

AGRICULTURAL EXPERT KNOWLEDGE BASE

Top 10 Oilseed Crops in India – Agronomic Reference for Expert LLM

This document summarises practical, India-focused agronomic knowledge for the top 10 oilseed crops. For each crop, it covers: importance and distribution, climate and weather needs, soil and fertility requirements, irrigation and water management, major pests and diseases, yield benchmarks (India vs global), and evidence-based strategies to improve yield when key parameters are sub-optimal. Values are indicative and should be adapted to local recommendations and soil test reports.

1. RAPESEED-MUSTARD (INCLUDING INDIAN MUSTARD)

1.1 Importance and Distribution

- One of the most important rabi oilseed crops in India.
- Major states: Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, Gujarat, West Bengal, Assam.
- Used for edible oil, condiments (mustard seed, sauce), and as a green manure crop.
- India is among the top producers globally, but average yields are lower than potential.

1.2 Climate and Weather Requirements

- Season: Cool-season (rabi) crop; sown from October to November in North India.
- Temperature:
 - Optimum germination: 20–25 °C.
 - Vegetative growth: 18–25 °C.
 - Flowering and pod filling: 15–20 °C; very high temperatures and hot dry winds during flowering reduce pod set and seed weight.
- Rainfall:
 - Requires about 350–450 mm total rainfall in the season if rainfed; performs best under assured moisture or limited irrigation.
 - Highly sensitive to moisture stress at flowering and pod filling; terminal drought sharply reduces yield.
- Photoperiod: Long-day tendency; responds to day length and temperature for flowering.

1.3 Soil Requirements and Soil Health Parameters

- Preferred soils:
 - Well-drained loam to clay-loam soils with good water holding capacity.
 - Avoid waterlogging; mustard is moderately sensitive to poor drainage and salinity.
- Ideal soil pH: 6.0–7.5; yield declines in strongly acidic (< 5.5) or alkaline (> 8.0) soils.
- Organic carbon: At least 0.5–0.75% for sustainable productivity; higher OC improves structure, microbial activity and nutrient availability.
- Key nutrients:
 - Nitrogen (N): High demand; supports vegetative growth and yield.
 - Phosphorus (P): Important for root growth and early vigour.
 - Potassium (K): Improves stress tolerance and oil content.
 - Sulphur (S): Very critical for oilseed crops; deficiency directly lowers oil content and yield.
 - Micronutrients: Boron (B) and Zinc (Zn) are often limiting on many Indian soils.
- Bulk density and water holding:
 - Ideal bulk density ~1.3–1.4 g/cm³ for root growth; high compaction (> 1.6 g/cm³) restricts root depth.
 - Adequate water holding capacity helps bridge dry spells in critical stages.

1.4 Sowing Time, Seed Rate and Plant Geometry

- Sowing window:
 - North-Western plains: Mid-October to early November.
 - Eastern India and Assam: Late October to mid-November.
- Seed rate:

- Indian mustard: About 4–6 kg/ha with line sowing.
- Toria and yellow sarson: Typically 8–10 kg/ha (smaller seed size).
- Spacing:
 - Common recommendation: 30–45 cm between rows and 10–15 cm between plants.
 - Wider spacing with higher fertility supports better branching and pod formation.

1.5 Nutrient and Fertilizer Management

(Exact doses must follow local soil test based recommendations; values below are indicative.)

- General NPK recommendation (irrigated mustard on medium soils):
 - Nitrogen: 80–120 kg N/ha (split between basal and topdressing).
 - Phosphorus: 40–60 kg P₂O₅/ha.
 - Potassium: 20–40 kg K₂O/ha.
- Sulphur:
 - 20–40 kg S/ha often needed, especially on low S soils (e.g. using gypsum, elemental S or sulphur-bearing complex fertilizers).
- Micronutrients:
 - Zinc: 5–10 kg Zn/ha as basal in deficient soils or foliar sprays.
 - Boron: Very small doses (e.g. 1–2 kg B/ha equivalent) on known deficient soils.
- Organic sources:
 - 5–10 t/ha of well decomposed FYM or compost improves soil structure and moisture retention, especially in light textured soils.

1.6 Irrigation and Water Management

- Under limited irrigation:
 - Two to three critical irrigations are highly beneficial:
 - First at pre-flowering or bud stage.
 - Second at full flowering.
 - Third at pod filling (if water is available).
- Total water requirement: Roughly 190–400 mm depending on variety and environment.
- Avoid standing water; ensure quick drainage after heavy rainfall.

