# PLANT DISEASE DETECTION & RECOMMENDATION SYSTEM

(1.Define Scope & 2. Collect Data)

1) ***DEFINE SCOPE***
2) ***COLLECT DATA***
3) ***PREPROCESS DATA***
4) ***CHOOSE MODEL***
5) ***MODEL TRAINING***
6) ***EVALUATE THE MODEL***
7) ***DEPLOYMENT***
8) ***FARMER USUABILITY***
9) ***GATHER FEEDBACK***

## 1. What are the plants and plant disease that leads to high loss in Tamil Nadu?

| PLANT | DISEASE | Causal organism |
|---|---|---|
| Coconut | Coconut grey blight | Pestalotia palmarumi (Cooke) Skey |
| Groundnut | Early leaf spot | Cercosporaarachidicola |
| | Late leaf spot | Phaeoisariopsis personata |
| | Rust | Puccinia arachidis |
| | Collar rot / Seedling blight / Crown rot | Aspergillus niger and A. pulverulentum |
| | Root rot | Macrophomina phaseolina |
| | Ring mosaic / Bud necrosis / Bud blight | Groundnut bud necrosis virus |
| Corn | Maize northern corn leaf blight | (Exserohilum turcicum (Pass.) |
| Jowar | | |
| Black Gram/ Green Gram | Root rot | Rhizoctonia bataticola |
| | Powdery mildew | Erysiphe polygoni |
| | Leaf spot | Cercospora canescens |
| | Rust | Uromyces phaseoli typical |
| | Yellow mosaic | Mungbean yellow mosaic virus (MYMV) |
| | Leaf crinkle | Urdbean leaf crinkle virus (ULCV) |
| Cotton | Fusarium wilt | Fusarium oxysporum f.sp. vasinfectum |
| | Verticillium wilt | Verticillium dahlia |
| | Root rot | Rhizoctonia solani |
| | Leaf blight | Alternaria macrospora |
| | Myrothecium leaf spot | Myrothecium roridum |
| | Areolate mildew | Ramularia areola |
| | Angular leaf spot / Black arm | Xanthomonas axonopodis pv. Malvacearum |
| Sugarcane | Red rot | Colletotrichum falcatum |

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|---|---|---|
| | Sett rot or Pineapple disease | Ceratocystis paradoxa |
| | Whip smut | Ustilago scitaminea |
| | Mosaic | Sugarcane mosaic potyvirus |
| | Grassy shoot Disease (GSD) | Candidatus phytoplasma |
| | Phanerogamic parasite | Striga spp |
| Mango | Anthracnose | Colletotrichum gloeosporioides |
| | Die back / Fruit Stem end rot | Lasiodiplodia theobromae |
| | Powdery mildew | Oidium mangiferae |
| | Grey leaf Blight | Pestalotia mangiferae |
| | Sooty Mould | Capnodium mangiferae C.ramosum |
| | Mango malformation | Fusarium moniliforme var. subglutinans |
| | Bacterial leaf black spot / canker | Xanthomonas campestris pv. mangiferaeindicae |
| | Red Rust | Cepbaleuros virescens |

1) **Coconut:**

1. **Coconut Grey Blight (**Pestalotia palmarumi (Cooke) Skey)

**Symptoms:**

- Appears first on **older leaves** (outer whorl).
- Small **yellow spots** with **greyish margins** develop on the leaflets.
- The center of the spots **turns greyish-white** with **dark brown margins** and a **yellow halo**.
- As the disease progresses, the leaf blade **dries out and shrivels**, giving a **blighted (burnt) look**.
- A large number of **black, round or oval acervuli** (fungal structures) appear on the upper surface of the leaves.

**Pathogen Characteristics:**

- The **fungus produces conidia (spores) inside acervuli**.
- **Acervuli:** Black, cushion-shaped, and break open to release spores.
- **Conidiophores:** Short, simple, and hyaline (transparent).
- **Conidia (spores):**
  - **Five-celled** structure.
  - The **middle three cells** are **dark-colored**.
  - The **end cells** are **hyaline (transparent)**.
  - The spore has **3–5 slender, elongated appendages** at its apex.

(Source: Rahman et al., 2013)

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2) **Groundnut:**

**1. Early Leaf Spot (**Cercospora arachidicola**)**

- **Symptoms**:
  - Circular to irregular spots, reddish brown to dark brown.
  - Spots appear on the upper surface with a bright yellow halo.
  - Lesions on the lower surface are light brown.
- **Key Indicators**:
  - Reddish-brown spots on upper surface.
  - Yellow halo around spots.

