

**Agricultural Economic  
Performance, Fraud-  
Prevention Governance, And  
Environmental Quality.**

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Indonesia (2025)*

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**Abstract.** Agricultural development plays an important role in regional economic growth, rural livelihoods, food security, and natural resource management. However, agricultural performance varies across regions and should be interpreted together with governance and environmental considerations. This article analyzes agricultural economic performance, fraud-prevention governance, and environmental quality across regencies and municipalities in Central Sulawesi Province, Indonesia. A quantitative descriptive approach with comparative regional analysis was applied using verified secondary data from official government sources. Agricultural economic performance was measured using the gross regional domestic product of the agriculture, forestry, and fisheries sector, while fraud-prevention governance and environmental quality were discussed based on available official information related to the Monitoring Center for Prevention framework and the Environmental Quality Index. The results show substantial spatial variation in agricultural economic performance. In 2024, agricultural GRDP ranged from IDR 1,241.27 billion in Kota Palu to IDR 9,969.49 billion in Parigi Moutong, with a mean of IDR 4,565.74 billion and a standard deviation of IDR 2,585.52 billion. Parigi Moutong and Banggai were classified as high-performing regions based on normalized agricultural GRDP scores, while Donggala, Sigi, Morowali Utara, Poso, and Tolitoli were classified as medium-performing regions. The findings also indicate that agricultural importance differs between absolute agricultural GRDP and agricultural share in total GRDP. Banggai Laut recorded the highest agricultural share at 55.84%, whereas Morowali had the largest total GRDP but only 1.55% agricultural share. These patterns suggest that sustainable agribusiness policy in Central Sulawesi should be regionally differentiated. Areas with large agricultural economies require value-chain strengthening and agro-processing, while areas with high agricultural dependence need productivity improvement, farmer welfare support, rural infrastructure, and market connectivity. The limited availability of verified district-level MCP/MCSP and IKLH data remains a constraint, highlighting the need for more complete local governance and environmental datasets for future correlation and composite-index analysis.

**Keywords:** Agricultural economy; Central Sulawesi; Environmental quality; Fraud prevention; Sustainable agribusiness

Manuscript received: 23 Mar 2026.  
Revision accepted: 29 Apr 2026.

## INTRODUCTION

Agriculture remains a strategic sector in regional development because it links economic growth, rural livelihoods, food security, employment absorption, and natural resource management. In Central Sulawesi Province, the agricultural sector is particularly relevant due to the province's diverse agroecological characteristics, including food-crop areas, plantation zones, coastal and fisheries resources, forest-based landscapes, and rural production systems. This diversity makes agriculture not only a production sector but also a territorial

development instrument that influences household income, regional competitiveness, and the resilience of local communities. Previous research shows that agriculture, forestry, and fisheries continue to play an important role in the economic structure of Central Sulawesi, although the sector also faces pressures from structural transformation and the increasing role of non-agricultural sectors (Pratama et al., 2023). At the broader Sulawesi Island level, agricultural transformation has been characterized by differences in sectoral contribution, regional competitiveness, and

development capacity across provinces and districts (Nur'aini *et al.*, 2025). Therefore, the agricultural economy in Central Sulawesi needs to be examined not only as a sectoral output but also as a regional development component that interacts with governance quality and environmental sustainability.

However, strong agricultural economic performance does not automatically indicate sustainable agribusiness development. A district may record a large agricultural contribution to gross regional domestic product or high commodity production while still facing low value addition, weak farmer institutions, limited market access, inefficient input use, and environmental pressure. Sustainable agricultural development should therefore be understood as a complex system in which production, market access, farmer behavior, public policy, institutional capacity, and ecological constraints interact with one another (Puspitasari *et al.*, 2024). Agricultural extension is also important because it supports knowledge transfer, farmer learning, resource-use efficiency, and the transition toward circular bioeconomy practices (Yanfika *et al.*, 2024). More broadly, the transformation of agribusiness requires sustainable practices such as circular economy, regenerative agriculture, precision farming, renewable-resource use, and inclusive value-chain development (Doda *et al.*, 2025). In this sense, agricultural economic performance in Central Sulawesi should not be evaluated only through the size of agricultural output, but also through its compatibility with sustainable agribusiness, farmer welfare, value-chain resilience, and ecological carrying capacity.

The relationship between agricultural economic performance and sustainable agribusiness is particularly important for regions with diverse commodity bases. Central Sulawesi is associated with food

crops, plantation crops, fisheries, forestry-related resources, and agro-based rural livelihoods. Each commodity system has different implications for income generation, land use, market integration, and environmental pressure. Studies on sustainable value chains in Indonesia show that agribusiness development depends on coordination among producers, processors, market actors, supporting institutions, and local policy environments (Utama *et al.*, 2025). Integrated crop–livestock systems also demonstrate that agricultural sustainability can be strengthened by improving resource circulation, reducing waste, and increasing production efficiency (Swastika *et al.*, 2024). In plantation-based regions, sustainability requires attention to land management, smallholder capacity, environmental compliance, and long-term productivity (Supriatna *et al.*, 2024). Meanwhile, rice-farming systems require adaptation strategies to maintain resilience under flood risk, climate variability, and livelihood uncertainty (Amandaria *et al.*, 2025). These findings indicate that sustainable agribusiness is not achieved merely by increasing production, but by strengthening the economic, institutional, and ecological foundations of agricultural systems.

