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Strategic management and mapping of corn farming for sustainable animal feed in Maros District, South Sulawesi, Indonesia

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Abstract. *Manaf S, Azisah A, Demmallino EB, Syamsuddin S. 2025. Strategic management and mapping of corn farming for sustainable animal feed in Maros District, South Sulawesi, Indonesia. Asian J Agric 9: 542-553.* The purpose of this study was to analyze corn mapping and internal and external factors that influence corn farming development strategies for the sustainability of animal feed in Tanralili Sub-district, Maros District, South Sulawesi, Indonesia. This study employed a range of data collection methods, including observation, social mapping, Focus Group Discussion, and interviews. The data analysis was ArcGIS and SWOT analysis, which was presented in qualitative descriptive form. The results of this study indicate that potential mapping based on the area of corn land in Tanralili Sub-district, Maros District, has a total area of 2,667.45 ha. The village with the most extensive corn land is Toddopulia Village, which has an area of 502.91 ha. Corn crop production in Tanralili Sub-district, Maros District, fluctuates every year, with a production value of 56.04 quintals/ha in 2021, 59 quintals/ha in 2022, and 53.17 quintals/ha in 2023. Internal and external factors of corn farming that have a significant influence are: (i) the existence of agricultural institutions (farmer groups), (ii) the use of agricultural technology is still lacking, (iii) government policy support, (iv) high market demand, (v) corn production centers, (vi) increasing feed needs and (vii) fluctuations in production prices. The corn farming business development strategy is in quadrant III, which is in a diversification position.

Keywords: Corn plants, development strategy, land mapping, Maros District, sustainability

INTRODUCTION

Public awareness can be fostered through pride in consuming local food. This can be applied in farmer group organizations as education for horticultural farmers in surviving the global food crisis (Nasikh et al. 2021; Rozi et al. 2023), which also needs to be supported by innovation and technology in the agricultural sector (Rajakumaran et al. 2024). The main livelihood of the Indonesian population is in the farming sector, which accounts for 28.64% of the population of Indonesia (BPS 2024). This makes the agricultural sector a supporting industry for the country's economy, which has an impact on state revenues. Corn plants are a sub-sector of agriculture that has a potential market for dominating domestic and export products. According to Alka et al. (2024), the integration of technology, capital, science, and accessibility is the main factor in agricultural development.

Sustainable agriculture supports ecological benefits in agricultural practices as one solution for creating a pro-environmental strategy (Can et al. 2015; Nguyen-Thi-Kim et al. 2024; Schleich et al. 2024). Environmentally friendly agricultural models are still carried out in the form of traditional agriculture by not using hazardous materials in the production process, and are based on narrow land (Giller et al. 2011; Sharma et al. 2022). This aligns with the agricultural initiatives in Nigeria, which involve converting corn into a commercial garden crop (Wossen et al. 2023). The calibration model can positively impact the growth and extensification of corn plants (Gupta et al. 2024). Modernization of technology to predict crop yields for agriculture that depends on natural conditions using Unmanned Aerial Vehicles (UAVs) technology (Demir et al. 2024). Agricultural development strategies can lead to the application of appropriate technology, increasing human resources and business efficiency (Nasikh et al. 2021).

Government policies must go through a bottom-up mechanism involving farmers in identifying their needs, both through individuals and small-scale agricultural organizations. This needs to be done in order to develop a local economy based on investment (Ayoub et al. 2023; Chen 2024; Gittins and McElwee 2024). The use of agricultural technology is very effective if managed by young people who will become the future generation of farmers (Chandra et al. 2024). Corn crop yields are highly dependent on rainfall, climate change, water management, suitability of agricultural land, and planting patterns (Banerjee et al. 2014; He et al. 2019; Rizwanullah et al. 2023; Srinivasarao et al. 2023; Bhat et al. 2024). This is inseparable from the quality of corn that will be used for feed (Jiang et al. 2024). Corn growth can be optimal if its management meets strategic factors that support corn growth so that it can increase the profit value by 102-120% (Guo et al. 2022; Xiong et al. 2022) with a trend in 2030, according to Erenstein et al. (2021) that in that year, one-third of the world's agriculture was controlled by corn plants.

Domestic corn demand in Indonesia is around 10 million tons of dry corn kernels per year, consisting of 51% as raw material for animal feed (Zaenab et al. 2025). Indonesia's corn production declined by 25% in 2020, reaching only 22.5 million tons, which poses risks to national food security and the sustainability of animal feed supply (Piona et al. 2024). South Sulawesi, recognized as a major production hub, contributes substantially with 377.7 thousand hectares of harvested land and an annual output of 1.82 million tons, including 20,023 hectares harvested in late 2021. While this potential highlights the importance of sustaining corn farming, existing studies have focused mainly on production statistics rather than strategic management and spatial mapping. Addressing this research gap is critical to enhance regional efficiency, identify suitable cultivation areas, and secure a long-term, sustainable supply of animal feed in Indonesia.

MATERIALS AND METHODS

Location and time of the study

This research was conducted in Tanralili Sub-district, which is one of the corn production centers in Maros District, South Sulawesi Province, Indonesia (Figure 1, Table 1). Tanralili Sub-district is situated in a geographical location comprising mountainous and lowland areas, and consists of 8 village governments, namely Allaere, Damai, Kurusumange, Sudirman, Leko Pancing, Purnakarya, Borong, and Toddopulia Villages. The area of Tanralili Sub-district in 2023 is 89.45 km^2 with a population of 33,939 people, consisting of 17,143 male residents and 16,796 female residents (BPS 2024). The research period starts from April to July 2024. The research location is an area that has a superior agricultural sector, especially corn farming.

Data type and source

This study uses data sources derived from primary and secondary data. The primary data used in this study are obtained from Focus Group Discussion, direct interviews, and questionnaires completed by corn farmers, ensuring accurate data collection. The secondary data used is data derived from official documents, books, research journals, and documents from related agencies.