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**2. Late Leaf Spot (**Phaeoisariopsis personata**)**

- **Symptoms**:
  - Dark, small, circular spots scattered on leaves.
  - Lower surface lesions turn black.
  - Petioles and stems also have black lesions.
  - Leaves shed prematurely.
- **Key Indicators**:
  - Dark circular spots.
  - Premature leaf shedding.
  - Black lesions on stems and petioles.
- **Favorable Conditions**:
  - High humidity for 3 days.
  - Low temperature (20°C).
  - Dew on leaf surface.
  - Heavy nitrogen and phosphorus fertilizers.
  - Magnesium deficiency in soil.

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**3. Rust (**Puccinia arachidis**)**

- **Symptoms**:
  - Small powdery pustules on the lower surface of leaves.
  - Upper surface shows yellow discoloration, later turning brown.
  - Pustules on petioles and stems.
  - Severe infection causes leaf drying and shedding.
- **Key Indicators**:
  - Powdery pustules on the lower surface.
  - Yellow to brown discoloration.
- **Favorable Conditions**:
  - High relative humidity (above 85%).
  - Heavy rainfall.
  - Low temperature (20-25°C).

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**4. Collar Rot / Seedling Blight / Crown Rot (**Aspergillus niger and A. pulverulentum**)**

- **Symptoms**:
  - **Post-emergence rot**: Circular brown spots on cotyledons and collar region.
  - **Crown rot**: Large brown lesions on the stem, leading to wilting.
- **Key Indicators**:
  - Brown circular spots on cotyledons and collar.
  - Drooping leaves and wilting plants.
- **Key Pathogen**: Fungus growth seen on affected regions.

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**5. Root Rot (**Macrophomina phaseolina**)**

- **Symptoms**:
  - Reddish-brown discoloration on the stem near soil level.
  - Drooping leaves and branches; plant wilts.
  - White fungal growth on lesions.
  - Shredded bark and sclerotia (fungal growth) on roots.
- **Key Indicators**:
  - Reddish discoloration near soil level.
  - Shredded bark and fungal growth on roots.
- **Favorable Conditions**:
  - Prolonged rainy season, especially during the seedling stage.
  - Low-lying areas.

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**6. Ring Mosaic / Bud Necrosis / Bud Blight (**Groundnut Bud Necrosis Virus**)**

- **Symptoms**:
  - Mottling and ring spots on leaves.
  - Reduction in leaf size and stunted plants.
  - Malformed, narrow leaves with necrotic lesions.
  - Streaks on stems and necrosis in buds.
- **Key Indicators**:
  - Mottling and ring spots on leaves.
  - Stunted growth and necrotic lesions.
- **Transmission**:
  - Spread by thrips (Frankliniella schultzi and Thrips tabaci).

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3) **Corn:**

1. **Maize Northern Corn Leaf Blight** (caused by Exserohilum turcicum):
   **Symptoms**:

- **Initial Stage**: Small, narrow, elongated, spindle-shaped spots on the leaves.
- **Progression**: These spots extend along the length of the leaf, becoming larger.
- **Older Plants**: Long, elliptical necrotic lesions that are straw-colored in the center with dark margins.

**Pathogen Characteristics**:

- **Fungal Features**: The mycelium (fungal threads) is brown and intercellular (found between cells).
- **Conidiophores (spore-producing structures)**: Emerge through the stomata (pores on leaves), long, olivaceous (olive-colored), septate (with segments), and geniculate (bent).
- **Conidia (spores)**: Olivaceous brown, 3-8 septate, and thick-walled.

**Disease Impact**:

- The disease causes **seed rot** and **seedling blight** in sorghum in addition to maize leaf blight.

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4) **Jowar:**

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5) **Black gram & Green gram:**

1. **Root Rot (**Rhizoctonia bataticola**)**
   - **Symptoms**: Drooping and drying of leaves and branches, brown basal stem, shredded root bark, presence of spherical to irregular black sclerotia in tissues.
   - **Favorable Conditions**: Day temperature of 30˚C, prolonged dry season followed by irrigation.

