

# IDENTIFICATION OF FACTORS INFLUENCING VEGETABLE GROWING-AREA SITE SELECTION: A SYSTEMATIC LITERATURE REVIEW AND FRAMEWORK FOR TONGHAI COUNTY, CHINA

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## Abstract

Vegetable growing-area site selection in Tonghai County should account for both natural production conditions and supply-chain accessibility. This systematic review followed the PRISMA 2020 guidelines and employed two complementary Scopus searches covering agricultural land suitability, GIS-based multi-criteria decision-making, cold-chain facilities, logistics hubs, and market accessibility. A total of 139 records were identified, of which 45 full-text studies were included in the final synthesis. Among the factors examined, slope received the strongest direct support in the literature, followed by travel time to major export markets, access to county-level wholesale markets or logistics hubs, and proximity to cold-storage, pre-cooling, or processing facilities. Based on the literature and the specific production and distribution conditions of Tonghai County, the proposed framework comprises three natural factors, four economic factors related to supply-chain accessibility, two social factors, and three categories of ecological and policy constraints. This framework provides a systematic basis for subsequent AHP-based weight determination and GIS-based land-suitability assessment.

**Keywords:** Vegetable growing-area site selection, PRISMA, Land suitability, GIS, Multi-criteria decision making

## 1. Introduction

Agricultural growing-area selection integrates natural, economic, social, and policy conditions. GIS and multi-criteria decision-making methods allow terrain, climate, soil, and accessibility factors to be evaluated within a common spatial framework, while AHP is widely used to determine factor weights (Akinci *et al.*, 2013; Sengupta *et al.*, 2022; Yalew *et al.*, 2016).

For commercial vegetable production, however, natural suitability alone is insufficient because perishable and time-sensitive vegetables depend on timely access to road networks, wholesale and logistics hubs, cold-chain facilities, and external markets. Long travel times may increase transport costs, delay postharvest handling, and increase product losses even where soil and climatic conditions are otherwise favorable (Abhinav *et al.*, 2022; Aljohani & Thompson, 2018). Vegetable growing-area selection should therefore consider both production suitability and supply-chain accessibility.

Tonghai County, located in central Yunnan Province, China, is an important commercial vegetable-producing and export-oriented area. Its agricultural landscape includes a relatively concentrated lake-basin production area and surrounding mountainous terrain, creating spatial differences in slope, cultivation conditions, road access, and transport convenience. Vegetable production in the county is strongly connected with external markets, and products are distributed to major cities outside the local area. These characteristics mean that locations with suitable natural production conditions may still face disadvantages if they are poorly connected to transport routes, logistics facilities, cold-chain services, or major markets.

For perishable and market-oriented vegetables, production suitability and postharvest accessibility are closely linked. Growing areas with shorter travel times to roads, logistics hubs, cold-chain facilities, and core export markets may have advantages in postharvest handling and market distribution; therefore, Tonghai County requires a framework that considers both natural suitability and supply-chain accessibility.

Existing reviews have examined GIS-based multi-criteria decision making and agricultural land-suitability assessment (Abdullah *et al.*, 2025; Malczewski, 2006;

Mugiyo *et al.*, 2021), but logistics, cold-chain accessibility, and market access have not always been integrated into the same site-selection framework. This systematic literature review therefore identifies relevant factors, classifies them into natural, economic and supply-chain, and social scoring indicators together with ecological and policy constraints, and develops a framework for vegetable growing-area site selection in Tonghai County.

## 2. Research Objectives

To identify the key influencing factors and develop a comprehensive site-selection framework for vegetable growing areas in Tonghai County, China, through a systematic literature review.

## 3. Systematic Literature Review Method

### 3.1 Data Sources and Search Strategy

This review followed PRISMA 2020 (Page *et al.*, 2021), and two Scopus searches were conducted on 2 August 2026 using the Article title, Abstract, and Keywords fields. The main search focused on agricultural land suitability, crop suitability, agricultural site selection, and GIS-based multi-criteria decision making, while the supplementary search focused on fruit and vegetable cold chains, wholesale and logistics facilities, and market accessibility. Scopus was selected as the sole formal database because of its broad multidisciplinary coverage relevant to agriculture, GIS, logistics, and supply-chain research.

Both searches were limited to English-language peer-reviewed journal articles to maintain consistency in screening and data extraction; no publication-year restriction was applied, and the retrieved records were published between 2007 and 2026. The searches were conducted separately because GIS, AHP, and MCDM terms are not always used in cold-chain and market-accessibility studies and combining all terms could exclude relevant supply-chain studies. The complete search strategy is shown in Table 1.

### 3.2 Literature Screening

The two searches identified 139 records, including 77 from the main search and 62 from the supplementary search, with no duplicates found. After title and abstract screening, 92 records were excluded and 47 reports were sought for full-text



retrieval. Two unavailable reports were excluded from the formal synthesis and frequency calculations, leaving 45 full-text studies for inclusion (Table 2; Figure 1).

