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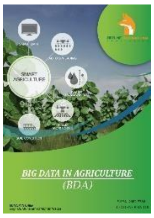

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RESEARCH ARTICLE

LAND SUITABILITY ANALAYSIS OF SESAME CROP USING GIS TECHNIQUES

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ABSTRACT

Land suitability analysis is a pre-requisite in achieving optimum utilization of the available land resources. This research aims to promote sustainable agriculture by guiding land planning, empowering local small-scale farmers through optimal sesame cultivation, and ultimately enhancing agricultural productivity in Bardaghat Municipality, furthering the goal of regional agricultural sustainability. The research utilized a comprehensive methodology, blending Pair- wise Comparison Matrix (PWCM) and Weighted Multi-Criteria Analysis with diverse biophysical criteria through Analytical Hierarchy Process (AHP). Thematic maps were generated using Remote Sensing, Geostatistics, and Geographic Information Systems. Expert input guided the assignment of weights to 3 primary criteria and 11 sub-criterion parameters, facilitating the creation of a weighted overlay tool for visualizing results. This approach aimed to assess land suitability for sesame cultivation effectively. The research findings underscore the significance of climatological factors (55.8%), topography (31.96%), and soil attributes (12.196%) in determining sesame production suitability. The land suitability map revealed that 24.29% of the study area, equivalent to 39.375 km2, was moderately suitable for sesame cultivation, while a substantial land area encompassing 75.71% (122.675 km2) was categorized as marginally suitable. Remarkably, no land was identified as unsuitable for sesame cultivation. The research excluded built-up regions, rivers, and road networks from its scope.

KEYWORDS

AHP, GIS, Land Suitability, PWCM, Sesame

1. INTRODUCTION

The method of predicting land performance over time based on particular types of usage is known as land suitability evaluation (Al-Mashreki et. al., 2015). Agricultural land suitability is a multidisciplinary field that requires key decisions to be undertaken at several levels, including identifying land use types (LUTs), assessment criteria, arranging criteria, and limits for every set of criteria (Rahman and Saha, 2008). It has been studied from soil, topography, land cover and interrelations among vegetation soil and landform. Specific soil and climatic condition require by the plant for its optimal growth. The land suitability deals with integration of land qualities and land characteristics. Using satellite data, digital maps, and computerized geospatial technologies, such as remote sensing and GIS, are highly helpful for gathering and handling of large spatiotemporal sets of information (Kingra et al., 2016). In order to put this technology in use, this study recommends using GIS to model land suitability for sesame. This could be the key to raising productivity to feed the world's growing population at a time when agricultural constraints are increasing. Land suitability assessment is thus a complex process, necessitating the simultaneous use of several decision support tools, such as Geographic Information Systems (GIS) and multi-criteria decision analysis (MCDA), which are unavoidable in determining suitable land for crop production (Malczewski, 2006).

Sesame (2n=26) is the oldest ancient oil seed, which belongs to family Pedaliaceae. It is known as queen of oil seeds because of its high quality polyunsaturated stable fatty acid, which restrains oxidative rancidity (Girmay, 2018). Sesame seeds are the good source of calcium phosphorous, iron and vitamin B,E and small amount of trace elements (Myint et al., 2020). The chemical composition of sesame shows that the seed is an important source of oil (44–63%), protein (18–25%), carbohydrate (13.5%) and ash (5%) (Yogranjan et al., 2014). Using multispectral and multitemporal Landsat photos, GIS and remote sensing technologies were employed to map the spatial distribution of land resources together with their appropriate status and current risks (Moisa et al., 2023). With the aid of GIS and a multi-criteria evaluation, this study will assess the appropriateness of the land in Bardaghat Municipality for the cultivation of sesame. The numerous research gap including low production and productivity were due to infestation of disease on standing crop. Incidence of insect and diseases, lack of irrigation facility, unsuitable soil properties, climatic condition, topography and unavailability of road and river sources for irrigation are the problems that are seem in the research area through the preliminary survey. Traditional method of Land Assessment for Sesame cultivation often lack precision and leading to suboptimal land use decisions. Natural disaster such as flooding, erosion lead to declination in crop production because of improper assessment of land (Bhandari et al., 2021). Production system is dominated by small-scale subsistence farming system largely based on low-input and low-output rain-fed agriculture (Ayalew et al., 2018).

This study focuses on the comprehensive assessment of land suitability for Sesame cultivation, employing a multi-dimensional approach encompassing soil properties, topographic characteristics, and climate parameters. The key factors examined include organic matter content, soil pH levels, nitrogen percentage, available phosphorus, available potassium, slope, aspect, elevation, temperature, precipitation, and land use and land cover mapping. Through the application of Geographic Information System (GIS) techniques, this research delineates suitable and unsuitable areas for Sesame cultivation. The findings generated from this research have significant implications for local governing bodies and policy-making institutes, aimed at enhancing Sesame crop productivity and elevating the socio-economic status of farmers within Bardaghat municipality. Additionally, GIS-based thematic maps derived from this study offer a valuable resource for a wide spectrum of stakeholders, including farmers,

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extension workers, agriculture students, and graduates, facilitating efforts to enhance sesame productivity and mitigate those research gaps in this region. The major objective of utilizing GIS in sesame cultivation is to enhance agricultural decision-making and production of sesame crop by integrating spatial data for optimized site selection, precision farming, resource management, risk assessment, and sustainable practices. This project aims at determining optimal cultivation areas by analyzing soil, climate, and topography data for sesame production. Additionally, it focuses on utilizing GIS data for precise input application, irrigation management, and pest control, optimizing resource efficiency. It helps to generate a map of the suitability of the sesame crop in Bardaghat Municipality. To obtain sustainable land use pattern and practice by small scale farmers for the cultivation of sesame crop; thus, this research would be beneficial.

