showed that the majority of respondents, namely 33 people (94.29%) are in the productive age category. The age difference among farmers has implications for their ability to manage agricultural businesses. Lindsjö et al. (2021), that the working capacity of young farmers tends to be different from older farmers. Similarly, in terms of openness to agricultural innovation, there is a difference in the level of acceptance between young farmers and older farmers. Haryanto et al. (2021) that farmers of productive age have high motivation in carrying out their farming.

Table 1: Socio-demographic Characteristics of Hydroponic Farmers

Socio-demographic Characteristics	Amount (Person)	Percentage (%)
Age (Years)		
Productive (25 – 55)	33	94.29
Older Farmers (> 55)	2	5.71
Total	35	100.00
Education (Level)		
Senior Secondary Education	5	14.29
Higher Education	30	85.71
Total	35	100.00
Length of Farming (Years)		
Inexperienced (1 – 5)	6	17.14
Experienced (> 5)	29	82.86
Total	35	100.00

Source: Results of Processed Primary Data Analysis (2025).

Table 1 also indicates that, all respondents had an adequate level of education. In fact, the majority of respondents, namely 30 people (85.71%), had completed higher education at the bachelor's level (S1). This indicates that farmers in the research area have a good educational background. Houngue & Nonvide (2020), that an adequate level of education will help farmers manage their farms optimally. Muraoka et al. (2023), that farmers' education has a positive influence on increasing and developing farm production. Farmer experience reflects the length of time they have been running a hydroponic farm. In fact, the majority of respondents, namely 29 people (82.86%), had more than five years of farming experience. Farming experience indicates that the longer a farmer operates, the more knowledge and skills they acquire. This knowledge and skills positively impact farmer productivity and income. This finding is in line with an earlier finding that showed that farming experience was positively correlated with farmer productivity and income (Sardar et al., 2021).

Table 2: Social Capital of Hydroponic Farmer Groups

No.	Indicatory	Score	Description
1	Trust	3.3	Moderate
2	Social Networks	3.4	Moderate
3	Norms	3.5	Moderate
	Average	3.4	Moderate

Source: Results of Processed Primary Data Analysis (2025).

3.2. Social Capital of Hydroponic Farmer Groups

Social capital is essentially defined as a set of unwritten values or norms that are naturally acquired among

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members of a group, thereby improving their collaboration (Guo et al., 2022). In this research, social capital within groups of farmers practicing hydroponics encompasses mutual trust, relational networks, and norms specific to these groups. Data relating to the social capital of these groups can be found in Table 2.

Table 2 showed that the social capital of hydroponic farmer groups in Kendari City is in the moderate category. This indicates that hydroponic farmer groups have good social capital, which includes: mutual trust, having a social network, and complying with norms of farmer groups in managing hydroponic farming. However, this social capital of hydroponic farmer groups still needs to be improved to achieve social capital in the high category (very good). In the trust dimension still needs to be improved in aspects leaders' trust in group members and the community's trust in the farmer group. In the social network dimension still needs to be improved in aspects networks for farm financing and networks for marketing agricultural products. In the norms dimension still needs to be improved in aspects provision of rewards for high-performing members and imposition of sanctions on members who violate group regulations.

Social capital within hydroponic farmer groups plays a pivotal role in enhancing the performance and sustainability of hydroponic farming systems. According to Ihm (2022), social capital refers to the relationships that are established and maintained through shared values, mutual trust, and social bonds, enabling group members to collaborate effectively and efficiently toward common objectives. Similarly, Kimbal (2020) defined social capital as the combination of trust, shared norms, and social networks that facilitate collective action among community members. In the context of hydroponic farming, these elements promote knowledge exchange, resource sharing, coordinated decision-making, and cooperation, thereby improving the overall effectiveness and resilience of farmer groups.

3.3. Role of Hydroponic Farmer Groups

The role of farmer groups is that farmer group activities are managed based on the agreement of their members, so that they are able to change or shape insight, understanding, thoughts, interests, determination and the ability to innovate to create an advanced agricultural system (Magesa et al., 2020). The results of research on the role of hydroponic farmer groups in Kendari City are presented in Table 3.

Table 3: Role of Hydroponic Farmer Groups

Number	Dimensions	Average value	Category
1.	Learning Class	3.57	Moderate
2.	Cooperation Platform	3.51	Moderate
3.	Production Unit	3.54	Moderate
Average value		3.60	Moderate

Source: Results of Processed Primary Data Analysis (2025).