**Table 1.** Scopus Search Strategy and Search Results

| Search                            | Purpose                                                                                                                    | Search String                                                                                                                                                                                                                                                                                                          | Search Limits                                                                         | Records Identified |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|--------------------|
| Main search                       | Agricultural land suitability, crop suitability, agricultural site selection, and GIS-based multi-criteria decision making | ("agricultural land suitability" OR "crop suitability" OR "agricultural site selection" OR "crop site selection" OR "agricultural suitability assessment") AND (GIS OR "geographic information system") AND (AHP OR MCDM OR "multi-criteria decision making" OR "multi-criteria analysis" OR "multicriteria analysis") | Scopus; Article title, Abstract, and Keywords; peer-reviewed journal article; English | 77                 |
| Supply-chain supplementary search | Fruit and vegetable cold chains, logistics nodes, and market accessibility                                                 | (vegetable* OR "fresh produce" OR horticulture*) AND ("cold chain" OR "cold storage" OR "pre-cooling" OR "processing facility" OR "wholesale market" OR "logistics center" OR "distribution center") AND (accessibility OR "travel time" OR distance OR proximity)                                                     | Scopus; Article title, Abstract, and Keywords; peer-reviewed journal article; English | 62                 |

**Note:** No publication-year restriction was applied. The retrieved records were published between 2007 and 2026. Both searches were conducted on 2 August 2026.

**Table 2.** Literature Inclusion and Exclusion Criteria

| Item                     | Inclusion Criteria                                                                                                                                                                                                                                    | Exclusion Criteria                                                                                                                                                                                                                  |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Research topic           | Studies addressing agricultural land suitability, crop or agricultural site selection, agricultural spatial layout, or the accessibility of roads, cold-chain facilities, logistics facilities, and markets in relation to vegetable production areas | Studies limited to pests and diseases, crop-quality experiments, crop identification, internal warehouse operations, or logistics optimization without a direct connection to agricultural spatial layout or growing-area selection |
| Document type            | Peer-reviewed journal research articles                                                                                                                                                                                                               | Conference abstracts, editorials, book reviews, duplicate publications, and non-research materials                                                                                                                                  |
| Language                 | English-language articles                                                                                                                                                                                                                             | Non-English publications                                                                                                                                                                                                            |
| Information completeness | Full text available, with sufficient information for factor and method extraction                                                                                                                                                                     | Full text unavailable; excluded from the formal synthesis and frequency calculations                                                                                                                                                |
| Result content           | At least one relevant site-selection factor, measurement approach, spatial effect, constraint treatment, or validation method could be extracted                                                                                                      | No information relevant to framework construction was clearly reported                                                                                                                                                              |

A coding sheet recorded study context, research method, natural, economic and supply-chain, and social factors, constraints, indicator measurement, and validation information. Title and abstract screening, full-text assessment, and data extraction were conducted by the first author using predefined criteria and the coding sheet; extracted information and factor classifications were rechecked against the full texts for consistency. Similar indicators representing the same site-selection meaning were combined, such as distance, accessibility, or travel time to roads and markets. Each article was counted once per combined indicator, although one article could support several indicators. Frequency represents the number of supporting studies, not indicator weight. Because the included studies used heterogeneous research designs, a single formal risk-of-bias tool was not applied. Methodological transparency was instead descriptively checked across factor reporting, measurement or spatialization, analytical method, and validation where applicable. The study-level evidence and methodological characteristics of the 45 included full-text studies are reported in Appendix A.

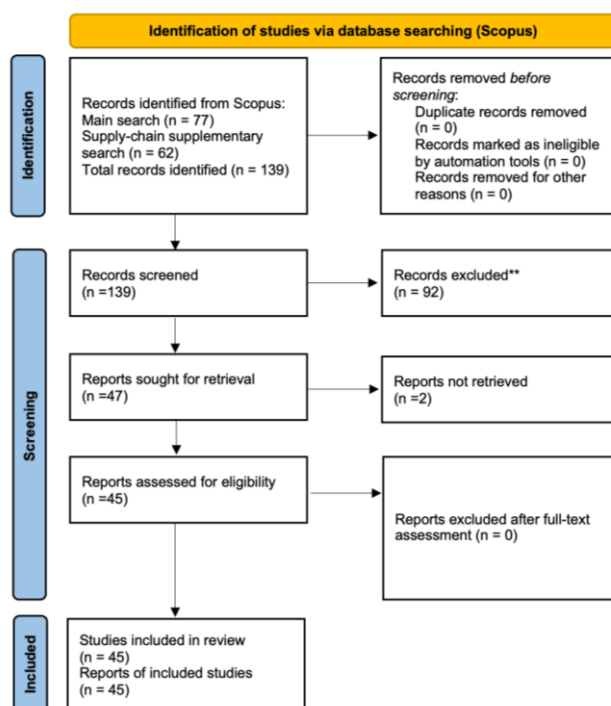


Figure 1. Identification and Screening of Studies Based on PRISMA 2020

### 3.3 Factor Classification and Framework Development

Following data extraction, the identified factors were synthesized in three steps. First, factors with equivalent site-selection meanings were standardized and grouped; for example, distance, accessibility, network distance, and travel time to the same destination were treated as a common accessibility concept. Second, the number of studies directly supporting each grouped factor was recorded as descriptive evidence rather than indicator weight. Third, candidate factors were assessed using five considerations: literature support, relevance to vegetable production and distribution, applicability to Tonghai County, feasibility of GIS-based spatial representation, and data availability. These considerations were applied jointly rather than as mandatory thresholds, allowing locally relevant and spatially measurable factors with limited direct support to be retained.

Based on this assessment, the retained factors were classified as natural, economic and supply-chain, or social scoring indicators, while legally or environmentally restricted areas were treated separately as ecological and policy constraints to prevent compensation by higher scores from other factors. This synthesis produced nine scoring indicators and three categories of ecological and policy constraints. Permanent Basic Farmland was retained as a policy layer because its treatment depends on the research objective and type of agricultural activity.

