



The Role of Livestock Commodities in Boosting Per Capita Income in the Tomini Bay Region: Implications for Feed Security and Area Development Strategies

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Abstract | Feed security is the ability of a system or region to ensure the availability, accessibility, and sustainability of sufficient feed for livestock or poultry to meet their feed nutritional needs and productivity in the long term. This research aims to analyze the advantages of livestock sub-sector commodities in the districts/cities of the Tomini Bay area, the impact of these commodity advantages on the per capita income of the community, and to design strategies for developing feed security in the region using SWOT analysis. This research is a quantitative study. The data sources in this research are secondary data from the Central Statistics Agency (BPS) and the Ministry of Agriculture, as well as primary data obtained through observations, interviews, and questionnaires. The secondary data sample consists of 85 data points, namely 17 districts/cities and data from 5 years, while the primary data includes 85 individuals consisting of farmers and related stakeholders. The data analysis techniques used are Localization Index (LI) analysis, Specialization Index (SI), Location Quotient (LQ), Multiple Regression of Panel Data, and SWOT Analysis. The results of this study indicate that (1) livestock tends to be widespread and none are considered special, while the analysis shows that beef cattle serve as the basis in an average of 11 districts/cities, horses in an average of 4 districts/cities, goats in an average of 10 districts/cities, and pigs in an average of 7 districts/cities. For poultry, only local chickens fall into the special and widespread category, while the others are not special and widespread, with local chickens excelling in 13 districts/cities, layer chickens excelling in 7 districts/cities, broiler chickens excelling in 5 districts/cities, and ducks excelling in 6 districts/cities (2) Beef cattle, local chickens, broiler chickens, and ducks have a positive and significant impact on per capita income in the districts/cities of the Tomini Bay area, or can increase per capita income, while goats, pigs, and layer chickens have a positive but insignificant impact on per capita income, or are in the sufficient category, whereas horses have a negative and insignificant impact, meaning that horses tend to reduce income due to high maintenance costs (3) The strategy for developing feed security areas in the districts/cities of the Tomini Bay region is positioned in quadrant 3, which is the Turn Around strategy. This is implemented through strategic initiatives, including optimizing natural resources and agricultural waste for feed, improving human resource capabilities through training in modern feed production technology and management, reinforcing government support in infrastructure, governance, and agribusiness development for farming and livestock enterprises, and fostering collaboration among districts and cities in the Tomini Bay region to strengthen feed security.

Keywords | Feed, Income, Livestock, Security, Strategy

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The livestock development program outlined in various activities is the government's facilitates community empowerment and participation, as well as developing regions, community groups, and the economy (Adams *et al.*, 2021; Famona and Gunawan, 2022). The increasing community income is a key goal for any nation. However, to achieve a higher income level, appropriate strategies are needed, especially in the context of strengthening the livestock sector. One of the advantages of livestock commodities in increasing per capita income for the community is due to the large market potential. The livestock sector involves various types of jobs, ranging from farmers, livestock caretakers and slaughterhouse workers, to sales and marketing staff for livestock products.

The livestock sector has a significant positive impact on people's income, both through increasing livestock business results and creating jobs in various supply chains. However, in order for these benefits to remain sustainable, a stable and efficient livestock system is needed. This sustainability is depending heavily on sufficient, high-quality, and affordable feed. Without adequate feed, livestock productivity can decrease, which ultimately has an impact on the welfare of farmers and overall food security. A key challenge in the livestock sector is ensuring a sustainable feed supply. Factors such as climate change, fluctuations in raw material prices, and limited natural resources are often obstacles in maintaining a stable feed supply. Therefore, innovations are needed in feed management, such as the use of agricultural waste as alternative feed, the development of feed production technology, and improving distribution systems so that feed can be easily accessed by farmers. With through cooperative efforts, feed security can be achieved, so that the livestock sector continues to provide sustainable economic benefits for the farming community (Subekti, 2009).

This can hinder the growth and production of livestock, as well as increase production costs for farmers. Therefore, the development of regional feed security strategies becomes very important in supporting the growth and sustainability of the livestock sector in the Tomini Bay area. This strategy must encompass various approaches, ranging from the development of local feed agriculture to the application of appropriate technology in natural resource management. One of the strategies for developing food resilience areas that can be implemented is the diversification of feed sources (Mukhtar, 2021).

The development of livestock farming, especially the advancement of animal husbandry, needs to be carried out through a sustainable, modern, and professional business approach by utilizing technological innovations to enhance

operational efficiency. In addition, the development of livestock farming should be supported by the feed industry by optimizing the use of location-specific feed materials through an integrated pattern (Rusdiana and Prahara-ni, 2018; Bayu, 2022). The Department of Animal Husbandry plays a role as an insulator and regulator in the development of livestock farming in its region, due to its contribution to the development of sectoral policies. The development of this livestock farming can progress very rapidly if it is carried out collaboratively among business actors (private sector), financing institutions, farmers, and the government. Furthermore, the government also plays a crucial role as a link between farmers and livestock business actors with banks or financing institutions. Bank Indonesia and banking institutions are making efforts to support the people's economy and implement the Feed security Commodity Development Program as an opportunity to develop productive, quality, and competitive businesses in a programmed manner (Sodiq and Yuwono, 2016). The Feed security Commodity Development Program is carried out, among other things, through the development of livestock SMEs. Financing through the role of the government is directed towards the enhancement of business scale oriented towards agribusiness (Pawlak and Kołodziejczak, 2020).

Livestock farming in the districts/cities of the Tomini Bay area needs to be developed because these regions have good livestock potential for increasing income, especially when considering various local government programs for the development of the livestock sector. Data from the central statistics agency for each district/city in the Tomini Bay area shows a trend of increasing populations of livestock and poultry. This increase must, of course, be accompanied by the availability of effective and efficient feed to enhance farmers' income and support feed security in the Tomini Bay region. The issue at hand that forms the basis of this research is that the livestock commodities prioritized in the districts/cities of the Tomini Bay area are quite diverse, yet there is no mapping of priority potential that can be pursued by each government. In fact, the districts/cities in the Tomini Bay area could certainly become suppliers of animal food needs in the region of the new national capital if they could maximize their efforts in the livestock sector. This research is a development of research on the development of beef cattle in Gorontalo using the Analytical Hierarchy Process (Mukhtar *et al.*, 2023), but with various expansions, especially in development based on the value of excellence and more targeted strategic steps because previous research has not focused on feed security. Then, the approaches of agroecology and permaculture have also become new trends in the sustainable management of natural resources. The integration of these principles into the feed security development strategy can help create a more environmentally friendly and economically efficient agricultural system that will make a significant contribution in

facing new challenges and seizing current opportunities in the development of the livestock sector in the Tomini Bay area.

Furthermore, the potential of superior livestock commodities in the Tomini Bay area, along with the formulation of a comprehensive and sustainable feed security development strategy, will certainly encourage the availability of animal feed and various downstream businesses that can enhance the macroeconomic conditions of a region and its community, one of which is the increase in community income. Thus, the livestock sector in this region could become a key driver of economic welfare and supporting feed security in both the Sulawesi region and nationally, even serving as a food buffer, especially in livestock for the National Capital region in Kalimantan.

