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# Inventorying Land Resources to Identify Potentially Suitable Land for Oilseed Production in Semi-arid Land, Rayalaseema Region, India

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## ABSTRACT

**Background:** In India, there is a huge demand for edible oils and the supply is limited. In Andhra Pradesh, edible oil seeds produced in 8.51 per cent of the area which accounts 6.68 per cent of the total oilseed production in the country. Groundnut and sunflower are major oilseed crops being grown in the Rayalseema region Andhra Pradesh. These crops are cultivated both during *Kharif* and *Rabi* seasons. Sunflower oil is considered premium compared to other edible oilseed crops in the state. The objective of the study is to assess land suitability and identification of potentially suitable land for groundnut and sunflower production in the Rayalseema region.

**Methods:** A detailed survey at a 1:10000 scale was conducted using Sentinel-2, Google imagery and a toposheet. Studied 103 soil profiles and identified 10 soil series and 53 mapping units. The suitability evaluation for groundnuts and sunflowers was assessed and suitability maps were generated in ArcGIS.

**Result:** Groundnut and sunflower are moderately suitable (Class S2) in 43.27 and 6.61 per cent area and marginally suitable (Class S3) in 27.74 and 50.27 per cent area and also 1.14 and 15.27 per cent area are unsuitable (N), respectively with the limitation of topography, soil texture, gravelliness, soil fertility, rooting condition and drainage. The study has implications for enhancing the area under groundnut and sunflower cultivation by addressing the soil-related constraints in specific mapping units in the semi-arid land of the Rayalseema region by adopting suitable soil and water conservation measures, including agronomic management practices to achieve better production and productivity and to improve the livelihood status of farmers.

**Key words:** Mapping units, Oilseeds, Potentially suitable land, Rayalseema region.

## INTRODUCTION

The land suitability evaluation is a method of assessing the performance of soil/land by transforming land resources information to meet the requirements of specific crops to explore maximum benefits from limited land/soil resources without affecting its quality and obtaining crop suitability maps for specific crops for specific land mapping units for agricultural purposes which helps to identify better crop choice for a specific land unit by considering the potential and constraints of that particular land unit. Based on the FAO (1976) approach of criteria for evaluating land resources by considering climatic, soil and topographical requirements, including soil salinity and alkalinity, fertility, slope, erosion risk and moisture requirement for each crop production, the suitability assessment can be done (Sathiyamurthi *et al.,* 2024). In soil-site suitability evaluation, importance is given to fundamental edaphic properties *viz*., soil texture, available nutrient status, soil reaction, organic carbon, electrical conductivity and soil resiliency because of their maximum influencing capacity on cropping systems, irrespective of the other ecological characteristics as which helps for optimizing crop productivity (Mandal *et al.,* 2020).

YSR Kadapa district being an aspirational district identified by Govt. of India, Rayachoty Mandal belongs to Agro-Ecological Sub Region (AESR) South Telangana Plateau (Rayalseema) and Eastern Ghat, a hot, dry semi-arid eco-sub region *i.e*., AESR 7.1 in which limited water resources and high temperature and climatic conditions affecting crop production and also there was no large-scale soil data available for farm planning. Hence this Mandal was given priority to take up detailed survey as it investigates all the parameters required for crop production and productivity such as soils-site properties *viz.,* climate,

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slope, water, erosion, geology, gravelliness and stoniness, topography, crops, vegetation and land use type. The groundnut and sunflower were the major oilseed crops adopted and being cultivated in this area hence land suitability assessment was done in the present study. Major soil constraints identified through fertility capability classification in this region (Chandrakala *et al.,* 2021) were dry soil moisture, gravelliness, low K reserve, basic reaction, low organic carbon content, acidity and low cation exchange capacity.

Groundnut (*Arachis hypogaea* L.) is a major oilseed crop cultivated in India and in Andhra Pradesh (occupying 0.13 lakh ha area with a production of 6.03 lakh tonne and productivity of 595 kg $ha^{-1}$). In the Kadapa district, groundnuts occupied 65000 ha with a production of 66000 tonnes and a productivity of 1002 kg $ha^{-1}$. Farmers choose to cultivate groundnut in the Rayalseema region due to its better nutritional composition (40-48% oil, 26% protein, 12% starch, 5% soluble sugar and 2% crude fibre), maximum yield potential and well adopted to gravelly soils of that region and few more benefits such as food, feed and cover crop and for restoring soil fertility, ability to grow in marginal soils with minimum input and management and less problem of pests and diseases and found successful as rainfed crop during *kharif-rabi* season under rainfed conditions. Groundnut can be grown successfully in places receiving a minimum rainfall. It can be cultivated in various soil types. The crop is best suited on loamy, sandy loam and black soils provided with good drainage. Heavy and clayey soils are unsuitable as pod development is hampered in these soils. Since the Rayalseema region has low rainfall, farmers opt for groundnut due to its suitability under low rainfall under rainfed conditions. Crop production without knowing specific soil and site characteristics leads to yield reduction. Hence, it is critical to assess the soil-site characteristics for their suitability for major crop grown in this area and alternative land use planning on a suitable basis (Savalia and Gundalia, 2009).