## 4. Literature Screening Results and Factor Identification

### 4.1 Screening and Methodological Characteristics

The final sample included 33 land-suitability studies and 12 supply-chain studies. The main search provided evidence on slope, temperature, soil conditions, and GIS-based multi-criteria decision making, while the supplementary search added evidence on cold-chain facilities, wholesale and logistics hubs, and export-market accessibility. The smaller number of supply-chain studies reflects the narrower scope of the supplementary search, which focused specifically on spatial accessibility relevant to growing-area selection. Therefore, the reported frequencies were interpreted as descriptive evidence rather than as directly comparable measures of factor importance.

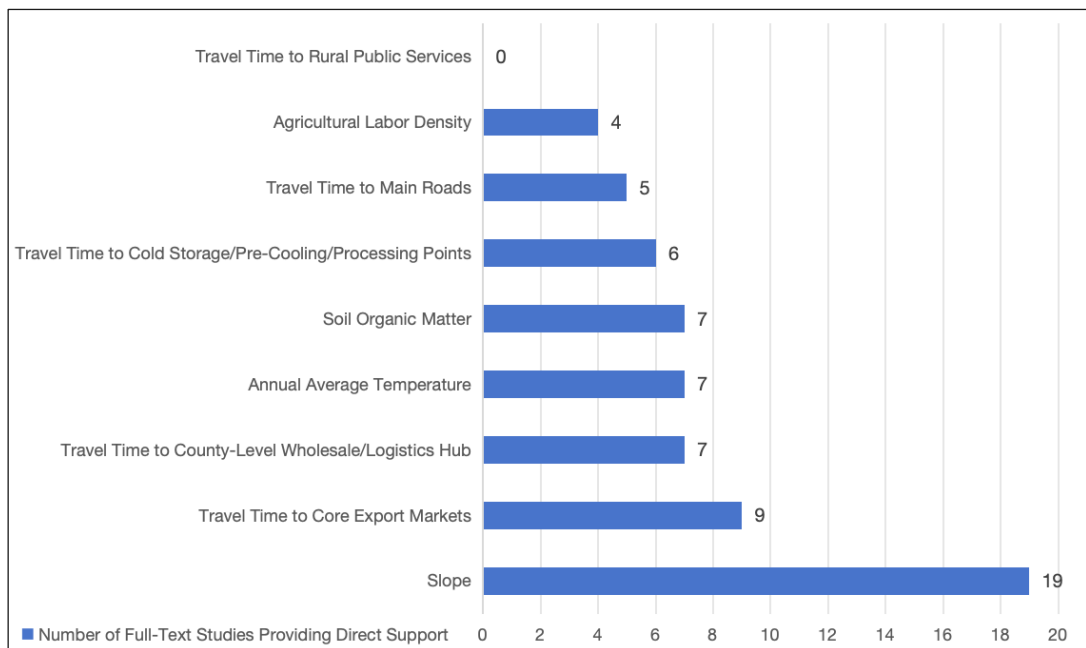
GIS combined with AHP, Fuzzy AHP, TOPSIS, WLC, and other multi-criteria methods was the dominant approach. Studies generally involved factor selection, weighting, spatial standardization, overlay, classification, and validation. Accessibility was measured using Euclidean distance, road-network distance, or travel time, while restricted areas were commonly treated using Boolean masks or other non-compensatory methods.

#### 4.2 Natural Factors

Natural factors were widely used in the land-suitability studies. Slope appeared in 19 studies and was generally treated as a cost indicator because increasing slope may restrict cultivation and mechanization and increase erosion and infrastructure costs (Akinci *et al.*, 2013; Wotlolan *et al.*, 2021; Yalew *et al.*, 2016). Annual average temperature was supported by 7 studies and was treated as an interval indicator because temperatures below or above the suitable range may limit crop growth (Jayathilaka *et al.*, 2012; Sathiyamurthi *et al.*, 2024). Soil organic matter was also supported by 7 studies and was treated as a benefit indicator reflecting soil fertility, structure, and water-retention capacity (Sawant *et al.*, 2025; Sengupta *et al.*, 2022).

#### 4.3 Economic and Supply-Chain Factors

Travel time to main roads was supported by 5 studies, county-level wholesale or logistics hubs by 7, cold-storage/pre-cooling/processing points by 6, and core export markets by 9 (**Figure 2**). Road-network travel time is preferable to straight-line distance because it reflects road class, connectivity, detours, and travel speed. Shorter travel times can reduce collection and postharvest delays and improve market access. Previous studies also show that facility location and transport distance affect logistics costs, service coverage, product loss, and economic returns (Abhinav *et al.*, 2022; Aljohani & Thompson, 2018; Ash *et al.*, 2017; Kamruzzaman & Takeya, 2008).



**Note:** Frequencies are based on the 45 included full-text studies. One study could support multiple indicators. Travel Time to Rural Public Services received no direct support and was retained based on local applicability and spatial measurability.

**Figure 2.** Direct Literature Support for the Nine Scoring Indicators

#### 4.4 Social Factors and Ecological-Policy Constraints

Agricultural labor density or agricultural employment ratio was supported by 4 studies and treated as a benefit indicator reflecting labor availability for vegetable production and postharvest activities (Bose & Halder, 2023; Ozsahin & Ozdes, 2022; Zhu *et al.*, 2022). Travel Time to Rural Public Services received no direct full-text support but was retained as a locally applicable cost indicator reflecting access to agricultural extension and production services.

Three ecological and policy constraints were identified: Ecological Conservation Red Lines and Protected Areas, Drinking-Water Source Protection Zones and Buffer Areas, and Permanent Basic Farmland. Ecological and water-protection areas may be treated using Boolean masks or zoning rules. Permanent Basic Farmland requires treatment according to the research objective rather than automatic exclusion from agricultural suitability assessment. Separating constraints from scoring indicators prevents restricted areas from receiving high suitability through score compensation.