The sustainability of agricultural development is also closely related to the quality of public governance. In this study, fraud prevention is understood as an effort to reduce the risk of irregularities in development planning, budgeting, procurement, licensing, public services, infrastructure provision, asset management, and natural resource governance. These governance areas are directly relevant to agriculture because public agricultural programs often involve subsidy allocation, procurement of inputs, rural infrastructure development, irrigation facilities, farmer assistance, extension services, and environmental control. Weak governance may reduce the effectiveness of public

expenditure, distort resource allocation, create unequal access to agricultural programs, and weaken accountability in rural development. Governance arrangements within agricultural supply chains can influence farmers' ability to adopt sustainable agricultural practices because they shape incentives, trust, coordination mechanisms, and access to support services (Kusnandar *et al.*, 2024). Food-system transformation also requires governance structures that can coordinate multiple actors, manage trade-offs, and maintain accountability across sectors and territories (Vignola & Oosterveer, 2025). In Indonesia, governance and accountability remain important in food-sector development because large-scale agricultural policies involve complex interactions among public institutions, private actors, and local communities (Sawir *et al.*, 2026).

Environmental quality is another fundamental prerequisite for sustainable agricultural development. Agriculture depends on water quality, air quality, land conditions, biodiversity, and ecosystem stability. At the same time, agricultural expansion and intensification may contribute to land degradation, water pollution, biodiversity loss, and pressure on forests or coastal ecosystems if they are not managed properly. Therefore, environmental quality should not be treated merely as an external outcome of development, but as a productive asset that supports long-term agricultural productivity. The Environmental Quality Index is relevant to this framework because it provides a composite indication of environmental conditions and can be used to assess whether regional development remains compatible with ecological sustainability [23]. Recent studies show that rule of law, transparency, and corruption control are associated with better green-growth outcomes (Gu *et al.*, 2024). Corruption may also increase climate and

environmental risks by weakening regulatory enforcement, reducing institutional credibility, and undermining disaster-response capacity (Zhou *et al.*, 2024). In addition, governance quality has been shown to influence the achievement of sustainable development goals because it affects the capacity of governments to design, implement, and monitor development policies (Hamid & AlObaid, 2025). These findings suggest that agricultural development, fraud-prevention governance, and environmental quality should be examined as interconnected dimensions rather than isolated policy areas.

A comparative analysis across districts and municipalities in Central Sulawesi is necessary because regional development conditions are not spatially uniform. Each local government has different agricultural resources, commodity structures, infrastructure capacity, fiscal capability, institutional performance, and environmental pressure. Some areas may be more dependent on plantation crops, while others may be shaped by food crops, fisheries, forestry, urban expansion, or extractive economic activities. Such differences can generate unequal patterns of agricultural economic performance, fraud-prevention capacity, and environmental quality. Studies on cocoa land dynamics in Indonesia show that plantation development varies across regions and may produce different sustainability challenges depending on land-use history, local resources, and development trajectories (Sahlan *et al.*, 2025). Sustainable agribusiness transformation also requires practices that are sensitive to differences in local institutions, market structures, production systems, and environmental conditions (Doda *et al.*, 2025). Sustainability standards in Indonesian agri-food export sectors further show that governance frameworks may differ across commodities and institutional contexts,

suggesting the importance of region-specific policy analysis (Rifai *et al.*, 2026).

Despite the growing literature on sustainable agriculture, agribusiness governance, corruption prevention, and environmental quality, there remains a research gap in integrating these three dimensions at the district and municipal levels. Existing studies on sustainable agriculture have commonly focused on production systems, extension services, circular bioeconomy, climate adaptation, digital learning, crop–livestock integration, and agribusiness transformation. Other studies have examined governance, corruption, and environmental sustainability mainly at national, cross-country, or macro-regional levels. Meanwhile, studies on food-system governance and agricultural policy accountability have highlighted the importance of institutional coordination, transparency, monitoring, and inclusive decision-making, but have not specifically combined agricultural economic performance, fraud-prevention governance, and environmental quality in a comparative district-level framework. This gap is important because district and municipal governments are key actors in implementing agricultural programs, managing public resources, coordinating local development planning, and protecting environmental quality.

Based on this background, this study aims to analyze the relationship between agricultural economic performance, fraud-prevention governance, and environmental quality across districts and municipalities in Central Sulawesi Province. Specifically, the study seeks to describe regional variation in agricultural economic performance, compare available fraud-prevention governance indicators, assess environmental quality using official indicators, and examine the association among these dimensions when complete and comparable data are available. By

adopting a cautious verified-data approach, this study avoids unsupported claims regarding data availability and ensures that statistical analysis is conducted only on indicators that can be traced to official sources. The findings are expected to contribute to evidence-based regional agricultural planning, sustainable agribusiness development, stronger public-sector governance, and better integration between agricultural economic policy and environmental protection in Central Sulawesi.

## MATERIALS AND METHODS

### Study Area and Research Period

This study was conducted in Central Sulawesi Province, Indonesia. The research units consisted of all regencies and municipalities within the province. Central Sulawesi was selected because it has diverse agricultural resources, including food crops, plantation crops, fisheries, forestry-related resources, and rural production systems. Such diversity provides an appropriate context for examining the relationship between agricultural economic performance, fraud-prevention governance, and environmental quality at the subnational level.

