Plant Sci. Arc.
Plant Science Archives
An International Journal of Plant Biology

Survey Research Article
ISSN 2518-6965
Journal Homepage: www.plantarc.com

Evaluation of Land Suitability for Corn (Zea Mays L) Crops in Basi Dondo District, Tolitoli Regency

Lukman*, Adnan and Kahar

Department of Agrotechnology, Faculty of Agriculture, University of Madako Tolitoli, Indonesia

Citation: Lukman, Adnan and Kahar (2025). Evaluation of Land Suitability for Corn (*Zea Mays* L) Crops in Basi Dondo District, Tolitoli Regency. **DOI: https://doi.org/10.51470/PSA.2025.10.1.18**

Corresponding Author: **Lukman** | E-Mail: **(iffahmasayu02@gmail.com)**

Received 24 November 2024 | Revised 29 December 2024 | Accepted 15 January 2025 | Available Online 13 February 2025

ABSTRACT

Corn (Zea mays L) is a food ingredient that contains high levels of carbohydrates and calories so it can be a solution to the problem of food security and feed needs for livestock. This research aims to evaluate the suitability of corn plantations in Basi Dondo District, Tolitoli Regency, Indonesia. This research was carried out using survey methods and purposive sampling on five land map units (LMU) using ArcGIS The results of the research show that the area is classified as quite suitable (S2) to very suitable (S1) land class, but all LMUs have different limiting factors. Very extreme, namely high rainfall in class (N). with a total land area of 429.63 Ha. Limiting factors Rainfall (N) LMU 1 (31.40 Ha), LMU 2 (192.17 Ha), LMU 3 (18.65 Ha) limiting factors (N) Rainfall, Nutrient Retention and Slope (S2), LMU 4 (176.69 Ha) and SPL 5 (10.71 Ha) have limiting factors for rainfall and nutrient retention. The limiting factors for rainfall cannot be corrected to increase to level (S3) but for nutrient retention and slope can be corrected to (S1) by adding fertilizer and making terracing.

Keywords: *Drainage, land evaluation, land suitability, nutrient retention, Zea mays L.*

Introduction

The development of dry land agriculture in Indonesia has enormous hopes in realizing resilient agriculture in the future considering the potential and land area is much larger than wet land. Corn is an agricultural commodity that is needed in quite large quantities, so it is not surprising that the government has decided that corn is an imported commodity. It is estimated that more than 58% of domestic corn needs are used for feed, while only around 30% is used for food, and the rest is for other industrial needs and seeds [1] One of the determining factors in the availability of corn is the readiness of the land for cultivation. Evaluation of land suitability is very necessary for planning productive and sustainable land use. The use of computer-based technology to support planning is increasingly necessary to analyze, manipulate, and present information in tabular and spatial form. Create a model that provides a description, explanation, and estimate of a factual condition. [2] One technology for evaluation is a method GIS (Geographic Information System), through GIS, can make it easier to match the level of suitability according to the growing requirements of corn plants. Land evaluation is the process of assessing the potential of land for certain land uses ([3] and evaluating a diversity of factors Land evaluation has an important role in the potential for agricultural efficiency and sustainable land use [4]. Inappropriate land use, apart from causing land damage, can also cause socio-economic problems, and can even destroy a previously existing culture. On the other hand, appropriate land use is the first step to support sustainable land conservation programs.

Tolitoli Regency with a land use area of 772,323 Ha (14 611 paddy fields and 757 712 Ha non-rice fields) [5]. In connection with this, research was conducted on evaluating land suitability for corn crops in Basi Dondo District, Tolitoli Regency. This research aims to evaluate the level of land suitability for corn crops in Basi Dondo District, Tolitoli Regency.

Methodology

The method used in this research is 2 things, namely the interview method and sampling using the purposive sampling method, which is based on the needs and objectives of making maps and land suitability analysis which is used to obtain representative elements of data on each land unit using GIS (Geography Information System).

Data retrieval

To collect primary and secondary data, several data collection techniques were used, namely:

1. preparation and creation of work maps
2. Field survey
3.Carry out an inventory of potential resource data and information.
4. Analyze soil samples in the laboratory
5.Prepare a map of potential resources, opportunities, and regional development areas.
6. Data management and report preparation

Activities carried out at this preparation stage include arranging field surveys, collecting secondary data (both numerical data and spatial data or base maps) related to the implementation of the study, providing tools, materials, and plans for placing observation and collecting soil samples and area coverage. The base map is used as a guide in determining the boundaries of the mapping planning area and as a guide for determining observation points and taking soil samples because the map produced from this study is classified as a detailed scale.