The utilization of agricultural waste as livestock feed in the Tomini Bay area has both positive environmental and economic impacts, including reducing waste accumulation and lowering feed costs for farmers. However, local feed production technologies, while improving, still lag behind global standards in terms of efficiency and long-term sustainability. Climate change poses a significant threat to feed availability by altering rainfall patterns and reducing pasture yields, particularly during the dry season. To mitigate feed shortages, livestock farmers can adopt strategies such as forage conservation, crop diversification, and utilizing alternative feed sources. There is a strong quantitative relationship between feed security and livestock productivity, as consistent and quality feed supply directly influences animal growth and reproduction rates. This, in turn, affects farmers' per capita income by increasing livestock output and market participation. Advanced technologies, such as CRISPR-based genetic improvements in feed crops, offer potential solutions for enhancing feed quality and resilience against environmental stresses. However, the adoption of these technologies at the community level faces barriers including high implementation costs, limited technical knowledge, and inadequate infrastructure support.

So this study aims to analyze the commodity superiority of the livestock sub-sector in the Regency/City of the Tomini Bay area consisting of beef cattle, horses, goats, pigs, free-range chickens, laying hens, broilers and ducks, the influence of the commodity superiority of the livestock sub-sector on the per capita income of the community and design a strategy for the development of feed security areas.

MATERIALS AND METHODS

This research was conducted in 17 districts/cities in the Tomini Bay area using data from 5 years, namely 2019-2024. The districts/cities in question are South Bolaang Mongondow Regency, East Bolaang Mongondow Re-

gency, Southeast Minahasa Regency, Minahasa Regency, North Minahasa Regency, Bitung City, Banggai Laut Regency, Banggai Islands Regency, Banggai Regency, Tojo Una-Una Regency, Poso Regency, Parigi Moutong Regency, Pohuwato Regency, Boalemo Regency, Gorontalo Regency, Bone Bolango Regency, and Gorontalo City. This research is a quantitative study. The data sources in this research are secondary and primary data, where the secondary data consists of data from the Central Bureau of Statistics (BPS) and the Ministry of Agriculture, while the primary data is obtained through observations, interviews, and the distribution of questionnaires to respondents relevant to the study. The primary data sample consists of 85 individuals, comprising 51 farmers and 34 stakeholders. A saturated sampling method was used, including the entire population.

The data analysis techniques used are Localization Index (LI), Specialization Index (SI), and Location Quotient (LQ) (Gustia *et al.*, 2024). This analysis uses data from BPS and uses Excel as a tool for analyzing research data.

LOCALIZATION INDEX (LI) ANALYSIS

This analysis is used to measure the distribution or relative concentration of commodities. The formula used for localization analysis is:

$$\alpha = \frac{v_i}{V_i} - \frac{v_t}{V_t}$$

with the following definitions:

v_i = population of the commodity in the district.

V_i = population of the commodity in the province.

v_t = total population of the commodity in the district.

V_t = total population of the commodity in the province.

α represents the localization coefficient.

The localization coefficient is obtained by summing $(v_i/V_i) - (v_t/V_t)$ that are positive, with the stipulations:

$\alpha \geq 1$: the commodity is concentrated in one area.

$\alpha < 1$: the commodity is spread across several areas.

SPECIALIZATION INDEX (SI) ANALYSIS

This analysis is used to observe specialization in commodities using the following formula:

$$\beta = \frac{v_i}{v_t} - \frac{V_i}{V_t}$$

with the following definitions:

v_i = commodity population of the district.

V_i = commodity population of the province.

v_t = total commodity population of the district.

V_t = total commodity population of the province.

β represents the specialization coefficient.

The specialization coefficient is obtained by summing $(v_i/v_t) - (V_i/V_t)$ that are positive, with the stipulation:

- $\beta \geq 1$: a region specializes in the commodity.
- $\beta < 1$: not specialized.

LOCATION QUOTIENT (LQ) ANALYSIS

This analysis is used to identify commodities produced in a district, classifying them into basic and non-basic sectors using the following formula:

$$LQ = \frac{v_i/v_t}{V_i/V_t}$$

with the following definitions:

- v_i = commodity population of the district.
- V_i = commodity population of the province.
- v_t = total commodity population of the district.
- V_t = total commodity population of the province.
- LQ is the location quotient coefficient.

A commodity in a region is considered a basic sector if the LQ coefficient ≥ 1 , whereas if $LQ < 1$, then the commodity is not part of the sector.

The next data analysis is multiple regression analysis of panel data, which is used because the data structure consists of cross-section and time series data (Supianti, 2023). The data in this study consists of 85 data points, namely 17 cross-section data and 5 time series data. The free variable in this analysis is using numbers from the base analysis which is then analyzed for multiple regression of panel data using the Eviews version 9 program. The multiple regression model for panel data is as follows:

$$Y_{it} = \alpha + \beta_1 X1_{it} + \beta_2 X2_{it} + \beta_3 X3_{it} + \beta_4 X4_{it} + \beta_5 X5_{it} + \beta_6 X6_{it} + \beta_7 X7_{it} + \beta_8 X8_{it} + \varepsilon_{it}$$

Where:

- Y_{it} = Per capita income.
- α = Constant, the value of Y when X = 0.
- $\beta_1 - \beta_8$ = Regression coefficients indicating the change in Y when there is a change in X.
- X1 – X8 = beef cattle, horses, goats, pigs, village chickens, laying hens, broilers and ducks.
- ε_{it} = it is the error term, reflecting estimation error.

The stage for multiple analysis of panel data is carried out with the stage of testing the selection of regression models, namely using the Chow test and the hausman test so that the panel data analysis uses the Random Effect Model (REM) approach. Then the analysis continued with the testing of classical assumptions, namely normality, multicollinearity, autocorrelation and heterokedasticity. This classical assumption test fully satisfies the multiple regression analysis

of panel data with credible results. After that, hypothesis testing was carried out, namely the determination coefficient test, F test (simultaneous) and the t-test (partial). The Random Effect Model (REM) was chosen for panel data analysis in this study because it accounts for individual heterogeneity across the regencies and cities in the Tomini Bay region while providing greater efficiency compared to the Fixed Effects Model (FEM). The Chow test confirmed that the significance value was less than 0.05, indicating that FEM was preferred over the Common Effect Model (CEM), leading to further testing with the Hausman test. Meanwhile, the Hausman test showed that REM was preferred over FEM because the significance value was greater than 0.05. However, multiple regression analysis has limitations due to the cross-sectional and time-series nature of the data, including potential omitted variable bias, measurement errors, and the challenge of capturing dynamic relationships over time.