Table 3 indicates that the role of hydroponic farmer groups of hydroponics in the city of Kendari falls into a moderate category or intermediate class. This indicates that hydroponic farmer groups have good role of farmer groups, which includes: learning class, cooperation platform, and production unit in management of farmer groups and hydroponic farming. However, this role of hydroponic farmer groups still needs to be improved to achieve role in the high-performance category (very good). In the learning class dimension still needs to be improved in aspects the group organizes learning activities for members and facilitation of member learning within the group. In the cooperation platform dimension still needs to be improved in aspects cooperation among group members and mutual cooperation in group activities. In the production unit dimension still needs to be improved in aspects facilitation of production processing, facilitation of production storage and facilitation of product marketing.

The role of hydroponic farmer groups plays a crucial role in supporting the performance of hydroponic farming. Pretty et al. (2020) that the formation of farmer groups is an agricultural development effort that functions as a strong forum for farmers in rural areas. Kangogo et al. (2020), that role of farmer groups is to act as learning classes, a forum for farmer collaboration, and a production unit. All members of the farmer groups receive training to increase their productivity.

3.4. Performance of Hydroponic Farming

The performance of a hydroponic farming business is the result of achievements, work accomplishments, or productivity of a hydroponic farming business carried out in a 1 year period (Goh et al., 2023; Rajaseger et al., 2023). For details on the results of the hydroponic farming performance study, see Table 4.

Table 4: Performance of Hydroponic Farming

Number	Dimensions	Average value	Category
1.	Quantity of Farming Results	3.51	Moderate
2.	Quality of Farming Results	3.60	Moderate
3.	Timeliness of Farming Activities	3.55	Moderate
	Average value	3.55	Moderate

Source: Results of Processed Primary Data Analysis (2025).

Table 4 reveals that the overall performance of hydroponic farming in Kendari City falls into the moderate category. Although this performance indicates reasonably good results, it still requires substantial improvement to reach the high (very good) category. In the quantity of farming results dimension still needs to be improved in aspects the volume of farm sales achieved and the amount of farm income achieved. In the quality of farming results dimension still needs to be improved in aspects quality of seeds and quality of harvest yields. In the timeliness of farming activities still needs to be improved in aspects dimension timeliness of harvesting and timeliness of selling

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farm harvests.

Particular attention should be given to enhancing the advisory planning and evaluation stages of hydroponic farming activities. According to Rivaldo & Nabella (2023), Performance in this context refers to the achievement of work outcomes, both in terms of quality and quantity, within a specific period, in accordance with assigned responsibilities (Hasan, 2023), It can also be understood as the comparison between actual results achieved and predetermined standards.

3.5. Research Result Data Analysis

3.5.1. Outer model analysis: Each indicator block analyzed using the measurement model will show whether or not there is a relationship with the latent variable. Validity and discriminant analysis are tested through confirmatory factor analysis. There are two methods for validity testing: Cronbach's Alpha and Composite Reliability Composite Reliability (Purwanto & Sudargini, 2021). The external model is used to measure the accuracy of the predictive model according to the parameters (Sinurat et al., 2024). The following results of outer model processing are presented in Fig. 2.