The research period was determined based on the availability of official and verifiable secondary data. Agricultural economic data were obtained from the publication of gross regional domestic product of regencies/municipalities in Central Sulawesi by industrial origin. BPS Central Sulawesi provides the publication *Produk Domestik Regional Bruto Kabupaten/Kota di Provinsi Sulawesi Tengah Menurut Lapangan Usaha 2021–2025*, which includes regional economic data by sector and local government unit ([sulteng.bps.go.id](http://sulteng.bps.go.id), 2026). The BPS publication page confirms that this dataset is available at the regency/municipality level and was released by BPS Central Sulawesi.

For fraud-prevention governance and environmental quality, the study used the most recent official data available at the regency/municipality level. If complete district- and municipality-level data were not available, the relevant indicators were used only for contextual discussion and were not included in correlation or composite-index analysis. This approach was adopted to avoid unsupported statistical claims.

### Research Design

This study employed a quantitative descriptive design with a comparative regional approach. The descriptive design was used to explain the distribution, variation, and relative position of each regency and municipality based on the selected indicators. The comparative approach was used to identify differences among local governments in agricultural economic performance, fraud-prevention governance, and environmental quality.

The study did not aim to establish causal relationships. Instead, it examined regional patterns and statistical associations among variables when complete and comparable data were available. Therefore, the findings were interpreted as descriptive and correlational evidence rather than causal inference.

### Type of Data and Data Sources

This study used secondary data obtained from official government sources. The main data sources included BPS Central Sulawesi, the Corruption Eradication Commission, the Ministry of Environment and Forestry, BPS environmental statistics metadata, and official environmental agencies or government data portals.

Agricultural economic performance was measured using the gross regional domestic product of the agriculture, forestry, and fisheries sector at the regency/municipality level. This indicator was selected because it represents the

economic contribution of agriculture-related sectors to local development and is available from official BPS publications (sulteng.bps.go.id, 2026).

Fraud-prevention governance was measured using the Monitoring Center for Prevention or equivalent official corruption-prevention indicator issued by the Corruption Eradication Commission. MCP 2025 focuses on eight prevention areas, namely planning, budgeting, procurement of goods and services, public services, internal supervision, civil-service management, regional asset management, and local tax optimization (kpk.go.id, 2025). KPK's official explanation confirms that these eight intervention areas remain central to the 2025 prevention framework.

Environmental quality was measured using the Environmental Quality Index or its official components when available at the regency/municipality level. The Environmental Quality Index reflects the quality of the environment within a territory and is constructed from environmental components such as water quality, air quality, land quality, and seawater quality, depending on the official calculation framework used (BPS, 2026). BPS metadata explains that the provincial IKLH formula includes weighted components of water quality, air quality, land quality, and seawater quality.

### Unit of Analysis

The unit of analysis was the regency or municipality in Central Sulawesi Province. Each regency or municipality was treated as one observation. The use of local governments as units of analysis is appropriate because agricultural development planning, budget allocation, procurement, public-service delivery, natural-resource governance, and environmental management are strongly influenced by district and municipal government performance.

If a variable was available only at the provincial level, it was not assigned

uniformly to all districts or municipalities. Such data were used only as contextual information because using provincial values as district-level observations would reduce analytical validity.

### Operational Definition of Variables

This study consisted of three main variables: agricultural economic performance, fraud-prevention governance, and environmental quality. The operational definitions are presented in Table 1.

**Table 1.** Operational definition of research variables

Variable	Indicator	Unit/Scale	Data Source	Interpretation
Agricultural economic performance	GRDP of agriculture, forestry, and fisheries by regency/municipality	Million or billion rupiah, depending on BPS publication	BPS Central Sulawesi; BPS regency/municipality publications	Higher values indicate a larger agricultural economic contribution in the regional economy.
Agricultural economic performance	Share of agriculture, forestry, and fisheries in total GRDP	Percentage	BPS Central Sulawesi; BPS regency/municipality publications	Higher values indicate stronger dependence of the regional economy on agriculture-related sectors.
Agricultural economic performance	Production of major commodities, when available	Tonnes, hectares, or other official units	BPS; agricultural statistics; local government publications	Higher values indicate stronger commodity production capacity, depending on the commodity.
Fraud-prevention governance	MCP/MCSP score or equivalent official prevention indicator	Index or score	Corruption Eradication Commission; official local-government documents	Higher values indicate stronger local-government performance in preventing corruption or fraud risks.
Environmental quality	Environmental Quality Index	Index	Ministry of Environment and Forestry; BPS metadata; environmental agency; official regional data portal	Higher values indicate better environmental quality.
Environmental quality	Water Quality Index	Index	Ministry of Environment and Forestry; environmental agency; official regional data portal	Higher values indicate better water quality.
Environmental quality	Air Quality Index	Index	Ministry of Environment and Forestry; environmental agency; official regional data portal	Higher values indicate better air quality.
Environmental quality	Land Quality or Land Cover Index	Index	Ministry of Environment and Forestry; environmental agency; official regional data portal	Higher values indicate better land or land-cover quality.

### Data Collection Technique

Data were collected using documentation techniques. The process involved identifying official publications, downloading relevant datasets, extracting district- and municipality-level indicators, and organizing them into a structured database.

The data collection process consisted of five stages. First, the required indicators were identified based on the research objectives. Second, official data sources

were reviewed to determine whether each indicator was available at the district and municipal level. Third, the data were extracted and tabulated according to local government unit, year, indicator, measurement unit, and source. Fourth, the dataset was checked for consistency in regional names, administrative coverage, observation year, and measurement units. Fifth, only data that could be traced to official sources were retained for statistical analysis.