Furthermore, to analyze the development strategy for feed security areas in the districts/cities of the Tomini Bay area, a SWOT analysis will be used. SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) is a strategic planning method used to evaluate internal and external factors that influence the success of a project, business, organization, or initiative (Rangkuti, 2016). The results of the SWOT analysis can be applied to practical strategies by leveraging strengths and opportunities while addressing weaknesses and mitigating threats. SWOT analysis is analyzed in stages (1) determination of internal factors consisting of strengths and weaknesses and external factors consisting of opportunities and threats, (2) items of internal and external factors are made into questionnaires which are then distributed to respondents who meet the sample standards, (3) the data of the research results are then tabulated and analyzed descriptively to determine the points of each statement item for each aspect of SWOT, (4) the results of the points that have been calculated are then weighted for each item of the questionnaire statement, (5) after that a rating is determined for each statement on each aspect of SWOT (Figure 1). The rating is determined by the researcher and stakeholders related to the designed strategy (6) Furthermore, the determination of the score obtained is through the result of multiplication between the weight and the rating, which then the score of each aspect is obtained (7) For internal factors, the total score of strength is compared to the total score of weakness. If the strength is greater in value compared to the weakness, then a positive result is obtained on the internal factor, and if it is the other way around, the result is negative on the internal factor (8) For external factors, the total score of the opportunity is compared to the total score of the threat. If the opportunity is greater than the threat, then a positive result is obtained on external factors, and if it is the opposite, then a negative result is obtained on external factors (9) After obtaining

Table 1: Livestock commodities data.

No	Regency/Cities	Beef Cattle	Horse	Goats	Pigs	Village Chickens	Laying Hens	Broilers	Ducks
1	South Bolaang Mongondow Regency	5,551	0	4,896	816	61,319	1,600	3,090	4,075
2	East Bolaang Mongondow Regency	5,117	0	5,074	4,029	72,353	15,961	18,268	4,811
3	Southeast Minahasa Regency	4,800	0	2,463	16,030	94,413	12,500	16,753	16,206
4	Minahasa Regency	32,334	3,384	2,067	130,636	743,161	449,880	2,028,600	79,171
5	North Minahasa Regency	18,212	175	3,904	28,669	264,841	287,130	4,529,598	5,726
6	Bitung City	3,059	11	2,422	31,062	164,641	61,544	41,952	5,727
7	Banggai Laut Regency	3,116	28	3,228	1,629	225,269	0.00	2,210	8,627
8	Banggai Islands Regency	18,145	353	31,429	35,944	96,543	9,884	14,571	20,697
9	Banggai Regency	89,928	22	150,373	55,301	1,917,020	167,428	819,179	655,630
10	Kabupaten Tojo One-One	35,096	201	36,621	5,599	381,091	55,179	579,268	19,291
11	Poso Regency	20,453	46	10,519	59,133	351,886	63,527	216,098	41,600
12	Parigi Moutong Regency	31,410	21	41,616	26,966	573,295	43,874	694,074	83,331
13	Kabupaten Pohuwato	32,907	7	14,189	6,575	308,443	6,487	24,036	14,368
14	Boalemo Regency	41,629	72	10,350	3,454	276,588	22,324	20,037	11,565
15	Gorontalo Regency	91,715	638	49,728	0.00	622,556	191,701	3,244,784	19,391
16	Bone Bolango Regency	43,842	245	7,527	7.00	240,693	132,589	940,231	10,073
17	Gorontalo City	3,546	743	13,012	0.00	118,972	2,597	239,591	11,187

the internal score and external score, then the appropriate and ideal strategy is determined.

RESULTS

The development of livestock farming aims not only to enhance the government’s prestige by increasing livestock populations but also, more importantly, to improve the welfare of livestock entrepreneurs, enabling them to make meaningful contributions to the regional economy. Farmers are increasingly experienced and often operate within a global network where efficiency and productivity are highly prioritized. The livestock sector has various potential advantages that must be mapped out so that the government can identify livestock businesses that are suitable to become the hallmark of a region, along with various supporting activities for livestock, such as the industrialization of animal feed (Fitratunnisa *et al.*, 2022). This is also aimed at enabling the livestock sector to contribute to increasing the per capita income of communities in specific areas. An explanation regarding the mapping of the advantages of the livestock sub-sector commodities, their impacts and influences, as well as the potential for feed industrialization is outlined as follows:

ANALYSIS OF THE ADVANTAGES OF LIVESTOCK SUB-SECTOR COMMODITIES

The livestock and veterinary development program outlined in various activities is a government facilitation aimed at empowering and increasing community participation, as well as regional development, specifically in the districts/

cities in the Tomini Bay area. The farms that are the focus in this case are beef cattle, horses, goats, pigs, village chickens, laying hens, broiler chickens, and ducks. The average population data of eight livestock commodities in seventeen districts/cities in the Tomini Bay area can be seen in Table 1.

Table 2: Advantages of beef cattle in the Tomini bay region district/city.

Year	Localization		Specialties		Basis	
	Value	Category	Value	Category	Area	%
2019	0.2704	Spread	0.3540	Not Special	12	70.59
2020	0.2768	Spread	0.3837	Not Special	11	64.71
2021	0.2924	Spread	0.3782	Not Special	12	70.59
2022	0.2612	Spread	0.2702	Not Special	11	64.71
2023	0.2945	Spread	0.2920	Not Special	11	64.71
Average	0.2791	Spread	0.3356	Not Special	11	67.06

Source: Processed data, 2024.

BEEF CATTLE: Table 2 shows that beef cattle from 2019 to 2023 are a commodity that falls into the category of being widespread throughout the districts/cities in the Tomini Bay area (based on localization index analysis) and tends to be non-specialized. This is because all districts/cities in the Tomini Bay area have various programs aimed at developing the beef cattle population and improving the welfare of farmers, so each region has a good opportunity for developing beef cattle as a sub-sector focused on welfare and per capita income of the community. The

analysis results indicate that beef cattle tend to be the main or superior basis in 11-12 districts, namely South Bolaang Mongondow, East Bolaang Mongondow, Southeast Minahasa, Banggai Islands, Banggai, Tojo Una-Una, Poso, Pohuwato, Boalemo, Gorontalo, and Bone Bolango. These findings suggest that these regions can prioritize beef cattle in their economic development strategies, as focusing on beef cattle yields optimal results and should be sustained.

Table 3: Advantages of Horses in the Tomini bay region district/city.

Year	Localization		Specialties		Basis	
	Value	Category	Value	Category	Area	%
2019	0.5517	Spread	0.0046	Not Special	4	23.53
2020	0.5634	Spread	0.0042	Not Special	4	23.53
2021	0.5668	Spread	0.0038	Not Special	4	23.53
2022	0.6091	Spread	0.0031	Not Special	3	17.65
2023	0.6302	Spread	0.0032	Not Special	4	23.53
Average	0.5842	Spread	0.0038	Not Special	4	22.35

Source: Processed data, 2024.

HORSES: Table 3 shows that horses from 2019 to 2023 are a commodity that falls into the category of being widespread throughout the districts/cities in the Tomini Bay area (based on localization index analysis) and tends to be non-specialized. This means that horses tend to be distributed across all districts/cities in the Tomini Bay area, but in relatively small numbers, as evidenced by the basis analysis (advantage) indicating that horses are only a basis in 4 districts/cities, namely Minahasa Regency, Banggai Laut Regency, Banggai Islands Regency, and Gorontalo City. Horses have become increasingly rare over the past few years, and the economic activities related to horse maintenance are limited to services such as horse-drawn carriage rides, tourism, or other freight transport. However, the businesses that operate in this field are certainly less intensive.