Sunflower (*Helianthus anthus*), the word “Helianthus” is derived from ‘Helios’ which means ‘sun’ and ‘Anthus’ which means ‘flower’. Sunflower is called due to its nature of following the sun’s direction. It is an important oilseed crop in the country. The edible sunflower oil is extensively used because of its flavour, colour, good smoke point and sufficient levels of linoleic acid, which is good for heart patients. Its seeds contain 48-53 per cent edible oil and it has high yield potential and oil quality. Since sunflower, being an edible oil in India, has big domestic and external markets thus its cultivation employs farmers, which improves their livelihood. In the country Andhra Pradesh, followed by Karnataka, Maharashtra and Tamil Nadu, contributes >90% area and 80% of the production and it is occupied in 7.2 lakh ha area with a productivity of 805 kg $ha^{-1}$. In Andhra Pradesh, it occupied 0.21 lakh ha with a production of 0.21 lakh tonne and a productivity of 1006 kg $ha^{-1}$ and in YSR Kadapa, it occupied 9000 ha with a production of 11000 tonnes and a productivity of 1281 kg $ha^{-1}$. Due to its drought-tolerant nature and also being less affected by pests and diseases, it suits well in the semi-arid climate of the Rayalseema region. It grows well on various soil types, like sandy loam to black soils. It thrives well under fertile and well-drained soil. It can tolerate slightly alkaline conditions, but acidic and waterlogged soil is not good. The ideal pH is around 6.5-8.

With these above views, the present study has been undertaken with the objectives i) assessment of land suitability for groundnut in Rayachoty Mandal, Rayalseema region, ii) assessment of land suitability for sunflower in Rayachoty Mandal, Rayalseema region and iii) to identify potential suitable lands for groundnut and sunflower production in Rayachoty Mandal, Rayalseema region.

## MATERIALS AND METHODS

### Study area details

The present investigation was conducted at ICAR-National Bureau of Soil Survey and Land Use Planning, Regional Centre, Hebbal, Bangalore during 2017-2020. The study area was Rayachoty Mandal (23,240.7 ha), YSR Kadapa district (chronically drought-affected district), Rayalseema Region, Andhra Pradesh, in which 16768.55 ha is cultivated land. Lying between north latitudes 13°59′45.28″and 14° 7′12.263″ and east longitudes 78°35′24.85″ and 78°54′ 5.608″. Mandal is divided into seventeen villages. The annual mean rainfall of the Mandal is 638 mm falls under the ustic soil moisture regime and the mean yearly temperature of 23°C lower to 34°C maximum falls under the iso-hyperthermic soil temperature regime. LGP (length of the growing period) is 145 days with granite-gneiss geology. Mandal is divided into six landforms, namely hills and ridges, isolated hillocks, gently sloping uplands, very gently sloping uplands, nearly level uplands and nearly level lowlands/ valleys. Very gently sloping uplands were identified as the major landform (52.32% area). The land use type in the upland is rice, red gram, cowpea, groundnut, sunflower, sesamum, mulberry and coconut and mango plantations and also rice and other irrigated crops such as sunflowers, tomatoes and chillies in the lowlands.

### Land/soil suitability evaluation and mapping

To arrive at a land evaluation for groundnut and sunflower first, we conducted a detailed soil survey at a 1:10000 scale. Land suitability classification is done as per Sehgal (1996) and FAO (1976) procedures. It is a four-tier system that includes orders, classes, subclasses and units. First, the land units are separated into suitable or not suitable based on the type of suitability for the selected land use at the order level, these orders are sub-divided into classes based on degrees of land suitability for specific crops and further as per the type of constraint/limitations found these classes are sub-divided into subclasses. However, based on specific land/soil management requirements sub-classes are again drawn into land suitability units. Orders are, Class S1, S2, S3, N1 and N2 which indicate highly

suitable (land having no or slight limitations for sustainable use), moderately suitable (land with moderate limitations for sustained use), marginally suitable land (severe limitations for sustained use), currently not suitable (land with severe or very severe limitations but that can be managed in time but cannot be corrected with existing knowledge at current acceptable cost) and permanently not suitable (land having limitations that cannot be managed thus as to excluded for land use for agriculture), respectively.