No estimated or artificial values were inserted to replace missing data. If an indicator was incomplete, unavailable, or not verifiable at the regency/municipality level, it was excluded from correlation and composite-index analysis. However, the indicator could still be discussed qualitatively or contextually when supported by official aggregate data.

**Data Verification Procedure**

To ensure data reliability, this study applied a verified-data procedure. Each indicator had to meet four criteria before being included in the quantitative analysis.

First, the data had to come from an official institution, such as BPS, KPK,

KLHK, a provincial environmental agency, or a district/municipal government agency. Second, the data had to have clear territorial coverage at the regency/municipality level. Third, the data had to include a clear observation year. Fourth, the data had to have a clear unit of measurement or index scale.

Indicators that did not meet these criteria were not used in statistical comparison. This procedure was important because the study combined economic, governance, and environmental variables from different institutions. Without verification, the use of inconsistent or unofficial data could lead to misleading conclusions.

**Table 2.** Reported ammonia-control measures implemented at CH Kembar Farm

Management component	Reported practice in the manuscript	Intended role in ammonia control
Backup power supply	A generator set was prepared to maintain closed-house operation during power outages.	Prevents interruption of ventilation and climate-control functions that are needed to remove heat, moisture, and harmful gases
Warning system	The house was equipped with a siren/alarm that sounded during an electrical failure; one such event reportedly occurred during the study period.	Enables rapid operator response so that generator power can be activated immediately
Maintenance of climate-control equipment	Cooling pads, exhaust fans, blower fans, and generator units were checked and cleaned after each production cycle.	Supports stable airflow and environmental control, thereby reducing conditions that favor ammonia accumulation
Litter material	Rice husk litter was used on the floor	Provides an absorbent bedding base for manure and moisture management
EM-4 spraying	EM-4 Livestock was sprayed on the litter from approximately 2 weeks of age until harvest, 3 times per week, in the morning	Intended to support litter decomposition and odor reduction
Litter stirring	Litter was stirred or loosened 3 times per week, on the same days as EM-4 application, in the afternoon.	Intended to reduce caking, maintain litter friability, and limit moisture accumulation

Table 2 indicates that the farm relied on a layered control approach: infrastructure reliability, rapid emergency response, ventilation and equipment maintenance, and active litter management. This approach is consistent with recent literature showing that ammonia emissions in broiler houses are strongly influenced by litter condition, ventilation efficiency, temperature, humidity, and manure-handling practices. Experimental evidence also shows that

improved air movement can reduce ammonia release by improving litter condition, while environmental monitoring systems can support faster correction when house conditions begin to deteriorate (Bist *et al.*, 2023; Godinho *et al.*, 2025).

The litter-management component deserves particular attention because it was the most direct intervention aimed at the manure-litter interface, where ammonia is generated. The manuscript states that EM-4

spraying and litter stirring were started at approximately 2 weeks of age and continued three times weekly until harvest. The authors also observed that this practice helped maintain drier, less compact litter and improved ease of litter handling. This field observation is directionally consistent with a recent Indonesian study reporting reduced ammonia concentration in semi-closed broiler housing after EM4 spraying. However, the present manuscript did not include a controlled before-versus-after comparison (Azzahra et al., 2024).

**Measured ammonia concentration inside the closed house**

The manuscript reports NH3 measurements at eight points distributed across five longitudinal zones of the house. All recorded values were 10 ppm. The reported observations are reorganized in Table 3 for clarity.

To improve readability, the measurement results are reorganized below without changing the reported values.

**Table 2.** Data verification matrix.

Variable	Minimum Requirement for Quantitative Analysis	If Requirement Is Not Met
Agricultural economic performance	Complete GRDP data by regency/municipality and year	Use only descriptive provincial or sectoral context.
Fraud-prevention governance	Complete MCP/MCSP or equivalent official score by regency/municipality	Use only aggregate governance discussion; exclude from correlation and composite index.
Environmental quality	Complete IKLH or component index by regency/municipality	Use only provincial environmental context; exclude from district-level correlation and composite index.
Commodity production	Complete commodity data by regency/municipality and year	Use as supporting descriptive analysis only.

**Data Analysis Technique**

The analysis consisted of descriptive statistics, regional comparison, normalization, classification, correlation analysis, and optional composite-index construction.

Descriptive statistics were used to summarize the minimum, maximum, mean, median, and standard deviation of each variable. These statistics were used to describe the general distribution of agricultural economic performance, fraud-prevention governance, and environmental quality across regencies and municipalities.

Regional comparison was conducted by ranking districts and municipalities according to each indicator. This comparison was used to identify regions with relatively high, medium, and low performance. Ranking was not interpreted as an absolute measure of success or failure,

but as a relative position based on available official data.

**Min–Max Normalization**

Because the variables used different units of measurement, min–max normalization was applied before classification and composite-index construction. This procedure transformed each indicator into a comparable score ranging from 0 to 1.

For indicators where higher values indicate better performance, the formula was:

$$X'_{ij} = \frac{X_{ij} - X_{j(min)}}{X_{j(max)} - X_{j(min)}}$$

where  $X'_{ij}$  is the normalized score of region  $i$  for indicator  $j$ ,  $X_{ij}$  is the original value,  $X_{j(min)}$  is the minimum value of indicator  $j$ , and  $X_{j(max)}$  is the maximum value of indicator  $j$ .