GOATS: Table 4 shows that goats from 2019 to 2023 are a commodity that falls into the category of being widespread throughout the districts/cities in the Tomini Bay area (based on localization index analysis) and tend to be non-special. Goats serve as the basis in 9-11 districts/cities, namely South Bolaang Mongondow Regency, East Bolaang Mongondow Regency, Southeast Minahasa Regency, Banggai Islands Regency, Banggai Regency, Tojo Una-Una Regency, Parigi Moutong Regency, Pohuwato Regency, Boalemo Regency, and Gorontalo City. Goats are quite popular among farmers because they tend to breed quickly and are spread throughout the districts/cities in the Tomini Bay area. Even in urban areas, goats can serve as a foundation due to the potential of the Aqiqah goat selling business, which is quite challenging for urban regions.

Table 4: Advantages of goats in the Tomini bay region district/city.

Year	Localization		Specialties		Basis	
	Value	Category	Value	Category	Area	%
2019	0.4042	Spread	0.2771	Not Special	9	52.94
2020	0.4617	Spread	0.3110	Not Special	9	52.94
2021	0.4691	Spread	0.2854	Not Special	9	52.94
2022	0.4504	Spread	0.2838	Not Special	11	64.71
2023	0.4619	Spread	0.3002	Not Special	10	58.82
Average	0.4495	Spread	0.2915	Not Special	10	56.47

Source: Processed data, 2024.

Table 5: Advantages of pigs in the tomini bay region district/city.

Year	Localization		Specialties		Basis	
	Value	Category	Value	Category	Area	%
2019	0.5069	Spread	0.3848	Not Special	8	47.06
2020	0.4802	Spread	0.3981	Not Special	9	52.94
2021	0.4764	Spread	0.3905	Not Special	7	41.18
2022	0.4918	Spread	0.4430	Not Special	6	35.29
2023	0.4825	Spread	0.4117	Not Special	7	41.18
Average	0.4876	Spread	0.4056	Not Special	7	43.53

Source: Processed data, 2024.

PIGS: Table 5 shows that pigs from 2019 to 2023 are a commodity that falls into the category of being widespread throughout the districts/cities in the Tomini Bay area (based on localization index analysis) and tends to be non-special. In the districts/cities of the Tomini Bay area, only a few regions raise pigs, so they are primarily found in just 6-9 areas, namely East Bolaang Mongondow Regency, Southeast Minahasa Regency, Minahasa Regency, Bitung City, Banggai Laut Regency, Banggai Islands Regency, and Poso Regency.

LOCAL CHICKEN: Table 6 shows that local chicken from 2019 to 2023 is a commodity that falls into the categories of widespread and specialty. This indicates that the districts/cities in the Tomini Bay area have various potentials for local chicken farming to enhance the economy, with 13 out of 17 regions serving as the basis. Local chickens are easy to raise, making this commodity highly popular and widely cultivated by the community. The regions with potential for the development of local chickens are South Bolaang Mongondow Regency, East Bolaang Mongondow Regency, Southeast Minahasa Regency, Bitung City, Banggai Laut Regency, Banggai Islands Regency, Banggai Regency, Tojo Una-Una Regency, Poso Regency, Parigi Moutong Regency, Pohuwato Regency, Boalemo Regency, and Gorontalo Regency.

Table 6: Advantages of free range chickens in the tomini bay region district/city.

Year	Localization		Specialties		Basis	
	Value	Category	Value	Category	Area	%
2019	0.2962	Spread	3.4675	Special	13	76.47
2020	0.3456	Spread	3.8228	Special	13	76.47
2021	0.3471	Spread	3.7227	Special	13	76.47
2022	0.2822	Spread	3.5852	Special	13	76.47
2023	0.2883	Spread	3.8085	Special	13	76.47
Average	0.3119	Spread	3.6813	Special	13	76.47

Source: Processed data, 2024.

Table 7: Advantages of layer chickens in the tomini bay region district/city.

Year	Localization		Specialties		Basis	
	Value	Category	Value	Category	Area	%
2019	0.2528	Spread	0.4869	Not Special	8	47.06
2020	0.2419	Spread	0.4094	Not Special	8	47.06
2021	0.2899	Spread	0.3972	Not Special	7	41.18
2022	0.2159	Spread	0.2652	Not Special	5	29.41
2023	0.2107	Spread	0.2755	Not Special	6	35.29
Average	0.2422	Spread	0.3668	Not Special	7	40.00

Source: Processed data, 2024.

Table 8: Advantages of broiler chickens in the tomini bay region district/city.

Year	Localization		Specialties		Basis	
	Value	Category	Value	Category	Area	%
2019	0.1601	Spread	0.5872	Not Special	5	29.41
2020	0.2075	Spread	0.7115	Not Special	6	35.29
2021	0.2221	Spread	0.7782	Not Special	6	35.29
2022	0.2249	Spread	0.8058	Not Special	5	29.41
2023	0.2204	Spread	0.7428	Not Special	5	29.41
Average	0.2070	Spread	0.7251	Not Special	5	31.76

Source: Processed data, 2024.

LAYER CHICKENS: Table 7 shows that layer chickens from 2019 to 2023 are a commodity that falls into the category of being spread throughout the districts/cities in the Tomini Bay area (based on localization index analysis) and tends to be non-specialized. Layer chickens serve as a base in 5-8 districts, with 6 districts being more potential, namely East Bolaang Mongondow, Minahasa, Bitung City, Tojo Una-Una, Boalemo, and Bone Bolango. This shows that layer chickens are quite beneficial in improving the economy and per capita income, but not all districts/cities are able to maximize the potential of these layer chickens.

BROILER CHICKEN: Table 8 shows that broiler chicken from 2019 to 2023 is a commodity that falls into the category of being widespread throughout the districts/

cities in the Tomini Bay area (based on localization index analysis) and tends to be non-specialized, with 5 districts/cities serving as the main bases, namely Minahasa Regency, North Minahasa Regency, Gorontalo Regency, Bone Bolango Regency, and Gorontalo City. Broiler chickens are cultivated by all districts, but only a small portion maximizes economic development through this broiler chicken commodity.

Table 9: Advantages of ducks in the tomini bay region district/city.

Year	Localization		Specialties		Basis	
	Value	Category	Value	Category	Area	%
2019	0.4944	Spread	0.3381	Not Special	8	47.06
2020	0.5511	Spread	0.2567	Not Special	5	29.41
2021	0.5205	Spread	0.2530	Not Special	6	35.29
2022	0.5523	Spread	0.3565	Not Special	7	41.18
2023	0.5763	Spread	0.2701	Not Special	4	23.53
Average	0.5389	Spread	0.2949	Not Special	6	35.29

Source: Processed data, 2024.

DUCKS: Table 9 shows that ducks from 2019 to 2023 are a commodity that falls into the category of being widespread throughout the districts/cities in the Tomini Bay area (based on localization index analysis) and tends to be non-specialized. Ducks serve as a basis in 4-8 districts/cities, but in 2021, they were only present in 4 districts/cities, namely Southeast Minahasa Regency, Banggai Islands Regency, Banggai Regency, and Parigi Moutong Regency. Ducks have many benefits, but the progress of duck farming is not as good as that of chicken, which is more favored by consumers. As a result, many farmers choose to raise chickens instead of ducks.

INCREASING PER CAPITA INCOME OF THE COMMUNITY THROUGH THE LIVESTOCK SUBSECTOR

Efforts in the livestock sector are expected to deliver economic benefits for entrepreneurs and farming communities. With the livestock subsector as a commodity supported by various government programs, it will have an impact on increasing the per capita income of the community.