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2. **Powdery Mildew (**Erysiphe polygoni**)**
   - **Symptoms**: White powdery growth on the upper leaf surface, turning grey and causing the leaves to become brown, especially severe during flowering and maturity.
   - **Favorable Conditions**: Warm, humid weather, particularly during late kharif and rabi seasons.

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3. **Leaf Spot (**Cercospora canescens**)**
   - **Symptoms**: Small circular to irregular reddish spots on leaves, turning grey at the center, causing defoliation in severe cases, conidiophores and conidia in the center of lesions.
   - **Favorable Conditions**: Humid weather and dense plant population.

4. **Rust (**Uromyces phaseoli typical**)**
    - **Symptoms**: Reddish-brown pustules on the lower leaf surface, leaves turning yellow, uredospores (brown, echinulate), and teliospores (elliptical, papillate).
    - **Favorable Conditions**: Cloudy, humid weather, temperatures between 21-26˚C, nights with heavy dew.

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5. **Yellow Mosaic (**Mungbean Yellow Mosaic Virus (MYMV)**)**
    - **Symptoms**: Small, irregular yellow patches on leaves that enlarge and cover the whole leaf, leading to complete yellowing; pods become yellow, small, and distorted.
    - **Favorable Conditions**: Transmitted by whiteflies (Bemisia tabaci), prevalent in summer crops, with weed hosts serving as reservoirs for inoculum.

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6. **Leaf Crinkle (**Urdbean Leaf Crinkle Virus (ULCV)**)**
    - **Symptoms**: Puckered, curled leaves, stunted plants, bushy appearance, deformed inflorescences, and seldom-open flowers.
    - **Favorable Conditions**: Presence of weed hosts like Aristolochia bracteata and Digera arvensis, continuous cropping of other legumes, and primary infection via infected seeds. Secondary spread can occur through whiteflies.

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6) **Cotton:**
    1. **Fusarium Wilt (***Fusarium oxysporum f.sp. vasinfectum***)**
        - **Symptoms**: Wilting of plants starting from the base, yellowing and dropping of leaves, stunted tap root, black streaks on roots and stem, hyphal growth in vascular bundles.
        - **Favorable Conditions**: Soil temperature of 20-30˚C, hot and dry periods followed by rains, heavy black soils with an alkaline reaction, excessive nitrogen and phosphorus fertilizers, wounds caused by nematodes and weevil grubs.

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    2. **Verticillium Wilt (***Verticillium dahlia***)**
        - **Symptoms**: Stunted plants, bronzing of veins, interveinal chlorosis, leaf yellowing and scorched appearance, pinkish discoloration of infected stem and roots.
        - **Favorable Conditions**: Low temperatures (15-20˚C), ill-drained, heavy, alkaline soils, high nitrogen fertilizer usage.

3. **Root Rot (***Rhizoctonia solani***)**
    - **Symptoms**: Sudden wilting, root decay, shredded bark on roots and stem, presence of sclerotia on affected tissue.
    - **Favorable Conditions**: Dry weather following heavy rains, high soil temperature (35-39˚C), cultivation of favorable hosts (vegetables, oilseeds, legumes), wounds caused by weevil grubs and nematodes.

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4. **Leaf Blight (***Alternaria macrospora***)**
    - **Symptoms**: Brown, round or irregular necrotic spots with concentric rings, spots merge into larger patches, infected leaves wither.
    - **Favorable Conditions**: High humidity, intermittent rains, moderate temperature (25-28˚C).

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5. **Myrothecium Leaf Spot (***Myrothecium roridum***)**
    - **Symptoms**: Circular spots with grey centers and dark brown margins, centers of spots dry out leaving shot holes.
    - **Favorable Conditions**: Generally associated with humid conditions but specific favorable conditions were not provided.

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6. **Areolate Mildew (***Ramularia areola***)**
    - **Symptoms**: Irregular to angular lesions on the lower leaf surface, pale white spots bound by veinlets, frosty white fungal growth, chlorosis and yellowing of leaves.
    - **Favorable Conditions**: Wet, humid conditions during winter cotton season, intermittent rains during North-East monsoon, low temperatures (20-30˚C), excessive nitrogen fertilizer application, close planting, early or late sowing.