For indicators where lower values indicate better performance, the reverse formula was used:

$$X'_{ij} = \frac{X_{j(max)} - X_{ij}}{X_{j(max)} - X_{j(min)}}$$

In this study, agricultural GRDP, agriculture share, fraud-prevention score, and environmental quality index were treated as benefit indicators because higher values generally indicate better performance. If future analysis includes pollution, degradation, poverty, or risk indicators, reverse normalization should be applied.

### Correlation Analysis

Correlation analysis was used to examine the association among agricultural economic performance, fraud-prevention governance, and environmental quality when complete district- and municipality-level data were available.

Pearson correlation was used when the variables were approximately normally distributed and the relationship between variables was linear. The Pearson correlation coefficient is expressed as:

$$r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2 \sum(Y_i - \bar{Y})^2}}$$

where  $r$  is the Pearson correlation coefficient,  $X_i$  and  $Y_i$  are observed values of two variables, and  $\bar{X}$  and  $\bar{Y}$  are the respective means.

Spearman rank correlation was used when the data were not normally distributed, contained outliers, or showed a monotonic but non-linear relationship. The Spearman coefficient is expressed as:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)}$$

where  $\rho$  is the Spearman rank correlation coefficient,  $d_i$  is the difference between ranks of the two variables for

observation  $i$ , and  $n$  is the number of observations.

The interpretation of correlation results was conducted cautiously. A positive correlation indicates that two variables tend to increase together, while a negative correlation indicates that one variable tends to decrease when the other increases. However, because this study used a descriptive and correlational design, correlation coefficients were not interpreted as causal effects.

### Composite Index Construction

If complete and comparable data were available for all three dimensions, a simple composite index was constructed to describe the integrated position of each regency or municipality. The composite index combined normalized scores of agricultural economic performance, fraud-prevention governance, and environmental quality.

The formula was:

$$CI_i = \frac{AE_i + FG_i + EQ_i}{3}$$

where  $CI_i$  is the composite index of region  $i$ ,  $AE_i$  is the normalized agricultural economic performance score,  $FG_i$  is the normalized fraud-prevention governance score, and  $EQ_i$  is the normalized environmental quality score.

Equal weighting was used because the three dimensions were treated as equally important in the framework of sustainable agribusiness. However, if one of the three dimensions was not available at the district/municipality level, the composite index was not calculated. This rule was applied to avoid producing an index based on incomplete or incomparable data.

### Regional Classification

Districts and municipalities were classified into high, medium, and low categories based on normalized scores or composite-index values. The classification criteria are presented in Table 3.

**Table 3.** Regional classification criteria

Normalized Score or Composite Index	Category	Interpretation
0.667–1.000	High	The region shows relatively strong performance in the observed dimension.
0.334–0.666	Medium	The region shows moderate performance and may require targeted improvement.
0.000–0.333	Low	The region shows relatively weak performance and may require policy priority.

This classification was used to simplify interpretation and identify policy priorities. However, the categories were relative to the distribution of the available dataset and should not be interpreted as absolute development standards.

### **Analytical Scenarios Based on Data Availability**

Because the study used official secondary data from different institutions, the final analytical model depended on data completeness. Three analytical scenarios were prepared.

#### **Scenario 1: Complete data available for all variables.**

If agricultural economic performance, fraud-prevention governance, and environmental quality were all available at the regency/municipality level, the study conducted descriptive statistics, normalization, ranking, correlation analysis, and composite-index construction.

#### **Scenario 2: Fraud-prevention governance data incomplete.**

If MCP/MCSP scores were not available for all regencies and municipalities, the governance dimension was discussed descriptively using available official aggregate information. Correlation and composite-index analysis were conducted only for variables with complete local-level data.

#### **Scenario 3: Environmental quality data incomplete.**

If IKLH or its components were available only at the provincial level, environmental quality was discussed as a

contextual variable. It was not inserted into district-level statistical analysis because doing so would create artificial uniformity across local governments.

This scenario-based strategy ensures that the study remains methodologically valid while still addressing the conceptual relationship among agricultural economic performance, fraud-prevention governance, and environmental quality.

## **RESULTS AND DISCUSSION**

### **Verified Data Availability**

The analysis in this section is based on a verified-data approach. Complete district- and municipality-level data were available for agricultural economic performance, particularly the gross regional domestic product (GRDP) of the agriculture, forestry, and fisheries sector in Central Sulawesi Province. The agricultural economic data were obtained from the official BPS Central Sulawesi publication on GRDP by industrial origin for regencies and municipalities (sulteng.bps.go.id, 2026).

In contrast, complete and verified district- and municipality-level data for fraud-prevention governance and environmental quality were not available from official open sources at the time of analysis. For fraud-prevention governance, available information from the Corruption Eradication Commission provides aggregate information on prevention monitoring and integrity assessment, but not a complete open table of MCP/MCSP scores for each district and municipality in Central Sulawesi (kpk.go.id, 2025). Similarly, environmental quality data from

official sources were available mainly at the provincial level, while complete district-level Environmental Quality Index data were not verified from official open sources (BPS, 2026). Therefore, quantitative analysis was conducted only for agricultural economic performance, while fraud-prevention governance and environmental quality were discussed contextually.

This decision was made to maintain methodological validity. Assigning aggregate provincial values to individual districts and municipalities would create artificial uniformity and could lead to misleading statistical interpretation. As a result, correlation analysis and composite-index construction involving MCP/MCSP and IKLH were not conducted in this study.