2. Materials and Methodology

2.1 Study Area

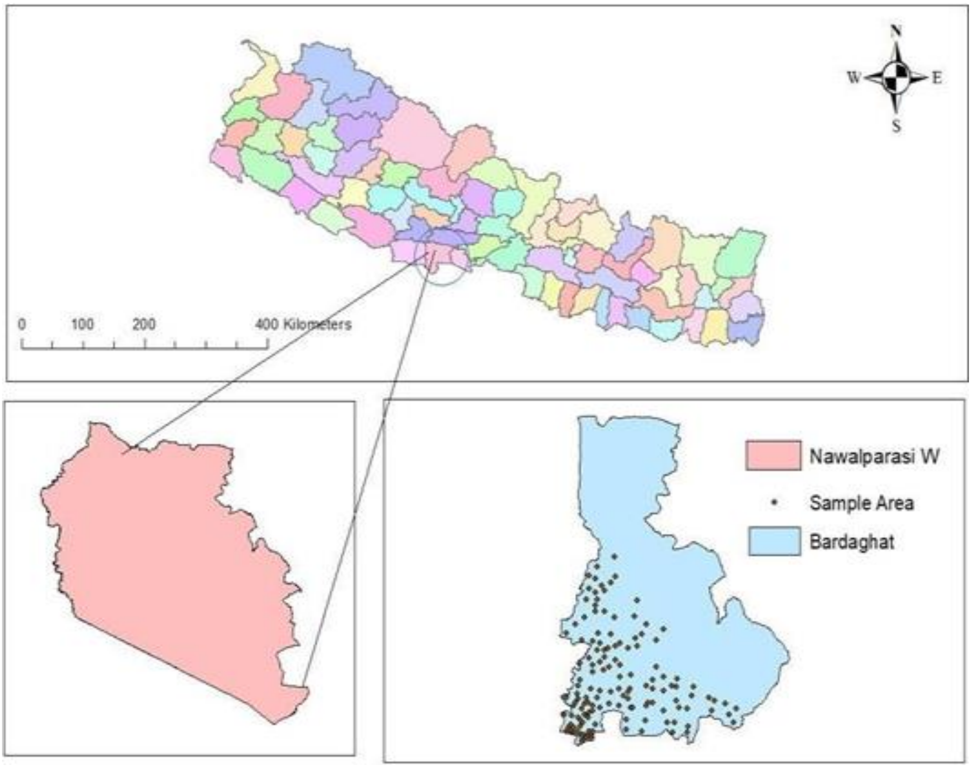


Figure 1: Study Area

Bardaghat Municipality is located in Nawalparasi West District in Lumbini Province, Nepal. It is situated in the lap of Chure range. This region is scattered across 162.05 square kilometers of geographical area.

Bardaghat Municipality is located between 27.5404° N, 83.7943° E at an elevation of 91 meters to 1936 meters above sea level.

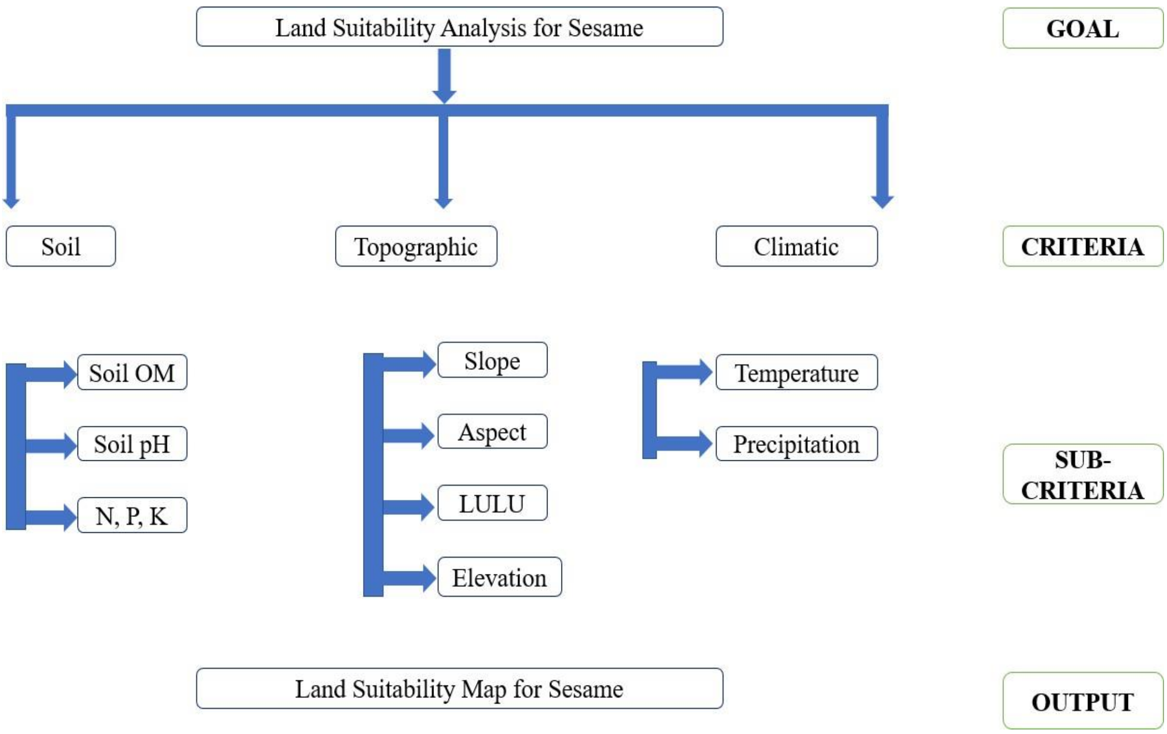


Figure 2: Flow chart of Land Suitability Assessment

Table 1: Land Suitability Classes		
Order	**Class**	**Description**
Suitability (S)	S1 (Highly Suitable)	Land having no significant limitations to sustained application of a given use, or only minor limitations that will not significantly reduce productivity or benefits and will not raise inputs above an acceptable level.
	S2 (Moderately Suitable)	Land having limitations which in aggregate are moderately severe for sustained application of a given use; the limitations will reduce productivity or benefits and increase required inputs to the extent that the overall advantage to be gained from the use, although still attractive, will be appreciably inferior to that expected on Class S1 land.
	S3 (Marginally Suitable)	Land having limitations which in aggregate are severe for sustained application of a given use and will so reduce productivity or benefits, or increase required inputs, that this expenditure will be only marginally justified.
Non- Suitability (N)	N (Permanently not suitable)	Land with so severe limitations which are very Difficult to be overcome.