#### 4.5 Framework for Tonghai County

After factor harmonization and application of the considerations described in Section 3.3, overlapping factors with the same site-selection function were merged, while highly crop-specific, duplicated, or insufficiently spatializable factors were not retained. The remaining candidates were assessed using literature support, relevance to vegetable production and distribution, applicability to Tonghai County, GIS-based spatial representation, and data availability.

This synthesis resulted in three natural factors, four economic and supply-chain factors, two social factors, and three categories of ecological and policy constraints. Table 3 summarizes their attributes, functions, GIS expressions, and evidence bases. Study-level evidence is provided in Appendix A.

**Table 3.** Factors Influencing Vegetable Growing-Area Site Selection in Tonghai County

| Category                  | Indicator                                                  | Attribute/<br>Treatment | Main Function                                  | GIS Expression                       | Evidence Basis |
|---------------------------|------------------------------------------------------------|-------------------------|------------------------------------------------|--------------------------------------|----------------|
| Natural                   | Slope                                                      | Cost                    | Cultivation, mechanization, erosion            | DEM-derived slope raster             | 19 studies     |
|                           | Annual Average Temperature                                 | Interval optimum        | Growth cycle and development                   | Climate raster/station interpolation | 7 studies      |
|                           | Soil Organic Matter                                        | Benefit                 | Fertility, structure, water retention          | Soil raster/sample interpolation     | 7 studies      |
| Economic and supply-chain | Travel Time to Main Roads                                  | Cost                    | Regional network access                        | Shortest road-network time           | 5 studies      |
|                           | Travel Time to County-Level Wholesale/ Logistics Hubs      | Cost                    | Collection, trading, distribution              | Road-network time                    | 7 studies      |
|                           | Travel Time to Cold-Storage/Pre-Cooling/ Processing Points | Cost                    | Postharvest handling and preservation          | Road-network time                    | 6 studies      |
|                           | Travel Time to Core Export Markets                         | Cost                    | Transport cost, timeliness, price transmission | Cross-regional road-network time     | 9 studies      |
| Social                    | Agricultural Labor Density or Agricultural                 | Benefit                 | Production and postharvest labor support       | Township statistics spatialization   | 4 studies      |



| Category                          | Indicator                                               | Attribute/<br>Treatment | Main Function                                    | GIS Expression                     | Evidence Basis           |
|-----------------------------------|---------------------------------------------------------|-------------------------|--------------------------------------------------|------------------------------------|--------------------------|
|                                   | Employment Ratio                                        |                         |                                                  |                                    |                          |
|                                   | Travel Time to Rural Public Services                    | Cost                    | Production services and long-term support        | Road-network time to service nodes | Local applicability      |
| Ecological and policy constraints | Ecological Conservation Red Lines and Protected Areas   | Boolean/<br>zoning      | Prevent prohibited areas from score compensation | Official boundary mask             | Studies + Chinese policy |
|                                   | Drinking-Water Source Protection Zones and Buffer Areas | Boolean/<br>zoning      | Control water-source risks                       | Official boundaries/buffers        | Regulatory basis         |
|                                   | Permanent Basic Farmland                                | Policy layer            | Land-use control; treatment varies by objective  | Official boundaries                | Chinese policy basis     |

The framework integrates natural production conditions with supply-chain accessibility and social support, while ecological and policy constraints are treated separately. It provides the factor basis for subsequent AHP weighting, GIS-based suitability evaluation, and constraint-layer processing in Tonghai County.

## 5. Discussion

### 5.1 Integration of Production and Supply-Chain Factors

Natural conditions remain the foundation of vegetable growing-area selection but do not fully represent the location requirements of perishable and market-oriented vegetables. Conventional land-suitability frameworks mainly emphasize biophysical production conditions, whereas the proposed framework also incorporates access to main roads, logistics hubs, cold-chain facilities, and core export markets. Conceptually, this extends site selection from a production-only perspective toward a production–distribution perspective. Methodologically, these supply-chain dimensions are expressed as GIS-compatible accessibility indicators, allowing production suitability and distribution accessibility to be evaluated within the same spatial framework.

## 5.2 Value of Travel-Time Indicators

Straight-line distance does not reflect road hierarchy, network connectivity, detours, or travel speed. This is particularly relevant in Tonghai County, where vegetable-growing areas are distributed across basin and mountainous terrain. Road-network travel time is therefore a more practical accessibility measure. Previous studies also demonstrate its importance: relocation of Melbourne's wholesale market increased retailer travel distance by 31% and wholesaler travel by 14.1 km per delivery (Aljohani & Thompson, 2018), while GIS-based cold-storage planning in Kolar District reduced the maximum distance to the nearest facility from 50.97 km to 13.98 km (Abhinav *et al.*, 2022). These findings support the use of travel-time indicators in vegetable growing-area selection.

## 5.3 Local Applicability and Policy Constraints

The framework is locally relevant to Tonghai County because its perishable and market-oriented vegetable production is distributed across a basin–mountain landscape, making access to roads, logistics hubs, cold-chain facilities, and external markets important for postharvest handling and distribution. Literature frequency was not the sole basis for factor retention. Travel Time to Rural Public Services received no direct full-text support but was retained because it represents spatially measurable access to agricultural extension and production services. The ecological and policy constraints were retained mainly according to Chinese regulatory and planning requirements rather than international literature frequency.

