

Strategies for Strengthening Agricultural Institutions in Support of Food Security: A Mixed-Methods Study from Parepare City, Indonesia

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Abstract— Agricultural institutions play a crucial role in enhancing the effectiveness of agricultural development and strengthening food security, particularly in resource-limited areas such as Parepare City. This study aims to analyze the role of agricultural institutions and formulate institutional strengthening strategies to support food security. The study employed a mixed methods approach, with data collected through in-depth interviews, observations, and questionnaires. Institutional role analysis was conducted using MAXQDA, while strengthening strategies were analyzed using Interpretative Structural Modeling (ISM). The results suggest that agricultural institutions contribute through three sectors: the public sector, the voluntary sector, and the private sector, which play a role in providing production facilities, extension services, access to capital, food distribution, and digital-based marketing. The ISM analysis identified five priority strategies: increasing the capacity of extension workers, increasing farmer knowledge through education and mentoring, providing production facilities, providing fertilizers as needed, and using quality seeds to increase productivity. Strengthening human resource capacity and synergy between stakeholders emerged as key factors in realizing adaptive and sustainable agricultural institutions to support regional food security.

Keywords— Agricultural institutions, food security, MAXQDA, Interpretative Structural Modeling, strengthening strategies.

I. INTRODUCTION

Agriculture is a strategic sector that holds a central position in national development (Tahir et al., 2025; Sanga & Schlüter, 2025). However, the agricultural sector in Indonesia continues to face various fundamental structural challenges, one of which relates to agricultural institutions (Hakim & Febrianti, 2025). These institutional weaknesses result in low competitiveness, limited access to resources, and the agricultural sector's suboptimal contribution to supporting national food security (Bachtiar et al., 2022; Akbar et al., 2022).

Agricultural institutions encompass the formal and informal organizations, rules, norms, and networks that govern agricultural production, distribution, and consumption (Uphoff, 1986; Ostrom, 1990). These institutions serve as critical intermediaries between farmers and markets, between policy makers and practitioners, and between knowledge producers and knowledge users (North, 1990). In developing country contexts, strong agricultural institutions have been shown to facilitate technology adoption, improve market access, enhance risk management, and ultimately contribute to food security outcomes (Bawa, 2019; Obayelu et al., 2021).

In a regional context, Parepare City is an autonomous area with urban status characterized by limited agricultural land and a tendency for land conversion to occur. Parepare City's agricultural land covers 9,933 hectares. However, only 735.8 hectares, or approximately 7.41% of the total area, is used for rice fields (BPS Parepare City, 2024). Various studies demonstrate that

agricultural institutions make a significant contribution to strengthening national food security (Jumiati et al., 2023; Dewi Anggun Oktaviani, 2020). However, aggregate food availability at the national level does not automatically guarantee the fulfillment of food security at the regional, household, and individual levels (Usman, Ratnawati T, 2024). Limited land represents the primary challenge in developing the local agricultural sector.

A preliminary survey in Parepare City identified several issues hampering the development of the agricultural sector. The predominantly hilly geography and limited agricultural land mean that most land is rain-fed, meaning cultivation can only be carried out once a year. Furthermore, of the 150 registered farmer groups, 12 remain inactive, while the overall participation rate among farmer group members is only 49%. The role of the Farmer Group Association (Gapoktan) tends to be limited to administrative functions and has not yet functioned optimally as a farmer's economic institution. Another issue is the lack of specialized cooperatives supporting agricultural sector capital, forcing farmers to access financing individually through formal financial institutions. Furthermore, the presence of four Agricultural Extension Centers (BPP) in Parepare City has not been matched by effective extension functions, as BPP activities are still dominated by administrative matters without adequate technical and educational support for farmers.

These institutional weaknesses have a direct impact on regional food security. Parepare City is highly dependent on food supplies from other regions such as Sidrap, Barru, and Pinrang Regencies. This dependency increases the risk of food insecurity, especially when there are distribution disruptions or price fluctuations in supplier areas. Data from the Parepare City Food Security Office shows that Parepare City's food security index (IKP) is 82.76, placing the city in 61st place out of 98 cities in Indonesia. This indicates the need for strengthening aspects of food availability, access, and utilization.

Despite the acknowledged importance of agricultural institutions for food security, there remains a gap in understanding how institutional strengthening strategies can be effectively implemented in urban contexts with limited agricultural land and high dependency on external food supplies. Furthermore, there is limited research that systematically analyzes both the roles of different institutional sectors and prioritizes strengthening strategies using robust analytical methods.

Therefore, an analysis of the role of agricultural institutions in supporting food security is crucial to identify aspects that are already functioning effectively and those that remain weak. Furthermore, it is necessary to formulate a strategy for strengthening agricultural institutions that is targeted, measurable, and based on regional needs. This would enable agricultural institutions not only to function administratively but also to play an effective role in strengthening the food supply chain and increasing regional food independence in Parepare City.

The objectives of this study are:

- 1) To analyze the role of agricultural institutions in supporting food security.
- 2) To formulate a strategy for strengthening agricultural institutions in supporting food security.

II. RESEARCH METHODS

2.1 Type of Research

This research uses a combined qualitative and quantitative approach (mixed methods). Creswell and Plano Clark (2018) state that mixed methods is a research approach that combines qualitative and quantitative approaches to obtain more comprehensive, valid, reliable, and objective data. In this study, a convergent parallel design was employed, where qualitative and quantitative data were collected simultaneously, analyzed separately, and then integrated during interpretation. The qualitative approach was used to analyze the role of agricultural institutions through stakeholder interviews, while the quantitative approach (specifically the ISM technique) was used to prioritize strategies for strengthening agricultural institutions in supporting food security.

2.2 Location and Time of Research

This research was conducted in Parepare City, South Sulawesi Province over 7 (seven) months, from June to December 2025. The selection of Parepare City as the research location was based on empirical conditions indicating that this area faces food and nutrition security issues with a high level of urgency. Geographically, Parepare is an urban area with limited agricultural land, where only about 7.41% of the area is used as rice fields and most of it is rain-fed, resulting in low local food production capacity that is unable to meet community needs. This condition causes a very large dependence on food supplies from other

areas. Weak agricultural institutions have a direct impact on aspects of access, distribution, and utilization of food in the community.

2.3 Informant Selection

The selection of informants for analyzing the role of agricultural institutions and strategies for strengthening effective agricultural institutions was carried out using a purposive sampling method, namely selecting informants who were considered to have in-depth knowledge, were willing to participate, and could provide information relevant to the research objectives. Inclusion criteria included having at least three years of experience in their respective roles, direct involvement in agricultural or food security programs, and willingness to participate in the study. To fulfill the data that could support the achievement of the research objectives, the number of informants was set at 13 experts or practitioners consisting of as shown in Table 1.