### Descriptive Statistics of Agricultural Economic Performance

Agricultural economic performance across regencies and municipalities in Central Sulawesi showed substantial

variation in 2024. Agricultural GRDP ranged from IDR 1,241.27 billion in Kota Palu to IDR 9,969.49 billion in Parigi Moutong. The mean agricultural GRDP was IDR 4,565.74 billion, while the median was IDR 4,353.56 billion. The standard deviation reached IDR 2,585.52 billion, indicating that agricultural economic capacity was unevenly distributed across the province.

The share of agriculture, forestry, and fisheries in total GRDP also varied considerably. The lowest agricultural share was recorded in Morowali, at 1.55%, while the highest was recorded in Banggai Laut, at 55.84%. The mean agricultural share was 33.27%, with a median of 39.18%. This difference shows that agricultural importance depends on the indicator used. Agricultural GRDP reflects the absolute size of the agricultural economy, whereas agricultural share reflects the degree of regional dependence on agriculture.

**Table 2.** Descriptive statistics of agricultural economic indicators, 2024

Indicator	Minimum	Maximum	Mean	Median	Standard Deviation
Agricultural GRDP, IDR billion	1,241.27	9,969.49	4,565.74	4,353.56	2,585.52
Total GRDP, IDR billion	3,223.42	173,858.99	31,774.39	12,738.41	45,019.96
Agriculture shares in total GRDP, %	1.55	55.84	33.27	39.18	16.97

Source: Processed from BPS Central Sulawesi GRDP data (sulteng.bps.go.id, 2026)

The descriptive findings indicate that Central Sulawesi cannot be treated as a homogeneous agricultural region. Some regions have large agricultural economies in absolute terms, while others have smaller agricultural output but stronger dependence on agriculture. This distinction is important for sustainable agribusiness policy because regions with large agricultural GRDP may require value-chain strengthening and downstream processing, while regions with high agricultural dependence may require productivity support, rural infrastructure, and farmer welfare programs.

### Agricultural GRDP Across Regencies and Municipalities

Based on agricultural GRDP at current prices in 2024, Parigi Moutong recorded the highest agricultural economic performance, with IDR 9,969.49 billion, followed by Banggai with IDR 8,849.04 billion. These two regions were classified as high-performing regions based on min-max normalization. Their large agricultural GRDP values indicate that agriculture, forestry, and fisheries play a major role in generating regional economic value.

The medium-performing group consisted of Donggala, Sigi, Morowali Utara, Poso, and Tolitoli. Their agricultural GRDP values ranged from IDR 4,353.56 billion to IDR 5,960.12 billion. These

regions have relatively important agricultural economies, although their absolute values remain below Parigi Moutong and Banggai.

The low-performing group consisted of Buol, Tojo Una-Una, Morowali, Banggai Kepulauan, Banggai Laut, and Kota Palu.

However, the “low” category should be interpreted carefully. It does not necessarily mean that agriculture is unimportant in these regions. Instead, it means that their agricultural GRDP values are relatively lower compared with other regions in Central Sulawesi.

**Table 3.** Ranking of agricultural economic performance based on agricultural GRDP, 2024

Rank	Regency/Municipality	Agricultural GRDP, IDR billion	Total GRDP, IDR billion	Agriculture Share, %	Normalized Score	Category
1	Parigi Moutong	9,969.49	23,475.94	42.47	1	High
2	Banggai	8,849.04	40,737.03	21.72	0.872	High
3	Donggala	5,960.12	16,527.22	36.06	0.541	Medium
4	Sigi	5,171.94	12,562.35	41.17	0.45	Medium
5	Morowali Utara	5,169.81	30,233.51	17.1	0.45	Medium
6	Poso	4,957.70	12,738.41	38.92	0.426	Medium
7	Tolitoli	4,353.56	11,074.94	39.31	0.357	Medium
8	Buol	3,769.68	7,791.00	48.39	0.29	Low
9	Tojo Una-Una	2,881.41	7,354.21	39.18	0.188	Low
10	Morowali	2,702.86	173,858.99	1.55	0.167	Low
11	Banggai Kepulauan	2,527.87	5,377.32	47.01	0.147	Low
12	Banggai Laut	1,799.81	3,223.42	55.84	0.064	Low
13	Kota Palu	1,241.27	32,918.74	3.77	0	Low

Source: Processed from BPS Central Sulawesi GRDP data (sulteng.bps.go.id, 2026)

The ranking shows that Parigi Moutong and Banggai are the main agricultural economic centers in Central Sulawesi based on absolute agricultural GRDP. These regions may have stronger potential for agro-processing, commodity-based industrial development, logistics improvement, and agricultural value-chain strengthening. In the context of sustainable agribusiness, however, large agricultural GRDP should not be interpreted only as production success. It also implies a greater need for sustainable land management, institutional support, environmental safeguards, and transparent governance in agricultural development programs.

#### Agricultural Share in Total GRDP

A different pattern emerges when agricultural performance is viewed from the share of agriculture, forestry, and fisheries in total GRDP. Banggai Laut had the highest agricultural share, with agriculture contributing 55.84% of its total GRDP. This indicates that more than half of Banggai

Laut’s regional economic output was associated with agriculture, forestry, and fisheries. Buol also showed a high agricultural share of 48.39%, followed by Banggai Kepulauan with 47.01% and Parigi Moutong with 42.47%.

These results show that some districts with relatively small agricultural GRDP in absolute terms are highly dependent on agriculture. For example, Banggai Laut was classified as low based on absolute agricultural GRDP, but it had the highest agricultural share in the province. This means that agriculture, forestry, and fisheries remain central to its regional economy and local livelihoods.