S2 and S3 orders were again divided into sub-classes by considering the particular limitations of the study area. The specific constraints/limitations for crop production in the area are indicated with their symbols (climate: temperature, rainfall total and distribution, dry months and growing period - c; topography - l; soil depth or rooting condition- r; soil texture (sandy or heavy clay) - t; coarse fragments - g; soil fertility (calcareousness) - n; drainage- w). Limitations are indicated in lowercase letters after the class symbol. For example, marginally suitable land with low rainfall/short growing period as a limitation is designated as S3c. Generally, two or three limitations are indicated at the sub-class level. Using the soil site suitability criteria (NBSS and LUP, 1994; Sys *et al.,* 1993), land resources of the Rayachoty Mandal were assessed for their suitability for groundnut and sunflower.

Using sentinel-2, Survey of India toposheet (1:50,000 scale) and google imagery, digitised the habitation, roads, drainage lines and waterbody from which land use land cover and landform map has been prepared. Using soil phases as mapping units, soil profiles location map and landform map, soil boundaries were drawn. Soil map was then prepared in the Arc GIS environment. This map shows 10 soil series and 53 mapping units or soil phases and mapping unit description in the entire Rayachoty mandal. For this soil mapping units the groundnut and sunflower suitability recommendations presented in Table 3 and 4 were assigned and the respective suitability maps were generated in Arc GIS environment.

## RESULTS AND DISCUSSION

### Details of land resources

Detailed soil survey identified Alfisols, Inceptisols and Entisols in the Rayachoty mandal, Rayalseema region. Moderately shallow to deep, well-drained to somewhat poorly drained soils. Reddish brown, brown and dark gray in surface to dark reddish brown, reddish brown, grayish brown, brown, dark reddish brown, light yellowish brown, dark yellowish brown, dark brown, dark red, red, gray and dark gray in subsurface soils. Loamy sand, sandy loam and sandy clay loam are the soil texture on the surface to

**Table 1:** Soil-site suitability criteria (crop requirements) for groundnut.

| Soil-site characteristics | | | Rating | | | |
|---|---|---|---|---|---|---|
| | | Unit | Highly suitable (S1) | Moderately suitable (S2) | Marginally suitable (S3) | Not suitable (N) |
| Climatic regime | The mean temperature | °C | 24-30 | 22-33 | 20-21 | <20 |
| | in the growing season | | | 31-33 | 34-40 | >40 |
| | Total rainfall | mm | 700-1000 | 500-700 | 350-500 | <350 |
| Land quality | Land characteristics | | | | | |
| Moisture availability | Length of growing period | | | | | |
| | Bunch varieties | days | 100-125 | 90-105 | 75-90 | |
| | Spreading varieties | days | 120-135 | 105-120 | 90-105 | |
| Oxygen | Soil | class | Well | Moderately | Imperfectly | Poorly |
| availability to roots | drainage | | drained | well drained | drained | drained |
| Nutrient availability | Texture-surface | class | ls, sl | cl, sicl, scl | c, sic | |
| | Texture-sub-surface | class | sil, l, scl, cl, sicl | sc, sic, c | s, ls, sl,c >60% | |
| | pH | 1:2.5 | 6.0-8.0 | 8.1-8.55.5-5.9 | >8.5<5.5 | |
| | $CaCO_3$ in the root zone | % | high | medium | low | |
| Rooting conditions | Effective soil depth | cm | >75 | 51-75 | 25-50 | <25 |
| | Crusting | | none | slight | moderate | |
| | Coarse fragments | Vol % | | | | |
| Soil toxicity | Salinity (EC | dS/m | <2.0 | 2.0-4.0 | 4.0-8.0 | >8.0 |
| | saturation extract) | | | | | |
| | Sodicity (ESP) | % | Non-sodic | 5-10 | >10 | |
| Erosion hazard | Slope | % | <3 | 3-5 | 5-10 | >10 |