TABLE 1
DETAILS OF SOURCES AND NUMBER OF INFORMANTS

No	Informant Source	Amount
1	Department of Agriculture, Maritime Affairs, and Fisheries of Parepare City	1
2	Parepare City Food Security Service (DKP)	1
3	Parepare City Trade Office	1
4	Parepare City Health Office	1
5	Regional Development Planning Agency (Bappeda) of Parepare City	1
6	Agricultural Extension Center (BPP)	1
7	Farmers Group Association (Gapoktan)	1
8	Farmers Group	1
9	College	1
10	Banking	1
11	Farmer	1
12	Micro, Small and Medium Enterprises	1
13	Supermarket or Market	1
Total		13

2.4 Research Instruments

Several instruments were used in this study, adapted to each research objective, namely the In-depth Interview Guide and the Household Food Insecurity Access Scale (HFIAS) Questionnaire. The interview guide contained semi-structured questions covering the roles of agricultural institutions, challenges faced, and potential strengthening strategies. The HFIAS questionnaire, adapted from the standard instrument developed by the Food and Nutrition Technical Assistance (FANTA) project, was used to measure household food security levels in terms of food access.

2.5 Data Collection Techniques

Data collection techniques were carried out through six main stages:

2.5.1 In-depth Interviews (In-depth Interview)

Interviews were conducted using semi-structured interview guidelines to allow researchers flexibility in exploring more in-depth information about the research variables. Each interview lasted approximately 60-90 minutes and was conducted at the informant's workplace or a mutually agreed location. All interviews were audio-recorded with informant consent and transcribed verbatim for analysis.

2.5.2 Field Observation

Field observations were conducted to verify and complement the interview results through direct observation of the actual conditions of agricultural institutions in Parepare City. Aspects observed included the roles and strategies that strengthen agricultural institutions in food security. Observations were conducted at multiple sites including agricultural extension centers, farmer groups, markets, and agricultural input distribution points.

2.5.3 Household Food Insecurity Access Scale (HFIAS) Questionnaire

The HFIAS questionnaire was used to measure household food security levels in terms of food access. This instrument consists of nine questions describing households' experiences with food shortages over the past four weeks. The HFIAS data were collected to provide contextual information about the food security situation in the study area.

2.6 Data Analysis Techniques

The data analysis techniques used consisted of several methods according to the research objectives.

2.6.1 Research Objective 1

To achieve research objective 1, MAXQDA software was used. MAXQDA was used to organize, code, and analyze interview data related to the research objectives. The analysis process was carried out through the following stages (Qomaruddin & Sa'diyah, 2024):

a. Import Data

Data collected from interviews with all informants were uploaded into MAXQDA in the form of text transcripts.

b. Data Coding

The coding process was carried out by grouping data based on research objectives, namely the role of agricultural institutions in supporting food security. Codes were developed both deductively (based on the food security literature and institutional theory) and inductively (emerging from the interview data). The lead researcher conducted the primary coding, with a second researcher independently coding a subset of transcripts (30%) to assess coding consistency. Discrepancies were resolved through discussion until consensus was reached.

Relevant text sections were coded into appropriate categories to facilitate analysis.

c. Thematic Analysis

The coded data were analyzed using a thematic approach to identify patterns, relationships, and similarities and differences in the research findings. The Code System feature in MAXQDA was used to organize key themes, while Keywords-in-Context (KWIC) was used to identify frequently used terms related to agricultural institutions in supporting food security.

d. Data Visualization

To understand the relationship between various factors and research findings, several visualization tools in MAXQDA were used, such as:

- a) Creative Coding to view research results regarding the role of agricultural institutions and strengthening agricultural institutions in supporting food security found in research.
- b) Document Comparison Chart to compare perspectives from various informants.

e. Interpretation and Reporting of Results

The analysis results were summarized using the Summary Grid feature in MAXQDA to compile conclusions that support the research objectives.

2.6.2 Research Objective 2

The analysis used for research objective 2 was Interpretative Structural Modeling (ISM). ISM is a group learning process in which structural models are generated to capture complex aspects of a system through carefully designed patterns using graphical representations. The ISM technique is intended for team assessments but can also be used by a single researcher (Sage, 1977; Warfield, 1974).

In this study, ISM analysis was used to analyze the institutions that play a role and formulate strategies for strengthening agricultural institutions in supporting food security. The 13 sub-elements for ISM analysis were derived from the qualitative interview findings and supplemented with insights from the literature. Informants were asked to provide their assessments regarding the contextual relationships between these sub-elements. The ISM process involved pairwise comparisons where informants judged whether one sub-element influences or is influenced by another.

The stages of ISM analysis were as follows:

a. Compiling a Structural Self-Interaction Matrix (SSIM)

This involved obtaining input (assessment) from respondents regarding the sub-elements above, as a result of considering contextual relationships, using the symbols V, A, X, and O. The symbols represent:

- V: Element i influences element j
- A: Element j influences element i
- X: Elements i and j influence each other
- O: Elements i and j are not related

b. Compile a Reachability Matrix

The SSIM was converted into a binary Reachability Matrix using the symbols V, A, X, and O with the numbers 1 and 0 based on standardized ISM conversion rules.

c. Compile a structural model (element level) of each element

Based on the reachability matrix, element levels were determined to create a hierarchical structural model.

d. Compile the Driver Power-Dependent (DP-D) Matrix

The DP-D matrix consisted of four sectors as shown in Figure 1.

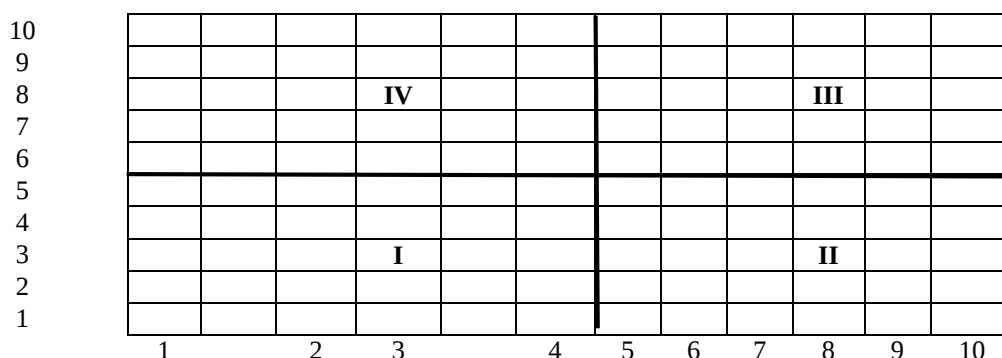


FIGURE 1: DP-D matrix

From the four sectors in question, a strategy for strengthening agricultural institutions in supporting food security can be determined based on the Driver Power-Dependent weight.

Sector I: Autonomous, not strongly influencing, but not easily influenced

Sector II: Dependent, easily influenced but not strongly influencing

Sector III: Linkage, strong influence but easily influenced

Sector IV: Independent, strong influence and not strongly influenced

The following are elements and sub-elements related to the research objectives.