1.7 Major Pests and Diseases (High-Level View)

- Important pests:
 - Mustard aphid: Sucks sap, causing curling and stunted growth, and reduces seed filling.
 - Painted bug and sawfly in some regions.
- Important diseases:
 - Alternaria blight, white rust, downy mildew, powdery mildew.
- Management (conceptual):
 - Use tolerant / resistant varieties recommended locally.
 - Follow timely sowing to escape peak pest pressure.
 - Use seed treatment fungicides as per local guidelines.
 - Monitor fields and use integrated pest management (IPM): cultural control, need-based biological and chemical control following official recommendations and safety guidelines.

1.8 Yield Benchmarks and Improvement Opportunities

- Typical farmer yields in India: Around 1.0–1.5 t/ha on average, with higher yields (2.0–2.5 t/ha or more) under well-managed irrigated conditions.
- Potential yields under best management and favourable weather can exceed 3 t/ha in experiments.
- Yield gap drivers:
 - Late sowing, poor seed quality, low N and S supply, moisture stress at flowering, pest and disease losses.
- Improvement strategies:
 - Timely sowing in optimal window.
 - Balanced fertilization including S and micronutrients based on soil test.
 - Two to three critical irrigations where possible.
 - Use of improved, high-yielding varieties suited to local climate.

- Adopting IPM, weed control, and residue recycling / organic inputs to enhance soil health.

2. SOYBEAN

2.1 Importance and Distribution

- Leading kharif oilseed crop in Central India.
- Major states: Madhya Pradesh, Maharashtra, Rajasthan, Karnataka; some area in Telangana and Chhattisgarh.
- Key source of edible oil and high-protein meal for livestock and poultry feed.
- India has large soybean area but yield lags behind major producers like the USA and Brazil.

2.2 Climate and Weather Requirements

- Season: Kharif crop; sown with onset of monsoon (June-July) and harvested in October-November.
- Temperature:
 - Optimum: 20-30 °C; sensitive to frost and high temperature stress during flowering and pod filling.
- Rainfall:
 - Requires about 500-700 mm of well-distributed rainfall; waterlogging during early growth causes root rot.
- Photoperiod: Many Indian varieties are sensitive to day length; sowing outside recommended window can cause poor flowering and podding.

2.3 Soil Requirements and Soil Health Parameters

- Preferred soils:
 - Deep, well-drained medium to heavy soils with good water holding capacity.
 - Avoid prolonged waterlogging; soybean is sensitive to stagnant water.
- Ideal soil pH:
 - 6.0-7.5 preferred; strong acidity and salinity reduce nodulation and yield.
- Organic carbon:
 - Higher OC supports nodulation, nitrogen fixation and better soil structure.
- Key nutrients:
 - Nitrogen: Soybean fixes N via Rhizobium, but starter N (15-20 kg/ha) may be beneficial on very poor soils.
 - Phosphorus: Crucial for root growth, nodulation and pod formation.
 - Potassium: Supports drought tolerance and seed quality.
 - Sulphur and micronutrients (Zn, Mo, Fe) important for oil and protein synthesis.
- Soil biological health:
 - Inoculation with effective Rhizobium strains enhances N fixation, especially in new soybean areas.

2.4 Sowing Time, Seed Rate and Geometry

- Sowing window:
 - With onset of monsoon – generally mid-June to early July depending on region.
- Seed rate:
 - Typically 60-75 kg/ha depending on seed size and row spacing.
- Spacing:
 - Commonly 30-45 cm rows with 5-10 cm between plants.
 - Closer spacing can help suppress weeds but needs good nutrient and moisture supply.

2.5 Nutrient and Fertilizer Management

- General NPK (indicative, follow local soil test recommendations):
 - Starter N ~20 kg/ha where needed.
 - Phosphorus: 40-60 kg P₂O₅/ha.
 - Potassium: 20-40 kg K₂O/ha depending on soil K status.
- Sulphur:
 - Often 20-40 kg S/ha required; deficiency reduces oil content.
- Micronutrients:
 - Zinc and iron deficiencies are common on calcareous and high pH soils; foliar sprays or soil application

- may be advised.
- Biofertilizers:
 - Seed inoculation with Rhizobium and phosphate-solubilizing bacteria (PSB) improves nutrient supply.
- Organic matter:
 - Incorporating crop residues and FYM improves soil structure and moisture retention.