**Table 2:** Soil-site suitability criteria (crop requirements) for sunflower.

| Soil-site characteristics | | | Rating | | | |
|---|---|---|---|---|---|---|
| | | Unit | Highly suitable (S1) | Moderately suitable (S2) | Marginally suitable (S3) | Not suitable (N) |
| Climatic regime | The mean temperature in the growing season | °C | 24-30 | 31-34<br>20-23 | 35-38<br>16-19 | >38<br><16 |
| | Total rainfall | mm | 600-700 | 500-600 | 400-500 | <400 |
| **Land quality** | | | | | | |
| Moisture availability | Length of growing period | days | >90 | 80-90 | 70-80 | <70 |
| Oxygen availability to roots | Soil drainage | class | Well drained | Moderately well drained | Imperfectly drained | Poorly drained |
| Nutrient availability | Texture | class | l, cl, sil, sc | scl, sic, c | c >60%, sl | ls, s |
| | pH | 1:2.5 | 6.5-8.0 | 8.1-8.5<br>5.5-6.4 | 8.6-9.0<br>4.5-5.4 | >9.0<br><4.5 |
| Rooting conditions | Effective soil depth | cm | >100 | 76-100 | 50-75 | <50 |
| | Coarse fragments | Vol % | <15 | 15-35 | >35 | |
| Soil toxicity | Salinity (EC saturation extract) | dS/m | <1.0 | 1.0-2.0 | 2.0-4.0 | >4.0 |
| | Sodicity (ESP) | % | <10 | 10-15 | >15 | |
| Erosion hazard | Slope | % | <3 | 3-5 | 5-10 | >10 |

sandy clay, sandy loam, sandy clay loam and loamy sand in the subsurface. Soils are non-gravelly to gravelly. Calcium carbonate equivalent per cent ranged from 0 to 9.0 and 0 to 13.39 on the surface and in subsoils, respectively. Clay content varied from 4.62 to 23.32 and 8.10 to 40.55 on the surface and in subsoils, respectively. The CEC varied from 2.80 to 15.60 cmol (+) $kg^{-1}$ and 4.10 to 18.30 cmol (+) $kg^{-1}$ on the surface and in the subsoil, respectively. Base saturation varied from 56.76 to >100 per cent. Soils are strongly acidic to strongly alkaline in reaction. Organic carbon is low to high. Soils are low in Available P, K and S. DTPA extractable micronutrients *viz*., Fe, Mn and Cu are sufficient, whereas Zn is deficient. Hot water extractable boron is low. Based on the soil morphological, physical and chemical properties, were classified as *Lithic Rhodustalfs, Lithic Ustipsamments, Rhodic Paleustalfs, Typic Haplustalfs, Typic Haplustepts, Typic Rhodustalfs and Typic Ustorthents.* Soils were mapped into 10 soil series and 53 mapping units.

### Land suitability for groundnut and sunflower

Using the soil site suitability criteria and land use requirements and the diagnostic factors given in Table 1 and 2 for groundnut and sunflower, respectively, the climatic, soil and land characteristics of Rachoty Mandal were matched and were assessed for the respective suitability evaluation. The recommendations were given in Table 3 and Fig 1 for groundnut which indicates that 43.27 per cent of the total area is moderately suitable with slight limitations of topography, soil texture, gravelliness, soil fertility, rooting condition and drainage. 27.74 per cent of the total geographical area is marginally suitable with slight limitations of root restriction, soil fertility, soil texture and drainage and 1.14 per cent of the area is unsuitable. Similar kinds of soil limitations were existed in Andhra Pradesh for groundnut crops (Kumar and Naidu, 2012). Similarly, soil suitability for sunflowers and their recommendation were given in Table 4 and Fig 2 which indicates that moderately suitable area present in 6.61 per cent, with slight limitations of topography, soil texture, gravelliness, rooting condition and drainage. 50.27 per cent of the total geographical area is marginally suitable with slight limitations of gravelliness, root restriction and soil texture and 15.27 per cent of the total area is unsuitable. Sunflowers are marginally suitable in around 50 per cent area because of limitations like gravelliness, depth and texture. Management of gravelliness and depth is difficult however addition of more organic manures and vermicompost to clay soil and tank silt to sandy soil on the soil surface helps to manage soil texture. Similar studies on the soil-site suitability evaluation for sorghum and pigeon pea in a Semi-arid Ecosystem of