TABLE 2
ELEMENTS AND SUB-ELEMENTS OF RESEARCH ON STRENGTHENING AGRICULTURAL INSTITUTIONS IN SUPPORTING FOOD SECURITY

Element		Sub-Elements
Strategy for Strengthening Agricultural Institutions in Supporting Food Security	1	Improving the capacity of extension workers through training and technical guidance
	2	Improving farmers' knowledge through education and mentoring
	3	Providing production facility assistance programs
	4	Strengthening cooperation between institutions to create synergy
	5	Facilitate and optimize the use of agricultural technology
	6	Providing easy access to capital for farmers and MSMEs
	7	Drafting regulations that limit the conversion of agricultural land
	8	Implement structured pest and disease control
	9	Using quality seeds to increase productivity
	10	Preparation of fertilizer according to the needs and experience of farmers
	11	Assistance in the implementation of sustainable agricultural principles
	12	Developing digital and innovation-based marketing sectors
	13	Forming a research and development team to drive innovation

III. RESULTS

3.1 Informant Characteristics

The description of the characteristics of informants in this study can be grouped into several groups according to Table 3, namely informant initials, gender, age, last education, and informant's occupation.

TABLE 3
INFORMANT CHARACTERISTICS BASED ON INITIALS, GENDER, AGE, AND LAST EDUCATION

Initials	Gender	Age (Years)	Last education	Job / Position
AR	P	54	S2	Head of Agriculture Division of DPKP Parepare City
AW	L	57	S2	Head of the Food Availability, Vulnerability and Distribution Division of the Parepare City Marine and Fisheries Service
AC	P	57	S1	Head of General Administration and Personnel Sub-Division, Parepare City Trade Office
HA	P	38	S2	Nutrition Coordinator of the Parepare City Health Office
AT	P	48	S2	Head of Regional Development and Natural Resources Sub-Division, BAPPEDA, Parepare City
HH	P	56	S2	Head of the West Bacukiki Agricultural Extension Center (BPP)
MB	L	39	Vocational School	General Treasurer of the Berdikari Lompoe Farmers Group
MR	L	45	Junior High School	Head of the Galung Maloang Riawa Farmers Group
SU	P	49	S3	Dean of the Faculty of Agriculture, Animal Husbandry and Fisheries, Muhammadiyah University of Parepare
AE	P	50	S1	Micro Business Manager of Bank Rakyat Indonesia (BRI) Parepare Branch
LS	L	55	Elementary School	Farmer
SP	L	52	Senior High School	Owner of UD. Masagenae
YB	L	39	S2	Owner of E Rice Business

The description of the characteristics of informants in this study can be grouped into age, gender, and education as follows:

TABLE 4
CHARACTERISTICS OF INFORMANTS BASED ON AGE, GENDER, AND EDUCATION

Characteristics	Frequency (f)	Percentage (%)
Age		
31 - 40	3	23.08
41 - 50	4	30.77
51 – 60	5	46.15
Total	13	100
Gender		
Man	6	46.15
Woman	7	53.85
Total	13	100
Last education		
Elementary School	1	7.69
Junior High School	1	7.69
High School/Equivalent	2	15.39
College	9	69.23
Total	13	100

Source: Primary Data 2025

Based on the data in Table 4, the characteristics of the informants can be explained as follows. In terms of age, the majority of respondents were in the 51–60 year group (5 people, 46.15%), followed by the 41–50 year group (4 people, 30.77%) and the 31–40 year group (3 people, 23.08%). In terms of gender, the distribution of respondents was relatively balanced, with 7 women (53.85%) and 6 men (46.15%), suggesting that the research data is not biased towards one gender. Meanwhile, in terms of the last education, the majority of respondents had a college education (9 people, 69.23%), followed by high school/equivalent (2 people, 15.39%), and elementary and junior high school (1 person each, 7.69%). The high proportion of higher education indicates that respondents generally have the ability to understand and respond to research questions well, though it also suggests that the sample may be skewed toward more educated stakeholders.

3.2 The Role of Agricultural Institutions in Supporting Food Security

The results of the interview analysis related to the role of agricultural institutions using MAXQDA software are presented in Figure 2.

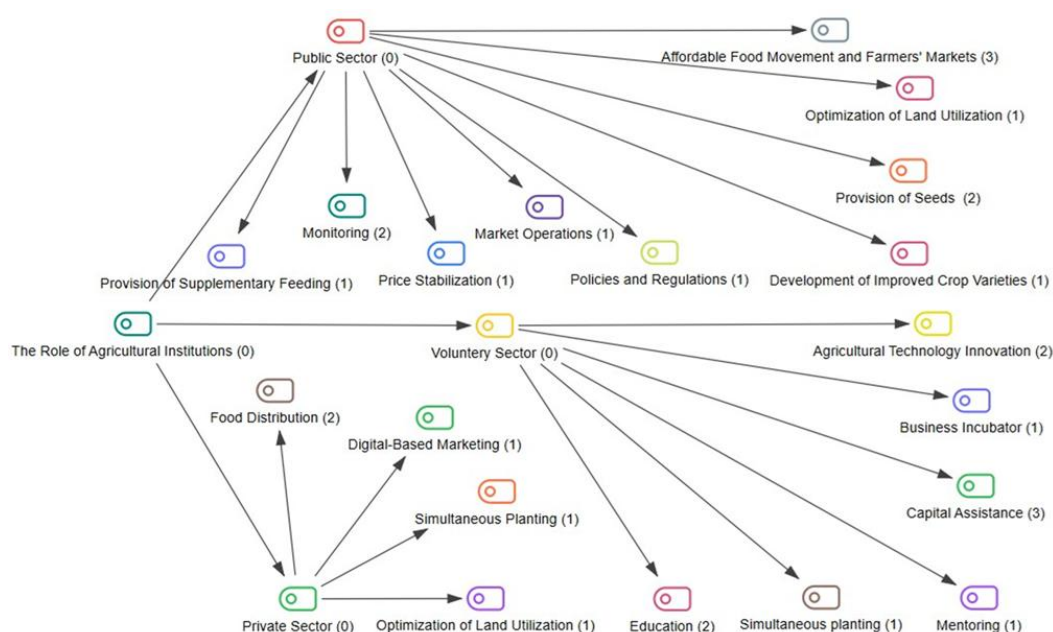


FIGURE 2: MAXQDA Visualization - The role of agricultural institutions in supporting food security

Based on the results of the analysis using MAXQDA from the research that has been conducted, several roles of agricultural institutions in supporting food security were identified, distributed across three scopes: the public sector, the voluntary sector, and the private sector. Informants across all sectors consistently emphasized the interconnected nature of institutional roles, with one extension officer noting: *"We cannot work in isolation. The success of agricultural programs depends on how well we coordinate with the food security office, the trade office, and even the banking sector"* (HH, Extension Center Head).

In the public sector, there are 9 activities or programs identified. The voluntary sector has 6 activities or programs, while the private sector has 4 activities or programs.