By contrast, Morowali recorded the largest total GRDP, at IDR 173,858.99 billion, but its agricultural share was only 1.55%. This indicates that Morowali’s economy is dominated by non-agricultural sectors. Kota Palu also had a low agricultural share of 3.77%, reflecting its urban economic structure. These findings show that a low agricultural share does not

necessarily mean that agriculture has no social or food-system relevance, but it does

indicate that agriculture is not the dominant contributor to regional output

**Table 4.** Highest and lowest agricultural shares in total GRDP, 2024

Group	Regency/Municipality	Agriculture Share, %	Agricultural GRDP, IDR billion	Interpretation
Highest share	Banggai Laut	55.84	1,799.81	Strong dependence on agriculture despite small absolute scale.
Highest share	Buol	48.39	3,769.68	Agriculture remains a dominant sector in the regional economy.
Highest share	Banggai Kepulauan	47.01	2,527.87	High dependence on agriculture, forestry, and fisheries.
Highest share	Parigi Moutong	42.47	9,969.49	Large agricultural economy and high agricultural dependence.
Lowest share	Morowali	1.55	2,702.86	Regional economy dominated by non-agricultural sectors.
Lowest share	Kota Palu	3.77	1,241.27	Urban economic structure with limited agricultural contribution.
Lowest share	Morowali Utara	17.1	5,169.81	Agriculture remains relevant but not dominant.
Lowest share	Banggai	21.72	8,849.04	Large agricultural GRDP within a more diversified economy.

Source: Processed from BPS Central Sulawesi GRDP data (sulteng.bps.go.id, 2026)

The distinction between agricultural GRDP and agricultural share has important policy implications. Regions with high agricultural GRDP, such as Parigi Moutong and Banggai, may be prioritized for agro-industrial development and value-chain upgrading. Meanwhile, regions with high agricultural shares, such as Banggai Laut, Buol, and Banggai Kepulauan, require policies that protect agricultural livelihoods, improve productivity, strengthen rural infrastructure, and reduce vulnerability to market and environmental shocks.

### Regional Classification Based on Normalized Agricultural GRDP

The min-max normalization results classify the regencies and municipalities into three categories: high, medium, and low. The high category includes regions with normalized scores between 0.667 and 1.000. The medium category includes regions with scores between 0.334 and 0.666. The low category includes regions with scores between 0.000 and 0.333.

Based on this classification, Parigi Moutong and Banggai were categorized as

high-performing regions. Donggala, Sigi, Morowali Utara, Poso, and Tolitoli were categorized as medium-performing regions. Buol, Tojo Una-Una, Morowali, Banggai Kepulauan, Banggai Laut, and Kota Palu were categorized as low-performing regions.

This classification is relative to the distribution of agricultural GRDP values across Central Sulawesi. It should not be interpreted as an absolute judgment of agricultural success or failure. A region categorized as low based on agricultural GRDP may still have high agricultural dependence, as shown by Banggai Laut, Buol, and Banggai Kepulauan. Therefore, classification based on absolute agricultural GRDP should be interpreted together with agriculture share in total GRDP.

The classification supports the need for differentiated agricultural development policy. A uniform approach would not capture the different economic realities of each region. Parigi Moutong and Banggai require strategies that strengthen agricultural competitiveness and downstream processing. Banggai Laut,

Buol, and Banggai Kepulauan require strategies that protect agricultural livelihoods and improve productivity because their economies remain highly dependent on agriculture. Morowali and

Kota Palu require a different approach, focusing on local food systems, land protection, and the role of agriculture within diversified or urban economies.

Table 5. Regional classification based on normalized agricultural GRDP, 2024

Category	Normalized Score Range	Regency/Municipality	Policy Interpretation
High	0.667–1.000	Parigi Moutong; Banggai	Strong agricultural economic base; priority for value-chain upgrading, agro-processing, and sustainable land-use management.
Medium	0.334–0.666	Donggala; Sigi; Morowali Utara; Poso; Tolitoli	Moderate agricultural economic base; priority for productivity improvement, market access, and institutional strengthening.
Low	0.000–0.333	Buol; Tojo Una-Una; Morowali; Banggai Kepulauan; Banggai Laut; Kota Palu	Lower absolute agricultural GRDP; policy should consider agricultural share, livelihood dependence, and local economic structure.

Source: Processed from BPS Central Sulawesi GRDP data (sulteng.bps.go.id, 2026)

### Contextual Discussion of Fraud-Prevention Governance

Fraud-prevention governance remains an important dimension of sustainable agricultural development, although it could not be included in the quantitative district-level analysis. Available official information from KPK indicates that the average MCSP achievement of 13 local governments in Central Sulawesi was 64.37%, while the 2024 Integrity Assessment Survey score was 66.36 (kpk.go.id, 2025). KPK also highlighted several governance concerns, including budgeting transparency, procurement risks, weak internal supervision, and regional asset management.

These governance issues are relevant to agricultural development because public agricultural programs depend on credible planning, transparent budgeting, accountable procurement, and effective supervision. Agricultural infrastructure, irrigation facilities, input assistance, farmer-support programs, and extension services may become less effective if governance risks are not properly managed. Therefore, fraud-prevention governance

should be treated as an institutional foundation for sustainable agribusiness development.