The reference sources for collecting data are: Administrative maps, land cover maps, soil maps, slope maps, rainfall maps, and climate maps. Other data required for land suitability analysis is in the form of physical field data to obtain the results of soil chemical analysis, both intact soil and incomplete soil, using a hoe, soil drill, and sample ring.

DOI: https://doi.org/10.51470/PSA.2025.10.1.18

Data analysis

Analysis of Soil Physical and Chemical Properties

Analysis of soil samples/samples was carried out at the Soil Laboratory, Faculty of Agriculture, Tadulako University, Palu, namely to determine the texture (clay, sand, and dust), while soil chemistry consisted of macro and micronutrients: Nitrogen (N Total), Phosphorus (P2O5), Potassium (K2O), Soil acidity (pH), Cation Exchange Capacity (CEC) and Organic C [6].

GIS analysis

GIS analysis is using various types of maps to view or match fields or areas that will be research objects according to certain objectives [7]. Some of the map attributes are overlaid to make it easier to determine land map units or land units because Each land unit has its properties and characteristics ([8]

Land Suitability Evaluation

The method used in evaluating land suitability is the limiting factor method, namely, each land quality is arranged sequentially from the best (lightest limiting factor) to the worst (the most severe limiting factor), and each land quality is arranged in a criteria table.

The optimum land quality for plant needs or land use is the limit for the most suitable land suitability class (S1). Meanwhile, land quality that is below optimum is the limit of the land suitability class between the quite suitable class (S2), and/or marginally suitable (S3). Outside these limits are lands that are physically classified as unsuitable (N) [9].

Parameters in Land Evaluation

Temperature

Temperature or temperature is the degree of hot or cold which is measured based on a certain scale using a thermometer. Land characteristics from the Soil Temperature (tc) variable used in assessing land suitability classes are determined from the average temperature characteristics.

Rainfall

Rainfall is the height of rainwater (in millimeters) that is received on the surface before experiencing surface flow and infiltration or seepage into the ground. This needs to be considered to increase corn production [10].

Humidity

Humidity is the amount of water vapor in the air. Humidity can be seen from the climate classification of a place. According to Schmidt and Ferguson, the type of rain in an area is determined based on the Q value, namely by considering the number of dry months and wet months in one year multiplied by 100%.

Soil Drainage

Soil drainage assessment consists of Fast, Somewhat Fast, Good, Somewhat Good, Somewhat Inhibited, Inhibited, Very Inhibited.

Soil Texture

It is the relative ratio of grains of sand, dust, and clay.

Nutrient Availability

What is measured in nutrient availability are C (%), N (%), C/N, P2O5 HCl 25% (mg/100 gr), K2O (Morgan) (ppm), P2O5 Bray (ppm), CEC (col(+)/kg clay), C-organic [11].

Results and Discussion

Result

In determining the research location, the GIS (Geographic Information System) method was used based on climate, soil, topography, and surface water resources [3]; [12], as well as slope and soil type [13], some of these parameters are limiting factors in corn cultivation [14] ; [15].

The results of the analysis of actual and potential land suitability maps in land map units (LMU) 1 - 5 for the area of corn plant development can be seen in the map image below:

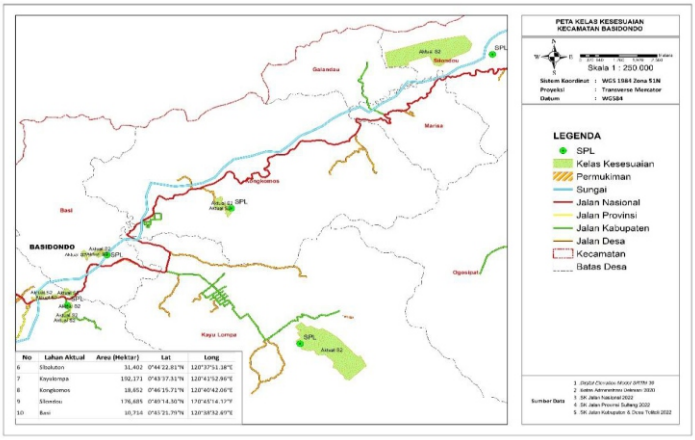

Figure 1. Map of actual land suitability and potential for corn plant development in Basi Dondo District

Table 2. Limiting factors for the development of Corn (Zea mays L) plants in Basi Dondo District