2.2 Selection of suitable crop

In this step, a potential vegetable crop will be chosen for the research area based on a variety of physical and socioeconomic factors. Since vegetables are short-term crops that demand a lot of attention and input, they are grouped together for study. Where crops are grown which is promising in a certain area based on the social acceptance of vegetables and the current farming systems crops, vegetable grower's agricultural expertise, significant agricultural markets, and facility long-term increasing, population, economic state of the society, and farmers experience.

To get firsthand information on the landform, the state of vegetables, and farming practices pertaining to them, field observations and questionnaire surveys were used. It works best when is used to prioritize needs and highlight issues in the research field. The most promising crop was then discussed with a group made up of stakeholders, agricultural technicians, agribusiness owners, and municipality officials. The selection of Sesame crop in Bardaghat Municipality due to its necessary daily consumption use and sharp output decline over the past ten years. The farmer claims that the nearby Indian market satisfies the demand for sesame. Sesame plant vigor and productivity were affected by a number of factors, including fertilizer, crop management, insects, pests, and other problems. After a sharp decline in productivity, sesame cultivation no longer offered the best financial return, which prompted farmers to commercially plant sesame and other crops. Eventually, we decided to study and analyze the nutritional status of soil and suitability of sesame crop for the production in Bardaghat Municipality.

Table 2: Data source used in analysis			
S.N.	**Data Sets**	**Spatial Resolutions**	**Sources**
1	DEM	30m	https://earthexplorer.usgs.gov/
2	Land use land cover data	10m	https://hermes.com.np/
3	Soil map		https://soil.narc.gov.np/soil/soilmap/
4	Climate map	0.5°	https://crudata.uea.ac.uk/cru/data/hrg/
5	Boundary map		https://nationalgeoportal.gov.np/#/

2.3 Generation of Thematic Map

The slope, aspect, elevation, land use, land cover, temperature, precipitation, soil texture, soil organic matter, pH, N, P, and K thematic maps were made using the IDW interpolation tool of the Arc GIS 10.8 application. Inverse Distance Weighted (IDW) interpolation calculates cell values by combining a set of sample points that are linearly weighted. The inverse distance determines the weight. Using IDW, the user can alter the importance of known points on interpolated values based on how far away they are from the output point.

2.4 Criteria

The core of the suitability study lies in criteria selection, assessing land suitability based on the research area's biophysical conditions. Choosing primary and sub-criteria is an iterative process. Selection methods include literature review, analytical analysis, and local input. These criteria establish climatic, soil, and topography needs for the chosen land use. Variability of land, soil, and climatic parameters falls within a specific range in the area. The requirements are provided in the table, which includes ranges and threshold values for relevant land qualities as well as suitability ratings for sesame cultivation.

Table 3: Criteria of each factor						
Criteria	**Unit**	**S1**	**S2**	**S3**	**N**	**Reference**
Climatic						
Temperature	°C	>22	21-22	19- 21	<19	https://doi.org/10.1016/j.ocsci.2022.08.001
Rainfall	mm	<1458	1458-1494	1494-1534	>1534	https://doi.org/10.1016/j.ocsci.2022.08. 001
Topographical						
Elevation	masl	<1250				
Slope	%	0-5	5-10	10-20	>20	https://doi.org/10.1016/j.ocsci.2022.08.001
Aspect						
LULC		Crop land	Vegetation	Bare land	Build up	
Edaphic						
OM	%	>2	1.2-2	0.8-1.2	<0.8	GIS-Based Assessment of Land Suitability for Industrial Crops (Cotton, Sesame and Groundnut) in the Abyan Delta, Yemen
pH		6.2-7	7-7.5, 5-6.2	7.5-8.2	>8.2	GIS-Based Assessment of Land Suitability for Industrial Crops (Cotton, Sesame and Groundnut) in the Abyan Delta, Yemen
N	%	>0.4	0.2-0.4	0.1-0.2	<0.1	Response of sesame to nitrogen and phosphorus fertilization in Northern Sudan
P	Kg/ha	>44	30-55	<30	-	https://doi.org/10.3390/agronomy9120819
K	Kg/ha	>280	110-280	<110		

2.5 Generation of Hierarchy Structure

The research findings highlight the consideration of four primary criterion groups: Soil, Topography, Climate, and Socio-economic factors. Each of these major criteria is further subdivided into a diverse range of sub-criteria. The process of selecting and refining these criteria and sub-criteria is meticulously outlined in the table provided. This hierarchical organization stems from a combination of inputs, including farmer opinions and insights, expert knowledge, and input from key stakeholder groups.

At the apex of this hierarchy are the major criteria, prominently featuring Soil, Topography, Climate, and Socio-economic factors. Below these overarching categories, the sub-criteria are meticulously decomposed, each occupying a distinct tier in the hierarchical structure. This thoughtful arrangement seeks to capture the complex interplay between various factors influencing the decision-making process. It ensures that essential perspectives and expert insights are integrated cohesively, allowing for a comprehensive evaluation framework that adequately addresses the multifaceted nature of the subject.