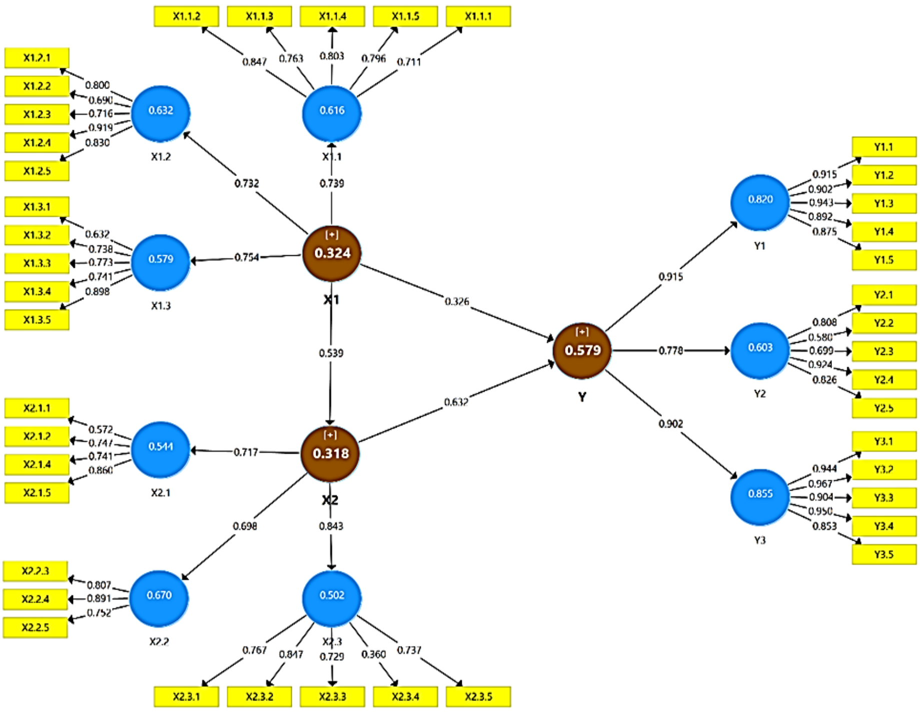

Fig. 2: Outer Model Data Processing Results.

Convergent validity tests in partial least squares structural equation modeling (PLS-SEM) are based on the idea that there should be a strong correlation between the measurements of a construct. These tests use indicators that show the concept being measured. Their validity is checked by looking at the factorial saturations, which show how strongly each part relates to the overall idea. A common criterion for convergent validity is a factor loading greater than 0.7, as mentioned (Hair et al., 2021). In some cases, this threshold of 0.70 is not reached, especially for new questionnaires. Therefore, factorial saturations between 0.40 and 0.70 are still relevant (Wardhani et al., 2020). It is sometimes important to focus on factorials saturations between 0.40 and 0.70.

Fig. 2 also showed that several invalid research instruments (with external saturation coefficients less than 0.5) have been eliminated. Regarding the variable for role of farmers' groups, one instrument is invalid to the learning class dimension: $X_{2.1.3}$ (0.319) and two instruments are invalid to the cooperation platform dimension: $X_{2.2.1}$ (0.274) and $X_{2.2.2}$ (0.199). for research in the early stages of developing a measurement scale, a loading factor value of 0.50 to 0.60 is considered sufficient to meet the convergent validity requirement of the data (Pervan et al., 2018; Kholed et al., 2021).

Another way to check the cross-loading value is by looking at the average variance extracted, or AVE. If the correlation between the indicator and the latent variable is higher than the correlation between the indicator and other latent variables, it is said that the latent variable has high discriminant validity (Nurhalizah et al., 2024). The AVE value in this study is suggested to be at least 0.5.

The model reliability test uses a composite reliability test, which is supported by Cronbach's alpha. Composite reliability is the part that checks how reliable the indicators are for a variable. To make a reliability test with composite reliability more reliable, you can use Cronbach's alpha. (Ghozali & Latan, 2014), a variable is considered reliable or meets the Cronbach's alpha standard if its Cronbach's alpha value is greater than 0.6. Latent variables are considered to have good reliability when the composite reliability score is 0.6 or higher. According to Ringle et al., (2020), the composite reliability coefficient should be more than 0.7, although a value of 0.6 is still considered acceptable, as noted (Hair et al., 2021). The internal consistency test is not always necessary if construct validity has already been achieved, because a valid construct is also reliable. However, a reliable construct does not automatically mean it is valid, as stated (Sürücü, 2020). A composite reliability between 0.6 and 0.7, along with a Cronbach's alpha higher than 0.7, is seen as showing good reliability (Sarstedt et al., 2021).

The reliability of the measurement model was assessed using composite reliability and Cronbach’s alpha. Composite reliability evaluates the internal consistency of the indicators measuring each latent variable. Cronbach’s alpha serves as a complementary measure to support the reliability assessment. According to Ghozali & Latan (2014), a construct is considered reliable if its Cronbach’s alpha value exceeds 0.60. In the context of PLS-SEM, latent variables demonstrate acceptable reliability when the composite reliability value is 0.60 or higher, with values above 0.70 preferred (Ringle et al., 2020; Legate et al., 2023). A composite reliability ranging between 0.60 and 0.70, supported by a Cronbach’s alpha greater than 0.70, is generally viewed as indicating good reliability (Sarstedt et al., 2021). It is important to note that while a valid construct is typically reliable, a reliable construct does not automatically guarantee validity (Sürücü, 2020). Therefore, internal consistency reliability testing remains relevant even when construct validity has been established. The following describes the results from the test of the measurement model (outer model), which includes assessments of convergent validity, discriminant validity, composite reliability, and Cronbach's alpha for the variables and dimensions related to social capital of farmer groups, role of farmer groups, and the performance of hydroponic farming.