Scoring indicators were separated from ecological and policy constraints because restricted areas should not be compensated by higher scores from other factors. Boolean masks or zoning rules are therefore more appropriate for such restrictions. Permanent Basic Farmland requires separate treatment because its interpretation depends on the planning objective and type of agricultural activity.

## 5.4 Limitations

This review used Scopus as the sole formal database and may have omitted relevant Chinese-language or local studies. Two potentially relevant reports were unavailable in full text and were excluded from the formal synthesis. Literature frequency reflects direct support rather than indicator weight, which requires separate

expert judgment and AHP. Locally specific social and policy factors also require verification using official planning and spatial data.

## 6. Conclusions

Two Scopus searches identified 139 records, of which 45 full-text studies were included. Slope was the most frequently supported natural factor, while the four supply-chain accessibility indicators received 27 direct-support occurrences, confirming the relevance of roads, logistics facilities, cold-chain services, and market access to vegetable growing-area selection.

The final framework contains nine scoring indicators and three categories of ecological and policy constraints. It integrates production suitability with Tonghai-relevant supply-chain accessibility and separates compensatory scoring indicators from non-compensatory spatial constraints. The framework provides a basis for AHP weighting and GIS-based suitability evaluation in Tonghai County and may also inform commercially oriented and externally connected vegetable-producing areas where topographic variation and access to roads, logistics hubs, cold-chain facilities, and external markets are important site-selection considerations.

## 7. Acknowledgments

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## Appendix A

Table A1. Study-Level Evidence Matrix for the 45 Included Full-Text Studies

| Study                                                                                                                                                                                         | Study Context                                                    | Method / Measurement                                                                                                   | Supported Indicator(s) | Methodological Characteristics                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Bozdağ <i>et al.</i> (2016)<br>AHP and GIS based land suitability analysis for Cihanbeyli (Turkey) County                                                                                     | Cihanbeyli County, Turkey; dryland and irrigated agriculture.    | GIS-AHP; soil, land use, climate, topography, irrigation-water quality, groundwater depth; slope classes.              | N1                     | Separate dryland and irrigated suitability models; AHP hierarchy and comparison with current land use.                                  |
| Sengupta <i>et al.</i> (2022)<br>Assessment of agricultural land suitability using GIS and fuzzy analytical hierarchy process approach in Ranchi District, India                              | Ranchi District, India; agricultural land suitability.           | GIS-fuzzy AHP; climatic, topographic, soil and road/river accessibility factors; membership functions.                 | N1, N2, N3, E1         | Weighted overlay with fuzzy standardization; MAE and RMSE used for model evaluation.                                                    |
| Sathiyamurthi <i>et al.</i> (2024)<br>Agricultural land suitability of Manimutha Nadhi watershed using AHP and GIS techniques                                                                 | Manimutha Nadhi watershed, India; agricultural land suitability. | GIS-AHP; 57 soil samples; 20-year climate data; kriging; SRTM-derived slope.                                           | N1, N2, N3             | AHP consistency ratio = 0.028; weighted overlay and FAO five-class suitability mapping.                                                 |
| Akinci <i>et al.</i> (2013)<br>Agricultural land use suitability analysis using GIS and AHP technique                                                                                         | Turkey; agricultural land-use suitability.                       | GIS-AHP; nine parameters; weighted overlay; post-overlay exclusion of restricted land.                                 | N1                     | AHP CR = 0.0674; 1-10 subclass scoring; forests, grassland and reservoir areas excluded from final map.                                 |
| Bose & Halder (2023)<br>Identification of crop suitable land using geospatial techniques and assessment with socio-economic factors—case study from India                                     | India; multiple crops including vegetables.                      | GIS-AHP; natural, road-network and socio-economic factors.                                                             | N1, E1, S1             | RMSE validation (about 11%); agricultural productivity and labor compared with suitability results.                                     |
| Shawon <i>et al.</i> (2025)<br>Land suitability Analysis for Sustainable Agriculture Development using Multi-Criteria Analysis and Machine Learning Techniques: Case Study of Shibpur Upazila | Shibpur Upazila; sustainable agricultural land suitability.      | Multi-criteria analysis and machine-learning techniques; slope, elevation, land cover, flood risk and soil conditions. | N1                     | Three suitability classes and parcel-level land information system; public full text provides limited weighting/standardization detail. |
| Wotlolan <i>et al.</i> (2021)<br>Land suitability evaluation for multiple crop agroforestry planning using GIS and multi-criteria decision analysis: A case study in Fiji                     | Sigatoka Valley, Fiji; multi-crop agroforestry planning.         | Single-crop land-suitability models; GIS-MCDA; AHP for benefit objectives; Weighted Maximum model.                     | S1                     | Scenario-based multi-crop spatial allocation integrating crop requirements, expert judgment and planning objectives.                    |