2.6 Development of comparison matrix at each level of hierarchy

The hierarchical organization guides the comparison process among alternatives, criteria, and sub-criteria, following a structured approach. This entails assessing each element in relation to the next higher level in pairs. In the scope of this study, a pivotal task involved creating pair-wise comparison matrices for climate, soil, topography, and socioeconomic factors. These matrices were instrumental in ascertaining the relative significance of these factors in the context of sesame cultivation suitability.

To construct these matrices, a survey questionnaire employing a 1-9-point scale for pair-wise comparisons was utilized. Expert interviews were pivotal in shaping the content of the matrices, with comparisons initially carried out verbally and then translated into corresponding numerical values. Assigning values between 1 and 9 facilitated the distinction of parameter significance. Notably, if the horizontal parameter held less significance compared to the vertical one, its value ranged from the reciprocals of 1/2 to 1/9, ensuring a nuanced representation of preference.

An essential requirement to validate the weighting outcomes at each hierarchy level involves assessing the consistency of pair-wise comparisons. The Consistency Ratio (CR) serves as a quantifiable measure of this consistency. This systematic approach guarantees the robustness of the decision-making process, lending credibility to the derived weights and allowing for well-informed choices based on a balanced evaluation of factors. To avoid the bias from the pair-wise comparison, a consistency ratio (CR) was calculated and was expected to be less than 10% for the weights to be approved N (Baniya, 2008).

$$CI = \frac{\lambda\, max - N}{N-1} \quad (1)$$

$$CR = \frac{CI}{RI} \quad (2)$$

Where: λmax: The maximum eigenvalue CI: Consistency Index

CR: Consistency ratio RI: Random index

N: The number of criteria or sub-criteria in each pair-wise comparison matrix.

According to the Random Index (RI), the average consistency of a comparing matrix in pairs is 1- 10, as determined by an experiment conducted by Oak Ridge National Laboratory and Wharton School. According to a study, the higher the level of inconsistency, the larger the matrix (Huynh Van, 2008).

Table 5: Fact value for criteria/sub-criteria

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Fact value for criteria/sub-criteria (Huynh Van, 2008)

The requirements needed are:

- If CR ≤ 10%, AHP is consistent and AHP can be continued.
- If CR > 10%, the Assessment requires revision because the matrix is not consistent.

2.7 Computation of weighted factor of criteria and sub- criteria

The weights of the criteria and sub-criteria were determined through an analytical hierarchy process (AHP). Horticulture professionals, soil scientists experienced in horticultural crops, and ecologists provided input to establish the relative importance of one criterion compared to another. Each feature was assigned a knowledge- based weight, which was then synthesized and analyzed using a weighted aggregation matrix.

In the AHP technique, the weight of each criterion was quantified in numerical values after conducting pair- wise comparisons for all interconnected combinations of criteria. The assessment of weight estimation involved evaluating the consistency ratio. If the consistency ratio was found to be below 10%, the limited acceptance level of the performance matrix was considered. On the contrary, if the consistency ratio exceeded 10%, the pair-wise relationships of the criteria were deemed unacceptable and subject to rejection.

According to Eastman, the weight of the criteria is determined based on the acceptable performance matrix relationship and maintains the total of factor weights to be 1 to meet the requirement of the weighted linear combination (WLC) procedure (Eastman, 2006).

Table 7: Analytical hierarchical process results after assigning weights to the individual.

Criteria	Climate	Topography	soil	Soil sub criteria	N	P	K	pH	OM
Climate	1	2	4	N	1	2	4	1/4	½
Topography	1/2	1	3	P		1	2	1/6	¼
Soil	1/4	1/3	1	K			1	1/8	1/6
				pH				1	2
				OM					1

A. PWCM within criteria at CR=1.8%, RI=0.58

B. PWCM within criteria at CR=1%, RI=1.12

Criteria	Elevation	Slope	Aspects	LULC	Criteria	Rainfall	Temperature
Elevation	1	4	3	6	Rainfall	1	
Slope		1	½	1	Temperature	3	1
Aspects			1	2			
LULC				1			