Table 1. Research location coordinates

Station	Village	Latitude	Longitude
1	Toddopulia	E119° 39' 5,732"	S5° 6' 13,889"
2	Toddopulia	E119° 38' 16,737"	S5° 6' 28,613"
3	Purnakarya	E119° 37' 28,014"	S5° 8' 22,819"
4	Purnakarya	E119° 36' 33,235"	S5° 8' 46,926"
5	Leko Pancing	E119° 37' 28,213"	S5° 6' 48,263"
6	Leko Pancing	E119° 37' 18,167"	S5° 7' 28,977"
7	Kurusumange	E119° 34' 27,146"	S5° 5' 52,109"
8	Kurusumange	E119° 35' 3,276"	S5° 6' 17,848"
9	Sudirman	E119° 35' 55,092"	S5° 5' 47,902"
10	Sudirman	E119° 35' 56,187"	S5° 5' 24,017"
11	Damai	E119° 35' 18,874"	S5° 4' 34,415"
12	Damai	E119° 36' 5,320"	S5° 4' 35,621"
13	Borong	E119° 36' 45,298"	S5° 4' 7,820"
14	Borong	E119° 37' 8,781"	S5° 4' 34,041"
15	Allaere	E119° 35' 46,325"	S5° 3' 20,335"
16	Allaere	E119° 36' 26,047"	S5° 3' 26,606"

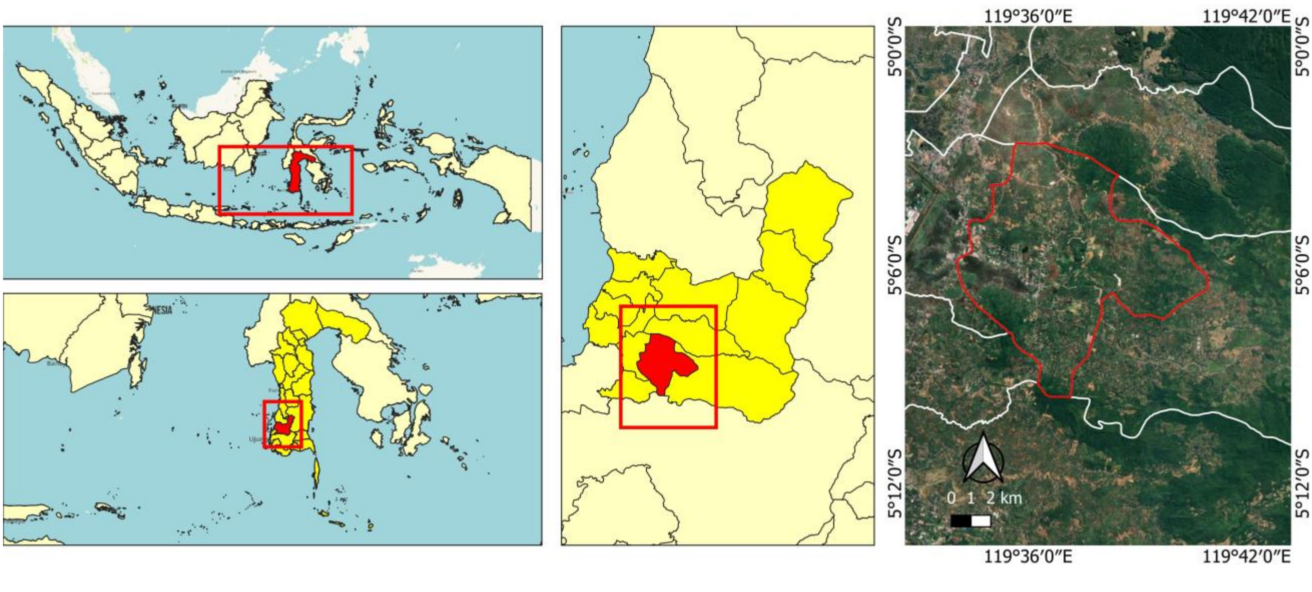

Figure 1. Map of research locations in Maros District, South Sulawesi, Indonesia

Data collection method

There are three methods used in data collection. First, the observation method is a method of collecting data by conducting direct observation of the object being studied. The following method involves a Focus Group Discussion and interview conducted directly with corn farmers, using questions and questionnaires prepared in advance to meet specific data needs. This study employed a survey approach, engaging 100 corn farmers from Tanralili Sub-district as respondents. Participants were chosen using purposive sampling, focusing on villages recognized as key corn production centers. The selection criteria for respondents included diversity in age groups, farming experience, land ownership, and involvement in local farmer associations. The sample size was determined based on the need for adequate socio-economic representation of the community, adhering to the recommended minimum sample proportion (20-25% of the population) for agricultural surveys in Indonesia, as suggested by Arikunto (2006), and applying the Slovin formula where population data were available. Spatial classification results from ArcGIS and Random Forest were validated against field data using a confusion matrix (with a 70:30 train-test split), achieving 89.6% accuracy and a Kappa of 0.84. Additional variables like NDVI, surface temperature, and soil were used for model triangulation. Validation points were randomly chosen across priority zones and checked through field surveys, ensuring even coverage to minimize spatial bias. The last method employed is the recording and documentation method, which involves recording and documenting information from all sources that can enrich the study in the research. A total of 100 corn farmers from Tanralili Sub-district participated in this study. Data collection employed a mixed-method approach, combining quantitative surveys with qualitative insights obtained through Focus Group Discussions (FGDs).

The socio-economic characteristics of respondents highlight key considerations for corn farming strategies in Tanralili Sub-district. Youth participation remains limited (24% under 35), presenting an opportunity for regeneration through training and technology access. Female involvement in decision-making (18%) suggests the need for greater gender inclusion in agricultural programs. With 43% of farmers managing less than 1 hectare, strategies must align with smallholder capacities. Although 87% have over five years of experience, only 18% have received formal training, revealing a gap between practice and technical knowledge. Additionally, only 25% have access to formal credit, indicating financial constraints that may hinder diversification. These factors underscore the importance of inclusive, accessible, and support-driven development strategies (Table 2).