Table 5 indicated that all dimensions of social capital within the farmer groups engaged in hydroponic farming were found to be valid. In the trust dimension, all five indicators were valid, encompassing: (1) mutual trust among group members; (2) members’ trust in the group leadership; (3) leaders’ trust in group members; (4) members’ trust in the broader farmer group community; and (5) the community’s trust in the farmer group. Similarly, the social network dimension demonstrated validity across all indicators, which included: (1) networks for farm financing; (2) networks for procuring farming equipment; (3) networks for obtaining production inputs; (4) labor networks; and (5) networks for marketing agricultural products. In the norms dimension, the five indicators were also valid. These consisted of: (1) the existence of written group regulations; (2) socialization of group rules; (3) members’ agreement to comply with the established rules; (4) provision of rewards for high-performing members; and (5) imposition of sanctions on members who violate group regulations.

Table 5: Outer Model of Social Capital of Farmer Groups

Variable	Dimensions	Instrument	*Factor Loading*	*Composite Reliability*	Cronbach’s Alpha	AVE
Social Capital of Farmer Groups (X1)	Trust (X1.1)	X1.1.1	0.711	0.889	0.844	0.617
		X1.1.2	0.847			
		X1.1.3	0.763			
		X1.1.4	0.804			
		X1.1.5	0.796			
	Social Network (X1.2)	X1.2.1	0.800	0.895	0.858	0.632
		X1.2.2	0.690			
		X1.2.3	0.716			
		X1.2.4	0.919			
		X1.2.5	0.830			
	Norms (X1.3)	X1.3.1	0.632	0.872	0.819	0.579
		X1.3.2	0.739			
		X1.3.3	0.772			
		X1.3.4	0.741			
		X1.3.5	0.898			

Source: Results of Processed Primary Data Analysis (2025).

Table 6 showed that several instruments within the variable of farmer group roles were invalid, as indicated by their factor loading values below 0.5. Specifically, three instruments were found to be invalid and subsequently removed from further analysis. In the learning class dimension, one instrument was invalid: facilitating members’ learning outside the group ($X_{2.1.3}$), with a factor loading value of 0.319. In the cooperation platform dimension, two instruments were invalid: member collaboration with other parties ($X_{2.2.1}$) with a factor loading of 0.274, and group collaboration with other agencies ($X_{2.2.2}$) with a factor loading of 0.199. These invalid instruments were excluded from their respective dimensions to ensure the validity of the measurement model.

Table 6 also showed that the remaining instruments in the role of farmer groups variable were valid. In the learning class dimension, four instruments were valid: (1) the group organizes learning activities for members ($X_{2.1.1}$); (2) facilitation of member learning within the group ($X_{2.1.2}$); (3) members' independent learning within the group ($X_{2.1.4}$); and (4) members learning together with other members in the group ($X_{2.1.5}$). In the cooperation platform dimension, three instruments were valid: (1) cooperation among group members ($X_{2.2.3}$); (2) mutual cooperation in group activities ($X_{2.2.4}$); and (3) mutual assistance among members within the group ($X_{2.2.5}$). Meanwhile, all five instruments in the production unit dimension were valid, namely: (1) facilitation of farming activities ($X_{3.1.1}$); (2) facilitation of increased production ($X_{3.1.2}$); (3) facilitation of production processing ($X_{3.1.3}$); (4) facilitation of production storage (X3.1.4); and (5) facilitation of product marketing ($X_{3.1.5}$).

Table 7 showed that all dimensions of the hydroponic farming performance variable were valid. In the quantity of farming results dimension, all five instruments were valid: (1) the number of nurseries achieved; (2) the number of plantings achieved; (3) the volume of farm production achieved; (4) the volume of farm sales achieved; and (5) the amount of farm income achieved. In the quality of farming results dimension, the five instruments were also valid: (1) quality of farming facilities; (2) quality of seeds; (3) quality of fertilizers; (4) quality of plant growth; and (5) quality of harvest yields. In the timeliness of farming activities dimension, all instruments were valid: (1) timeliness of seeding; (2) timeliness of planting; (3) timeliness of fertilization; (4) timeliness of harvesting; and (5) timeliness of selling farm harvests.