Table 10, which is the result of the E-Views version 9 analysis, shows that the significance of the F-statistic is 0.000, which is smaller than the alpha value. This indicates that the livestock subsector, which includes beef cattle, horses, goats, pigs, village chickens, laying hens, broilers, and ducks, has a positive and significant impact on per capita income in the Tomini Bay region's districts/cities, with an influence value of 29.76%. This suggests that the development of the livestock sector through government programs and support from livestock farmers will enhance per capita income in the Tomini Bay region's districts/cities. Mean-

while, the results for each variable of livestock commodities are presented as follows:

Table 10: Analysis results of the per capita income increase in the community through the livestock subsector.

Dependent Variable: PEND_PERKAPITA?				
Method: Pooled EGLS (Cross-section random effects)				
Date: 12/29/22 Time: 08:29				
Sample: 1 5				
Included observations: 5				
Cross-sections included: 17				
Total pool (balanced) observations: 85				
Swamy and Arora estimator of component variances				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.911868	3.923806	-1.251812	0.2145
BEEF_CATTLE	0.599890	0.298150	2.012041	0.0478
HORSE?	-0.104229	0.340486	-0.306118	0.7604
GOATS?	0.103025	0.565289	0.182253	0.8559
PIGS?	0.147523	0.247822	0.595279	0.5534
VILLAGE_CHICKENS?	5.501455	1.176777	4.675021	0.0000
LAYING_HENS	0.578373	0.400591	1.443801	0.1529
BROILERS?	9.796355	2.322663	4.217726	0.0001
DUCKS?	0.963673	0.420765	2.290289	0.0248
Random Effects (Cross)				
_BOLSEL--C	-1.414251			
_BOLTIM--C	-7.064234			
_MITENG--C	-0.411075			
_MINAHASA--C	-3.999371			
_MINUT--C	-4.868125			
_BITUNG--C	-4.962606			
_BANGLA--C	2.077141			
_BANGKEP--C	3.532897			
_BANGGAI--C	-5.710949			
_TOUNA--C	4.484584			
_POSO--C	3.007765			
_PARIMO--C	3.149963			
POHUWATO--C	3.737688			
_BOALEMO--C	4.703745			
_KABGOR--C	6.112800			
_BONBOL--C	4.196655			
_KOTAGOR--C	-6.572627			
R-squared	0.297636	Mean dependent var	1.779540	
Adjusted R-squared	0.223703	S.D. dependent var	1.494006	
S.E. of regression	1.316335	Sum squared resid	131.6880	
F-statistic	4.025743	Durbin-Watson stat	0.975103	
Prob(F-statistic)	0.000500			

Source: Processed data E-Views version 9, 2024.

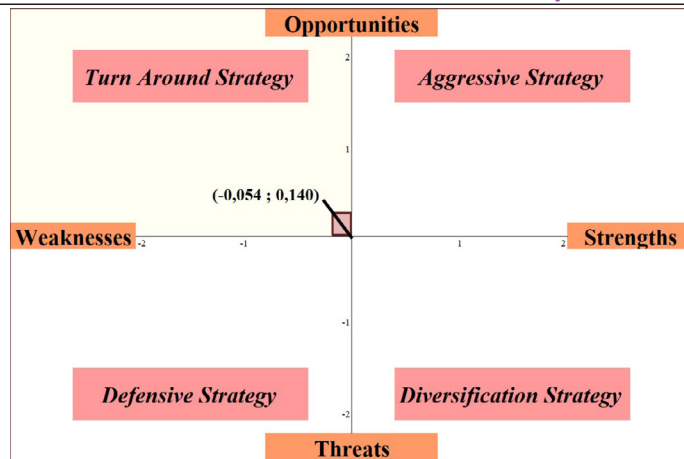


Figure 1: SWOT analysis diagram; Source: Processed data, 2024.

BEEF CATTLE: The significance value of the t-statistic for cattle is 0.0478, which is smaller than the alpha value, indicating that the cattle commodity has a positive and significant effect on per capita income in the Tomini Bay Region. The positive and significant result means that the greater the number of cattle or the interest of the community in cattle farming, the higher the per capita income in the Tomini Bay Region, as cattle farming shows continuous economic progress, especially in the months leading up to Eid al-Adha.

HORSES: The significance value of the t-statistic for horses is 0.7604, which is greater than the alpha value, indicating that the horse commodity has a negative and insignificant effect on per capita income in the Tomini Bay Region's districts/cities. This negative result means that horses are not a commodity capable of enhancing the economy of the communities in the Tomini Bay Region, as their economic added value is low, compounded by the relatively challenging maintenance, particularly in terms of upkeep costs.

GOATS: The calculated t-value for goats is 0.8559, which is greater than the alpha value, indicating that goat commodities have a positive but not significant effect on per capita income in the Tomini Bay District/City area. This positive result suggests that goats can provide economic benefits to the community in the Tomini Bay District/City area; however, the value of these benefits is still relatively small, particularly in terms of increasing community income.

PIGS: The significance value of the t-statistic for pigs is 0.5534, which is greater than the alpha value, indicating that the pig commodity has a positive but insignificant effect on per capita income in the Tomini Bay Region Districts/Cities. This positive result means that pigs can provide economic benefits to the community in the Tomini Bay Region Districts/Cities; however, not all Districts/Cities consider pigs as a livestock business.

LOCAL CHICKEN: The significance value of the t-test for local chicken is 0.000, which is smaller than the alpha value, indicating that the local chicken commodity has a positive and significant impact on per capita income in the Tomini Bay Region District/City. The positive and significant result means that the larger the number of local chickens, the higher the per capita income in the Tomini Bay Region District/City, due to the relatively easy maintenance of local chickens and their popularity among the community for culinary ventures.

LAYER CHICKENS: The significance value of the t-count for layer chickens is 0.1529, which is greater than the alpha value, indicating that the layer chicken commodity has a positive but insignificant effect on per capita income in the Tomini Bay District/City area. This positive result suggests that the community in the Tomini Bay District/City area has not engaged significantly in layer chicken farming due to the considerable capital required, thus this livestock commodity has not been able to enhance the economic value and income of the community.

BROILER CHICKENS: The significance value of the t-test for broiler chickens is 0.0001, which is smaller than the alpha value, indicating that broiler chicken commodities have a positive and significant effect on per capita income in the districts/cities of the Tomini Bay area. The positive and significant results mean that the larger the number of broiler chickens, the higher the per capita income in the districts/cities of the Tomini Bay area, where these chickens are widely cultivated for culinary needs. Thus, the demand for broiler chickens can serve as an economic stimulus and increase community income.

DUCKS: The significance value of the t-count for ducks is 0.0248, which is smaller than the alpha value, indicating that duck commodities have a positive and significant impact on per capita income in the Tomini Bay Region's District/City. The positive and significant result indicates that an increase in duck populations leads to higher per capita income in the Tomini Bay region, as ducks are increasingly favored for their nutritional benefits and culinary uses.

Thus, the livestock sub-sector provides significant benefits to per capita income in the Tomini Bay region's districts/cities, where the results above show that there are 8 districts/cities that heavily rely on their community's income from the livestock sub-sector, both in the form of raw food and ready-to-eat (culinary) products, namely South Bolaang Mongondow, East Bolaang Mongondow, Southeast Minahasa, Minahasa, North Minahasa, Bitung City, Banggai Regency, and Gorontalo City. This means that these districts/cities will experience a decline in per capita income if there is a decrease in the commodities of the livestock sub-sector.