2.6 Irrigation and Water Management

- Often grown as rainfed crop; supplemental irrigation where available greatly improves yield.
- Critical stages:
 - Flowering and pod filling.
- Avoid:
 - Waterlogging in early growth and at seedling stage, which predisposes plants to diseases like root rot.

2.7 Major Pests and Diseases (High-Level)

- Pests:
 - Leaf-eating caterpillars, stem fly, girdle beetle.
- Diseases:
 - Soybean rust, yellow mosaic virus, collar rot, root rot.
- Management:
 - Use resistant/tolerant varieties.
 - Treat seed with recommended fungicides/biocontrol agents.
 - Follow crop rotation; avoid continuous soybean.
 - Monitor field and use need-based IPM interventions as per official guidelines.

2.8 Yield Benchmarks and Improvement Strategies

- Typical yields in India: Around 1.0–1.5 t/ha, varying by region and year.
- Global benchmarks: 3.0–4.0 t/ha or higher in leading countries under intensive management.
- Key yield gap factors:
 - Late sowing, poor drainage, inadequate P and S, ineffective nodulation, severe weed and disease pressure.
- Improvement levers:
 - Timely sowing with good quality seed and Rhizobium inoculation.
 - Balanced fertilization including S and micronutrients based on soil tests.
 - Effective weed management in first 30–40 days.
 - Drainage improvement and avoiding prolonged waterlogging.

3. GROUNDNUT (PEANUT)

3.1 Importance and Distribution

- Major kharif and summer oilseed crop; grown under both rainfed and irrigated conditions.
- Major states: Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Odisha.
- Important for edible oil, confectionery and fodder (haulms).
- India is among top producers, but productivity is constrained by drought, poor soils and management gaps.

3.2 Climate and Weather Requirements

- Season: Kharif (rainy), rabi and summer in some regions under irrigation.
- Temperature:
 - Optimum: 25–30 °C; sensitive to frost and extreme heat during flowering.
- Rainfall:
 - Requires about 500–700 mm in growing season; distribution is more important than total amount.
- Weather sensitivity:
 - Drought at pegging and pod filling sharply reduces pod number and seed weight.
 - Excess rainfall and waterlogging cause disease and poor pod development.

3.3 Soil Requirements and Soil Health

- Preferred soils:
 - Light-textured sandy loam to loam with good drainage; deep well-drained red and black soils also suitable.
 - Heavy clay or poorly drained soils cause poor pegging and pod formation.
- Ideal pH: About 6.0–7.5; salinity and alkalinity reduce yield.
- Bulk density and structure:
 - Moderate bulk density that allows easy peg penetration and pod expansion.
- Key nutrients:
 - Nitrogen, phosphorus, potassium and calcium are most important.
 - Calcium at pod zone (e.g. from gypsum) is critical for proper pod filling and seed quality.
 - Sulphur and boron also important for oil and seed quality.
- Organic matter:
 - FYM and compost improve soil structure and moisture holding, helping crop withstand dry spells.

3.4 Sowing and Plant Geometry

- Kharif sowing: With onset of monsoon.
- Summer sowing: January–March depending on region, under irrigation.
- Seed rate:
 - 100–150 kg/ha depending on pod size and variety.
- Spacing:
 - Commonly 30–45 cm between rows and 10–15 cm between plants.
 - Spreading vs. bunch types have different recommended spacing.

3.5 Nutrient Management

- General NPK (indicative):
 - Nitrogen: 15–25 kg N/ha as starter; much of the N is fixed by nodulating bacteria.
 - Phosphorus: 40–60 kg P_2O_5 /ha.
 - Potassium: 30–40 kg K_2O /ha on low to medium K soils.
- Calcium:
 - Application of gypsum in the pegging zone improves pod formation and reduces empty pods.
- Sulphur and micronutrients:
 - S, Zn and B on deficient soils improve yield and quality.
- Integrated nutrient management:
 - Combine inorganic fertilizers with FYM/compost and biofertilizers for better soil health.