Data analysis

Analysis of the mapping of potential corn plants in Tanralili Sub-district, Maros District

Data analysis for mapping the potential of corn plants in Tanralili Sub-district, Maros District, was carried out using spatial data analysis and social mapping by the community. The data was then processed using the Geographic Information System (ArcGIS). This method was chosen because it has high accuracy and fast processing (Tatsumi et al. 2015). Previous studies have also shown that Random Forest has the highest accuracy compared to other classification methods, and has succeeded in classifying corn plants with weeds around them with high accuracy (Gao et al. 2018; Chauhan et al. 2021). The classification accuracy results have been presented in the results section, which includes the following indicators: an overall accuracy of 89.6% and a Kappa coefficient of 0.84. Validation was carried out using a confusion matrix with a 70:30 split between training and testing datasets. The model utilized input variables such as NDVI, land surface temperature, elevation, soil characteristics, and proximity to roads. These metrics demonstrate that the classification model performs effectively and can be considered reliable for mapping corn cultivation areas in Tanralili Sub-district.

Analysis of corn farming business strategies in supporting feed availability in Maros District

The analysis used to determine the corn farming strategy in supporting feed availability in Maros District is a SWOT analysis, which is a way to design strategic planning to evaluate factors that influence efforts to achieve goals (Rangkuti 2000). SWOT analysis analyzes various factors, namely strengths, weaknesses, opportunities, and threats. The use of SWOT analysis aims to plan strategies based on existing situations and conditions. IFAS and EFAS analysis data in SWOT analysis can provide an overview of internal conditions in the form of strengths and weaknesses, as well as external conditions in the form of opportunities and threats, in formulating corn farming development strategies in Tanralili Sub-district, Maros District.

This section should explain how the research was conducted. It should be written clearly and thoroughly, containing a clear description of (i) population and sampling, (ii) data measuring and collecting, (iii) variable and data analysis. This research method should be sufficiently detailed to reproduce the described procedure. For qualitative research, please adjust this method to the scientific writing habits while considering the repeatability of the research. It was unnecessary to write standard analysis methods (e.g., F-test formula, t-test), but refer to your source. References to original methods/procedures must be stated, and all modifications of procedures (if any) should be explained. A symbol description of the model was suggested to be written in the narration.

Table 2. Respondent profile

Category	Percentage (%)
Farmers under 35 years	24%
Women as primary decision-makers	18%
Land ownership of less than 1 hectare	43%
Farming experience over 5 years	87%
Have attended agricultural training	18%
Access to formal credit or financing	25%

The evaluation approach of this research is: (i) The weighting of each internal and external factor was determined using a 4-point Likert scale, reflecting the level of importance as perceived by respondents, ranging from 1 (least important) to 4 (most important). (ii) Each factor was rated according to its relevance as a strength, weakness, opportunity, or threat within the local farming context. These ratings were established through consensus in Focus Group Discussions (FGDs) and further verified by three regional agricultural experts. (iii) Composite scores for each factor were derived by multiplying the assigned weight by its corresponding rating. (iv) To enhance reliability, validation was strengthened through triangulation involving qualitative data from in-depth interviews and direct field observations.

RESULTS AND DISCUSSION

Mapping the potential of corn plants in Tanralili Sub-district, Maros District

Tanralili Sub-district, Maros District, consists of eight villages with the potential for corn plants. ArcGIS technology can significantly improve the accuracy and efficiency of agricultural practices by offering new opportunities for optimal and sustainable crop production. Mapping potential corn crops using ArcGIS technology provides farmers with the opportunity to discover and study how crop land changes over time and space by considering the diversity of specific land characteristics with different agricultural techniques (Nawar et al. 2017).

Based on the research results, eight villages have corn farming businesses and are corn plant centres for Maros District in particular and South Sulawesi Province in general. Table 2 and Figure 2 show the total area of each village. Based on Table 3 and Figure 2, the potential area of corn plantations in Tanralili Sub-district, Maros District, totals 2,667.45 ha. Corn plays an important role in global food security, as the main source of nutrition for livestock as well as an important raw material for various industrial applications (Saritha et al. 2020). Corn plays an important role as it serves as a raw material for various industries, making corn a significant contributor to the global agricultural economy (Bell-Gam et al. 2021). Corn is one of the most widely cultivated crops throughout the world and serves as the main staple food for small-scale farmers (Rashid et al. 2021). The village with the largest corn plantation area is Toddopulia Village, with an area of 502.91 ha. This potential is enormous if developed according to the right strategy.

The dynamics at the local level are reflected in several recent studies. For instance, research conducted in Java by Prasetyo and Firdauzi (2023) emphasized that environmental and socio-economic conditions greatly influence the success of empowerment initiatives, particularly when there is strong community involvement. Similarly, Wijayanto and Lestari (2022) found that although the Farmer Card Program in Central Java improved the speed of fertilizer distribution, it continued to encounter challenges related to verifying farmers' actual needs and ensuring equitable access.

The total area of corn cultivation mapped in Tanralili Sub-district was 2,667.45 hectares, with Toddopulia Village accounting for the largest share at 502.91 hectares. Over the years 2021 to 2023, production showed variability attributed to factors like climate fluctuations and market influences. These variations reflect patterns seen in similar farming regions in Indonesia and globally, where seasonal weather changes and price instability influence yields (Banerjee et al. 2014; He et al. 2019).

Figures 3 and 4 show that Toddopulia Village is one of the largest centers of corn production among other villages in Tanralili Sub-district. Figure 5 shows the potential for corn plants in Maros District produced from Tanralili Sub-district.

Table 3. Total area of corn plantation in each village in Tanralili Sub-district, Maros District, South Sulawesi, Indonesia

Village	Land area (ha)
Allaere	401.65
Damai	441.78
Kurusumange	418.79
Sudirman	56.83
Leko Pancing	315.43
Purnakarya	308.49
Borong	221.57
Toddopulia	502.91
Total Area	2667.45

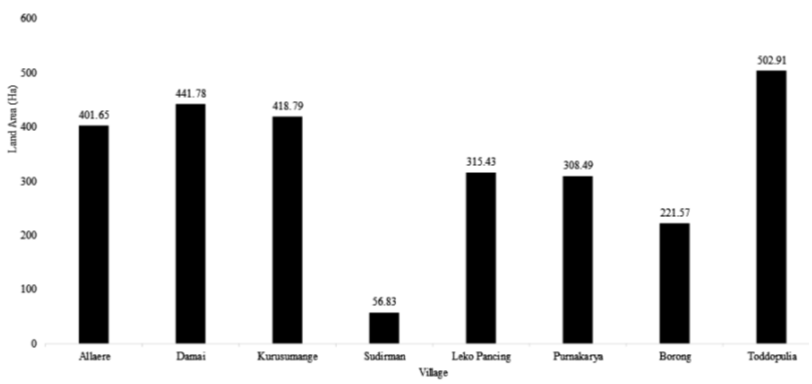

Figure 2. Level of corn plantation area in each village in Tanralili Sub-district, Maros District, South Sulawesi, Indonesia