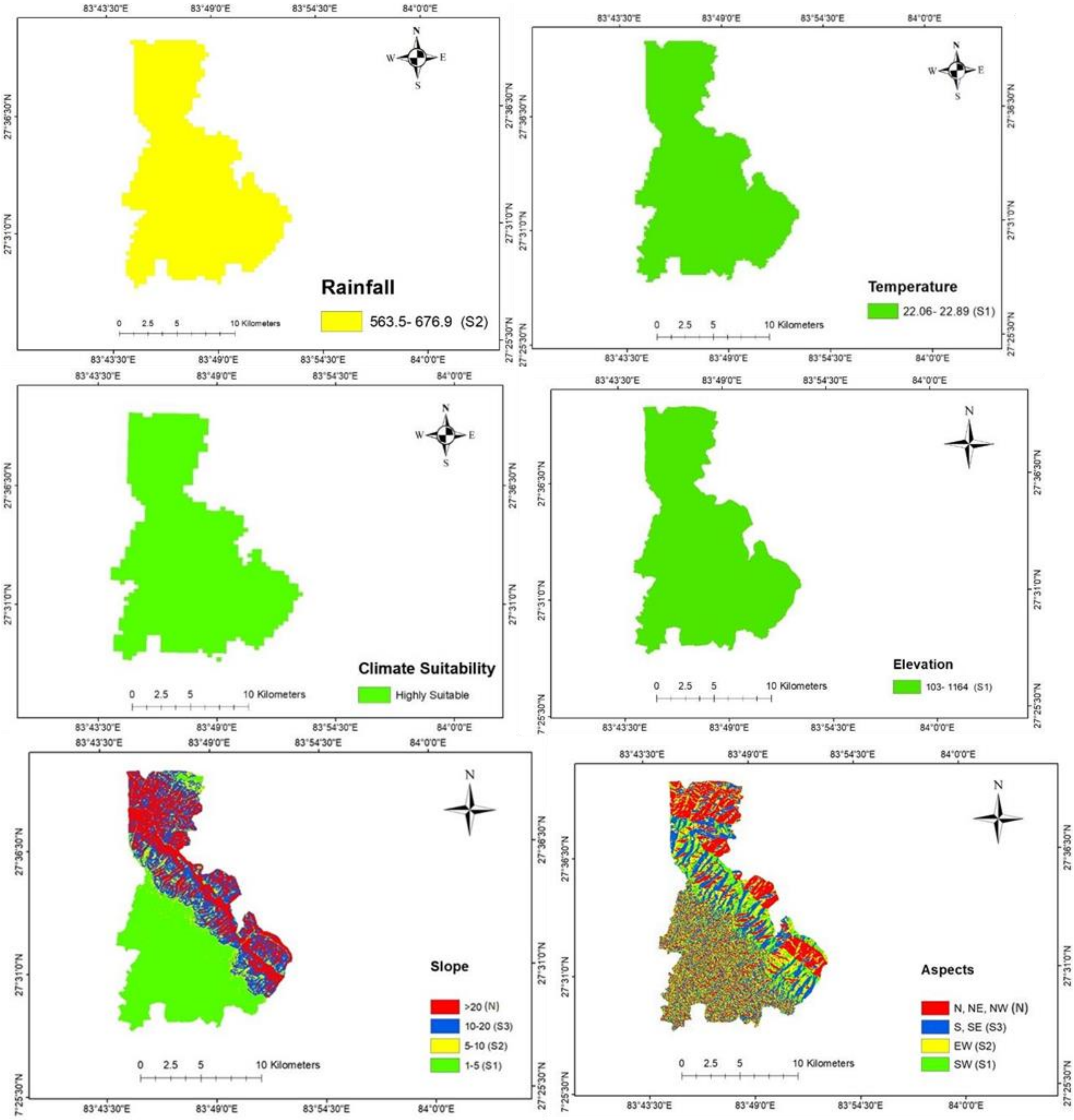
C. PWCM within criteria at CR=0%. RI=0 D. PWCM within criteria CR=0.8%,

RI= 0.90

Table 8: Analytical hierarchical process results of Soil Parameters			
Parameter	Weighted sub-criteria	Rank	Overall weighted
Soil	100%		12.196%
N	14.25%	3	1.73%
P	7.514%	5	0.91%
K	4.367%	4	0.53%
pH	47.099%	1	5.74%
OM	26.77%	2	3.26%

Table 9: Analytical hierarchical process results of Topography Parameter			
Parameter	Weighted sub- criteria	Rank	Overall weighted
Topography			31.96
Altitude	55.97	1	18.2%
Aspects	20.92	3	6.68%
Slope	11.64	4	3.72%
LULC	10.46	2	3.34%