Table 6: Outer Model of Role of Farmer Groups

Variable	Dimensions	Instrument	Factor Loading	Composite Reliability	Cronbach's Alpha	AVE
Role of Farmer Groups (X2)	Learning Class (X2.1)	X2.1.1	0.573	0.824	0.713	0.544
		X2.1.2	0.747			
		X2.1.4	0.741			
		X2.1.5	0.860			
	Cooperation Platform (X2.2)	X2.2.3	0.806	0.858	0.758	0.670
		X2.2.4	0.891			
		X2.2.5	0.752			
	Production Unit (X2.3)	X2.3.1	0.767	0.826	0.740	0.502
		X2.3.2	0.847			
		X2.3.3	0.729			
		X2.3.4	0.359			
		X2.3.5	0.737			

Source: Results of Processed Primary Data Analysis (2025).

Table 7: Outer model of performance of hydroponic farming

Variable	Dimensions	Instrument	*Factor Loading*	*Composite Reliability*	Cronbach's Alpha	AVE
Performance of Hydroponic Farming (Y)	Quantity of Farming Results (Y1)	Y1.1	0.916	0.958	0.945	0.820
		Y1.2	0.901			
		Y1.3	0.943			
		Y1.4	0.892			
		Y1.5	0.876			
	Quality of Farming Results (Y2)	Y2.1	0.824	0.881	0.832	0.603
		Y2.2	0.578			
		Y2.3	0.783			
		Y2.4	0.900			
		Y2.5	0.826			
	Timeliness of Farming Activities (Y3)	Y3.1	0.944	0.967	0.957	0.855
		Y3.2	0.967			
		Y3.3	0.904			
		Y3.4	0.950			
		Y3.5	0.853			

Source: Results of Processed Primary Data Analysis (2025).

3.5.2. Inner model analysis: Inner model analysis was conducted following the evaluation of the measurement model (outer model) in the SmartPLS analysis. The results of the outer model evaluation confirmed that all constructs and variables met the required validity and reliability criteria. Fig. 3 presents the results of the inner model assessment, obtained through the bootstrapping procedure in the SmartPLS application. Internal model analysis is an evaluation of structural models. This study includes the path coefficient test, the determination coefficient (R^2), and the hypothesis testing.

3.5.3. Path coefficient test: The path coefficient analysis was conducted to evaluate both the direction and strength of the relationships between independent and dependent variables. According to Sarstedt et al. (2021), a positive path coefficient indicates that the independent variable has a positive influence on the dependent variable (same direction), whereas a negative path coefficient indicates an inverse relationship (opposite direction). This analysis also reveals the magnitude of the effect exerted by each independent variable on the dependent variable (Purwanto &

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Sudargini, 2021). Details can be seen in Table 8.

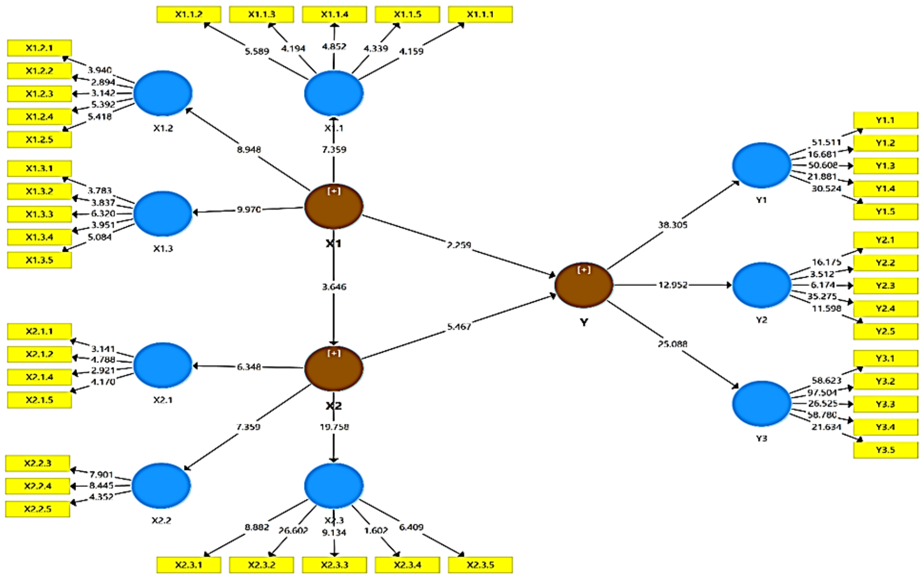

Fig. 3: Results of Structural Model Evaluation.