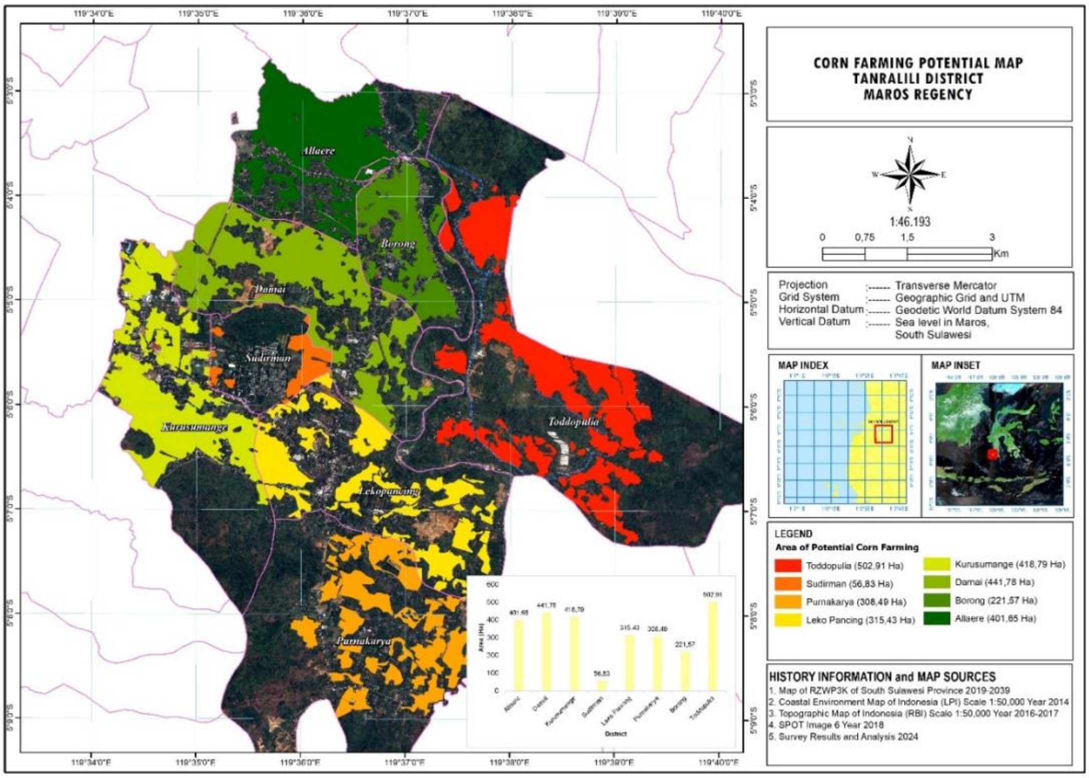

Figure 3. Corn farming potential map for each village in Tanralili Sub-district, Maros District, South Sulawesi, Indonesia

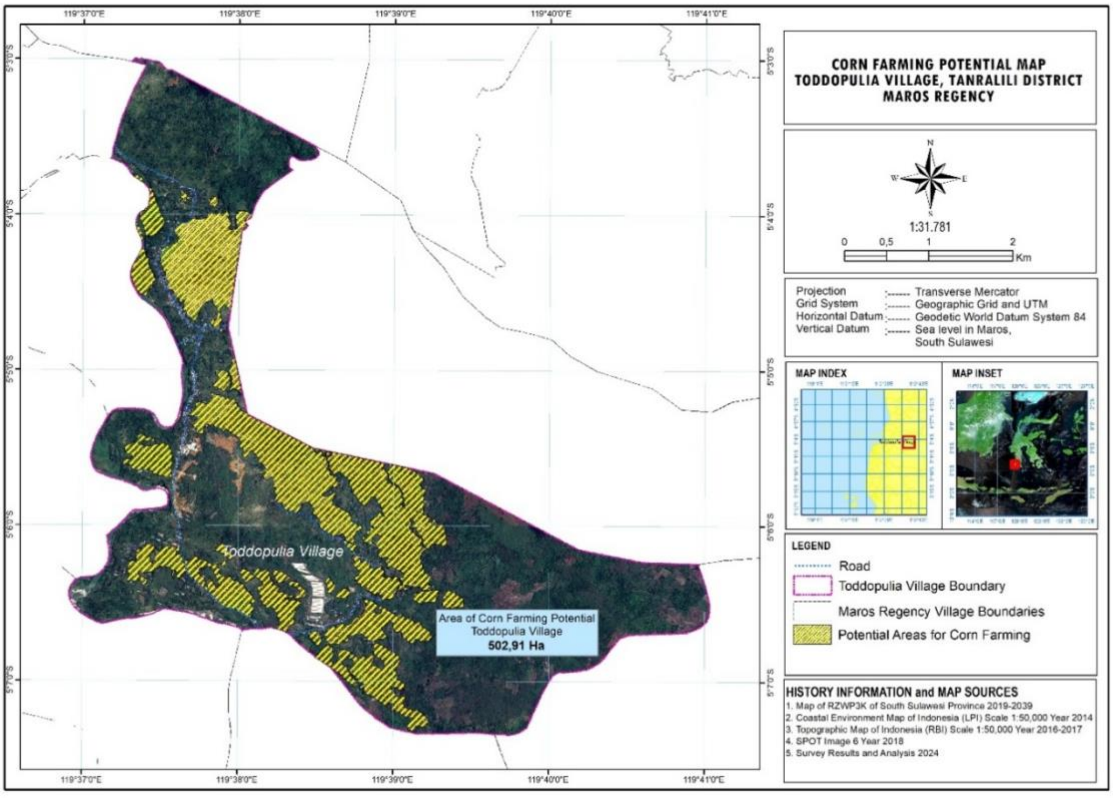

Figure 4. Map of the largest corn farming potential in Toddopulia Village, Tanralili Sub-district, Maros District, South Sulawesi, Indonesia

Based on the diagram presented in Figure 5, it can be seen that corn crop production in Tanralili Sub-district, Maros District, is 56.04 quintals/ha in 2021, 59 quintals/ha in 2022, and 53.17 quintals/ha in 2023. Based on this, it can be analyzed that the instability of corn production over the past 3 years in this area is influenced by several factors, which cause production to fluctuate, sometimes increasing and also decreasing. This, of course, requires the right development strategy to produce sustainable corn crops by maximizing existing potential.