LMU	Land Suitability Class	Area (Ha)	Limiting Factors	Additions/improvements
LMU 1	N	31,40	Rainfall	Cannot be repaired
LMU 2	N	192,17	Rainfall	Cannot be repaired
LMU 3	N, S2	18,65	Rainfall Nutrient retention Kelerengan	Cannot be repaired N-Total, K_2O
LMU 4	N, S3	176,69	Rainfall Nutrient retention	KTK liat (cmol), N-Total, K_2O dan C Organik
LMU 5	N, S2	10,71	Rainfall Nutrient retention	N-Total, P_2O_5
	Aktual N			Potential S1

Texture

Texture is a characteristic of a soil type that cannot be changed by agronomic treatment, but can only be done by managing it so that the soil moisture is optimal. If the soil contains a lot of clay, the soil can store large amounts of water, but the water does not easily seep into the soil because water will flow more easily on the surface and cause erosion, while sandy soil is more easily seeped and cannot store water. Soil texture is said to be good if the composition of sand, dust, and clay is almost balanced. This kind of soil is called clay soil. The finer the grains of sand, the stronger thq e soil holds water and nutrients. The texture suitable for corn plants is fine, somewhat fine, and medium [9]. The results of the actual suitability analysis at the research location are at a fine, rather fine level so it is classified as very suitable (S1) at LMU 5 Villages so that the texture in this area is not a limiting factor.

Drainage

Soil drainage is the speed at which water absorbs from the soil or the condition of the soil which indicates the duration and frequency of water saturation. Poor drainage makes it difficult for water to seep into the soil or it absorbs very easily so the water disappears quickly. The relationship between these parameters and climate parameters influences groundwater flow ([23]; [24].

Drainage suitability is very necessary for plants, [25] including for corn cultivation in Basi Dondo District, the results of the land evaluation are included in suitability class S1, namely very suitable**.**

Cation Exchange Capacity

Cation exchange capacity (CEC) is defined as the capacity of the soil to absorb and exchange cations in the soil. Soil colloids can absorb and exchange several cations, including Ca, Mg, K, Na, NH4, Al, Fe, and H. Bases that can be exchanged include Potassium (K), Sodium (Na), Calcium (Ca), and Magnesium (Mg) [26] Cation exchange capacity (CEC) is a chemical property of soil that is closely related to soil fertility. Soil with a high CEC can absorb and provide nutrients better than soil with a low CEC because these nutrients are not easily washed away by water [27]. The average CEC at the research location was classified as quite suitable (S2/SPL 2 and 4) ≤16 and very suitable (S1/SPL1.3) namely 22.93. To improve this limiting factor, it is necessary to limit and add organic or organic fertilizer. Soil with a high organic matter content has a higher CEC, likewise, young soil with a new level of weathering starting from soil with an advanced level of weathering has a low CEC value [28].

Soil Acidity (pH H2O)

pH is the level of soil acidity that regulates the absorption and distribution of cations by soil particles. High soil pH of less than 6 causes the elements Forfor, Calcium, Sulfur, Calcium, Magnesium, and Molybdenum to decrease rapidly, while soil pH higher than 8 will cause the elements Nitrogen, Iron, Manganese, Boron, Copper, and Zinc availability is relatively small [29]. The pH for corn plants is 5.5 – 8.2, while at the research location, the pH reaches 4.9 or marginally suitable (S3/ LMU 2) and very suitable (S1/ LMU 2,3,4 and 5) with a pH of 6.01. The way to overcome LMU 2 is by liming and adding organic materials.

C-Organic

C-organic or organic material content is plant remains that act as a reservoir for plant nutrients. The amount of organic C content in the soil can also determine the amount of organic matter content in the soil [30]. Organic matter is generally found on the surface of the soil, the amount is very small, around 3-5% but its influence is quite large on soil properties. Organic matter can function to improve soil structure, as a source of nutrients, the capacity to increase the CEC value of the soil, a source of energy for soil microorganisms, and increase the soil's ability to retain water. C-organic for corn plants is suitable > 0.4% [9] at the research location in the very suitable category (S1), namely 0.76 – 3.01%. Organic materials increase soil fertility, plant growth, and higher crop yields [31].

Efforts to Improve Limiting Factors

Based on the analysis carried out, the limiting factors include Cation Exchange Capacity, pH, and C-Organic, then the characteristics of available nutrients, namely N-total, P2O5, and K2O, while the erosion hazard characteristics are slope and actual erosion hazard. Improvement of limiting factors for drainage is by improving the irrigation system. Improving the limiting factors for nutrient retention, including cation exchange capacity, pH, and organic C, can be done by liming and adding soil organic matter. Improvements in the limiting factors for available nutrients, including N-total, P2O5, and K2O, can be done with balanced fertilization with the right dose and at the right time. Improving the limiting factors for erosion hazards which include slopes can be done by making terracing, planting parallel to contours, cultivating land according to contours, and planting ground covers.