In the scope of the public sector, the interventions carried out are quite diverse with significant intensity, such as the Cheap Food Movement and Farmers' Markets (mentioned 3 times), provision of seeds and agricultural machinery (2), supervision (2), while price stabilization, policies, market operations, development of superior varieties, provision of PMT (Supplementary Feeding), and optimization of land use were each mentioned 1 time. A government official emphasized: *"Our role is to ensure that staple foods remain accessible to all communities, especially during price fluctuations. The Cheap Food Movement is one way we do this"* (AR, Head of Agriculture Division).

In the voluntary sector, the role is more emphasized on capital assistance (mentioned 3 times), then agricultural technology innovation and education (2 times each), while business incubators, mentoring, and simultaneous planting are each mentioned 1 time. The banking representative noted: *"We provide access to capital with easy requirements and fast processes. The challenge is ensuring farmers understand how to manage these funds effectively"* (AE, Bank Manager).

In the private sector, a number of programs are aimed at supporting food security, such as assisting with food distribution (mentioned 2 times), while land optimization, simultaneous planting, and digital-based marketing are each implemented once. A market owner explained: *"We try to source from local farmers when possible. Digital marketing has helped us reach more customers and stabilize prices"* (SP, Market Owner).

3.3 Strategy for Strengthening Agricultural Institutions in Supporting Food Security

The sub-elements of the strategy for strengthening agricultural institutions to support food security are alternative options compiled from various sources, both through interviews and literature. This study has compiled 13 sub-elements as a strategy for strengthening agricultural institutions to support food security, namely:

- a. Improving the capacity of extension workers through training and technical guidance
- b. Improving farmers' knowledge through education and mentoring
- c. Providing production facility assistance programs
- d. Strengthening cooperation between institutions to create synergy
- e. Facilitate and optimize the use of agricultural technology
- f. Providing easy access to capital for farmers and MSMEs
- g. Drafting regulations that limit the conversion of agricultural land
- h. Implement structured pest and disease control
- i. Using quality seeds to increase productivity
- j. Preparation of fertilizer according to the needs and experience of farmers
- k. Assistance in the implementation of sustainable agricultural principles
- l. Developing digital and innovation-based marketing sectors
- m. Forming a research and development team to drive innovation

3.3.1 Structural Self-Interaction Matrix of Strengthening Strategies

From the results of the analysis of respondents' opinions obtained through expert surveys after tabulating the questionnaire, a structural self-interaction matrix (SSIM) is compiled which aims to determine whether there is a contextual relationship between elements i and j and vice versa. The compilation of SSIM uses the symbols V, A, X, and O, as shown in Table 5.

TABLE 5

SSIM STRATEGY FOR STRENGTHENING AGRICULTURAL INSTITUTIONS IN SUPPORTING FOOD SECURITY

Element/Institution to-	13	12	11	10	9	8	7	6	5	4	3	2	1
1	V	V	V	X	X	V	V	V	X	V	X	X	-
2	V	V	V	X	X	V	V	V	X	V	X	-	-
3	V	X	V	X	X	X	V	X	V	V	-	-	-
4	X	X	X	A	A	A	X	A	A	-	-	-	-
5	V	V	X	X	X	X	V	X	-	-	-	-	-
6	V	V	V	X	X	X	X	-	-	-	-	-	-
7	A	A	X	A	A	A	-	-	-	-	-	-	-
8	V	V	V	X	X	-	-	-	-	-	-	-	-
9	V	X	V	X	-	-	-	-	-	-	-	-	-
10	V	V	V	-	-	-	-	-	-	-	-	-	-
11	X	X	-	-	-	-	-	-	-	-	-	-	-
12	V	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-

3.3.2 Reachability Matrix of Agricultural Institutional Strengthening Strategies

After the SSIM is compiled, the reachability matrix (RM) table is created by replacing the respondent's answer codes from V, A, X, and O with the numbers 1 and 0. After the final RM is compiled, it is used to determine the order of the driver power (DP) and Dependent (D) of each sub-element, and the ranking of each sub-element.

TABLE 6

FINAL REACHABILITY MATRIX

	j															
	A	B	C	D	E	F	G	H	I	J	K	L	M	DP	R	
i	A	1	1	1	1	1	1	1	1	1	1	1	1	1	13	1
	B	1	1	1	1	1	1	1	1	1	1	1	1	1	13	1
	C	1	1	1	1	1	1	1	1	1	1	1	1	1	13	1
	D	0	0	0	1	0	0	1	0	0	0	1	1	1	5	7
	E	1	1	0	1	1	1	1	1	1	1	1	1	1	12	2
	F	0	0	1	1	1	1	1	1	1	1	1	1	1	11	3
	G	0	0	0	1	0	1	1	0	0	0	1	0	0	4	8
	H	0	0	1	0	1	1	0	1	1	1	1	1	1	9	4
	I	1	1	1	1	1	1	1	1	1	1	1	1	1	13	1
	J	1	1	1	1	1	1	1	1	1	1	1	1	1	13	1
	K	0	0	0	1	1	0	1	0	0	0	1	1	1	6	6
	L	0	0	1	1	0	0	1	0	1	0	1	1	1	7	5
	M	0	0	0	1	0	0	1	0	0	0	1	0	1	4	8
	D	6	6	8	11	9	9	12	8	9	8	13	11	12		
	R	6	6	5	3	4	4	2	5	4	5	1	3	2		

Information:

- Improving the capacity of extension workers through training and technical guidance
- Improving farmers' knowledge through education and mentoring
- Providing production facility assistance programs
- Strengthening cooperation between institutions to create synergy
- Facilitate and optimize the use of agricultural technology

- f. Providing easy access to capital for farmers and MSMEs
- g. Drafting regulations that limit the conversion of agricultural land
- h. Implement structured pest and disease control
- i. Using quality seeds to increase productivity
- j. Preparation of fertilizer according to the needs and experience of farmers
- k. Assistance in the implementation of sustainable agricultural principles
- l. Developing digital and innovation-based marketing sectors
- m. Forming a research and development team to drive innovation

3.3.3 Position and Comparison of DP-D Weights for Strengthening Strategies

The comparison of the power-dependent driver (DP-D) weights between sub-elements determines the position of each sub-element in the Power-Dependent Driver (DP-D) Matrix as in Table 7.

TABLE 7
POSITION AND COMPARISON OF DP-D WEIGHTS OF STRENGTHENING STRATEGIES

	DP	D	
Independent (Strong driving force. On the other hand, dependence on other elements is generally weak)	Improving the capacity of extension workers through training and technical guidance	1.00*	0.46
	Improving farmers' knowledge through education and mentoring	1.00*	0.46
	<i>Average</i>	<i>*1.00*</i>	<i>*0.46*</i>
Linkage (Strong driving force for the program but has high dependency on other elements)	Providing production facility assistance programs	1	0.61
	Preparation of fertilizer according to the needs and experience of farmers	1	0.61
	Using quality seeds to increase productivity	1	0.69
	Facilitating and optimizing the use of agricultural technology	0.92	0.69
	Providing easy access to capital for farmers and MSMEs	0.84	0.69
	Implement structured pest and disease control	0.69	0.61
	Developing digital and innovation-based marketing sectors	0.53	0.84
	<i>Average</i>	<i>*0.85*</i>	<i>*0.58*</i>
Dependent (Weak driving force on the program, but has a very strong dependency on other elements)	Assistance in the implementation of sustainable agricultural principles	0.46	1
	Strengthening inter-institutional cooperation to create synergy	0.38	0.84
	Drafting regulations that limit the conversion of agricultural land	0.31	0.92
	Forming a research and development team to drive innovation	0.31	0.92
	<i>Average</i>	<i>*0.36*</i>	<i>*0.92*</i>

Information:

DP and D $\leq$ 0.50 = small

DP and D $\geq$ 0.50 = large

= Priority strengthening strategy

From Table 7 it can be seen that the strategy for strengthening agricultural institutions in supporting food security at the key level is (1) Improving Extension Human Resources and (2) Improving Farmer Knowledge.