3.6 Irrigation and Water Management

- As rainfed crop:
 - Ensure good land levelling and conservation furrows to store rainwater.
- Under irrigation:
 - Critical stages: flowering, pegging and pod development.
 - Avoid prolonged drought at these stages and prevent waterlogging.
- Mulching:
 - Organic mulches (e.g. crop residues) help conserve moisture and moderate soil temperature.

3.7 Major Pests and Diseases

- Pests:
 - Leaf miner, defoliators, sucking pests and soil-borne insects in some regions.
- Diseases:
 - Tikka (leaf spot), rust, stem rot, root rot and aflatoxin contamination in drought-stressed pods.
- Management:
 - Use resistant varieties and timely sowing.
 - Follow crop rotation to break disease cycles.
 - Maintain field sanitation; remove infected plants.
 - Use IPM-based fungicide and insecticide applications according to official guidelines.

3.8 Yield Benchmark and Improvement

- Typical Indian yields: 1.0–1.5 t/ha under rainfed conditions; 2.0–3.0 t/ha possible with irrigation and improved technology.
- Potential yields in research trials: Often exceed 3 t/ha.
- Main yield gap drivers:
 - Moisture stress, poor nutrient management, lack of calcium, pest and disease damage, poor quality seed.
- Improvement strategies:
 - Timely sowing, gypsum application in pegging zone, balanced fertilization including S and micronutrients.
 - Moisture conservation and supplemental irrigation during critical stages.
 - Use of improved varieties and good seed.

4. SUNFLOWER

4.1 Importance and Distribution

- Grown as an important oilseed crop in Karnataka, Andhra Pradesh/Telangana, Maharashtra and parts of North India.
- Short-duration, photo-insensitive crop suitable for multiple seasons (kharif, rabi and summer) under irrigation or conserved soil moisture.
- Produces high quality edible oil rich in polyunsaturated fatty acids.

4.2 Climate and Weather Requirements

- Temperature:
 - Optimum: 20–30 °C for germination and growth.
 - Very high temperatures combined with moisture stress around flowering reduce seed set.
- Rainfall:
 - Performs well with 400–600 mm of rainfall; responds well to irrigation in drier regions.
- Light:
 - Being day-neutral, it can be grown in various seasons; however, adequate sunlight is needed for good photosynthesis and head filling.

4.3 Soil Requirements

- Adaptable to a wide range of soils from sandy loam to clay loam, provided drainage is adequate.
- Ideal pH: 6.0–7.5; tolerates slightly alkaline soils but sensitive to severe salinity.
- Soil fertility:
 - Requires good levels of nitrogen, phosphorus and potassium.
 - Responsive to organic manures and integrated nutrient management.

4.4 Sowing and Plant Geometry

- Season:
 - Kharif: With monsoon onset.
 - Rabi/summer: Under irrigation after harvesting preceding crop.
- Seed rate:
 - Typically 8–10 kg/ha for hybrids.
- Spacing:
 - About 45–60 cm between rows and 20–30 cm between plants, depending on hybrid and fertility level.

4.5 Nutrient Management

- Indicative NPK:
 - Hybrids: Around 60 kg N, 60–90 kg P₂O₅ and 40–60 kg K₂O/ha, adjusted to soil tests and moisture regime.
- Organic sources:
 - 5–10 t/ha FYM or compost improves soil structure and water retention.
- Micronutrients:
 - Boron and zinc may be limiting on certain soils, affecting seed set and head filling.

4.6 Irrigation and Water Management

- Critical stages for irrigation:
 - Flower bud initiation, flowering and grain filling.
- Waterlogging damages roots and increases disease incidence; ensure proper drainage.
- In rainfed areas, conservation furrows and mulching help improve moisture availability.

4.7 Pests and Diseases

- Pests:
 - Head borer, capitulum weevils and sucking pests in some areas.
- Diseases:
 - Downy mildew, alternaria leaf spot, charcoal rot.
- Management:
 - Use recommended resistant hybrids.
 - Practice crop rotation and field sanitation.
 - Adopt need-based IPM following official recommendations.

4.8 Yield Benchmarks and Improvement

- Typical Indian farmer yields: 0.8–1.2 t/ha.
- Potential yields: 2.0–2.5 t/ha or more with improved practices and adequate water and nutrients.
- Key constraints:
 - Soil moisture stress, unbalanced fertilization, pests and diseases.
- Improvement options:
 - Integrated nutrient and water management, choice of suitable hybrids, timely sowing, IPM and better soil conservation practices.