The Green Revolution, driven by technology, has significantly increased food production in Indonesia, including Maros District. Tanralili Sub-district uses an alternative approach to corn production that promises to increase crop and livestock yields while upholding environmental sustainability. The period of agricultural transformation, characterized by the introduction of superior crop varieties and modern agricultural practices, had a significant impact on global food production at the end of the 20th century (Swastika et al. 2024).

Sustainability indicators outlined in the updated abstract and discussion section include the following:

Economic aspect: The annual income of corn farmers in Maros District falls between IDR 25 million and IDR 40 million per household, with a Revenue-to-Cost (R/C) ratio of 6.27, demonstrating that corn farming is both highly profitable and economically viable in the long term.

Ecological aspect: Corn output in South Sulawesi, particularly in Maros, experienced a 10.34% growth from 2023 to 2024, accompanied by a 5.07% rise in the harvested area—highlighting enhanced ecological productivity and land-use sustainability.

Social aspect: Strengthening of local institutional capacity is evident through the active role of farmer groups and the presence of a corn seed processing facility in Maros with a production capacity of 1,000 tons per year—both of which support regional feed self-sufficiency and social resilience.

Spatial zones were determined by overlaying the results of the ArcGIS and Random Forest classification with crop yield data, resulting in three strategic zones (Figure 6).

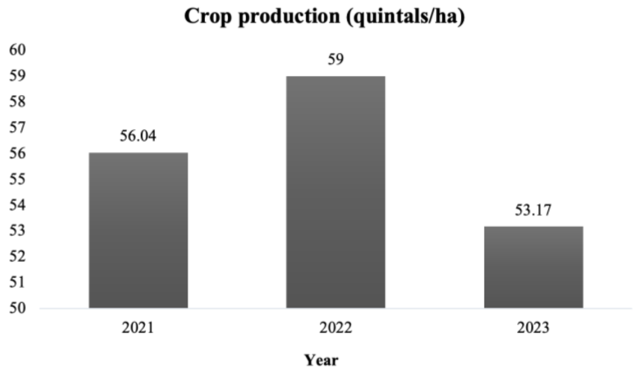

Figure 5. Corn production in Tanralili Sub-district, Maros District, South Sulawesi, Indonesia

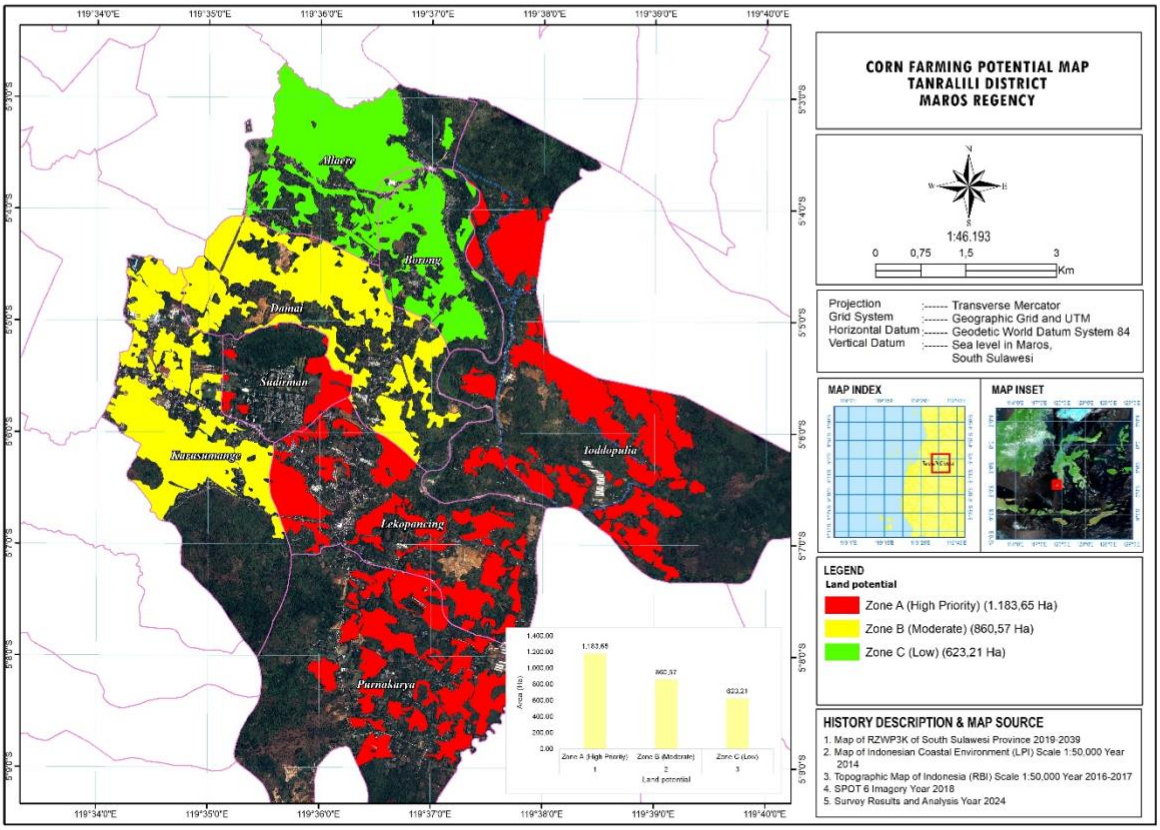

Figure 6. Map of corn farming potential based on strategic zones in Tanralili Sub-district, Maros District. South Sulawesi, Indonesia

Zone A (high priority): Extensive areas with stable yields, suitable for intensification and access to financing.