Table 11: Calculation of strengths and aspects.

No	Strength					Actual Score	Ideal Score	%
	1	2	3	4	5			
1	1	7	22	18	37	338	425	79.53%
2	2	7	7	28	41	354	425	83.29%
3	2	6	15	22	40	347	425	81.65%
4	1	16	11	22	35	329	425	77.41%
5	1	14	9	34	27	327	425	76.94%
6	2	5	9	37	32	347	425	81.65%
7	2	9	14	37	23	325	425	76.47%
Total	11	64	87	198	235	2,367	2,975	79.56%

Table 12: Calculation of the weaknesses aspect.

No	Debilitation					Actual Score	Ideal Score	%
	1	2	3	4	5			
1	4	2	8	32	39	355	425	83.53%
2	4	4	8	46	23	335	425	78.82%
3	0	0	1	27	57	396	425	93.18%
4	4	2	10	50	19	333	425	78.35%
5	2	4	8	47	24	342	425	80.47%
6	0	8	8	36	33	349	425	82.12%
7	2	6	9	44	24	337	425	79.29%
Total	16	26	52	282	219	2,447	2,975	82.25%

SWOT ANALYSIS (FEED SECURITY AREA DEVELOPMENT STRATEGY)

SWOT analysis is analyzed comprehensively and in stages so that the results can be more credible, such as for determining the score and weight in each assessment item in the SWOT analysis based on the results of the actual score analysis compared to the ideal score. The results of the analysis can be seen in Table 11, Table 12, Table 13 and Table 14. The analysis of the feed security area development strategy in the Tomini Bay region's districts/cities can be described as follows:

Table 13: Calculation of the opportunities aspect.

No	Chance					Actual Score	Ideal Score	%
	1	2	3	4	5			
1	0	0	8	45	32	364	425	85.65%
2	0	0	10	48	27	357	425	84.00%
3	2	2	6	39	36	360	425	84.71%
4	2	2	8	42	31	353	425	83.06%
5	2	4	6	50	23	343	425	80.71%
6	0	8	4	50	23	343	425	80.71%
7	4	0	10	45	26	344	425	80.94%
Total	10	16	52	319	198	2,464	2,975	82.82%

Table 14: Calculation of the threats aspect.

No	Threat					Actual Score	Ideal Score	%
	1	2	3	4	5			
1	1	15	12	36	21	316	425	74.35%
2	5	6	15	34	25	323	425	76.00%
3	2	10	12	36	25	327	425	76.94%
4	6	8	14	38	19	311	425	73.18%
5	2	11	12	39	21	321	425	75.53%
6	11	10	8	35	21	300	425	70.59%
7	2	11	14	33	25	323	425	76.00%
Total	29	71	87	251	157	2,221	2,975	74.66%

IFAS (INTERNAL STRATEGIC FACTORS ANALYSIS SUMMARY)

ANALYSIS: For internal factors (Table 15), the strength score is 1.349, while the weakness score is 1.403. Thus, the difference between internal and external factors is a negative value of -0.054, indicating that the strength score is lower than the weakness score. This means that the development of the feed security area in the Tomini Bay region's districts/cities still needs to be continuously optimized internally.

EFAS (EXTERNAL STRATEGIC FACTORS ANALYSIS SUMMARY)

ANALYSIS: For external factors (Table 16), the value of the opportunity factor possessed by the food resilience development strategy in the districts/cities of the Tomini Bay area is 1.439, while the threat factor is 1.299. Thus, when compared, the opportunity factor is greater than the score of the threats. This shows that there are good opportunities in the development of food resilience areas in the districts/cities of the Tomini Bay region, and this opportunity must be maximized to turn weaknesses into strengths and to overcome threats.

SWOT ANALYSIS DIAGRAM

Based on the IFAS and EFAS tables, the SWOT results indicate that the strategic position for the development of feed security areas in the districts/cities of the Tomini Bay region is in quadrant 3, which is the Turn Around strategy. This strategy emphasizes that efforts to develop feed security areas in the districts/cities of the Tomini Bay region can be focused on optimizing opportunities to reduce weaknesses in the development of feed security areas. The strategic steps that need to be taken are (1) the utilization of natural resources and agricultural waste as feed through the Smart Integrated Farming System (SIFS), (2) the enhancement of human resource capacity through training in modern technology in the fields of feed production and feed security management, (3) strengthening government support through infrastructure, management, and the downstreaming of agribusiness in farming and livestock enterprises, and (4) collaboration among districts/cities in the Tomini Bay area regarding feed security (produc-

tion-distribution-consumption of feed)

DISCUSSION

The Tomini Bay region has significant potential in the livestock sector. The diversity of natural resources and geographical conditions that support livestock growth serve as the main capital in increasing community income (Siebrecht, 2020). However, several challenges such as limited access to quality feed, suboptimal technology, and market price fluctuations pose obstacles that must be addressed (Huy et al., 2023). For this reason, the development of feed security areas becomes crucial to ensure the availability of sufficient and quality feed for livestock. Thus, the livestock sector can become the locomotive of the regional economy and improve the welfare of the community. The advantages of livestock commodities must be analyzed in order to make decisions about which commodities are viable for development or intervention by local governments, so that the outcomes can benefit the increase in livestock populations and ultimately improve the welfare of the community.

The development of livestock in the Tomini Bay area shows a fairly even trend across various regions. Cattle, for example, have become a flagship commodity with a fairly consistent population development program. Cattle slaughter is considered one of the commodities that can enhance the welfare of farmers and stimulate local economic growth. Horses, although scattered, have a relatively small population and are more often utilized in service economic activities such as horse-drawn carriage transportation or tourism. On the other hand, goats have become a popular choice among farmers due to their rapid reproduction and potential in the sales business, especially for traditional purposes such as aqiqah. Meanwhile, pigs have become a more limited commodity with a small population, although in some areas they still remain part of farming activities and economic development. Livestock such as cattle, goats, horses, and pigs have great potential to boost the economy and the income of the community. Cattle and goats, for example, provide meat that is in high demand, as well as by-products such as milk and organic fertilizer. A rapidly growing population makes livestock farming a sustainable source of income for farmers. In addition, animals like horses can be used in the service sector, such as transportation or tourism, which provides additional opportunities to enhance the well-being of the community.

The development of poultry in the Tomini Bay area shows quite interesting variations. Local chickens, as a highly sought-after commodity, are easy to care for and can thrive evenly across all regions. Layer hens, although spread across many areas, have not yet been fully utilized to their maximum potential by all regions. This commodity has great potential in increasing community income, especially in

Table 15: Internal rating factors (strengths and weaknesses).