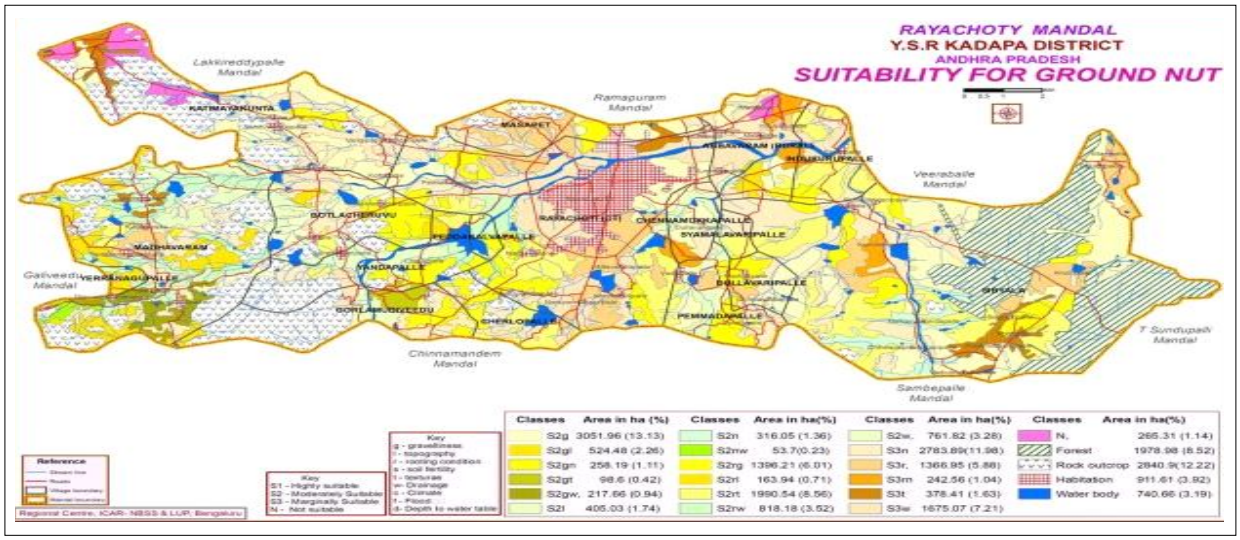



**Fig 1:** Soil suitability for groundnut in Rayachoty Mandal, Rayalseema Region, India.

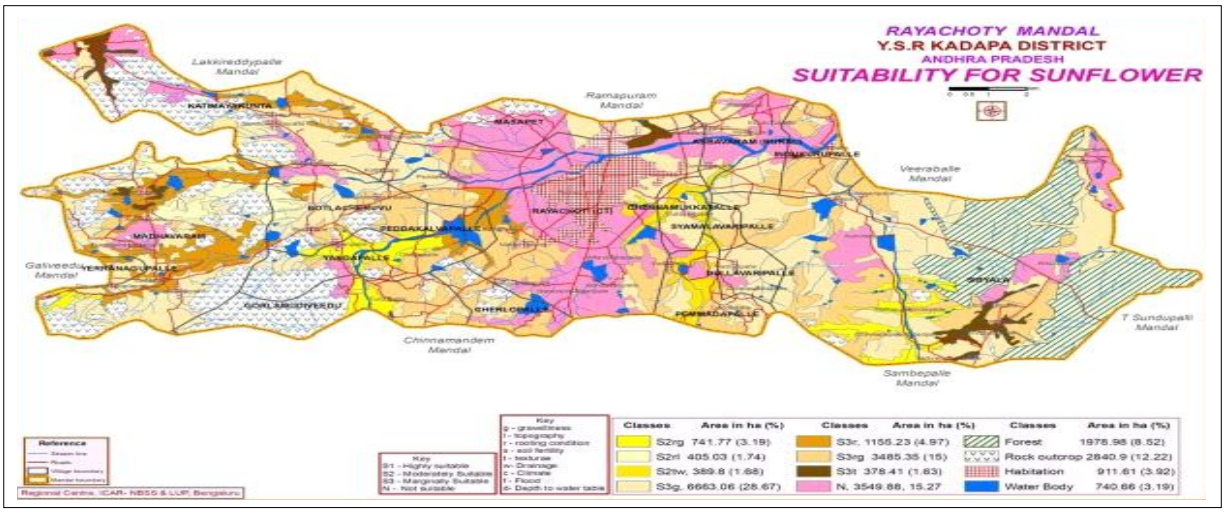



**Fig 2:** Soil suitability for sunflower in Rayachoty Mandal, Rayalseema Region, India.

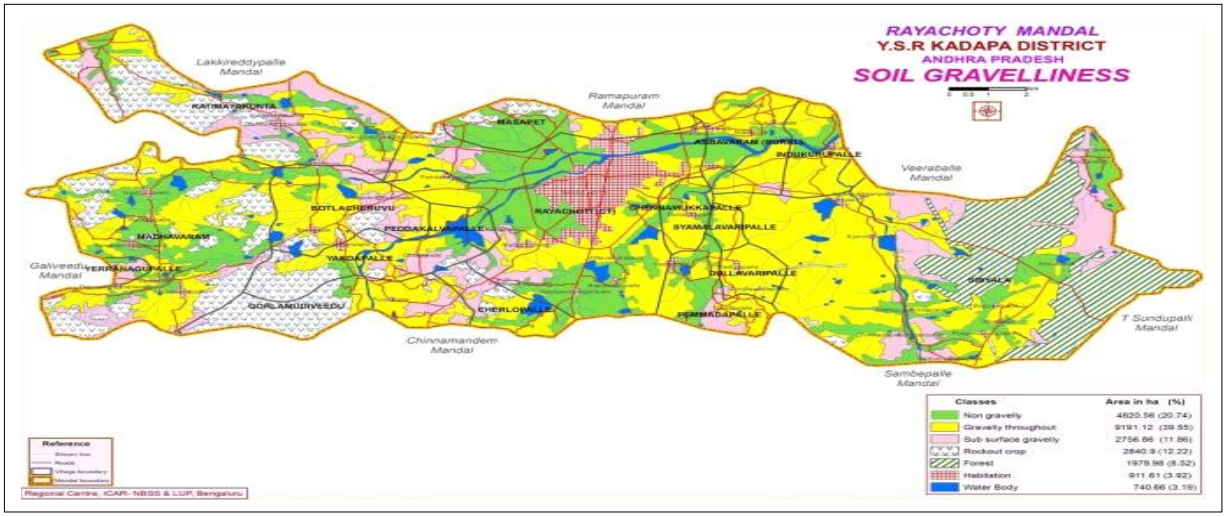



**Fig 3:** Surface coarse fragments in Rayachoty Mandal, Rayalseema Region, India.

Telangana, India, were reported by Karthika *et al.* (2024 and 2022, respectively) and on pigeon pea suitability by Ramamurthy *et al.* (2018) in the southern transition zone of Karnataka Plateau, India.

For groundnut cultivation gravelines is the major constraint (Fig 3) in a 5547.1 ha area (23.87 per cent) of the total geographical area covering mapping units KmpbB2(29), KvpbB1(41), KvpbB2(42), KvpbB2g2(43), KvpcA2g1(44),

**Table 3:** Soil suitability for groundnut in Rayachoty mandal, Rayalseema region, India.

| Mapping unit no. | Suitability classes | Description | Area (ha) | Area (%) |
|---|---|---|---|---|
| 29,41,42,43 44,46 | S2g | Moderately suitable land with slight limitation of gravelliness | 3051.96 | 13.13 |
| 31,33,35 | S2gl | Moderately suitable land with slight limitations of gravelliness and topography | 524.48 | 2.26 |
| 30,47,48 | S2gn | Moderately suitable land with slight limitations of gravelliness and soil fertility | 258.19 | 1.11 |
| 10 | S2gt | Moderately suitable land with slight limitation of gravelliness and soil texture | 98.6 | 0.42 |
| 34 | S2gw | Moderately suitable land with slight limitations of gravelliness and drainage | 217.66 | 0.94 |