Zone B (moderate priority): Medium-sized areas with yield fluctuations, recommended for training and technological support.

Zone C (low priority): Small or marginal lands, suggested for crop rotation or development of alternative livelihoods.

This zoning was then used to enhance the SWOT-based diversification strategy (Quadrant III), allowing interventions to be tailored to the specific characteristics of each zone.

Corn farming business strategy to support feed availability in Maros District

Internal and external factors of corn farming in Tanralili Sub-district, Maros District

Corn farming development is an activity oriented towards increasing production results and business performance, as determined by the cultivation techniques applied by farmers and traders, who are the leading actors supporting the growth and development of farming businesses in Toddopulia Village. Based on respondent data, corn farming in Tanralili Sub-district incurs an average production cost of ± IDR 7.5 million/ha, with yields around 56 quintals/ha and a selling price of IDR 5,000-5,500/kg. This generates a gross income of IDR 28-30.8 million and a net profit of IDR 20.5-23.3 million per hectare. The R/C ratio of 3.7-4.1 indicates high profitability. These figures confirm that corn farming is economically viable and holds potential for expansion through better market access, input efficiency, and financial support.

Corn farming carried out by farmers is closely related to factors originating from within the farming business (internal) and the farming business environment (external). It influences production and sustainable farming business development. Internal and external factors of corn farming in Tanralili Sub-district obtained through respondent interviews can be seen in Table 4.

Previous research reports that the development of corn farming has significantly increased food productivity and farmer income, thereby lifting people in many countries out of poverty and contributing to economic growth (John and Babu 2021). Internal factors influencing corn farming include land capabilities, productivity, and farmers' knowledge of technology use. Corn farmers who are able to make maximum use of technology will produce better harvests. On the other hand, small farmers are still left behind, and increasingly marginalized, because they are unable to apply technology and lack access to transportation. Internal factors lead to a decrease in the prices of commodities produced, as well as an increase in the prices of production inputs. In addition, the Green Revolution is claimed to have reduced employment opportunities in rural areas. Internal and external factors based on interviews in Tanralili Sub-district show various conditions that influence corn crop yields.

The internal and external factors obtained were then classified to determine the strengths, weaknesses, opportunities, and threats in corn farming in Tanralili Sub-district. The identification results are in Table 5. Based on the classification of internal and external factors, specific conclusions can be drawn in Table 6.

Table 4. Results of identification of internal and external factors of corn farming business in Tanralili Sub-district, Maros District, South Sulawesi, Indonesia

Internal factors	External factors
1. Availability of ample land	1. Government policy support
2. Existence of agricultural institutions (farmer groups)	2. High market demand
3. Experience in farming	3. Corn production centers
4. Land easily accessible by vehicles	4. Increasing livestock feed needs
5. Lack of understanding regarding farming	5. Unpredictable climate conditions
6. Low productivity	6. Pest and disease attacks
7. The use of agricultural technology is still lacking	7. High prices of production inputs
8. Limited capital	8. Fluctuations in production prices

Table 5. Classification of internal factors (strengths and weaknesses) and external factors (opportunities and threats) in corn farming in Tanralili Sub-district

Strengths	Weakness	Opportunities	Threats
1. Availability of ample land	1. Lack of understanding regarding farming	1. Government policy support	1. Unpredictable climate conditions
2. Existence of agricultural institutions (farmer groups)	2. Low productivity	2. High market demand	2. Pest and disease attacks
3. Experience in farming	3. Lack of use of agricultural technology	3. Corn production center	3. High prices of production inputs
4. Land easily accessible by vehicles	4. Limited capital	4. Increasing demand for animal feed	4. Fluctuations in production prices

Table 6. Internal and external factor specifications

Strengths	Weakness	Opportunities	Threats
1. Farmers' experience in maize cultivation (87% of respondents have more than 5 years of experience) 2. Adequate availability of agricultural land (average 1.5 ha per farmer) 3. Availability of family labor (65% of respondents utilize family labor) 4. Strong social networks and farmer groups (70% of respondents are members of farmer associations)	1. Limited access to capital (reported by 75% of respondents) 2. Low level of technology adoption (only 28% of respondents use modern technologies) 3. Limited access to training and technical assistance (82% of respondents have never participated in recent training) 4. Inadequate storage facilities, leading to post-harvest losses (reported by 62% of respondents)	1. Increasing market demand for maize (10% price increase trend over the past two years) 2. Government support through subsidized seed and fertilizer programs (80% of farmers receive seed subsidies) 3. Potential partnerships with the livestock feed industry 4. Access to new markets through digital platforms and local cooperatives (reported by 40% of farmers as a new opportunity)	1. Climate uncertainty (54% of respondents reported crop failure due to off-season rainfall in the past three years), ease attacks 2. Fluctuating fertilizer prices (15–25% price increase in the past year) 3. Pest and disease outbreaks (fall armyworm infestations reported on 60% of respondents' farmland) 4. Increased competition from imported maize products (reported concern by 48% of respondents)

Based on the analysis of internal and external factors (Tables 5 and 6), it was found that the majority of farmers (87%) have considerable experience in maize cultivation, which represents an important strength in supporting farm development. However, limited access to capital — experienced by 75% of respondents — remains a significant constraint to increasing productivity. On the external side, market opportunities remain strong, with a 10% price increase trend over the past two years. However, climate uncertainty poses a significant threat, as 54% of farmers reported experiencing crop failure due to unpredictable weather patterns. Key internal contributors to successful corn farming included strong farmer organizations and institutional support, which have been linked to enhanced productivity and resilience (Goodwin et al. 2022). Nevertheless, challenges like limited technological uptake and restricted capital access remain prevalent, echoing issues found in rural agricultural communities elsewhere (Nasikh et al. 2021; Chandra et al. 2024). On the external front, robust market demand and favorable government policies provide fertile ground for growth.