In the context of Central Sulawesi, the absence of complete district-level MCP/MCSP data limits the ability to statistically test the relationship between governance and agricultural performance. However, the available aggregate information still provides a useful policy signal. Strengthening fraud-prevention mechanisms may improve the credibility, efficiency, and accountability of agricultural development programs, especially in regions where agriculture remains a dominant source of livelihood.

### Contextual Discussion of Environmental Quality

Environmental quality is also essential for sustainable agricultural development, but complete district- and municipality-level IKLH data were not verified from official open sources. The available official environmental-quality information is mainly presented at the provincial level (BPS, 2026). As a result, environmental quality could not be

compared quantitatively across districts and municipalities in this study.

This limitation is important because environmental pressures are likely to differ across regions. Agricultural, plantation, fisheries, urban, industrial, forestry, and extractive activities may generate different environmental risks. Regions with large agricultural GRDP may face pressure related to land use, water demand, and production intensification. Regions with high agricultural dependence may be more vulnerable to environmental degradation because local livelihoods depend strongly on land, water, and ecosystem stability.

Although IKLH could not be included in district-level statistical analysis, environmental quality remains central to the interpretation of agricultural sustainability. Agriculture depends on the quality of land, water, air, biodiversity, and ecosystem functions. Declining environmental quality may reduce agricultural productivity, increase production costs, weaken food-system resilience, and threaten rural livelihoods. Therefore, future monitoring should prioritize consistent district-level environmental indicators, especially water quality, air quality, land-cover quality, and other components relevant to agricultural sustainability.

### **Implications for Sustainable Agribusiness Policy**

The results show that sustainable agribusiness policy in Central Sulawesi should be regionally differentiated. Regions with large agricultural economies, such as Parigi Moutong and Banggai, should be supported through value-chain strengthening, agro-processing development, logistics improvement, commodity-based industrialization, and sustainable land-use governance. These regions have the potential to generate greater regional value added if agricultural output can be connected to processing, distribution, and market systems.

Regions with high agricultural dependence but smaller economic scale, such as Banggai Laut, Buol, and Banggai Kepulauan, require a different policy emphasis. In these regions, agriculture is not only an economic sector but also a livelihood foundation. Policy should therefore focus on productivity improvement, farmer welfare, rural infrastructure, market connectivity, risk management, and environmental resilience.

For regions with low agricultural shares but large or diversified economies, such as Morowali and Kota Palu, agricultural policy should not be neglected. Agriculture may still be important for food supply, peri-urban livelihoods, local ecological balance, and land-use sustainability. In these regions, agricultural development should focus on protecting productive agricultural land, strengthening local food systems, and preventing excessive marginalization of agriculture in regional planning.

Governance improvement is also necessary across all regional categories. The KPK findings suggest that fraud-prevention governance remains relevant in Central Sulawesi, especially in relation to planning, budgeting, procurement, supervision, and asset management (kpk.go.id, 2025). Stronger governance can improve the effectiveness of agricultural programs and reduce the risk of resource misallocation. Similarly, better district-level environmental data are needed to ensure that agricultural economic development does not compromise ecological sustainability.

Overall, the findings indicate that agricultural economic performance, governance quality, and environmental protection should be integrated in regional agricultural planning. Although only agricultural economic data were available for full district-level quantitative analysis, the contextual evidence on governance and environmental quality shows that

sustainable agribusiness development requires more than output growth. It requires accountable institutions, reliable environmental monitoring, and policies adapted to the specific characteristics of each district and municipality.

### CONCLUSION

Agricultural economic performance across regencies and municipalities in Central Sulawesi Province shows substantial spatial variation. In 2024, agricultural GRDP ranged from IDR 1,241.27 billion in Kota Palu to IDR 9,969.49 billion in Parigi Moutong, with a mean of IDR 4,565.74 billion and a standard deviation of IDR 2,585.52 billion. Based on normalized agricultural GRDP scores, Parigi Moutong and Banggai were classified as high-performing regions, while Donggala, Sigi, Morowali Utara, Poso, and Tolitoli were classified as medium-performing regions. Other regencies and municipalities were placed in the low category, indicating that agricultural economic capacity is unevenly distributed across the province.

The findings also demonstrate that agricultural importance differs when measured by absolute agricultural GRDP and by the share of agriculture in total GRDP. Parigi Moutong recorded the highest agricultural GRDP, whereas Banggai Laut had the highest agricultural share, with agriculture, forestry, and fisheries contributing 55.84% of its total GRDP. In contrast, Morowali recorded the largest total GRDP at IDR 173,858.99 billion, but its agricultural share was only 1.55%, indicating that its economy is dominated by non-agricultural sectors. These patterns imply that sustainable agribusiness policy in Central Sulawesi should be regionally differentiated. Areas with large agricultural economies require value-chain strengthening, agro-processing, and sustainable land-use management, while areas with high agricultural

dependence but smaller economic scale require productivity improvement, farmer welfare support, rural infrastructure, and market connectivity.

A key limitation of the analysis is the incomplete availability of verified district- and municipality-level data for fraud-prevention governance and environmental quality. As a result, MCP/MCSP and IKLH indicators were discussed contextually and were not included in correlation or composite-index analysis. Future research should update the analysis when complete local-level MCP/MCSP and IKLH data become available, allowing Pearson or Spearman correlation, composite-index construction, panel-data analysis, or spatial analysis. Such work would provide stronger evidence on how agricultural economic performance, fraud-prevention governance, and environmental quality interact in supporting sustainable agribusiness development in Central Sulawesi.

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