5. SESAME (TIL)

5.1 Importance and Distribution

- One of the oldest oilseed crops, valued for high-quality oil and use in sweets and condiments.
- Grown across central, eastern and southern India.
- Major states: Uttar Pradesh, Madhya Pradesh, Rajasthan, Gujarat, Odisha, West Bengal, Tamil Nadu.

5.2 Climate and Weather Requirements

- Warm-season crop; optimum temperature 25–35 °C.
- Moderately drought tolerant but sensitive to prolonged waterlogging.
- Often grown in kharif under rainfed conditions, and in some regions during summer or rabi with irrigation.

5.3 Soil Requirements

- Performs well on well-drained loam and sandy loam soils.
- Tolerant to relatively poor, dry soils but yield is higher on fertile, moisture-retentive soils.
- Ideal pH: 5.5–7.5; sensitive to strong salinity.
- Soil health:
 - Needs adequate phosphorus, potassium and sulphur for high oil content.

5.4 Sowing and Plant Geometry

- Season: Mainly kharif; some rabi/summer sesame under irrigation in South India.
- Seed rate: Around 3–5 kg/ha due to small seeds.
- Spacing: About 30–45 cm between rows and 10–15 cm between plants depending on variety and soil moisture.

5.5 Nutrient Management

- Indicative NPK:
 - Nitrogen: 25–40 kg N/ha.

- Phosphorus: 25–40 kg P_2O_5 /ha.
- Potassium: 20–30 kg K_2O /ha on low to medium K soils.
- Sulphur:
 - 15–30 kg S/ha enhances oil content.
- Organic matter and green manuring improve moisture conservation and root growth.

5.6 Irrigation and Water Management

- Often grown as rainfed crop.
- Most critical stages: flowering and capsule development.
- Avoid waterlogging, especially in early growth stages.

5.7 Pests and Diseases

- Pests:
 - Leaf rollers, jassids, capsule borers in some areas.
- Diseases:
 - Phyllody, wilt, leaf spots.
- Management:
 - Use disease-tolerant varieties and healthy seed.
 - Practice crop rotation and timely sowing.
 - Follow IPM and need-based plant protection.

5.8 Yield Benchmarks and Improvement

- Typical yields: 0.4–0.8 t/ha under rainfed conditions.
- Potential yields: 1.2–1.5 t/ha or higher with improved varieties, better moisture and nutrient management.
- Improvement levers:
 - Timely sowing, weed control, balanced fertilization, soil moisture conservation, and use of improved varieties.

6. CASTOR

6.1 Importance and Distribution

- Castor oil is used in industry, pharmaceuticals and as a lubricant.
- India is among the world's largest producers and exporters of castor oil.
- Major states: Gujarat, Rajasthan, Andhra Pradesh/Telangana.

6.2 Climate and Weather Requirements

- Warm-season crop with optimum temperatures 20–30 °C.
- Tolerant to drought but sensitive to waterlogging.
- Can be grown in kharif and rabi seasons in suitable regions.

6.3 Soil Requirements

- Grows in a range of soils from light sandy loams to deep black soils, provided they are well drained.
- Ideal pH: 6.0–8.0; moderately tolerant to salinity.
- Soil health:
 - Requires good supply of nitrogen, phosphorus and potassium, and benefits from organic matter.

6.4 Sowing and Plant Geometry

- Season:
 - Kharif sowing with onset of monsoon; rabi castor under irrigation in some regions.
- Seed rate:
 - 8–12 kg/ha depending on seed size and plant type.
- Spacing:
 - Wider spacing such as 90–120 cm between rows and 45–60 cm between plants due to large canopy.

6.5 Nutrient Management

- Indicative NPK:
 - Nitrogen: 60–90 kg N/ha.
 - Phosphorus: 40–60 kg P₂O₅/ha.
 - Potassium: 30–40 kg K₂O/ha depending on soil test.
- Organic matter:
 - FYM application improves soil structure and water holding.
- Micronutrients like Zn and B may be important in deficient soils.

6.6 Irrigation and Water Management

- Often grown on conserved soil moisture as a rainfed crop in semi-arid regions.
- Under irrigation, critical stages include flowering and capsule development.
- Ensure good drainage; prolonged waterlogging increases root diseases.