3.3.4 Matrix Driver Power-Dependent (DP-D) Strategy for Strengthening Agricultural Institutions

The separation of strategies for strengthening agricultural institutions in supporting food security into four sectors (independent, linkage, autonomous, dependent) can be shown in the form of a driver power dependent matrix (DP-D) as in Figure 3.

13						A, B		C,J	I				
12									E				
11									F				
10		Independent							Linkage				
9								H					
8													
7											L		
6													K
5											D		
4		Autonomous										G,M	
3									Dependent				
2													
1													
	1	2	3	4	5	6	7	8	9	10	11	12	13

FIGURE 3. Matrix driver power dependent (DP-D) reinforcement strategy

Information:

- Improving the capacity of extension workers through training and technical guidance
- Improving farmers' knowledge through education and mentoring
- Providing production facility assistance programs
- Strengthening cooperation between institutions to create synergy
- Facilitate and optimize the use of agricultural technology
- Providing easy access to capital for farmers and MSMEs
- Drafting regulations that limit the conversion of agricultural land
- Implement structured pest and disease control
- Using quality seeds to increase productivity
- Preparation of fertilizer according to the needs and experience of farmers
- Assistance in the implementation of sustainable agricultural principles
- Developing digital and innovation-based marketing sectors
- Forming a research and development team to drive innovation

IV. DISCUSSION

4.1 The Role of Agricultural Institutions in Supporting Food Security

4.1.1 Public Sector

The research findings indicate that the public sector plays the most dominant role in supporting food security through nine activities across various programs. Local governments, particularly through the Department of Agriculture, Maritime Affairs, and Fisheries and the Department of Food Security, implemented direct interventions such as the Affordable Food Movement and Farmers' Markets (mentioned three times), the provision of seeds and agricultural machinery (two times), supervision (two

times), and price stabilization activities, market operations, and the provision of PMT (Supplementary Feeding). This suggests that government interventions focusing on food availability and stability are key actors in maintaining food supply and price stability at the local level. This finding aligns with the institutional economics perspective that emphasizes the role of government in addressing market failures and ensuring public goods provision in agricultural systems (North, 1990).

Furthermore, the research found that policies on the provision of production facilities and seed subsidies have a significant impact on increasing regional food productivity (Obayelu et al., 2021). Similarly, research by Clark and Jablonski (2022) confirms that the effectiveness of public food policies increases when local governments are able to involve cross-agency agencies and streamline field monitoring mechanisms for farmers receiving assistance. Thus, the public sector becomes the main backbone of the food institutional system through its role in policy, market intervention, and the provision of agricultural resources.

Some institutional roles within the public sector include:

First, implementing affordable food programs and farmers' markets. The Affordable Food Movement aims to provide staple foods and nutritious food at affordable prices, especially for low-income communities. This concept aligns with the short food supply chain approach, which emphasizes distribution efficiency, price transparency, and increased income for local producers (Chiffolleau et al., 2025; Andini, 2025).

Second, providing seed and agricultural machinery assistance, driven by the Department of Agriculture, Maritime Affairs and Fisheries, and agricultural extension agencies. High-quality, superior seeds are a key factor in increasing crop yields, plant resistance to pests and diseases, and the quality of food produced. Recent research shows that the availability of adequate superior seeds and agricultural machinery significantly increases agricultural productivity, reduces production costs, and supports local food security (Widiyanti et al., 2025).

Third, conducting supervision, particularly regarding the stability of fertilizer availability and other programs. Supervision of fertilizer availability is an important part of maintaining the stability of agricultural production and food security in Parepare City. Recent research shows that effective supervision of fertilizer distribution contributes significantly to increasing agricultural yields, stabilizing food prices, and strengthening local food security (Spirenkov, 2024).

Fourth, maintaining price stability to ensure the availability of affordable food, carried out in collaboration with the regional inflation control team (TPID) and food stakeholder partners. Price stability directly impacts the ability of people, especially low-income groups, to access nutritious food sustainably (Xi et al., 2026; Rana et al., 2023).

Fifth, formulate policies in the form of regional regulations, specifically regarding LP2B (Sustainable Food Agricultural Land). This regional regulation (Regional Regulation No. 8 of 2021) aims to protect and maintain productive agricultural land from being converted to other uses, such as housing, industry, or commercial buildings (Rahma Dayanti & Soetjipto, 2024).

Sixth, conduct market operations programs to ensure the availability of staple foods for the community, especially during periods of price fluctuations or uneven harvest seasons. Recent research shows that market operations are effective in reducing food price volatility, increasing consumption of nutritious food in urban communities, and supporting local food security (PUSPAKA et al., 2022; Muhammadiyah et al., 2024).

Seventh, developing superior varieties, especially for corn. This program was implemented in collaboration with Hasanuddin University, Makassar. Previous research has shown that the use of superior varieties provides significantly higher financial returns than local varieties (Desiso & Kassa, 2024).

Eighth, providing supplementary feeding (PMT), especially to pregnant women and toddlers, is carried out by the health office. The PMT program, accompanied by nutrition education, health monitoring, and routine distribution, has been proven to significantly reduce the prevalence of stunting and strengthen family nutritional resilience (Gusman et al., 2025; Mardhiyah et al., 2025).

Ninth, encourage the optimization of land use, including the utilization of yard and marginal land through production intensification. Research shows that land optimization through agroecological and precision agriculture approaches can increase crop yields by up to 40%, reduce losses due to soil degradation, and increase farmer incomes (Jayaputra et al., 2020).

4.1.2 Voluntary Sector

The voluntary sector encompasses six main activities focused on empowerment, mentoring, and innovation. Research findings indicate that capital assistance is the most dominant program (mentioned three times), followed by agricultural technology innovation and community education (two times each), and business incubation, mentoring, and simultaneous planting (one time each).

This sectoral distribution suggests that voluntary institutions (including NGOs, farmer organizations, and financial institutions) primarily serve as facilitators and intermediaries, bridging gaps between public sector policies and private sector implementation. The emphasis on capital assistance and technology innovation indicates that these actors are responding to the immediate needs of farmers for resources and knowledge.