No.	Description	Actual Points	Points Weight	Rating	Score
1	Teluk Tomini has diverse and abundant natural resources, including marine and agricultural products that can support feed security.	79.53%	0.070	3.000	0.211
2	The high biodiversity allows for the development of various types of sustainable alternative feeds.	83.29%	0.074	4.000	0.294
3	There are government programs and policies that support feed security in the Teluk Tomini region.	81.65%	0.072	4.000	0.288
4	Basic infrastructure such as roads, ports, and adequate storage facilities for feed distribution.	77.41%	0.068	2.000	0.137
5	A large number of local workers are ready to be involved in the feed production and distribution sector.	76.94%	0.068	2.000	0.136
6	Collaboration with universities and research institutions that can support the development of feed technology and innovation.	81.65%	0.072	3.000	0.216
7	A large local market potential for livestock and aquaculture feed.	76.47%	0.068	1.000	0.068
Total Strengths			0.492		1.349
1	Limited modern and advanced technology for feed production and processing.	83.53%	0.074	4.000	0.295
2	Human resource capacity in terms of knowledge and skills still needs improvement.	78.82%	0.070	2.000	0.139
3	Limited access to capital and investment for feed business development.	93.18%	0.082	4.000	0.329
4	Limited diversification of feed products, leading to dependency on certain types of feed.	78.35%	0.069	1.000	0.069
5	Resource management and utilization that have not been optimized.	80.47%	0.071	3.000	0.213
6	Uneven distribution of infrastructure across the Teluk Tomini region.	82.12%	0.072	3.000	0.217
7	Education and outreach to the public about the importance of feed security still need to be enhanced.	79.29%	0.070	2.000	0.140
Total Weaknesses			0.508		1.403
Total IFAS		11.33	1.000		
Score IFAS					0.054

Source: Processed data, 2024.

egg production. Broiler chickens, on the other hand, are also widely cultivated, but only certain areas have succeeded in optimizing their potential to enhance the local economy. Ducks, despite having economic benefits, are not as popular compared to chickens, resulting in their farming efforts not being as optimal as other poultry commodities.

The results of the multiple regression show that beef cattle, horses, goats, pigs, village chickens, laying hens, broilers, and ducks have a positive and significant impact on per capita income in the Tomini Bay region with a coefficient of determination of 29.76%. The partial results indicate that beef cattle have a significant economic impact, especially leading up to occasions like Eid al-Adha, when the demand for beef surges. This positions beef cattle as a strategic commodity capable of increasing the per capita income of the community. Meanwhile, although goats also contribute to the economy, the added value they generate is still relatively small compared to beef cattle. Pigs also show positive economic potential, although not all regions utilize pigs as a primary source of income. In contrast, horses do not provide significant economic contributions due to their high maintenance costs and low profits, making them less optimal as a source of community income.

Poultry such as local chickens, laying hens, broilers, and ducks contribute positively to the economy of the community. Local chickens and broiler chickens yield significant results due to high market demand, especially for culinary needs. Local chickens have the advantage of simple maintenance, while broiler chickens have a fast harvest cycle that increases per capita income. Although ducks are not as popular as chickens, their presence as a food ingredient is becoming increasingly favored and is boosting the income of the community. Layer chickens, although they yield positive results, are still less popular because they require a significant initial investment, making their economic contribution not yet optimal. Village chickens and laying hens are easy to raise and provide meat and eggs, which have high market demand, thereby creating economic activities that can stimulate community income.

Then the SWOT analysis indicates that the strategy for developing feed security areas in the Tomini Bay region falls under quadrant 3, the turn-around strategy, which can be operationalized through four key steps, namely the utilization of natural resources and agricultural waste as feed through the Smart Integrated Farming System (SIFS).

Table 16: External rating factors (opportunities and threats).

No.	Description	Actual Points	Points Weight	Rating	Score
1	Increasing demand for feed along with the growth of the fisheries and livestock sectors.	85.65%	0.078	4.000	0.311
2	Opportunities to adopt new technologies in feed production and processing.	84.00%	0.076	3.000	0.229
3	Availability of funding programs and assistance from the government and international organizations.	84.71%	0.077	4.000	0.307
4	Potential to export feed products to international markets (at least demand around the IKN area).	83.06%	0.075	3.000	0.226
5	Development of innovative feed products based on local and environmentally friendly materials.	80.71%	0.073	1.000	0.073
6	Potential for Natural Increase of livestock and poultry, and expansion of crop areas integrated with complete feed production.	80.71%	0.073	2.000	0.146
7	Opportunities to establish partnerships with the private sector in feed industry development.	80.94%	0.073	2.000	0.147
Total <i>Opportunities</i>			0.526		1.439
1	Climate change that may affect the production of feed raw materials.	74.35%	0.067	2.000	0.135
2	Price instability of raw materials and overhead costs that may impact production costs.	76.00%	0.069	3.000	0.207
3	Competition with feed producers from other regions and abroad.	76.94%	0.070	4.000	0.279
4	Dependency on imported technology and raw materials that may hinder self-sufficiency.	73.18%	0.066	2.000	0.133
5	Risk of environmental degradation that could affect natural resources.	75.53%	0.069	3.000	0.206
6	Economic crises and inflation that may reduce public purchasing power and investment.	70.59%	0.064	1.000	0.064
7	Strict regulations related to feed production and distribution that may pose operational challenges.	76.00%	0.069	4.000	0.276
Total <i>Threats</i>			0.474		1.299
Total EFAS		11.02	1.000		
Score EFAS					0.140

Source: Processed data, 2024.

The utilization of natural resources and agricultural waste as feed through the Smart Integrated Farming System (SIFS) is a strategy to integrate various agricultural and livestock sectors into one sustainable ecosystem. By utilizing agricultural waste such as leaves, straw, and crop residues, this system can reduce dependence on more expensive commercial feed. In addition, SIFS enables the use of smart technology to efficiently monitor and manage feed production. Technologies such as soil sensors, automated feeding systems, and monitoring of feed crop growth can enhance productivity and reduce production costs (Sekaran *et al.*, 2021). SIFS also encourages the use of abundant local resources, reduces waste, and creates a more environmentally friendly production cycle. With this approach, farmers in the Tomini Bay area can enhance their feed resilience, reduce environmental impact, and strengthen their independence in livestock feed supply.

The enhancement of human resource capacity through modern technology training in the fields of feed production and feed security management is crucial to support the development of food resilience in Tomini Bay. Through modern technology training, farmers and agribusiness actors can acquire new knowledge and skills in feed pro-

duction and more efficient management. This training covers various aspects, ranging from the use of advanced technology in feed production such as automatic drying, feed fermentation, to the utilization of local materials for alternative feed (Rasanjali *et al.*, 2021; Liu *et al.*, 2022). By enhancing skills and knowledge, the local workforce can contribute more significantly to increasing productivity in the feed sector, reducing dependence on imports, and strengthening local feed security. In addition, this training will open up new job opportunities and improve the welfare of the community in the Tomini Bay area.

Strengthening government support through infrastructure, management, and the downstream processing of agribusiness in farming and livestock is essential for enhancing the effectiveness and sustainability of the agribusiness sector in the Tomini Bay region, particularly in the development of feed resilience. One important step is through the provision of adequate facilities and infrastructure, such as road infrastructure, electrical networks, and feed storage facilities. Good infrastructure will support more efficient feed distribution and reduce logistics costs. For example, in Gorontalo Province where there are not many animal feed processing centers and farmer-farmer groups formed to optimize feed

through an integrated agricultural system are still not running well due to infrastructure problems and facilities for better feed processing centers. In addition, the government also needs to strengthen agribusiness management through training and support for farmers and ranchers so that they can manage their businesses more professionally (Supendi, 2022). Agribusiness downstreaming should also be a focus, by encouraging the processing of agricultural and livestock products into value-added feed products that can be sold in both local and international markets. The collaboration between the central government, local authorities, and the private sector in these programs will accelerate the development of food resilience areas and improve the welfare of local communities.