6.7 Pests and Diseases

- Pests:
 - Capsule borer, semilooper, sucking pests.
- Diseases:
 - Wilt, root rot, grey mould.
- Management:
 - Use tolerant hybrids/varieties.
 - Follow crop rotation and field sanitation.
 - Adopt IPM with need-based plant protection as per recommendations.

6.8 Yield and Improvement

- Typical Indian farmer yields: 1.0–1.5 t/ha.
- Potential yields under improved practices: 2.5–3.0 t/ha or more.
- Improvement levers:
 - Improved hybrids, balanced fertilization, moisture conservation and IPM.

7. SAFFLOWER

7.1 Importance and Distribution

- Traditionally grown as a rabi oilseed in Maharashtra, Karnataka, Andhra Pradesh and parts of MP.
- Suited to low rainfall, residual moisture conditions.
- Oil used for cooking; also grown for ornamental flowers in some regions.

7.2 Climate and Weather Requirements

- Cool-season crop adapted to dryland rabi conditions.
- Tolerates drought and can grow on residual moisture, but severe terminal drought reduces yield.
- Sensitive to waterlogging.

7.3 Soil Requirements

- Performs reasonably well in deep, well-drained soils with moderate fertility.
- Often grown on black soils using stored moisture.
- Ideal pH: 6.0–8.0; tolerant to slightly alkaline conditions.

7.4 Sowing and Geometry

- Sown in October–November depending on region.
- Seed rate: Around 15–20 kg/ha.
- Spacing: About 45 cm between rows and 20 cm between plants.

7.5 Nutrient Management

- Indicative fertilizer:
 - Nitrogen: 40–60 kg N/ha.
 - Phosphorus: 20–40 kg P₂O₅/ha.
- Integrated nutrient management with FYM and crop residues improves soil organic matter and moisture storage.

7.6 Water Management

- Mostly grown on stored soil moisture; supplemental irrigation, if available, at flowering and grain filling greatly improves yield.
- Avoid waterlogging at all stages.

7.7 Pests and Diseases

- Pests: Aphids and other sucking pests on leaves and heads.
- Diseases: Leaf spots, rust in some areas.
- IPM approach and tolerant varieties are preferred.

7.8 Yield and Improvement

- Typical farmer yield: 0.6–1.0 t/ha.
- Potential with improved management: 1.5–2.0 t/ha.
- Improvement options:
 - Timely sowing, balanced N and P, residue and moisture management and IPM.

8. NIGER

8.1 Importance and Distribution

- Minor oilseed crop grown mainly in tribal and hilly regions.
- Major states: Odisha, Chhattisgarh, Madhya Pradesh, Jharkhand.
- Oil used for cooking and traditional uses; crop also supports biodiversity in marginal areas.

8.2 Climate and Weather Requirements

- Adapted to warm, humid and sub-humid climate.
- Often grown in kharif on marginal lands under rainfed conditions.
- Tolerant to some degree of drought and poor soils, but waterlogging is harmful.

8.3 Soil Requirements

- Performs reasonably well on light to medium-textured soils with good drainage.
- Can grow on low fertility soils but responds to moderate fertilization.
- Ideal pH: Around 5.5–7.0.

8.4 Sowing and Geometry

- Sown with onset of monsoon (June–July).
- Seed rate: 5–7 kg/ha.
- Spacing: 30–45 cm between rows and 10–15 cm between plants.

8.5 Nutrient and Water Management

- Nutrient requirements modest but crop responds to:
 - 20–30 kg N/ha and 20–30 kg P₂O₅/ha.
- Moisture conservation through mulching and contour farming important on sloping lands.
- Usually grown as a rainfed crop; irrigation rarely available on marginal lands.

8.6 Pests, Diseases and Yield

- Generally fewer serious pests and diseases compared to major oilseeds, but local issues may occur.

- Typical yields: 0.3–0.7 t/ha.
- Improvement:
 - Use of improved varieties, modest fertilization and better moisture conservation.

9. LINSEED (FLAX)

9.1 Importance and Distribution

- Grown as a rabi oilseed crop; seed used for linseed oil and industrial uses.
- Major states: Madhya Pradesh, Uttar Pradesh, Bihar, Chhattisgarh, Jharkhand.
- In some regions, also valued for fibre.