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7. **Angular Leaf Spot / Black Arm (***Xanthomonas axonopodis pv. Malvacearum***)**
    - **Symptoms**:
        - **Angular Leaf Spot**: Brown to black water-soaked spots on leaves, restricted by veins.
        - **Black Vein**: Blackened veins with bacterial ooze forming encrustations.
        - **Black Arm**: Elongated black lesions on stems and branches, causing branch breakage.
        - **Boll Rot**: Sunken, water-soaked lesions on bolls, premature opening and shedding, yellow lint due to bacterial ooze.
    - **Favorable Conditions**: Soil temperature of 28˚C, atmospheric temperature of 30-40˚C, relative humidity of 85%, early sowing,

delayed thinning, poor tillage, late irrigation, potassium deficiency, rain followed by sunshine.

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7) **Sugarcane**
    1. **Red Rot (***Colletotrichum falcatum***)**
        - **Symptoms**: Red margin and straw-colored center on the midrib of leaves, acervuli (black dots) in the center, leaf breakage at lesions, red internal tissues in canes, hollow stalks.
        - **Favorable Conditions**: Monoculturing of sugarcane, successive ratoon cropping, waterlogged conditions, insect injuries.
        - **Management**:
            - Use resistant varieties like Co86249, CoSi95071, CoG 93076, CoC 22, CoSi 6, and CoG 5.
            - Treat setts with Carbendazim (Carbendazim 50 WP, 0.05%, or Carbendazim 25 DS, 0.1%) with 1% Urea.
            - Increase irrigation interval to 15 days during tillering and growth phases, and 25 days during maturity.
            - Remove affected clumps early and apply soil drenching with Carbendazim or lime.
            - Rotate with rice for one season and other crops for two seasons.
            - Burn the trash after harvest.

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    2. **Sett Rot or Pineapple Disease (***Ceratocystis paradoxa***)**
        - **Symptoms**: Central core of affected sett tissue turns black, cavities form, rotting tissues emit a pineapple odor.
        - **Favorable Conditions**: Poorly drained fields, heavy clay soils, temperature of 25-30°C, prolonged rainfall after planting.
        - **Management**: Ensure proper drainage and soil management to avoid waterlogging, and maintain appropriate planting conditions.

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    3. **Whip Smut (***Ustilago scitaminea***)**
        - **Symptoms**: Stunted plants with a central shoot transformed into a long, curved whip-like sorus, covered by a silvery membrane which ruptures to expose a dark mass of teliospores.
        - **Favorable Conditions**: Monoculturing of sugarcane, continuous ratooning, and dry weather during the tillering stage.
        - **Management**:
            - Use resistant varieties such as Co86249, CoG 93076, CoC 22, CoSi6, and CoG 5.

- Treat setts with fungicides like Triadimefon (0.1%) or Carbendazim (0.1%) for 10 minutes.
- Use Aerated Steam Therapy (AST) or hot water treatments at specified temperatures.
- Remove and burn smut whips and discourage ratooning if infection exceeds 10%.

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4. **Mosaic (***Sugarcane mosaic potyvirus***)**
    - **Symptoms**: Chlorotic stripes alternating with dark green areas on young leaves, yellow stripes on leaf sheaths and stalks.
    - **Management**: Manage vector populations like aphids and ensure the use of healthy setts for planting. Avoid planting infected crops to prevent virus transmission.

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5. **Grassy Shoot Disease (GSD) (***Candidatus phytoplasma***)**
    - **Symptoms**: Excessive tillering, lanky growth, pale green to white leaves, shortened internodes, bushy appearance.
    - **Management**: Control aphid vectors (e.g., *Melanaphis sacchari* and *Raphalosiphum maidis*) and ensure proper crop management practices to minimize disease spread.

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6. **Phanerogamic Parasite (***Striga spp***)**
    - **Symptoms**: Partial root parasite with chlorophyll-bearing leaves, stunted plants due to nutrient and water extraction by the parasite.
    - **Management**:
        - Regular weeding and intercultural operations during the early stages of parasite growth.
        - Spray Fernoxone (sodium salt of 2,4-D) at 450g/500 liters of water.

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8) **Mango:**
    1. **Anthracnose (***Colletotrichum gloeosporioides***)**:
        - Affects leaves, panicles, twigs, and fruits.
        - Wet and humid conditions favor the disease, especially during flowering.
        - Symptoms include brown to black lesions on leaves, black spots on panicles, and premature fruit drop.

- Management includes pruning, proper sanitation, and fungicide sprays with Carbendazim, Mancozeb, and Pseudomonas fluorescens.