Some institutional roles within the voluntary sector include:

First, the distribution of capital assistance, specifically through the banking sector, specifically Bank Rakyat Indonesia (BRI). This program provides access to low-interest business capital, with easy requirements, and a fast process for farmers, livestock breeders, and fishermen. These funds can be paid quarterly, semi-annually, or even once the following year. This aligns with findings showing that capital support from local governments and non-governmental organizations contributes significantly to increasing farmer incomes and local food availability (Triyono et al., 2025).

Second, encouraging the implementation of agricultural technology, particularly the use of superior seeds, simple mechanization, deep irrigation, agricultural machinery, and dew zones. The application of agricultural technology is a crucial strategy for addressing modern challenges facing the agricultural sector, ranging from climate change, limited land, to increasing food production needs. The integration of mechanization, including the use of GPS-guided tractors and robotics for planting and harvesting, consistently improves resource efficiency and productivity in food crop cultivation (Wijayanto & Puspitojati, 2024).

Third, provide education to extension workers and farmers. Research conducted by Khuswati et al. (2022) shows that participatory education, both by field extension workers and agricultural institutions, is very effective in increasing the success of food security and public health programs, such as the Sustainable Food Home Area program and health education in various regions.

Fourth, organize a business incubator program, a program from BRI to support regional development through four main aspects: strengthening BUMDes, digitalization, innovation, and sustainability. These results are in line with research showing that participation in business incubator programs facilitated by agricultural institutions increases productivity, business efficiency, and digital marketing capabilities for food entrepreneurs (Albar & Amsal, 2024).

Fifth, provide assistance, especially in the OPL (Land Utilization Optimization) program with the aim of producing food crops such as vegetables for family consumption. Land optimization activities allow the remaining production to be sold at low-cost market activities to improve the welfare of farmers (Jayaputra et al., 2020).

Sixth, organizing a simultaneous planting program, such as the simultaneous corn planting activity, to support the achievement of national food security, carried out on plantation land in Galung Maloang Village, Bacukiki District. Research results show that this method has a significant impact on increasing crop yields, preventing pests and diseases, increasing irrigation efficiency, expanding farmer social networks, and accelerating the achievement of food self-sufficiency in various regions.

4.1.3 Private Sector

The private sector, while having fewer identified activities (4 programs), plays a complementary role to public and voluntary institutions. This pattern is consistent with the market-oriented perspective on institutional roles, where private actors primarily respond to market signals and profit incentives rather than directly pursuing food security objectives. However, their engagement in food distribution, land optimization, and digital marketing suggests that private sector participation is essential for creating efficient food value chains.

Some forms of institutional roles that fall within the scope of the private sector include:

First, carrying out food distribution activities through MSMEs so that food can reach the community directly. Food distribution practices involving MSMEs have proven effective in ensuring accessibility and affordability of staple foods for the wider community, especially in remote and food-insecure areas (Dwi Septi Haryani et al., 2025).

Second, optimizing land includes utilizing home yards and idle land. Research shows that land optimization through an agroecological approach and precision agriculture can increase crop yields by up to 40%, reduce losses due to soil degradation, and increase farmer income (Jayaputra et al., 2020).

Third, actively participating in simultaneous planting such as simultaneous corn planting activities to support the achievement of national food security carried out on plantation land in Galung Maloang Village, Bacukiki District.

Fourth, conducting digital-based marketing for MSME actors in marketing products, especially food. Digital-based marketing is a pillar in the transformation of modern agribusiness, providing broader and more efficient access for farmers and agribusiness actors to reach national and global markets (Butar-butur et al., 2025; Setiawan, 2022).

4.2 Strategy for Strengthening Agricultural Institutions in Supporting Food Security

The Interpretive Structural Modeling (ISM) research findings on strategies for strengthening agricultural institutions in supporting food security show that of the 13 sub-elements, 2 are in the Independent position, 7 are in the Linkage position, and 4 are in the Dependent position. The absence of elements in the Autonomous position indicates that all institutional strengthening strategies in Parepare City are interconnected, reflecting the complexity of an integrative institutional system that requires a systemic approach in its development. This finding has important theoretical implications, suggesting that institutional strengthening cannot be achieved through isolated interventions but requires coordinated action across multiple dimensions.

4.2.1 Independent Position Development Program

Independent development programs are strategic elements with high driving force and low dependence on other sub-elements. Research shows that two programs within this framework are enhancing the capacity of human resources (HR) for extension workers through training and technical guidance, and enhancing farmer knowledge through education and mentoring. These two elements serve as the primary foundation for strengthening local institutions, as the quality and competence of human resources are key factors in the success of agricultural systems and food security. Research by Ceria (2025) confirms that effective agricultural institutions depend on the ability of human resources to manage and implement agricultural policies at the grassroots level. Therefore, strengthening the capacity of human resources for extension workers and farmers is the initial step in determining the effectiveness of all institutional programs.

In the context of Parepare City, the presence of 20 agricultural extension workers for 150 farmer groups represents a less-than-ideal ratio. This situation limits the reach of guidance and counseling services to farmers. Therefore, strategies to increase human resource capacity through training, competency certification, and ongoing mentoring are crucial to enable extension workers to act as agents of change in sustainable agricultural development. This aligns with research by Mardiharini et al. (2023), which states that systematically increasing the capacity of extension workers has a significant impact on the effectiveness of agricultural institutions and farmer productivity in rural areas.

Furthermore, increasing farmer knowledge through ongoing education and mentoring serves to strengthen their adaptive capacity to technological and climate change. Educational programs based on local needs can enhance farmers' ability to manage agricultural risks, optimize production inputs, and implement sustainable agricultural practices. Mariyah et al. (2024) emphasize that institutional innovations in the form of participatory training and technical mentoring can increase the effectiveness of technology adoption and strengthen food security at the local level.

The application of this capacity building approach is also in line with the institutional development theory put forward by Uphoff (1986) and redeveloped by Ostrom (1990), which emphasizes that strong institutions are built by increasing the capacity of the actors within them. Institutions are not only formal structures, but also systems of values, norms, and competencies of individuals involved in the food production and distribution process. In the context of this research, an independent strategy has long-term implications for strengthening the competitiveness of agricultural institutions and the food independence of the Parepare community.

4.2.2 Linkage Position Development Program

A program in a linkage position is an element that has a high driving force but also a strong dependence on other sub-elements. This means that the success of this strategy is highly dependent on synergy between actors and supporting institutions. Based on research results, the seven elements included in this position are: providing production input assistance programs, preparing fertilizers according to farmers' needs, using quality seeds, facilitating the use of agricultural technology, facilitating access to

capital for farmers and MSMEs, implementing structured pest and disease control, and developing a digital and innovation-based marketing sector.

Assistance programs for production inputs, such as seeds, fertilizers, and agricultural tools, have a direct impact on increasing the productivity and efficiency of farming businesses. This is reinforced by research by Bakri and Hardiani (2024), which found that institutional support for the provision of production inputs plays a significant role in strengthening local food production systems. In the context of Parepare, which has limited land and a majority of small-scale farmers, support for production inputs is a vital strategy for maintaining production continuity.