Conclusions

Based on the research results, the suitability of land for developing corn plants in Basi Dondo District, Tolitoli Regency is as follows:

a. The overall LMU (LMU 1- 5) which is the main limiting factor is high rainfall, and is in the category of Unsuitable Class (N), while other limiting factors are nutrient retention (S2), which can be increased to (S1) and Slope (S2)

b. These limiting factors can be done by making terracing, planting cover crops, adding organic material, liming, and fertilizing.

References

1. S. Panikkai, "Analisis Ketersediaan Jagung Nasional Menuju Swasembada Dengan Pendekatan Model Dinamik," *Inform. Pertan.*, vol. 26, no. 1, p. 41, 2017, doi: 10.21082/ip.v26n1.2017.p41-48.

2. R. Wirosoedarmo *et al.*, "101338-None-E82914Ba," vol. 31, no. 1, 2011.

3. C. Han, S. Chen, Y. Yu, Z. Xu, and B. Zhu, "Evaluation of Agricultural Land Suitability Based on RS, AHP, and MEA : A Case Study in Jilin Province, China," 2021.

4. M. Rendana, S. A. Rahim, W. Mohd, R. Idris, and Z. A. Rahman, "Agricultural Land Evaluation Using GIS-Based Matching Method in Highland Areas for Oil Palm Cultivation," vol. 37, no. 1, pp. 100–110, 2022.

5. BPS, *Kaupaten Tolitoli Dalam Angka*. 2022.

6. S. O. I. Abagyeh, S. Idoga, and P. I. Agber, "Land suitability evaluation for maize (Zea mays) production in selected sites of the Mid-Benue valley, Nigeria," *Int. J. Agric. Policy Res.*, vol. 4, no. 3, pp. 46–51, 2016, [Online]. Available: http://www.journalissues.org/IJAPR/

7. B. Tashayo, A. Honarbakhsh, M. Akbari, and M. Eftekhari, "Land suitability assessment for maize farming using a GIS-AHP method for a semi- arid region, Iran," *J. Saudi Soc. Agric. Sci.*, vol. 19, no. 5, pp. 332–338, 2020, doi: 10.1016/j.jssas.2020.03.003.

8. J. Kesona, T. Silalertruksaa, and Shabbir H. Gheewala, "Land suitability class and implications to Land-Water-Food Nexus: A case of rice cultivation in Thailand," *Energy Nexus*, vol. 10, 2023.

9. D. Djaenudin, M. H., S. H., and A. Hidayat, *Petunjuk Teknis Evaluasi Lahan untuk Komoditas Pertanian*. 2011.

10. Bustami, Sufardi, and Bakhtiar, "Nutrient Uptake and Efficiency of Phosphate Fertilization and Growth of Local Varieties of Rice," *J. L. Resour. Manag.*, vol. 1, no. 2, pp. 159–170, 2012.

11. S. Rahimi, M. J. R. Martin, E. Obeysekere, D. Hellmann, X. Liu, and C. Andris, "A Geographic Information System (GIS) -Based Analysis of Social Capital Data : Landscape Factors That Correlate with Trust," pp. 1–16, doi: 10.3390/su9030365.

12. R. Elsheikh, A. R. B. Mohamed Shariff, F. Amiri, N. B. Ahmad, S. K. Balasundram, and M. A. M. Soom, "Agriculture Land Suitability Evaluator (ALSE): A decision and planning support tool for tropical and subtropical crops," *Comput. Electron. Agric.*, vol. 93, pp. 98–110, 2013, doi: 10.1016/j.compag.2013.02.003.

13. D. Freire and J. Rocha, "Evaluation of the factors explaining the use of agricultural land : A machine learning and model-agnostic approach," vol. 131, 2021, doi: 10.1016/j.ecolind.2021.108200.

14. M. Aissata, J. S. Y. Eleblu, K. Ofori, A. A. Hamani, Ousseini, and I. B. Ibrahim, "Identifying Sorghum Yield Limiting Factors and Farmer's Criteria Traits in East and Northern West Niger," *OALib*, vol. 09, no. 12, pp. 1–17, 2022, doi: 10.4236/oalib.1109543.

15. Komariah, D. P. Ariyanto, and V. A. Rachmawati, "Land suitability evaluation for sorghum (Sorghum bicolor L.) at Gunungkidul, Yogyakarta, Indonesia," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 724, no. 1, 2021, doi: 10.1088/1755-1315/724/1/012032.