3. RESULTS



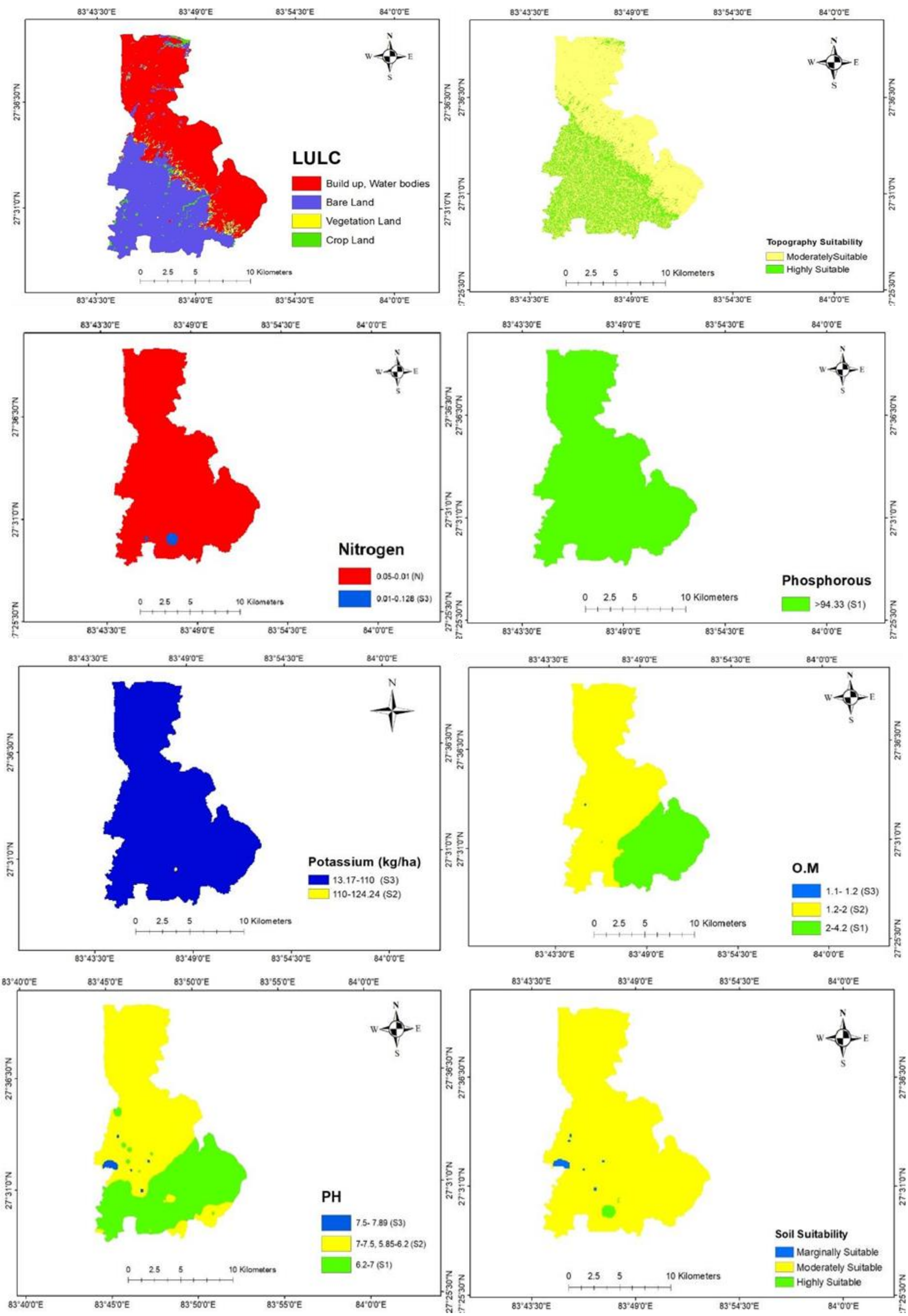


Figure 3: Final Land Suitability Map For Sesame

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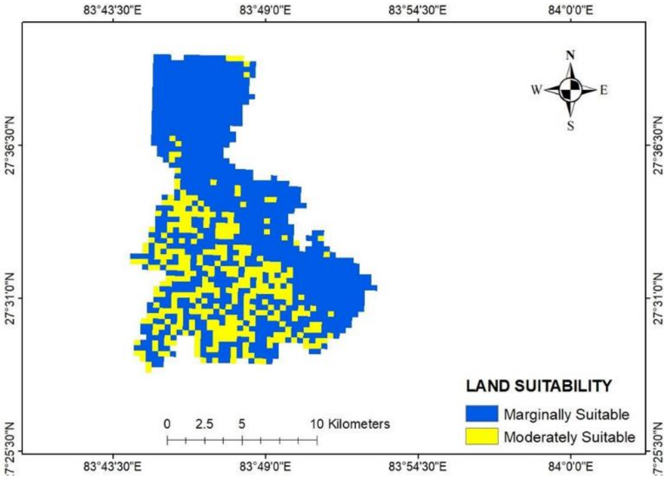

According to 10-year rainfall and temperature statistics, the average precipitation in the research area was 563.5- 676.9 mm and average temperature was 22.06 °C – 22.89 °C. The precipitation and temperature map revealed that the study area was appropriate and ideal for sesame cultivation, growth and development. Climatic variations such as averages of temperature, rainfall, and relative humidity influence the productivity of sesame (Mawcha et al., 2021).

Elevation and latitude are well-known broad-scale factors affecting species richness (Nepali et al., 2021). The assessment of land suitability for sesame production has revealed distinct categories based on slope characteristics. A substantial portion of the total land, approximately 82.97 km^2, falls within the highly suitable category, having a gentle slope gradient of 1-5%. These areas are conducive to efficient water management and minimal runoff, supporting healthy sesame growth while mitigating adverse impacts on nearby river networks. Moderately suitable land, covering 6.7 km^2 with slopes ranging from 5-10%, presents some challenges in water management and erosion control but remains viable for sesame cultivation. Marginally suitable land i.e. 34.66 km^2 and featuring slopes of 10-20%, requires advanced soil conservation measures. In contrast, the largest segment, covering 37.74 km^2 with slopes exceeding 20%, seems unsuitable for sesame cultivation due to significant erosion challenges and sedimentation risks. Identifying these suitability categories based on slope not only optimizes crop yield but also contributes to ecosystem preservation and soil quality maintenance. Effective soil conservation and land management strategies are essential for sustainable sesame cultivation across these diverse slope categories.

In the research area, the north facing aspect accounts for 50.82 km2, followed by the south and southwest with 36.09 km2. Also, the east-west facing aspect comprises area 45.86 km2 and 29.29 km2 respectively. The highly suitable area accounts 29.29 km2 whereas moderately suitable contributes 36.09 km2, also the marginally suitable area was 45.86 km2 while the non- suitable area was 50.82 km2.

There are built-up areas, grassland, forest, bare land, woody land, and cropland in the research area. Cropland covers 6.91 km2, which was extremely or highly suitable, while woodland and bare land cover 65.68 km2, which was marginally suitable. Vegetation land encompasses 9.22 km2 and was moderately favorable for sesame cultivation, while built-up areas and water body cover 80.24 km2 and are unsuited for sesame cultivation, according to the LULC analysis in the research region.

The final topography map indicates that the study area was moderately suitable with 124.73 km2 and highly suitable with 37.31 km2 area. Approximately 158.81 km2 of the total land was non-suitable for sesame cultivation with nitrogen 0.05-0.01 % and the rest of the land 1.24 km2 area was marginally suitable for sesame production with nitrogen 0.01-0.0128 %. Nitrogen deficiencies affect the transpiration, stomata conductivity, and chlorophyll content of plant leaves (Kalaji et al., 2016).

Total land area (162.05 km2) was highly suitable for the cultivation of sesame in relation to Phosphorus. Phosphorous helps in increasing root density proliferation (Jahan et al., 2019). Phosphorus plays a significant role in formation of energy rich phosphate bonds like ADP and ATP, nuclear protein and phospholipids and is essential constituent of nucleic acids (RNA and DNA), nucleoproteins, amino acids, protein, phosphatides, phytin and several co enzymes (NADP) (Jahan et al., 2019).

About 0.073 km2 of total land was moderately suitable for sesame cultivation with a potassium range of 110-124.24 kg/ha, while 161.97 km2 of total land was marginally suitable for sesame production with a potassium range of 13-110 kg/ha. Potassium plays an important role in activation of enzymes and resistance to cold, disease, water stress and other adverse conditions (Sita and Irfan, 2017). The oil and protein content of the crop were significantly influenced with the application of potassium (Sita and Irfan, 2017).