| 6 | S2l | Moderately suitable land with slight limitation of topography | 405.03 | 1.74 |
| 38 | S2n | Moderately suitable land with slight limitation of soil fertility | 316.05 | 1.36 |
| 37 | S2nw | Moderately suitable land with slight limitation of soil fertility and drainage | 53.7 | 0.23 |
| 18,19,20,2, 22,23 | S2rg | Moderately suitable land with slight limitation of root restriction and gravelliness | 1396.21 | 6.01 |
| 24 | S2rl | Moderately suitable land with slight limitation of root restriction and topography | 163.94 | 0.71 |
| 9,11,12,13, 14,16,17 | S2rt | Moderately suitable land with slight limitation of root restriction and soil texture | 1990.54 | 8.56 |
| 27,28 | S2rw | Moderately suitable land with slight limitation of root restriction and drainage | 818.18 | 3.52 |
| 39,40,51 | S2w | Moderately suitable land with slight limitation of drainage | 761.82 | 3.28 |
| 25,32,45 | S3n | Marginally suitable land with slight limitation of soil fertility | 2783.89 | 11.98 |
| 1,2,3,6,7 | S3r | Marginally suitable land with slight limitation of root restriction | 1366.95 | 5.88 |
| 4,5 | S3rn | Marginally suitable land with slight limitation of root restriction and soil fertility | 242.56 | 1.04 |
| 49,50 | S3t | Marginally suitable land with slight limitation of soil texture | 378.41 | 1.63 |
| 26,52,53 | S3w | Marginally suitable land with slight limitation of drainage | 1675.07 | 7.21 |
| 8 | N | Currently not suitable | 265.31 | 1.14 |
| | | Soil total | 16768.55 | 72.15 |
| Rock outcrops | | | 2840.9 | 12.22 |
| Forest | | | 1978.98 | 8.52 |
| Habitation | | | 911.61 | 3.92 |
| Waterbody | | | 740.66 | 3.19 |
| Total | | | 23240.7 | 100 |