Furthermore, strengthening access to capital through microfinance institutions and business partnerships is an integral part of the linkage strategy. Limited capital is one of the causes of stagnant farmer productivity in Parepare. Research by Bawa (2019) shows that easier access to financing through partnership schemes can strengthen farmers' economic institutions and increase the competitiveness of local agricultural products. Partnership programs that connect farmers, cooperatives, and industry players can also create more efficient value chains.

Another important aspect of the linkage strategy is the use of technology and digital marketing. The use of modern agricultural technology can improve labor efficiency, reduce production costs, and increase crop yields. Meanwhile, digital marketing encourages farmer integration with broader and more transparent markets. Research by Dewi Anggun Oktaviani (2020) shows that digital transformation in the agricultural sector strengthens farmers' bargaining power and supports regional food security. In the context of Parepare, the development of a digital-based marketing system can help farmer groups expand their distribution networks for agricultural products, particularly for horticultural commodities, which are the dominant sector.

Thus, the linkage strategy emphasizes the importance of integration between programs and cross-institutional collaboration. These programs cannot operate in isolation but must be supported by coordination between the agricultural services, food security, cooperatives, and the private sector. This finding resonates with the institutional synergy literature, which emphasizes that effective institutional arrangements require coordination mechanisms across organizational boundaries (Clark & Jablonski, 2022).

4.2.3 Dependent Position Development Program

Programs in the dependent position have weak driving force but a high degree of dependence on other elements. Based on research results, four programs fall into this position: strengthening inter-institutional cooperation, developing regulations limiting agricultural land conversion, assisting in the implementation of sustainable agriculture principles, and establishing an agricultural innovation research and development team. These four programs serve to support or reinforce the sustainability of strategies in the independent and linkage sectors.

Inter-institutional cooperation is a crucial aspect in strengthening institutional synergy. Weak coordination between relevant agencies, such as the agriculture, maritime affairs and fisheries agencies, the food security agency, and the banking sector, leads to overlapping programs and low policy implementation efficiency. Research by Nicholson et al. (2021) emphasizes that good agricultural institutional governance must be built through cross-sector coordination and collaborative mechanisms. Without institutional synergy, effective food security policies will be difficult to achieve.

Developing regulations that limit agricultural land conversion is also fundamental to ensuring sustainable food production. Parepare, a city with agricultural land covering only around 7.41% of its total area, is highly vulnerable to land conversion. Regulations that support the protection of productive agricultural land can be a crucial policy instrument for achieving local food security (Rahma Dayanti & Soetjipto, 2024). Therefore, strengthening regulations and oversight of land conversion should be a regional policy priority.

Furthermore, mentoring the implementation of sustainable agriculture principles and the formation of research and development teams serve as drivers of innovation. Research and development teams are expected to integrate academic research findings with field practices, such as the development of superior varieties, efficient irrigation systems, and food nutrition innovations. Research shows that consistent application of sustainable agriculture principles can improve resource efficiency and support community nutritional security (Willoughby et al., 2022).

The dependent position of these elements suggests that while they are important, they cannot be effectively implemented without addressing the independent elements first. This hierarchical relationship provides important guidance for policy sequencing in institutional strengthening efforts.

4.2.4 Autonomous Position Program

Autonomous position in the ISM model indicates elements with equally low driving force and dependency, and no direct impact on the system. The results show that there are no sub-elements in the autonomous position. This indicates that all aspects of strengthening agricultural institutions in Parepare City are interconnected, and no element stands alone without connection to other elements. This condition reflects the complexity of an integrative institutional system and requires a systemic approach in its development.

The absence of autonomous elements also shows that all institutional strengthening strategies in Parepare have direct relevance and linkages to food security. This finding has important practical implications: it suggests that local governments need to ensure that every institutional strengthening policy and program is not sectoral or partial, but rather built within a mutually reinforcing systemic framework. In this way, institutional strengthening in Parepare City can have a tangible impact on sustainable food security.

4.3 Structural Model of the Agricultural Institutional Strengthening Strategy

Based on the results of the ISM analysis, the involvement of sub-elements in the strategy of strengthening agricultural institutions in supporting food security shows a comparison of levels that correspond to the greatest driver power weight ($DP = 1.00$). Sub-elements at level 1 are increasing the capacity of extension workers, increasing farmer knowledge, providing production facility assistance programs, preparing fertilizers, and using quality seeds to increase productivity.

At level 1 there are 5 (five) strategies that need to be implemented in strengthening agricultural institutions in supporting food security:

The first strategy, which is to increase the capacity of human resources for agricultural extension workers through training and technical guidance, has the highest driver power weight ($DP=1.00$ and $D=0.46$), emphasizing that the quality of human resources is a fundamental factor in strengthening agricultural institutions. Agricultural extension workers have a strategic role as agents of social change, bridging government policies and the needs of farmers in the field (Sehat Tan & Mailena, 2021). In Parepare City, field evidence shows that most extension workers have not received adequate training in the use of information technology and participatory approaches, resulting in limited institutional capacity for innovation transfer. Previous research has shown that systematically improving the competence of extension workers through locally needed training can increase the efficiency of technology adoption and strengthen farmers' trust in extension institutions (Ceria, 2025). Therefore, the strategy of strengthening the capacity of human resources for agricultural extension workers is an initial driving element that has a broad influence on the effectiveness of food security programs.

The second strategy, increasing farmer knowledge through education and mentoring ($DP=1.00$ and $D=0.46$), is a follow-up step that is interrelated with the role of extension workers. Low modern agricultural literacy and minimal farmer participation in training lead to knowledge gaps that impact productivity and household food security. According to Bakker et al. (2022), adaptive extension approaches, such as field school methods and ongoing mentoring, have been shown to increase farmers' capacity to make efficient and sustainable production decisions. Recent research by Orjinta et al. (2025) also shows that increasing farmer education is positively correlated with household food diversification. Thus, strengthening farmers' knowledge capacity not only impacts agricultural yields but also strengthens the food security dimension in terms of the availability and access to nutritious food.

The third strategy, namely the provision of agricultural production input assistance programs ($DP=1.00$ and $D=0.61$), shows that productive input support remains a fundamental need for agricultural institutions in maintaining the sustainability of farming businesses. Most small-scale farmer groups still face obstacles in obtaining modern agricultural tools, superior seeds, and quality input materials at affordable prices. Providing targeted production input assistance can accelerate productivity increases and encourage efficiency in the local supply chain. This assistance program must be synergized with farmer group institutions to avoid creating dependency, but rather strengthen collective capacity (Widiyanti et al., 2025). The results of other studies support this view, namely that collaboration between local governments, extension institutions, and farmer cooperatives in distributing production inputs can create an agricultural ecosystem that is more resilient and adaptive to climate change and market fluctuations (Nugra Irianta Denashurya et al., 2025).