Approximately 51.49 km2 of the total land was highly suitable for sesame cultivation with OM 2-4.2 % while 109.98 km2 area was moderately suitable for sesame production with OM 1.2-2 %. About 0.058 km2 was marginally suitable for the cultivation and production of sesame. Soil functions and the production of their physical, chemical, and biological properties are intimately tied to carbon organic content, which improves soil structure and minimizes erosion, resulting in enhanced groundwater and surface water quality. The environment influences C-organic inputs and losses, which include geomorphologic processes, climatic conditions, ground cover, and vegetation (Sumarsono et al., 2023).

About 60.11 km2 of total land was highly suitable for sesame cultivation with pH 6.2 -7 while 100.81 km2 of total land was moderately suitable for sesame production with pH range 5.85-6.2, 7-7.5, and 1.14 km2 of total land was marginally suitable for sesame production with pH range 7.5-7.89. Soil pH was a master variable in soils because it regulates many chemical and biological processes that occur within the soil, controls plant nutrient availability by influencing the chemical forms of the various nutrients, and influences their chemical responses. As a result, soil and crop productivity are related to soil pH (Odutola, 2019). Soil pH shows influences on biogeochemical processes like trace element mobility, nitrification, and denitrification and it indicates soil condition and the expected direction of many soil processes (Neina, 2019). After plotting the individual map (N, P, K, pH, OM), the final soil map demonstrated that the highly suitable area was 1.475 km2 whereas moderately suitable area was 159.1 km2 and marginally suitable area was 1.475 km2 respectively.

Table 10: Final Land Suitability Map

Suitability Class	Area (sq. km)	Area %
Highly suitable	-	-
Moderately suitable	39.375 km^2	24.29%
Marginally suitable	122.675 km^2	75.71%
Non-suitable	-	-

3.1 Marginally Suitable

S3 denotes the class which was marginally suitable. This class includes only about 122.67 km2 of land or about 75.71% of the total land area of Bardaghat municipality. This class was characterized by a greater slope (10-20 %), a land use pattern, an east and south-east aspect, organic matter (1.1-1.2 %), nitrogen (0.01-0.128 %), and accessible potassium (13.17-110 kg/ha). Sesame growing in this category was said to be less efficient, both economically and environmentally. Farmers must seek a better alternative to boost yield while maintaining sustainable soil management methods.

3.2 Moderately Suitable

S2 denotes the moderately suitable class. Bardaghat municipality's reasonably appropriate area for sesame production was found to be 39.375 km2. This amount of space accounts for approximately 24.29 % of the entire area of the research site. The moderately suitable area was characterized by an East-West facing aspect, a slope of 5-10 %, a land use and land cover of pasture and cropland, an organic matter (OM) percentage of 1.2-2, a pH of 5.85-6.2, 7-7.5 and potassium ranging from 110-124.24 kg/ha. Sesame farming can be performed in this moderately suited region, but growers must spend more money on inputs and plant protection due to bug and pest infestations, water logging conditions, and fruit quality decline due to adverse climate and topography. The available nutrients are limited in study location, so farmers should concentrate on nutrient management strategies. Sloppy land may result in nutrient loss, and loss of the uppermost layer of soil limits the possibilities of sesame cultivation, limiting profit and crop output.

4. Conclusions

This research focuses on land suitability analysis in Bardaghat Municipality to promote sustainable agriculture, particularly for sesame cultivation. The study employs a comprehensive methodology that combines Pair-wise Comparison Matrix (PWCM), Weighted Multi-Criteria Analysis, and Analytical Hierarchy Process (AHP) to assess land suitability for sesame production. The research also integrates data from remote sensing, geostatistics, and Geographic Information Systems (GIS) to create thematic maps and visualize the results.

In summary, this research provides valuable insights into land suitability for sesame cultivation in Bardaghat Municipality, with a focus on promoting sustainable agriculture, improving crop productivity, and utilizing modern technology like GIS for land assessment. The findings offer guidance for local farmers and land planners to make informed decisions in the pursuit of regional agricultural sustainability. This study claims appropriate area for cultivation of sesame in given research site. The final output map shows that 24.29% (132.8 km2) of the study area was moderately suitable, and 75.71% (84.55 km2) was marginally suitable for Sesame cultivation.

REFERENCES

Al-Mashreki, M., Atroosh, K., Muflahi, A., Obaid, N., and Caoline, K., 2015. GIS-Based Assessment of Land Suitability for Industrial Crops (*Cotton, Sesame and Groundnut*) in the Abyan Delta, Yemen. American Journal of Experimental Agriculture, 8 (6), Pp. 384–405. https://doi.org/10.9734/ajea/2015/16572

Ayalew, B., Bekele, A., and Mazengia, Y., 2018. Analysis of Cost and Return of Soybean Production under Small holder Farmers in Pawe District, North Western Ethiopia. Journal of Natural Sciences Research Www.Iiste. Org ISSN, 8 (1), Pp. 28–34.

Baniya, N., 2008. Land Suitability Evaluation Using Gis for Vegetable Crops in Kathmandu Valley / Nepal. Dissertation, Pp. 1–259. https://www .deutsche-digitale- bibliothek.de/binary/MUK43CAYVEGQW4VV3OP N5ZSQKPIVO354/full/1.pdf

Bhandari, D., Joshi, R., Regmi, R.R., and Awasthi, N., 2021. Assessment of Soil Erosion and Its Impact on Agricultural Productivity by Using the RMMF Model and Local Perception: A Case Study of Rangun Watershed of Mid-Hills, Nepal. Applied and Environmental Soil Science, 2021. https://doi.org/10.1155/2021/5747138.