Note: Climate limitation is commonly present in Rayachoty Mandal.

KvpcB2g1(46), KmpbC2(31), KmpcC2g1(33), KmphC2(35), KmpbB2g1(30), KvphB1 (47), KvphB2(48), TppbC2(10), KmphB1(34) which makes these mapping units into moderately suitable in Rayachoty Mandal. Similarly for sunflower cultivation gravelines are the major constraint (Fig 3), in 10890.18 ha (46.86 per cent) of a total geographical area covering in mapping units BrphB1(37), BrpfB1(38), BrpiB1(40), KmpbB2(29), KmpbB2g1(30), KmpbC2(31), KmpcB2(32), KmpcC2g1 (33), KmphB1(34), KmphC2(35), KvpbB1(41), KvpbB2(42), KvpbB2g2(43), KvpcA2g1(44), KvpcB2 (45), KvpcB2g1(46), KvphB1(47), KvphB2(48), TppbB2(9), TppbC2(10), TppcA1(11), TppcB2(12), TppcB2g1(13), TppcC2g1(14), TpphB2g1(15), TppiC2(16), AnpbB1(17), AnpbB2(18), AnpbC2(19), AnpcB2(20), AnpcB2g1(21), AnphB1(22), AnpiA1(23) which makes these mapping units into moderately and marginally suitable for sunflower production in Rayalseema region. Gravelly soil can be managed by the addition of organic manures like compost, manure, mulch, or green manure into the top 4 inches of soil. The addition of topsoil to the top 4-inch soil also helps in improving gravelly soil. Gravelly soils generally form by washing out of clay soil associated with topsoil due to soil erosion in uplands and steep slopes hence erosion control measures help to prevent soil degradation and formation of gravelly soil. Use of reduced or no-till farming methods to leave crop residue on the field after harvest, which improves water retention and organic matter levels in gravelly soils. Application of soil fertility management practices like crop rotation with legumes and the use of improved germplasm will also help to improve gravelly soil. Similar studies on land suitability evaluation have been reported for different crops (Chandrakala *et al.,* 2019a), mango (Chandrakala *et al.,* 2023), paddy (Chandrakala *et al.,* 2022a), pigeon pea (Chandrakala *et al.,* 2022b) and rubber (Chandrakala *et al.,* 2019b).

Soil fertility constraint present in 3654.39 ha area (15.72 per cent) for groundnut cultivation covering mappingunits KmpbB2g1(30), KvphB1(47), KvphB2(48),

**Table 4:** Soil suitability for sunflower in Rayachoty mandal, Rayalseema region, India.

| Mapping unit no. | Suitability classes | Description | Area (ha) | Area (%) |
|---|---|---|---|---|
| 37,38,40 | S2rg | Moderately suitable land with slight limitations of root restriction and gravelliness | 741.77 | 3.19 |
| 36 | S2rl | Moderately suitable land with slight limitations of root restriction and topography | 405.03 | 1.74 |
| 51 | S2tw | Moderately suitable land with slight limitations of soil texture and drainage | 389.8 | 1.68 |
| 29,30,31,32,33,34,35,41 ,42,43,44,45,46,47, 48 | S3g | Marginally suitable land with slight limitation of gravelliness | 6663.06 | 28.67 |
| 24,25,27,28 | S3r | Marginally suitable land with slight limitation of root restriction | 1155.23 | 4.97 |
| 9,10,11,12,13,14,15,16, 17,18,19,20,21,22,23 | S3rg | Marginally suitable land with slight limitations of root restriction and gravelliness | 3485.35 | 15 |
| 49,50 | S3t | Marginally suitable land with slight limitation of soil texture | 378.41 | 1.63 |
| 1,2,3,4,5,6,7,8,26,39, 52,53 | N | Currently not suitable | 3549.88 | 15.27 |
| | | Soil total | 16768.55 | 72.15 |
| Rock outcrops | | | 2840.9 | 12.22 |
| Forest | | | 1978.98 | 8.52 |
| Habitation | | | 911.61 | 3.92 |
| Waterbody | | | 740.66 | 3.19 |
| Total geographical area | | | 23240.7 | 100 |