Table 8: Path Coefficient Values of Research Dependent Variables

Construct	Performance of Hydroponic Farming
Social Capital of Farmer Groups	0.326
Role of Farmer Groups	0.632

Source: Results of Processed Primary Data Analysis (2025).

Table 8 showed that all variables have positive path coefficients in this model. The higher the absolute value of the path coefficient, the stronger the influence. This study indicates that the path coefficient values of the social capital of farmer groups variable on the performance of hydroponic farming variables are as big as 0.326, and the path coefficient values of the role of farmer groups variable on the performance of hydroponic farming are as big as 0.632. Path coefficient values of the role of farmer groups variable on the performance of hydroponic farming show a stronger positive influence than path coefficient values of the social capital of farmer groups variable on the performance of hydroponic farming.

3.5.4. R- Square: The coefficient of determination (R^2) was used to evaluate the proportion of variance in the dependent variable that can be explained by the independent variables (Chicco et al., 2021), R^2 indicates the extent to which the independent variables collectively influence the dependent variable. A higher R^2 value reflects a better explanatory power and predictive accuracy of the proposed model. Furthermore, R^2 assesses the effect of exogenous variables on endogenous variables and helps determine the substantive impact of the predictors (Hayes, 2021). R-Square value, presented in Table 9.

Table 9: R-Square Value

Construct	R Square	R Square Adjusted
Performance of hydroponic farming (Y)	0.728	0.713

Source: Results of Processed Primary Data Analysis (2025).

Table 8 showed that the coefficient of determination (R^2) for the variable performance of hydroponic farming is as big as 0.728. This means that 72.8% of the performance of hydroponic farming is influenced by the social capital of farmer groups and role of farmer groups. According to the results of this study, the model is regarded as effective. Rashid, (2020), says that when the R^2 values are 0.67 or higher for endogenous latent variables in a structural model, it shows good performance, meaning the effect of exogenous variables on endogenous variables is significant. However, R squared value between 0.33 and 0.67 shows average performance, and R squared between 0.19 and 0.33 shows weak performance.

A determination coefficient (R^2) above 0.75 shows a strong model, an R^2 between 0.50 and 0.75 shows a moderate model, and an R^2 between 0.25 and 0.50 shows a weak model (Hair et al., 2021). According to Sarstedt et al. (2021) the criteria for measuring R^2 are as follows: (1) an R^2 of 0.75 or higher shows a strong relationship between the constructs; (2) an R^2 between 0.50 and 0.75 shows a moderate relationship between the constructs; and (3) an R^2 between 0.25 and 0.50 shows a weak relationship between the constructs.

3.6. Hypothesis Testing

Hypothesis testing is conducted by examining the values of the initial sample estimates to determine the direction of the relationship between variables, as well as using the t-statistic (T) and p-value (P) to assess the significance level of this relationship. Values in the initial sample close to +1 show a positive relationship, while values near -1 show a negative relationship. (Sarstedt et al., 2021). If the t-statistic is higher than 1.96 or the p-value is lower than the significance level, then the result is considered statistically significant.

Table 10 showed that all three hypotheses in this study are acceptable because each hypothesis has a $P<0.05$. Based on Table 10, it can be concluded that: (1) social capital of farmer groups has a significant positive effect on the performance of hydroponic farming; (2) role of farmer groups has a significant positive effect on the performance of hydroponic farming; and (3) social capital of farmer groups and role of farmer groups together have a significant positive effect on the performance of hydroponic farming.

Table 10: Effects of Social Capital and Farmer Group Roles on Hydroponic Farming Performance

Path	Original Sample (β)	Sample Mean	t-value	pp-value	Decision
Social Capital of Farmer Groups (X1) → Hydroponic Farming Performance (Y)	0.326	0.320	0.259	0.024	Supported
Role of Farmer Groups (X2) → Hydroponic Farming Performance (Y)	0.632	0.635	0.467	0.001	Supported
Social Capital of Farmer Groups (X1) × Role of Farmer Groups (X2) → Hydroponic Farming Performance (Y)	0.341	0.358	0.735	0.006	Supported

β = standardized path coefficient. Significant at $P<0.05$. Source: Processed primary data (2025).