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2. **Die Back / Fruit Stem End Rot (***Lasiodiplodia theobromae***)**:
   - Causes drying of twigs, branches, and fruit rotting.
   - High summer temperatures and humidity favor the disease.
   - Symptoms include gum exudation and brown streaking on old branches.
   - Management includes pruning infected plant parts, spraying with Carbendazim and Mancozeb, and harvesting fruits with stalks to avoid infection.

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3. **Powdery Mildew (***Oidium mangiferae***)**:
   - Affects leaves, panicles, and young fruits.
   - Cool, dry conditions favor disease development.
   - Symptoms include white powdery growth on leaves and panicles, causing premature leaf drop and fruit distortion.
   - Management involves pruning, fungicide sprays with Wettable Sulphur, Dinocap, and Tridemorph.

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4. **Grey Leaf Blight (***Pestalotia mangiferae***)**:
   - Causes brown spots on leaves that coalesce and lead to defoliation.
   - Heavy infection occurs during monsoon conditions with moderate temperatures.
   - Management includes removing infected plant parts and spraying with Copper oxychloride or Mancozeb.

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5. **Sooty Mould (***Capnodium mangiferae***)**:
   - Associated with insect activity like mealy bugs and hoppers, which secrete honeydew.
   - Black mould forms on leaves, reducing photosynthetic activity.
   - Management includes pruning affected branches, controlling insects, and spraying starch solution to remove mould.

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6. **Mango Malformation (***Fusarium moniliforme***)**:
   - Causes abnormal growth like bunchy tops and floral malformation.
   - Disease spreads through infected propagation material and is prevalent in cooler temperatures.
   - Management includes destroying diseased plants, pruning, and spraying Carbendazim or Captafol.

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7. **Bacterial Leaf Black Spot / Canker (***Xanthomonas campestris pv. mangiferae-indicae***)**:
    - Affects all above-ground parts, leading to fruit drop and yield loss.
    - Humid, wet conditions and mechanical injuries facilitate the spread of bacteria.
    - Management includes field sanitation, spraying Streptocycline or Agrimycin, and copper oxychloride for bacterial control.

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8. **Red Rust (***Cephaleuros virescens***)**:
    - Caused by algae, leading to reduced photosynthetic activity.
    - High humidity and closed plantations favor disease development.
    - Management includes nutrient supply, spraying Bordeaux mixture, and pruning.

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**Integrated Disease Management (IDM)**:

- Proper sanitation, pruning, and strategic spraying with fungicides like Carbendazim, Mancozeb, and copper compounds are key management strategies.
- Regular application of beneficial bacteria like *Pseudomonas fluorescens* helps reduce anthracnose incidence.
- Reducing post-harvest fungal infections involves dipping fruits in hot water or a hot water-Carbendazim mix.

  These strategies aim to reduce the impact of diseases on mango orchards, improving fruit quality and yield through proactive care, environmental management, and appropriate chemical treatments.

Reference**:**

- **Knowledge Based Information on Coconut: Planting Seasons & Climate**

**2. Collect at least 2 datasets for all disease for all the plants mentioned below: Coconut, Groundnut, Corn, Jowar, Black gram, green gram, Cotton, Sugarcane, and Mango. Also learn about the features and nature of the dataset.**

Dataset Citations:

- Research Data - Mendeley Data
- A novel groundnut leaf dataset for detection and classification of groundnut leaf diseases - ScienceDirect
- Dataset of groundnut plant leaf images for classification and detection - Mendeley Data
- Mango Leaf Disease Dataset - Mendeley Data
- Mango Leaf Diseases Dataset

- MangoLeafBD Dataset - Mendeley Data
- MLD24: An image dataset for mango leaf disease detection - Mendeley Data
- Cotton Leaf Disease Dataset with Severity Levels - Mendeley Data
- CoSEV: A cotton disease dataset for detection and classification of severity stages and multiple disease occurrence - Mendeley Data
- Cotton leaves Dataset for diseases classification using EfficienNet Model - Mendeley Data
- Cotton - Pest and Disease
- Construction of a Dataset for Knowledge Atlas of Cotton Diseases and Pests
- Image Dataset for Disease Detection in Black Gram (Vigna mungo) Leaves: A Resource for Machine Learning Research - Mendeley Data
- Corn southern leaf blight dataset
- southern corn rust dataset
- Corn rust dataset
- Corn northern leaf blight dataset
- Coconut Tree Disease Dataset - Mendeley Data
- Coconut Diseases and Pest Infestations