Corn farming business development strategy in Tanralili Sub-district, Maros District

Corn farming in Toddopulia Village needs to be developed using a participatory approach and technological support. The participatory approach aims to enable farmers to actively understand their living conditions and participate in decision-making so that adequate plans and actions are created. Technological support is needed to make agricultural businesses more effective and efficient, thereby increasing production. In developing farming businesses, strategic planning involves analyzing key factors and adjusting them to current conditions. With the grouping of internal and external factors of corn farming in Tanralili Sub-district previously (Table 3), the analysis based on the IFAS (Internal strategic factor analysis summary) and EFAS (External strategic factor analysis summary) tables of existing factors can be carried out to assist in assessing and presenting internal and external factors that have been obtained based on current conditions. The results of the analysis of corn farming development strategies in Tanralili Sub-district based on the IFAS and EFAS tables can be seen in Tables 7 and 8

Based on Table 7, the results of the internal factor analysis show that the greatest strength of corn farming in Tanralili Sub-district is the existence of agricultural institutions (farmer groups), with a value of 0.55. In contrast, the main weakness of corn farming in this village is the lack of use of agricultural technology, with a value of 0.34. The total value in this analysis is 3.60. The knowledge of farmer groups combined with experience is a comprehensive strategic step from institutions that can help facilitate joint learning and design policy interventions to support a more resilient agricultural system (Goodwin et al. 2022). The level of farmer awareness regarding the use of technology is still low due to limited technical assistance regarding risk management (OECD 2018).

Table 8 shows the results of the external factor analysis of corn farming in Tanralili Sub-district. The main opportunities from the analysis results are in the four opportunity factors, including government policy support, high market demand, corn production centers, and high livestock feed needs, with a value of 0.52. In contrast, the main threat to corn farming in Tanralili Sub-district is the factor of production price fluctuations, with a value of 3.23. The total value of the external factor analysis of corn farming in Tanralili Sub-district is 4.05. The use of agricultural machinery can reduce farming costs and provide profits for farmers, thereby enabling effective production (Aldillah 2016). Government policy support for corn production centers can be an opportunity to increase corn farming. Apart from that, the development of agricultural machinery in Indonesia generally requires good mapping and institutions to increase its effectiveness (Sahara et al. 2024).

Table 7. IFAS table corn farming business development strategy in Tanralili Sub-district, Maros District, South Sulawesi, Indonesia

Internal factor	Weight	Rate	Weight x Rate
Strength (S)			
Availability of sample land	0.13	3.93	0.54
Existence of agricultural institutions (farmer groups)	0.14	3.96	0.55
Experience in farming	0.11	3.23	0.36
Land easily accessible by vehicles	0.09	2.56	0.23
Weakness (W)			
Lack of understanding regarding farming	0.13	3.8	0.51
Low productivity	0.13	3.8	0.51
Lack of use of agricultural technology	0.11	3.13	0.35
Limited capital	0.13	3.9	0.54
Total	1.00	28.33	3.60
Difference			-0.19

Table 8. EFAS table corn farming business development strategy in Tanralili Sub-district, Maros District, South Sulawesi, Indonesia

External factor	Weight	Rate	Weight x Rate
Opportunity (O)			
Government policy support	0.13	4	0.52
High market demand	0.13	4	0.52
Corn production center	0.13	4	0.52
Increasing demand for animal feed	0.13	4	0.52
Threat (T)			
Unpredictable climate conditions	0.12	3.86	0.49
Pest and disease attacks	0.11	3.6	0.42
High prices of production inputs	0.12	3.86	0.49
Fluctuations in production prices	0.10	3.23	0.34
Total	1.00	30.56	4.05
Difference			0.13

The values obtained from the IFAS and EFAS tables are used in the SWOT analysis to determine the quadrant position of corn farming in Toddopulia Village. In the SWOT diagram, there are several divisions of quadrant positions, namely Quadrant I (positive, positive), which indicates a strong and potential organization; Quadrant II (positive, negative), which means a strong organization but faces significant challenges; Quadrant III (negative, positive) indicates a weak organization but has excellent opportunities and Quadrant IV (negative, negative) which indicates a weak organization and faces significant challenges. The IFAS and EFAS tables (Tables 6 and 7) show that the difference obtained from the calculation of the weight and rating of each internal and external factor in corn farming in Toddopulia Village is -0.19 (IFAS) and 0.13 (EFAS). The quadrant position of corn farming in Toddopulia Village, based on the results of the IFAS and EFAS Tables, can be seen in Figure 7.

The SWOT diagram in Figure 7 shows that the development of corn farming in Tanralili Sub-district is in quadrant III, namely the diversification position. This quadrant indicates that an organization retains internal strength despite facing various threats. Consequently, the implemented strategy utilizes this strength to overcome threats through diversification. Based on this, it is evident that the farming business managed by corn farmers is in a good position, but it still faces significant challenges. Consequently, the corn farming business is not operating effectively, and a suitable strategy is necessary for its development. Determining the corn farming business development strategy involves formulating a SWOT matrix that incorporates all internal and external factors. This matrix clearly outlines how to adjust opportunities and threats to the farming business's internal strengths and weaknesses. In addition, human resources in the agricultural sector are decreasing in number (Johnson and Cheein 2023), so alternative strategies are needed to attract human resources in order to increase land and labor productivity, as well as overcome labor shortages. This target can be achieved through the development of modern agriculture using machines.

In the SWOT matrix, four cells can potentially be alternative strategies for corn farming in Tanralili Sub-district, namely the S-O, W-O, S-T, and W-T strategies. The results of the analysis of the internal and external factors of farming are then divided into four main factors, namely strengths, weaknesses, opportunities, and threats. Strengths and weaknesses as internal factors of agriculture are combined with opportunities and threats as external factors of farming to produce alternative corn farming in Tanralili Sub-district (Table 9).

The combination of internal and external factors of corn farming in Tanralili Sub-district produces several alternative farming business development strategies that can be implemented in the process of developing corn farming in Tanralili Sub-district (Table 9), with the following description:

S-O strategy: (a) Increase production by maximizing the potential and reach of existing land to meet market and animal feed needs. (b) Utilization of government policies through farmer groups to expand access and cooperation in distributing production results.

W-O strategy: (a) Government policies should be utilized to conduct appropriate training to increase farmers' understanding of corn cultivation and the application of agricultural technology. (b) Capital for corn farming can be provided through People's Business Credit (KUR) or other credits.