16. M. Pasang Sirappa, E. D. Waas, and A. N. Susanto, "Land Suitability and Purposed Land Use of Selaru Island, West-Southeast Moluccas Regency," *J. TANAH Trop. (Journal Trop. Soils)*, vol. 15, no. 2, pp. 169–178, 2010, doi: 10.5400/jts.2010.15.2.169.

17. Sumani, Mujiyo, J. Winarno, H. Widijanto, and K. Hasanah, "Land suitability evaluation for sweet corn in third cropping period at Wonosari Village, Karanganyar, Indonesia," in *IOP Conference Series: Earth and Environmental Science*, Institute of Physics Publishing, Nov. 2018. doi: 10.1088/1755-1315/200/1/012007.

18. P. S. Patti, E. Kaya, and C. Silahooy, "ANALISIS STATUS NITROGEN TANAH DALAM KAITANNYA DENGAN SERAPAN N OLEH TANAMAN PADI SAWAH DI DESA WAIMITAL, KECAMATAN KAIRATU, KABUPATEN SERAM BAGIAN BARAT," vol. 2, no. 1, pp. 78–79, 2013.

19. A. W. Worqlula *et al.*, "Effect of climate change on land suitability for surface irrigation and irrigation potential of the shallow groundwater in Ghana," *Comput. Electron. Agric.*, vol. 157, pp. 110–125, 2019.

20. N. Herlina and A. Prasetyorini, "Effect of Climate Change on Planting Season and Productivity of Maize (Zea mays L.) in Malang Regency," *J. Ilmu Pertan. Indones.*, vol. 25, no. 1, pp. 118–128, 2020, doi: 10.18343/jipi.25.1.118.

21. A. Wahyudin, R. Ruminta, and S. A. Nursaripah, "Pertumbuhan dan hasil tanaman jagung (Zea mays L.) toleran herbisida akibat pemberian berbagai dosis herbisida kalium glifosat," *Kultivasi*, vol. 15, no. 2, pp. 86–91, 2017, doi: 10.24198/kultivasi.v15i2.11867.

22. I. and S. Wredaningrum, "ANALISIS PERUBAHAN ZONA AGROKLIMAT DAERAH ISTIMEWA YOGYAKARTA DITINJAU DARI KLASIFIKASI IKLIM MENURUT OLDEMAN Irwanda Wredaningrum," pp. 1–10, 2013.

23. M. Dawit, M. O. Dinka, O. T. Leta, and F. B. Muluneh, "Impact of climate change on land suitability for the optimization of the irrigation system in the Anger River Basin, Ethiopia," *Climate*, vol. 8, no. 9, 2020, doi: 10.3390/CLI8090097.

24. Y. A. Kassie, A. Y. Yimam, T. T. Assefa, and S. A. Belay, "Evaluating land suitability and water availability for surface irrigation in the Abbay basin of Ethiopia," *R. Soc. Open Sci.*, vol. 9, no. 12, 2022, doi: 10.1098/rsos.220674.

25. H. R. Mohammed, H. A. Alkanaani, and H. K. Alowaid, "Using GIS technology for land suitability analysis to select drainage project location: Nasiriya city south of Iraq as a case study," *J. Phys. Conf. Ser.*, vol. 1895, no. 1, 2021, doi: 10.1088/1742-6596/1895/1/012001.

26. D. A. S. D. NURSYAMSI1, K. IDRIS2, S. SABIHAM3, D.A. RACHIM3, "Sifat-Sifat Tanah Dominan yang Berpengaruh Terhadap K Tersedia pada Tanah-Tanah yang Didominasi Smektit," *J. TANAH DAN IKLIM*, pp. 13–28, 2007.

27. S. Wantasen, "Studi kualitas air irigasi dumoga di kabupaten bolaang mongondow provinsi sulawesi utara," no. 82, pp. 126–131, 2001.

28. D. S. Simanjuntak1* and Budi Hendrawan2, "All Fields of Science J-LAS," vol. 2, no. 2, pp. 549–553, 2022.

29. P. Tioner Purba, Hardian Ningsih, B. G. Abdus Salam Junaedi, and A. Junairiah, Refa Firgiyanto, *tanah dan nutrisi Tanaman*. 2021.

30. T. Sagiarti, D. Okalia, and G. Markina, "Analisis C-Organik, Nitrogen Dan C/N Tanah Pada Lahan Agrowisata Beken Jaya Di Kabupaten Kuantan Singingi," *J. AGROSAINS dan Teknol.*, vol. 5, no. 1, p. 11, 2020, doi: 10.24853/jat.5.1.11-18.

31. R. Y. H. A. N. P. Vats, "Improvement of soil health and crop production through utilization of organic wastes: A sustainable approach," *Int. J. Recycl. Org. Waste Agric.*, 2022.