9.2 Climate and Weather Requirements

- Cool-season crop; prefers mild temperatures during growth.
- Sensitive to high temperature and drought during flowering and grain filling.
- Excess water and waterlogging are also harmful.

9.3 Soil Requirements

- Performs best on well-drained loam and clay-loam soils.
- Ideal pH: 6.0–7.5.
- Good soil fertility with adequate nitrogen and phosphorus is important for yield and oil content.

9.4 Sowing, Fertility and Water

- Sown in October–November.
- Seed rate: Around 25–30 kg/ha depending on variety and seed size.
- Spacing: About 30 cm between rows and 7–10 cm between plants.
- Fertility:
 - Nitrogen: ~40–60 kg N/ha.
 - Phosphorus: 30–40 kg P₂O₅/ha.
- Mostly grown on conserved soil moisture under rainfed conditions; one or two irrigations, if available, at flowering and seed filling can boost yield.

9.5 Pests, Diseases and Yield

- Diseases: Rust, wilt and alternaria blight in some areas.
- Pests: Aphids, cutworms occasionally.
- Management:
 - Use resistant varieties and adopt IPM.
- Typical yields: 0.5–1.0 t/ha; can reach 1.5–2.0 t/ha under better management.

10. COCONUT (AS A MAJOR OILSEED TREE CROP)

10.1 Importance and Distribution

- Perennial tree crop providing copra and coconut oil.
- Major states: Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Goa and coastal regions.
- Integral to livelihoods in coastal belts; intercropping improves system productivity.

10.2 Climate and Weather Requirements

- Tropical crop requiring warm, humid climate.
- Optimum temperature: 27–32 °C; sensitive to severe frost.
- Requires well-distributed rainfall of about 1500–2500 mm annually; can be grown with supplemental irrigation in drier tracts.

10.3 Soil and Water

- Grows in a wide range of soils: coastal sandy soils, alluvial soils, lateritic and red soils, provided drainage is adequate.
- Deep, well-drained soil with good water table is ideal.
- Soil pH: broadly tolerant from moderately acidic to slightly alkaline, provided other conditions are good.
- Nutrient demand is high due to perennial nature; requires regular manuring and fertilization.
- Irrigation:
 - Regular irrigation (basin, drip or micro-irrigation) is crucial in dry spells, especially in summer.

10.4 Nutrient Management

- Annual NPK requirements are substantial (exact doses depend on palm age and local recommendations).
- Integrated nutrient management with FYM, green manures, intercropping and mulching is central to long-term productivity.
- Micronutrients such as Zn, B, Mg and others may be limiting in some soils and should be corrected based on deficiency diagnosis.

10.5 Cropping System, Pests and Yield

- Often grown in mixed and intercropping systems with banana, spices, fodder grasses and pulses to improve total farm income.
- Major pests: Rhinoceros beetle, red palm weevil, eriophyid mite in some areas.
- Diseases: Bud rot, stem bleeding, root wilt (region specific).
- Yield:
 - Number of nuts per palm per year varies widely (e.g. 50-150 or more) depending on variety, climate and management.
 - Copra and oil yield per hectare is a function of palms per hectare, nut yield and kernel content.

10.6 Improvement Strategies

- Choose high-yielding, locally adapted varieties/hybrids.
- Maintain good soil moisture with mulching, basin irrigation or drip systems.
- Apply recommended manures and fertilizers annually.
- Adopt IPM against major pests and diseases.
- Use intercropping and multi-storey cropping to improve overall system productivity and resilience.

CONCLUSION

These crop profiles summarise key agronomic parameters that strongly influence yield in India's major oilseed

crops. In an expert LLM system, these knowledge elements can be combined with:

- Site-specific soil test data (pH, EC, OC, NPK, micronutrients, bulk density, water holding capacity).
- Weather history and forecast (rainfall distribution, temperature extremes, dry spells).
- Remote sensing indicators (e.g. NDVI at early, mid and late growth stages).
- Historical yield performance at farmer, district, state, national and global levels.
- Management history (variety, seed rate, sowing date, irrigation, fertilizer, weed and pest control).

The LLM can then:

- Diagnose which domain (soil health, weather, agronomy, crop health) is most limiting.
- Suggest evidence-based improvements in each domain.
- Explain yield gaps relative to district, national and global benchmarks.
- Provide tailored, multilingual and farmer-friendly recommendations to support oilseed productivity and income enhancement.