3.7. The Influence of Social Capital of Farmer Groups on the Performance of Hydroponic Farming

As presented in Table 10, the path coefficient for the relationship between Social Capital of Farmer Groups and Hydroponic Farming Performance was positive and statistically significant ($\beta = 0.326$, $t = 2.259$, $P=0.024$). Since the *p*-value is less than 0.05, the results support the hypothesis that social capital positively influences hydroponic farming performance in Kendari City. This finding suggests that stronger social capital, characterized by trust, shared norms, and social networks, enhances collaboration among farmer group members and strengthens partnerships with external stakeholders. Such collaborative relationships facilitate the exchange of knowledge, access to resources, and collective problem-solving, thereby improving the management, productivity, and sustainability of hydroponic farming systems. According to Kehinde et al. (2021), social capital represents the value generated through social networks and interpersonal relationships that enhances the productivity and effectiveness of both individuals and groups. Similarly, Wang et al. (2021) reported that social capital improves farmers' performance by promoting participation, reciprocity, and social interaction in agricultural activities. Furthermore, Guo et al. (2023) emphasized that social capital constitutes a strategic resource that strengthens the resilience and long-term sustainability of farming communities.

3.8. The Influence of Role of Farmer Groups on the Performance of Hydroponic Farming

As presented in Table 9, the p-value for the Role of Farmer Groups is 0.000 ($P<0.05$), indicating a significant positive effect on the performance of hydroponic farming. This suggests that the active role of farmer groups substantially contributes to improving the management and overall performance of hydroponic farming businesses. Kusnandar et al. (2023) reported that farmer groups serve as platforms for members to interact, share experiences, and collectively solve farming-related problems through deliberation. Listiana et al. (2021) reported that they also strengthen cooperation among farmers in facing various challenges and threats in their farming activities. According to Mariyono et al. (2021), farmer groups play a strategic role in realizing optimal farming practices and improving the welfare of farming household.

3.9. The Influence of Social Capital of Farmer Groups and Role of Farmer Groups on the Performance of Hydroponic Farming

As shown in Table 9, the interaction between Social Capital of Farmer Groups and the Role of Farmer Groups had a positive and statistically significant effect on Hydroponic Farming Performance ($\beta = 0.341$, $t = 2.735$, $P=0.006$). Since the *p*-value is less than 0.05, the findings indicate that the role of farmer groups strengthens the positive influence of social capital on hydroponic farming performance. This suggests that strong social relationships characterized by trust, shared norms, and effective networks are more likely to enhance farming performance when supported by active and well-functioning farmer groups. The interaction between these two factors promotes stronger collaboration among members, improves communication with stakeholders, facilitates knowledge sharing and resource mobilization, and ultimately enhances the management, productivity, and sustainability of hydroponic farming systems. Etumnu & Gray (2020) reported that the active participation of group members contributes to improved collective performance and the achievement of shared objectives. Similarly, Rust et al. (2023) highlighted that social capital, through networks, trust, and social norms, encourages mutually beneficial cooperation toward common goals. Furthermore, Tan & Mailena (2021) and Dushkova & Ivlieva (2024) emphasized that farmer groups

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are essential institutions for community empowerment, fostering collective action and supporting sustainable agricultural development.

4. CONCLUSION

The findings indicate that the levels of social capital, the role of farmer groups, and the performance of hydroponic farming in Kendari City are all within the moderate category. The results further demonstrate that social capital has a significant positive effect on hydroponic farming performance, while the role of farmer groups also exerts a significant positive influence. Moreover, the interaction (or combined influence, if applicable to the study design) between social capital and the role of farmer groups significantly enhances the performance of hydroponic farming. These findings highlight the importance of strengthening trust, social networks, cooperation, and the institutional capacity of farmer groups to improve the management, productivity, and sustainability of hydroponic farming systems. Accordingly, policymakers, extension agencies, and other relevant stakeholders should implement strategies to enhance social capital and strengthen the functions of farmer groups through capacity-building programs, technical training, and collaborative networking initiatives. Future research should investigate additional factors that may influence hydroponic farming performance, such as farmers' technical competence, access to financial resources, innovation adoption, market accessibility, institutional support, and government policies, to provide a more comprehensive understanding of the determinants of sustainable hydroponic farming.

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