Table 9. SWOT matrix of the corn farming business in Tanralili Sub-district, Maros District, South Sulawesi, Indonesia

Internal factor / **External factor**	**Strength (S)**	**Weakness (W)**
	1. Availability of ample land 2. Existence of agricultural institutions (farmer groups) 3. Experience in farming 4. Land easily accessible by vehicles	1. Lack of understanding regarding farming 2. Low productivity 3. Lack of use of agricultural technology 4. Limited capital
Opportunity (O) 1. Government policy support 2. High market demand 3. Corn production center 4. Increasing demand for animal feed	**S-O strategy** 1. Increase production by maximizing the potential and reach of existing land to meet market and animal feed needs. 2. Utilization of government policies through farmer groups to expand access and cooperation in distributing production.	**W-O strategy** 1. Government policies should be utilized to conduct appropriate training to increase farmers' understanding of corn cultivation and the application of agricultural technology. 2. Capital for corn farming can be provided through People's Business Credit (KUR) or other credits.
Threats (T) 1. Unpredictable climate conditions 2. Pest and disease attacks 3. High prices of production inputs 4. Fluctuations in production prices	**S-T strategy** 1. Farmers' experience in farming can help them overcome pest and disease attacks and anticipate uncertain climate conditions. 2. Farmer groups serve as a forum for communication and farmer development, as a container and provider of access in the distribution of production inputs and outputs, and thus maintain the stability of production prices.	**W-T strategy** 1. Assisting in the form of superior varieties and high-selling values that are resistant to pests and diseases, and resistant to climate change. 2. Creating appropriate agricultural technology to reduce input prices and overcome limitations in the use of agricultural technology.

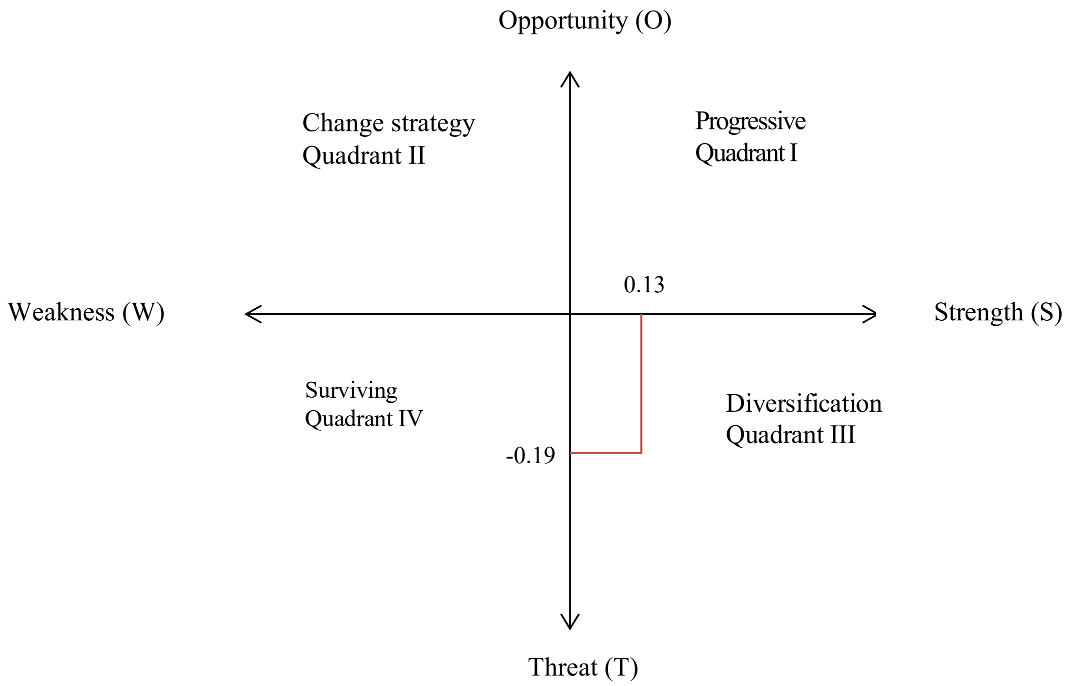

Figure 7. SWOT analysis diagram

S-T strategy: (a) Farmers' experience in farming can help them overcome pest and disease attacks and anticipate uncertain climate conditions. (b) Farmer groups serve as a forum for communication and farmer development, as a container and provider of access to the distribution of production inputs and outputs, and to maintain the stability of production prices.

W-T strategy: (a) Provision of assistance in the form of superior varieties with high sales value that are resistant to pests and diseases, and resistant to climate change. (b) Creating appropriate agricultural technology to reduce input prices and overcome limitations in the use of agricultural technology.

This study faces several limitations. Corn production data is affected by seasonal weather and climate variability, limiting prediction accuracy. Low adoption of agricultural technology and digital literacy among farmers impacted data consistency. Additionally, satellite image resolution and limited secondary data reduced spatial analysis precision. Thus, caution is needed when applying these findings to other regions with different socio-ecological conditions.

These findings imply that efforts to improve farmer education, expand credit availability, and encourage appropriate technology adoption are critical. For instance, combining corn cultivation with poultry farming could diversify income and buffer against market shocks, fostering sustainable livelihoods. Policy priorities should include better infrastructure, participatory decision-making, and strengthened extension services to accelerate technological adoption. In summary, the research offers valuable insight for crafting diversified cropping systems and innovative agribusiness approaches that maintain animal feed supplies while tackling environmental and economic challenges in Tanralili Sub-district. This aligns with national plans for agricultural development and supports wider goals of food security in the region.

In conclusion, mapping of corn cropland in Tanralili Sub-district revealed a total of 2,667.45 ha, with yields ranging between 53.17 and 59 quintals per hectare, which are comparable to both provincial and national averages. SWOT-QSPM analysis identified farmer groups as a key strength, limited use of agricultural technology as a significant weakness, and government support and market demand as primary opportunities, while price fluctuations remain the main threat. The recommended development strategy is diversification, particularly through feed product innovations targeting the poultry sector. Practical options include integrating corn farming with poultry production, processing residues into feed pellets, and adopting crop rotation with legumes, which together can strengthen farmer livelihoods and support sustainable feed supply chains.

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