Girmay, A.B., 2018. Sesame production, challenges and opportunities in Ethiopia. Vegetos, 31 (1), Pp. 51–56. https://doi.org/10.5958/2229-4473.2018.00007.1

Huynh Van, C., 2008. Multicriteria land suitability evaluation for selected crops in hilly region of central Vietnam Agricultural Climate Change View project Master Project in HUAF View project. https://www.researchgate.net/publication/269799354

Jahan, N., Alam, A.S., Mitu, A.S., Habib, M.A., and Rahman, M.S., 2019. Effect of phosphorus on growth and yield of sesame. Research in Agriculture Livestock and Fisheries, 6 (2), Pp. 245–251. https://doi.org/10.33 29/ralf.v6i2.43047

Kalaji, H.M., Jajoo, A., Oukarroum, A., Brestic, M., Zivcak, M., Samborska, I.A., Cetner, M. D., Łukasik, I., Goltsev, V., and Ladle, R.J., 2016. Chlorophyll a fluorescence as a tool to monitor physiological status of plants under abiotic stress conditions. In Acta Physiologiae Plantarum (Vol. 38, Issue 4). Polish Academy of Sciences. https://doi.org/10.1007 /s11738-016-2113-y

Kingra, P.K., Majumder, D., and Singh, S.P., 2016. Application of Remote Sensing and Gis in Agriculture and Natural Resource Management Under Changing Climatic Conditions. Agricultural Research Journal, 53 (3), Pp. 295. https://doi.org/10.5958/2395-146x.2016.00058.2

Maiti, D.D., and Jana, P.K., 1985. Effect of different levels of nitrogen and phosphorus on yield and yield attributes of sesame. Oilseeds Res, 2, Pp. 252-259.

Malczewski, J., 2006. Ordered weighted averaging with fuzzy quantifiers: GIS-based multicriteria evaluation for land-use suitability analysis. International Journal of Applied Earth Observation and Geoinformation, 8 (4), Pp. 270–277. https://doi.org/10.1016/j.jag.20 06.01.003

Mawcha, K.T., Gebreslassie, M.G., Gebreyohannes, H.M., and Kiros, A.M., 2021. Description of climatic factors for informed Sesame (Sesamum indicum L.) cultivation in Kafta Humera District, North Ethiopia. Sustainable Environment, 7 (1). https://doi.org/10.1080/27658511. 2021.1903699

Moisa, M.B., Busha Hinkosa, L., Negasa, G.F., Olika, G., Ijigu, T.E., Wedajo, Y.N., Gurmessa, M.M., Deribew, K.T., and Gemeda, D.O., 2023. GIS and remote sensing Based Analysis of Land use and Land cover Change in the Upper Anger watershed, Western Ethiopia. Geology, Ecology, and Landscapes, 00(00), Pp. 1–10. https://doi.org/10.1080/24749508. 2023.2237323

Myint, D., Gilani, S.A., Kawase, M., and Watanabe, K.N., 2020. Sustainable sesame (Sesamum indicum L.) production through improved technology: An overview of production, challenges, and opportunities in Myanmar. Sustainability (Switzerland), 12 (9), Pp. 1–21. https://doi.org/10.3390/SU12093515

Neina, D., 2019. The Role of Soil pH in Plant Nutrition and Soil Remediation. Applied and Environmental Soil Science, 2019 (3). https://doi.org/10.1155/2019/5794869

Nepali, B.R., Skartveit, J., and Baniya, C.B., 2021. Impacts of slope aspects on altitudinal species richness and species composition of Narapani-Masina landscape, Arghakhanchi, West Nepal. Journal of Asia-Pacific Biodiversity, 14 (3), Pp. 415–424. https://doi.org/10.1016/j.japb. 2021.04.005

Odutola, O.S., 2019. Introductory Chapter: Relevance of Soil pH to Agriculture. In Soil pH for Nutrient Availability and Crop Performance. IntechOpen. https://doi.org/10.5772/intechopen.82551

Rahman, R., and Saha, S.K., 2008. Remote sensing, spatial multi criteria evaluation (SMCE) and analytical hierarchy process (AHP) in optimal cropping pattern planning for a flood prone area. Journal of Spatial Science, 53 (2), Pp. 161–177. https://doi.org/10.1080/14498596. 2008.9635156

Saaty, T.L., 2002. Decision making with the Analytic Hierarchy Process. Scientia Iranica, 9 (3), Pp. 215–229. https://doi.org/10.1504/ijssci. 2008.017590

Saaty, T.L., and Vargas, L.G., 2006. Decision Making With The Analytic Network Process Economic, Political, Social and Technological Applications with Benefits, Opportunities, Costs and Risks.

Sita, R.J., and Irfan, M.R.C., 2017. Effect of Potassium and Sulphur on Quality of Sesame (Sesamum indicum L.). International Journal of Current Microbiology and Applied Sciences, 6 (4), Pp. 1876–1878. https://doi.org/10.20546/ijcmas.2017.604.223

Sumarsono, J., Widhiantari, I.A., and Saputra, S.E., 2023a. Analysis of land suitability of leading commodities tomato and chili in the sub-district of Moyo Hilir, Sumbawa Regency, West Nusa Tenggara. Proceedings of the International Conference on Sustainable Environment, Agriculture and Tourism (ICOSEAT 2022), Pp. 26. https://doi.org/10.2991/978-94-6463-086-2_8

Yogranjan, Satpute, G.K., Marabi, R.S., Mishra, M.K., and Mishra, S.P., 2014. Global Resurgence of Sesame (Sesamum Indicum L.) Utlization: a Current Scenario. J. Agric. and Vet. Sci. Yogranjan et Al, 2 No3, Pp. 2321– 9602. http://www.iajavs.com/currentissue.php