| Study                                                                                                                                                                                          | Study Context                                                                    | Method / Measurement                                                                                                           | Supported Indicator(s) | Methodological Characteristics                                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Sathiyamurthi <i>et al.</i> (2024)<br>Assessment of crop suitability analysis using AHP-TOPSIS and geospatial techniques: A case study of Krishnagiri District, India                          | Krishnagiri District, India; crop suitability assessment.                        | GIS; AHP-TOPSIS; climate, soil and topographic criteria.                                                                       | N1, N2, N3             | AHP used for weighting and TOPSIS for crop ranking; supports combined multi-method suitability assessment.                          |
| Paul <i>et al.</i> (2020)<br>Assessment of agricultural land suitability for irrigation with reclaimed water using geospatial multi-criteria decision analysis                                 | Agricultural land suitability for irrigation with reclaimed water.               | GIS-MCDA and AHP; agricultural land, climate, water policy, irrigation status and distance to wastewater-treatment facilities. | —                      | One-at-a-time +10% weight sensitivity analysis; supports facility-distance/accessibility as a spatial criterion.                    |
| Jayathilaka <i>et al.</i> (2012)<br>Spatial assessment of climate change effects on crop suitability for major plantation crops in Sri Lanka                                                   | Six agro-ecological regions in Sri Lanka; tea, rubber and coconut.               | GIS-AHP; 45 experts; annual rainfall, humidity, annual average temperature, evapotranspiration and yield; IDW interpolation.   | N2                     | Two climate periods compared; climate and suitability maps used to assess spatial change.                                           |
| Abdullah <i>et al.</i> (2025)<br>ADVANCEMENTS AND INTEGRATION OF BIOPHYSICAL, SOCIO-ECONOMIC, AND LOCAL KNOWLEDGE IN AGRICULTURAL LAND SUITABILITY ASSESSMENTS: A SYSTEMATIC LITERATURE REVIEW | Systematic review of agricultural land-suitability assessment studies.           | PRISMA; Scopus and Web of Science; review of GIS-MCDM, machine learning, hybrid models and socio-economic/local knowledge.     | —                      | Synthesized 34 studies and highlighted methodological gaps in validation, parameter standardization and socio-economic integration. |
| Karaelmas <i>et al.</i> (2026)<br>GIS and AHP-Based Agricultural Land-Use Suitability Analysis in Semi-Arid Regions of Southeastern Türkiye                                                    | Semi-arid southeastern Türkiye; agricultural land-use suitability.               | GIS-AHP; eight ecological criteria; FAO five-class suitability.                                                                | N1                     | Expert weighting and weighted overlay; ROC validation with AUC = 0.815.                                                             |
| Ezz & Abdel-Wahab (2025)<br>Land Suitability Mapping for Sustainable Agriculture in Egypt's Western Desert: A GIS-AHP Framework                                                                | Egypt's Western Desert; sustainable agricultural land suitability.               | FAO framework, GIS-AHP and weighted overlay; soil, slope, evapotranspiration, precipitation and land use.                      | N1                     | Integrated FAO land-suitability logic with AHP-GIS for dryland agricultural planning.                                               |
| Leila <i>et al.</i> (2026)<br>Integrated multi-criteria decision analysis and GIS for sustainable agricultural land use planning: the Saf Saf Basin, Northeastern Algeria                      | Saf Saf Basin, northeastern Algeria; sustainable agricultural land-use planning. | GIS-AHP and weighted linear combination; nine physical criteria including slope and road distance.                             | N1, E1                 | Expert AHP weighting (CR = 0.0993); 1-9 subclass scoring and five-class suitability mapping.                                        |

| Study                                                                                                                                                                                               | Study Context                                                      | Method / Measurement                                                                                                               | Supported Indicator(s) | Methodological Characteristics                                                                                                  |
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| Zhu <i>et al.</i> (2022)<br>Suitability evaluation of potential arable land in the Mediterranean region                                                                                             | Mediterranean region; potential arable land.                       | AHP, CRITIC and artificial neural network; 15 natural and socio-economic factors.                                                  | N2, N3                 | Extreme aridity without irrigation excluded; results validated against mean yield and harvested-area relationships.             |
| Hussain <i>et al.</i> (2024)<br>Agricultural land suitability analysis of Southern Punjab, Pakistan using analytical hierarchy process (AHP) and multi-criteria decision analysis (MCDA) techniques | Southern Punjab, Pakistan; agricultural land suitability.          | AHP and MCDA; terrain, soil, climate, irrigation and land-use factors.                                                             | —                      | Hierarchical pairwise comparison and multi-factor integration; about 43% of the study area classified as highly suitable.       |
| Ozsahin & Ozdes (2022)<br>Agricultural land suitability assessment for agricultural productivity based on GIS modeling and multi-criteria decision analysis: the case of Tekirdağ province          | Tekirdağ Province, Türkiye; agricultural productivity suitability. | GIS-MCDA; six criterion groups and 37 variables including temperature, soil properties, water access and farmer-related variables. | N1, S1                 | Model calibration/validation used NSE, RSR, PBIAS and R <sup>2</sup> .                                                          |
| Nungula <i>et al.</i> (2024)<br>Multicriteria land suitability assessment for cassava and bean production using integration of GIS and AHP                                                          | Cassava and bean production; crop-specific land suitability.       | GIS-AHP; topographic, climatic and soil criteria; separate crop models.                                                            | —                      | AHP used for main/sub-criterion weights and ArcGIS for spatial suitability mapping.                                             |
| Everest <i>et al.</i> (2021)<br>Determination of agricultural land suitability with a multiple-criteria decision-making method in Northwestern Turkey                                               | Northwestern Turkey; agricultural land suitability.                | AHP-GIS; seven land/terrain parameters; exclusion of forest, settlement, water and road areas.                                     | N1                     | Weighted suitability mapping combined with post-overlay hard exclusions.                                                        |
| Saha & Gayen (2025)<br>Identification of suitable land for sustainable agricultural practices in Koch Bihar district, West Bengal: A RS-GIS based MCDA approach                                     | Koch Bihar District, West Bengal, India; sustainable agriculture.  | Remote sensing, GIS and MCDA; 15 terrain, soil, hydrologic, climate and land-use variables.                                        | N1                     | Integrated multi-factor suitability assessment with weighted spatial layers and final suitability mapping.                      |
| Baja <i>et al.</i> (2007)<br>Spatial based compromise programming for multiple criteria decision making in land use planning                                                                        | Land-use planning; multiple spatial criteria.                      | GIS-MCDM; fuzzy standardization; compromise programming; road accessibility and water-body proximity.                              | E1                     | Explored compensatory to non-compensatory decision settings and sensitivity; road proximity derived from nearest-road distance. |
| Baite <i>et al.</i> (2024)<br>Agricultural land suitability analysis in Manipur, India using GIS and AHP                                                                                            | Manipur, India; agricultural land suitability.                     | GIS-AHP and remote sensing; eight terrain, soil, climate and land-use variables.                                                   | N1                     | AHP pairwise weighting and five-class suitability mapping.                                                                      |