The fourth strategy, preparing fertilizer according to farmers' needs and experience ($DP=1.00$ and $D=0.61$), emphasizes the importance of a participatory approach in subsidized fertilizer distribution policies. Based on field research findings, the fertilizer distribution system in Parepare is often not aligned with farmers' needs due to differences in land characteristics and

crop types. The effectiveness of fertilizer policies is greatly influenced by participatory mechanisms between farmers and agricultural institutions in determining the allocation and type of fertilizer used (Mhw et al., 2022). Furthermore, other research shows that farmer involvement in fertilizer needs planning can increase distribution accuracy by up to 30% and reduce waste of production inputs (Spirenkov, 2024). Therefore, a field-needs-based fertilizer preparation strategy has great potential to strengthen farmers' trust in regional institutions and increase the efficiency of production systems, supporting long-term food security stability.

The fifth strategy, using quality seeds to increase productivity ($DP=1.00$ and $D=0.69$), is a technical strategy with institutional implications. The use of superior seeds not only determines potential harvest yields but also reflects the effectiveness of distribution networks and the institutional function of seed quality control at the local level. According to research by Anisya and Wibowo (2024), the availability of quality seeds through local certification mechanisms can increase yields by up to 25% compared to the use of non-certified seeds. In the context of Parepare, the challenge faced is the still limited access of farmers to adaptive superior seeds that suit local agro-ecological conditions. Furthermore, institutional policies need to ensure the sustainability of the seed supply chain to avoid dependence on external parties. Research studies confirm that strengthening local seed systems based on cooperatives and Village-Owned Enterprises (BUMDes) can be a strategic solution to strengthen farmer independence while increasing sustainable food security (Zhang et al., 2022). Thus, the strategy of using quality seeds is a crucial instrument that connects the technical, institutional, and social dimensions in achieving inclusive and competitive food security.

4.4 Theoretical Contributions and Practical Implications

The findings of this study contribute to institutional theory in several ways. First, the three-sector classification of institutional roles (public, voluntary, private) provides a comprehensive framework for understanding how different institutional actors contribute to food security. This extends previous work by Uphoff (1986) and Ostrom (1990) by demonstrating how institutional functions operate across sectors in an urban agricultural context.

Second, the ISM analysis reveals the hierarchical structure of institutional strengthening strategies, showing that human capacity development (extension workers and farmers) must precede other interventions. This finding challenges approaches that prioritize infrastructure or technology provision without addressing human capabilities first.

Third, the identification of linkage position strategies highlights the importance of institutional synergy and coordination mechanisms. This supports the growing literature on institutional interconnectedness and network governance in agricultural systems (Clark & Jablonski, 2022).

From a practical perspective, the study provides evidence-based recommendations for local government and development partners. The priority strategies identified (extension capacity building, farmer education, production inputs, fertilizer provision, and quality seeds) offer a clear roadmap for institutional strengthening efforts. The hierarchical structure suggests that investments should be sequenced: starting with human capacity development before expanding to other interventions.

V. CONCLUSION

5.1 Summary of Findings

Agricultural institutions play a crucial role in supporting food security in Parepare City. The study identified institutional roles across three sectors:

In the public sector, institutional roles include affordable food movements and farmers' markets, seed and agricultural machinery provision, supervision, price stabilization, policymaking, market operations, development of superior varieties, provision of PMT (Supplementary Feeding), and optimization of land use. The public sector emerges as the primary actor in maintaining food availability and price stability.

In the voluntary sector, institutional roles include capital assistance, agricultural technology innovation, education, mentoring, and simultaneous planting. The voluntary sector serves primarily as a facilitator and intermediary, bridging gaps between public policy and private sector implementation.

In the private sector, institutional roles include food distribution, land optimization, simultaneous planting, and digital-based marketing. The private sector plays a complementary role in ensuring efficient food value chains.

The ISM analysis identified five priority strategies for strengthening agricultural institutions: (1) increasing the capacity of extension workers through training and technical guidance, (2) increasing farmer knowledge through education and mentoring, (3) providing production facility assistance programs, (4) preparing fertilizer according to farmers' needs and experience, and (5) using quality seeds to increase productivity. These strategies are hierarchical, with human capacity development (strategies 1 and 2) serving as the foundation for other interventions.

5.2 Theoretical Contributions

This study contributes to institutional theory by providing a comprehensive framework for understanding institutional roles across public, voluntary, and private sectors in an urban agricultural context. The ISM analysis reveals the hierarchical structure of institutional strengthening strategies, demonstrating that human capacity development must precede other interventions. The absence of autonomous elements in the ISM model highlights the interconnected nature of institutional systems, supporting the theoretical perspective that effective institutions require coordinated action across multiple dimensions.

5.3 Practical Implications

The findings have several implications for policy and practice:

- 1) **Sequencing of interventions:** Investments should prioritize extension worker capacity building and farmer education before expanding to other programs.
- 2) **Cross-sector coordination:** The success of linkage position strategies depends on synergy between public, voluntary, and private sector actors. Institutional mechanisms for coordination should be strengthened.
- 3) **Participatory approaches:** Farmer involvement in planning (e.g., fertilizer needs assessment) can improve program effectiveness and build trust in institutions.
- 4) **Technology integration:** Digital marketing and agricultural technology should be integrated into institutional strengthening strategies to improve efficiency and market access.
- 5) **Land use policy:** Given limited agricultural land in Parepare City, regulations protecting productive agricultural land are essential for long-term food security.

5.4 Study Limitations

This study has several limitations that should be acknowledged:

- 1) **Sample size:** The study relied on 13 informants, which limits the generalizability of findings. While purposive sampling is appropriate for qualitative institutional analysis, the findings should be interpreted as stakeholder perspectives rather than objective facts.
- 2) **Sample composition:** The high proportion of informants with higher education (69.23%) may not represent the broader farming community. The perspectives of less educated farmers might be underrepresented.
- 3) **Cross-sectional design:** The study captures institutional roles and strategies at a single point in time. Longitudinal research would be needed to assess the effectiveness of implemented strategies.
- 4) **Context specificity:** Findings are specific to Parepare City's urban agricultural context. Generalization to other contexts should be done cautiously.
- 5) **HFIAS data:** While the HFIAS questionnaire was administered, the results were not presented in this manuscript, limiting the integration of household food security data with institutional analysis.

5.5 Future Research Directions

Based on the findings and limitations of this study, several directions for future research are suggested:

- 1) **Longitudinal studies:** Research that tracks the implementation and impact of institutional strengthening strategies over time would provide evidence of effectiveness.
- 2) **Comparative studies:** Comparative research across multiple cities or regions would help identify context-specific versus generalizable institutional strengthening strategies.

- 3) **Farmer-centered research:** Studies that focus specifically on farmer perspectives and experiences with agricultural institutions would complement the stakeholder perspective of this research.
- 4) **Impact assessment:** Rigorous impact evaluations of institutional strengthening programs would provide causal evidence of their effectiveness on food security outcomes.
- 5) **HFIAS integration:** Future research should integrate household food security data with institutional analysis to examine the direct relationship between institutional strengthening and household food security.
- 6) **Gender analysis:** Research examining how agricultural institutions differentially affect men and women farmers would contribute to more inclusive institutional strengthening strategies.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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