Collaboration among districts/cities in the Tomini Bay area regarding feed security (production-distribution-consumption of feed) is an important strategy to strengthen feed security through the integration of the production, distribution, and consumption sectors of feed. Each region in Tomini Bay has different advantages and potential natural resources, so this collaboration allows for the efficient exchange of resources to meet the needs of livestock feed and fisheries. For example, regions with a surplus of feed production can distribute it to other areas that are experiencing shortages. This collaboration also enables the formulation of joint policies related to feed quality standards, the establishment of competitive pricing, and the strengthening of distribution networks across regions (Aswad *et al.*, 2021). With this synergy, the regions in Tomini Bay can more easily meet their local feed needs, reduce dependence on imports, and enhance the competitiveness of their feed products in both domestic and international markets. This collaboration also creates price stability and a supply of feed that will provide long-term benefits for the livestock and fisheries sectors in the Tomini Bay region.

The advantages of the livestock sector in the Tomini Bay area play an important role in increasing the per capita income of the community. With abundant natural resources and favorable geographical conditions, livestock farming has become one of the economic sectors that can develop rapidly. However, several challenges such as limited access to quality feed, market price fluctuations, and suboptimal technology require more attention in their development. In an effort to address these challenges, the strategy for developing feed security areas becomes crucial because adequate feed promotes the optimal performance of livestock enterprises (Santoso *et al.*, 2024). One approach that can be applied is the use of the Smart Integrated Farming System (SIFS), which integrates agricultural waste as livestock feed and smart technology to enhance production efficiency. In addition, the enhancement of human resource capacity through training in modern technology, as well as strengthening government support in terms of facilities,

infrastructure, and agribusiness management, is essential. With the collaboration between regions in terms of production, distribution, and consumption of feed, the livestock sector in this area has great potential to grow more sustainably, enhance feed security, and significantly contribute to improving the welfare of the community.

The Smart Integrated Farming System (SIFS) addresses feed security challenges in the Tomini Bay region by optimizing local resources through sustainable agricultural waste utilization and promoting circular agriculture practices. Pilot projects in selected districts have shown positive outcomes in reducing feed costs and improving livestock productivity. However, the environmental impacts of using agricultural waste as feed, such as soil degradation and water pollution, are mitigated through proper waste processing and the adoption of eco-friendly technologies. Modern technologies introduced to farmers through training programs include precision feeding systems, automated monitoring devices, and biofermentation techniques, which are made accessible through government subsidies and cooperative initiatives to support small-scale farmers. The effectiveness of these training programs is measured by tracking productivity improvements, knowledge retention, and adoption rates over time. Key infrastructure projects prioritized to support the livestock sector include feed storage facilities, cold chain logistics, and improved road networks to facilitate efficient distribution. Effective collaboration among districts and cities is ensured through inter-regional agreements and integrated management frameworks, promoting coordinated efforts in feed production, distribution, and consumption across the region.

CONCLUSIONS AND RECOMMENDATIONS

The analysis results found that (1) livestock tends to be widespread and none are considered special, while the analysis shows that beef cattle serve as the basis in an average of 11 districts/cities, horses in an average of 4 districts/cities, goats in an average of 10 districts/cities, and pigs in an average of 7 districts/cities. For poultry, only local chickens fall into the special and widespread category, while the others are not special and widespread, with local chickens excelling in 13 districts/cities, layer chickens excelling in 7 districts/cities, broiler chickens excelling in 5 districts/cities, and ducks excelling in 6 districts/cities (2) Beef cattle, local chickens, broiler chickens, and ducks have a positive and significant impact on per capita income in the districts/cities of the Tomini Bay area, or are able to increase per capita income, while goats, pigs, and layer chickens have a positive but insignificant impact on per capita income, or fall into the category of being somewhat capable, whereas horses have a negative and insignificant impact, meaning that horses tend to reduce income due to high maintenance

costs. The SWOT results are in quadrant 3, which indicates a Turn Around strategy operationalized through strategic steps such as utilizing natural resources and agricultural waste as feed through the Smart Integrated Farming System (SIFS), enhancing human resource capacity through training in modern technology in feed production and feed security management, strengthening government support through infrastructure, management, and agribusiness downstreaming of farming and livestock enterprises, as well as collaboration among districts/cities in the Tomini Bay area concerning feed security (produksi-distribusi-konsumsi pakan). These results highlight the need for the livestock subsector to be prioritized in the districts/cities of the Tomini Bay region. Government policies should align with the livestock potential, focusing on population growth and the availability of affordable, high-quality feed to boost community income.

To enhance the livestock subsector in the Tomini Bay region, the government should implement targeted policies that prioritize beef cattle, local chickens, broiler chickens, and ducks, as these commodities have a positive and significant impact on per capita income. Policy recommendations include subsidizing high-quality feed, promoting the Smart Integrated Farming System (SIFS) to utilize agricultural waste as feed, and investing in infrastructure such as feed storage facilities and distribution networks. To ensure that programs are tailored to each district/city, the government should conduct regular assessments of livestock potential and resource availability, enabling localized strategies that reflect the specific needs of each area. Long-term sustainability challenges, such as feed scarcity, environmental degradation, and high maintenance costs, can be addressed through sustainable agricultural practices, training programs on modern feed technologies, and strengthening inter-district collaboration to balance production, distribution, and consumption. Future research should focus on evaluating the economic and environmental impacts of SIFS implementation and feed security collaborations, ensuring continuous policy improvement and sustainable development in the livestock sector across the Tomini Bay region.

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NOVELTY STATEMENT

This study highlights the critical role of the livestock subsector in enhancing per capita income in the Tomini Bay

region while emphasizing the need for sustainable feed security strategies. The findings indicate that beef cattle, local chickens, broiler chickens, and ducks significantly contribute to regional income, whereas horses, goats, pigs, and layer chickens have a limited or insignificant impact. Given the challenges of feed availability, economic viability, and infrastructure gaps, a multi-faceted policy approach is essential to maximize the livestock sector's potential. The policy a more comprehensive SWOT strategy because it involves multi-stakeholders from 17 districts/cities in an area that has the potential to be sustainable animal feed security which representative of the unique livestock each district with the following target policies; feed Subsidies and Smart Integrated Farming System (SIFS) Adoption, district-specific livestock development strategies, strengthening institutional collaboration and policy frameworks. Moreover, use data-driven decision-making through real-time monitoring of livestock population trends, market prices, and feed availability to adjust policies accordingly with addressed through sustainable feed production, rotational grazing, and alternative feed sources

AUTHOR'S CONTRIBUTIONS

Muhammad Mukhtar and Mahludin H. Baruwadi: Conceptualization, methodology, data curation, writing original draft, writing – review and editing.

Mohammad Zubair Hippy and Wahid Talawo: data curation, supervision. writing original draft, writing – review and editing.

CONFLICT OF INTEREST

No potential conflicts of interest relevant to this article are reported.

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