| Study                                                                                                                                                                               | Study Context                                                                 | Method / Measurement                                                                                       | Supported Indicator(s) | Methodological Characteristics                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------|--------------------------------------------------------------------------------------------------------------------|
| Sawant <i>et al.</i> (2025)<br>Crop suitability analysis for the coastal region of India through fusion of remote sensing, geospatial analysis and multi-criteria decision making   | Coastal India; rice and coconut suitability.                                  | Remote sensing, GIS and AHP; elevation, slope, soil properties, rainfall, temperature and LULC constraint. | N1, N3                 | Crop-specific suitability mapping; land use/land cover treated as a constraint layer.                              |
| Esomchukwu Chinagorom <i>et al.</i> (2025)<br>A GIS-based analytical hierarchy process modeling for agricultural-land suitability in Awka South local government area               | Awka South local government area; agricultural land suitability.              | GIS-AHP; slope, elevation, soil, temperature, rainfall, drainage network and land use.                     | N1                     | Factor reclassification, standardization, AHP consistency testing and weighted suitability mapping.                |
| Bayar & Karabacak (2026)<br>Assessment of agricultural land suitability using GIS-based fuzzy logic and multi-criteria decision analysis: a case study of Silifke district, Türkiye | Silifke District, Türkiye; agricultural land suitability.                     | GIS-based fuzzy logic and MCDA; physical, human and economic factors.                                      | —                      | AHP weighting and fuzzy treatment of spatial uncertainty; suitability compared with current agricultural land use. |
| Abate & Anteneh (2024)<br>Assessment of agricultural land suitability for cereal crops based on the analysis of soil physico-chemical characteristics                               | Rainfed cereal crops (barley, wheat and teff); agricultural land suitability. | MCDM; climate, slope and field/laboratory soil physico-chemical measurements.                              | N1, N3                 | Crop-specific matching using observed soil and environmental properties.                                           |
| Elsheikh <i>et al.</i> (2013)<br>Agriculture Land Suitability Evaluator (ALSE): A decision and planning support tool for tropical and subtropical crops                             | Tropical and subtropical crops; decision-support tool.                        | ALSE system integrating FAO-SYS, GIS and expert knowledge for mango, banana, papaya, citrus and guava.     | —                      | Reusable rule/knowledge-based land-suitability evaluator for multiple crops.                                       |
| Kaur <i>et al.</i> (2024)<br>Agro-Eco-Resource Zonation (AERZ) for sustainable agriculture using GIS and AHP techniques in Indian Punjab                                            | Indian Punjab; agro-eco-resource zonation.                                    | GIS-AHP; temperature, rainfall, soil organic carbon, soil properties and groundwater; IDW spatialization.  | N3                     | Hierarchical AHP with consistency checks; final zones compared with rice and wheat yield maps.                     |
| Xu <i>et al.</i> (2024)<br>Agricultural Land Suitability Assessment at the County Scale in Taiyuan, China                                                                           | Taiyuan, China; county-scale agricultural land suitability.                   | GIS-AHP at 1-km resolution; natural and social criteria; urban land and nature-reserve constraints.        | C1                     | Weighted suitability assessment followed by removal of urban-construction and protected areas.                     |



| Study                                                                                                                                                                               | Study Context                                                   | Method / Measurement                                                                                                 | Supported Indicator(s) | Methodological Characteristics                                                                                                                  |
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| Xue <i>et al.</i> (2023)<br>Agricultural land suitability analysis for an integrated rice–crayfish culture using a fuzzy AHP and GIS in central China                               | Central China; integrated rice–crayfish culture.                | Fuzzy AHP and GIS; accumulated temperature, water distance, slope, land use and soil texture.                        | N1, N2                 | Crop-system-specific suitability weighting and spatial mapping.                                                                                 |
| Yalew <i>et al.</i> (2016)<br>AgriSuit: A web-based GIS-MCDA framework for agricultural land suitability assessment                                                                 | AgriSuit web-GIS-MCDA framework; Abbay Basin demonstration.     | Google Earth Engine, QGIS and webAHP; land cover, slope, elevation, soil/water stress and proximity factors.         | N1, C1                 | FAO S1-S3/N reclassification; AHP consistency demonstration; protected areas, forest and water included in unsuitable class.                    |
| Dutta <i>et al.</i> (2024)<br>Land capability assessment of Sali watershed for agricultural suitability using a multi-criteria-based decision-making approach                       | Sali watershed; agricultural land capability and crop planning. | MCDM integrating climate, soil fertility, topography and socio-economic factors.                                     | —                      | Land-capability assessment used to identify potential agricultural areas and support crop-layout planning.                                      |
| Rahman & Saha (2008)<br>Remote sensing, spatial multi criteria evaluation (SMCE) and analytical hierarchy process (AHP) in optimal cropping pattern planning for a flood prone area | Flood-prone agricultural area; multi-crop planning.             | Remote sensing, spatial multi-criteria evaluation and AHP; flood, land use and crop-suitability layers.              | —                      | Combined hazard and crop-specific suitability information to derive an optimal cropping pattern.                                                |
| Addressing the location problem of a perishables redistribution center in the middle of Europe (2021)                                                                               | Central Europe; perishables redistribution-center location.     | Facility-location models including center-of-gravity, p-median and p-center approaches.                              | E2                     | Compared alternative redistribution-center locations to reduce transport burden and perishability-related loss.                                 |
| Modeling the carbon footprint of fresh produce: effects of transportation, localness, and seasonality on US orange markets (2020)                                                   | U.S. orange markets; fresh-produce supply chain.                | Life-cycle/carbon-footprint modeling of transportation, localness and seasonality.                                   | E4                     | Quantified how transport and market connection influence fresh-produce supply-chain impacts.                                                    |
| The impacts of relocating a logistics facility on last food miles – The case of Melbourne's fruit & vegetable wholesale market (2018)                                               | Melbourne's fruit and vegetable wholesale market, Australia.    | Before/after relocation analysis using retailer telephone survey and semi-structured interviews with 19 wholesalers. | E2, E4                 | Relocation increased retailer vehicle-kilometers by 31% and wholesaler travel by 14.1 km per delivery; supports wholesale-market accessibility. |