Note: Climatic limitation is commonly present in Rayachoty Mandal.

BrpfB1(38), BrphB1(37), MdvcA1(25), KmpcB2(32), KvpcB2(45), SblcB2(4), VprbB1(5) which makes these mapping units into moderately and marginally suitable in Rayachoty mandal. Soil fertility constraints can be managed by the application of soil test-based fertilizer recommendations and site-specific soil management practices and reclamation of soil. Irrigation with alkaline water or salty water further aggravates the soil fertility constraint hence, irrigation water is to be tested before irrigation in that area. Reclamation of acidic, alkaline and calcareous soils (recommendation of amendments *viz*., gypsum or lime or locally available spent wash or press mud compost and removing calcium salts by flooding and draining) followed by good quality irrigation water management including soil test-based optimum and balanced soil fertilizer and manure recommendation helps to control these soil fertility constraints in the Rayalseema region. A few limitations like topography and gravelliness are difficult to manage.

Soil depth is a constraint in 5978.38 ha area (25.72 per cent) for groundnut production and 5787.38 ha (24.90 per cent) area for sunflower production in Rayachoty Mandal (Table 3 and 4). Since the Rayachoty Mandal has a semi-arid and hot climate, this high temperature and low rainfall are not congenial for the development of deep and very deep soils as this climate hinders the soil weathering and soil-forming process thus around 25 per cent area has a shallow depth which is not suitable for groundnut and sunflower cultivation. However, shallow depth can be changed to good by the adoption of land improvement practices such as deepening of topsoil by ridging, deep ploughing or breaking up of soil crust (Nagarjuna and Naidu, 2021).

Soil drainage is a constraint in 3526.43 ha (15.18 per cent) area for groundnut cultivation and a very negligible area (389.8 ha) for sunflower cultivation (Table 3 and 4). Generally drainage problem occurs in lowlands or submerged lands due to lack of proper drainage but it can be very easily managed by providing artificial surface and sub-surface drainage and also by sowing/planting in raised beds and raised ridges in lowlands. Soil texture is a constraint in 2467.55 (10.61 per cent) area for groundnut cultivation and 768.21 ha (3.31 per cent) for sunflower cultivation in Rayachoty Mandal, thus it can be managed by adding tank silt to the sandy soils. It is also necessary to control soil erosion by suitable soil and water conservation measures to avoid loss of clay in surface soil during intense rainfall in steep slopes and uplands. In some mapping units, though one factor is highly suitable, the other factor will not be favourable, making the soils moderately and marginally suitable (Chandrakala *et al.,* 2022a).

## CONCLUSION

In the Rayalseema region, groundnut and sunflower are the major edible oil crops being cultivated. The groundnut suitability shows that it can be grown in 43.27 per cent of the total area with manageable limitations such as topography, soil texture, gravelliness, soil fertility, rooting condition and drainage and 27.74 per cent of the total geographical area having limitations *viz*., root restriction, soil fertility, soil texture and drainage thus these area is marginally suitable. However, sunflower suitability shows that it can be cultivated in 50.27 per cent of the area. However, this needs to be addressed with limitations such as gravelliness, root restriction and soil texture and 15.27 per cent of the total area is unsuitable for sunflower cultivation. Apart from slight and moderate limitations, which can be modified and managed through soil and land management practices, groundnut and sunflower can be cultivated in more than 50-60 per cent of the area in the Rayalseema region. However, for elevated yield productivity and income, the above-mentioned limitations need to be addressed before taking up crop production. The area under groundnut and sunflower can be increased if we can address and manage these limitations in other parts of the Rayalseema region in Andhra Pradesh state so that rural livelihoods can be improved with better income.

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### Disclaimers

The study is a unique way of expression and does not represent the views of their affiliated institutions.

### Informed consent

The study does not involve animals.

### Conflict of interest

The authors declare that there are no conflicts of interest.

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