| Study                                                                                                                               | Study Context                                                            | Method / Measurement                                                                                                                                | Supported Indicator(s) | Methodological Characteristics                                                                                                                   |
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| Management of Postharvest Losses and Wastages in the Indian Tomato Supply Chain—A Temperature-Controlled Storage Perspective (2023) | Indian tomato supply chain; postharvest losses.                          | Temperature-controlled storage perspective on postharvest loss and wastage.                                                                         | N2, E3                 | Demonstrates the role of refrigerated/temperature-controlled storage in preserving vegetable value.                                              |
| Irrigated agricultural development in northern Australia: Value-chain challenges and opportunities (2017)                           | Northern Australia; irrigated agricultural development and value chains. | Systems/value-chain scenario analysis covering production potential, margins, transport, processing, storage, labor, services and markets.          | E2, E3, E4, S1         | Long transport distances (1,500-3,000 km) reduced margins for high-volume/low-value crops; nearer markets and local processing improved returns. |
| Urban transportation network design for fresh fruit and vegetables using gis-the case of bangkok (2019)                             | Bangkok; urban transport network for fresh fruit and vegetables.         | GIS-based transport-network design incorporating time windows, delivery routes and cold-chain conditions.                                           | E2, E3, E4             | Shows how logistics-node and market connections can be represented through urban network design.                                                 |
| Winter is coming: the battle over cold chain logistics in the global agriculture (2025)                                             | Murcia, Spain; export-oriented agricultural cold chain.                  | Qualitative interviews with logistics quality staff and transport practitioners; supporting official trade/statistical databases.                   | E3, E4                 | Highlights long-distance refrigerated transport, storage and specialized perishable-goods management as conditions for export-market access.     |
| GIS based infrastructure planning of Cold Storages for Crop Preservation: a case study of Kolar District, Karnataka (2022)          | Kolar District, Karnataka, India; cold-storage infrastructure.           | GIS planning using agricultural cover, villages, road network, existing cold stores and production data; buffering, overlay and spatial clustering. | E1, E3                 | Proposed 50 new cold stores; maximum village-to-cold-store distance reduced from 50.97 km to 13.98 km.                                           |
| A Multi-Objective Model to Find the Sustainable Location for Citrus Hub (2022)                                                      | Citrus supply chain; hub-location problem.                               | Multi-objective location model integrating farms, collection points, distribution centers and transport cost.                                       | E2, E4                 | Optimizes hub location under multiple supply-chain objectives.                                                                                   |

| Study                                                                                                                                    | Study Context                                                           | Method / Measurement                                                                                                           | Supported Indicator(s) | Methodological Characteristics                                                                                                          |
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| Influence of technology responsiveness and distance to market on capacity building (2008)                                                | Vegetable producers in Bangladesh; market access and capacity building. | Producer survey and multiple regression; market distance, technology responsiveness, age and farm size.                        | E2, E4                 | Market distance had a standardized coefficient of -0.41; producers nearer wholesale markets showed stronger capacity-building outcomes. |
| The role of fuel prices in spatial price transmission between horticultural markets: Empirical analysis from a developing country (2021) | Horticultural-market network in a developing-country context.           | Spatial price-transmission analysis linking market distance and fuel/transport costs.                                          | E2, E4                 | Shows that transport cost influences the strength and efficiency of market connections.                                                 |
| A Deep Reinforcement Learning-Based Algorithm for Multi-Objective Agricultural Site Selection and Logistics Optimization Problem (2024)  | Agricultural site selection and logistics optimization.                 | Deep-reinforcement-learning multi-objective model integrating cold storage, market demand, infrastructure and delivery routes. | E3, E4                 | Jointly optimizes agricultural location and logistics decisions.                                                                        |

**Note:** N1 = Slope; N2 = Annual Average Temperature; N3 = Soil Organic Matter; E1 = Travel Time to Main Roads; E2 = Travel Time to County-Level Wholesale/Logistics Hubs; E3 = Travel Time to Cold-Storage/Pre-Cooling/Processing Points; E4 = Travel Time to Core Export Markets; S1 = Agricultural Labor Density or Agricultural Employment Ratio; S2 = Travel Time to Rural Public Services; C1 = Ecological Conservation Red Lines and Protected Areas; C2 = Drinking-Water Source Protection Zones and Buffer Areas; C3 = Permanent Basic Farmland.