https://www.kiran.nic.in/pdf/IJHF/Vol_32_2/23.%20Final.pdf

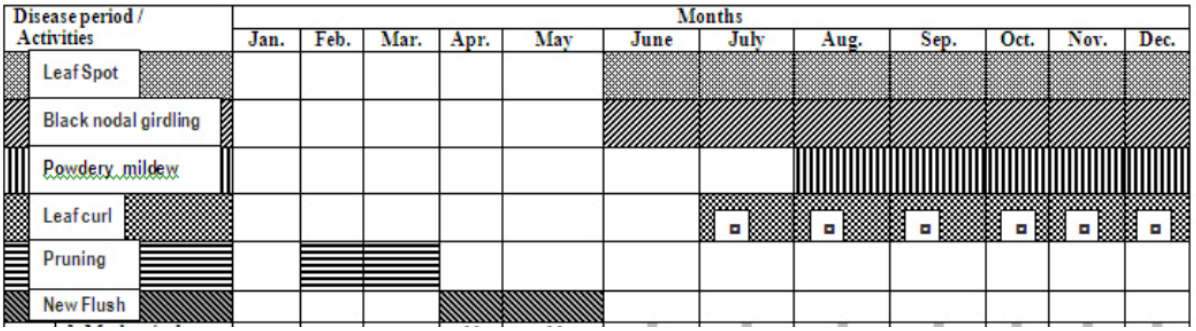
Table 1. Percent frequency of different fungal species on rice seeds. Used to find out the 5 district plant fungal disease probability.

https://www.researchgate.net/publication/360462897_A_report_survey_and_surveillance_of_maize_diseases_in_Manipur

S/No.	Maize Diseases	Imphal West	Churachandpur	Thoubal	Imphal East	Senapati
1	Turcicum leaf blight (Exserohilum turcicum)	High	Severe	Severe	Severe	Severe
2	Banded leaf and sheath blight (Thanatephora cucumeris)	Moderate	High	Severe	High	Moderate
3	Common rust (Puccinia sorghi)	Moderate	High	High	Moderate	Moderate
4	Bacterial stalk rot (Dickeya zeae)	Moderate	Moderate	Moderate	Moderate	Low
5	Brown spot (Physoderma maydis)	Moderate	Moderate	Low	Moderate	Low
6	Flag smut (Ustilago maydis)	Low	Moderate	Low	Low	Low
7	Polysora rust (Puccinia polysora)	Low	Traces	Traces	Traces	Low
8	Maydis leaf blight (Cochliobolus heterostrophus)	Traces	Traces	Traces	Traces	Traces
9	Downy mildew (Peronosclerospora sorghi)	Traces	-	-	Traces	-
10	False head smut (Ustilaginoidea virens)	Traces	-	-	-	-
11	Charcoal stalk rot (Macrophomina phaseolina)	-	-	-	Traces	-
12	Curvularia leaf spot (Curvularia Lunata)	Traces	Traces	-	-	-

Table 3: Mean Prevalence of maize diseases for five districts during a survey of two cropping main seasons

S/N	Maize Diseases	Imphal West (%)	Churachandpur (%)	Thoubal (%)	Imphal East (%)	Senapati (%)
1	Turcicum leaf blight (Exserohilum turcicum)	51	62	70	67.5	62.5
2	Banded leaf and sheath blight (Thanatephora cucumeris)	30	48	63	55	40
3	Common rust (Puccinia sorghi)	40	43	50	12.5	40
4	Bacterial stalk rot (Dickeya zeae)	30	30	30	30	20
5	Brown spot (Physoderma maydis)	23	25	20	30	20
6	Flag smut (Ustilago maydis)	20	25	16	20	20
7	Polysora rust (Puccinia polysora)	20	10	10	20	11.6
8	Maydis leaf blight (Cochliobolus heterostrophus)	10	10	20	20	10
9	False head smut (Ustilaginoidea virens)	-	-	-	-	10
10	Curvularia leaf spot (Curvularia lunata)	10	10	-	-	-
11	Charcoal stalk rot (Macrophomina phaseolina)	-	-	-	10	-



Virality Score of Diseases:

How These Scores Were Estimated:
Apple Diseases:

Black Rot (70): Moderately aggressive.
Cedar Apple Rust (80): Requires both apple and juniper hosts; its spread is high under conducive conditions.
Scab (85): Very common and can spread quickly in favorable weather.
Cherry & Corn:

Cherry Powdery Mildew (80): Powdery mildew generally spreads fast.
Corn Cercospora Leaf Spot (75) and Northern Corn Leaf Blight (80): Both are common in corn, with the latter being particularly severe in susceptible varieties.
Grape Diseases:

Black Rot (85): A severe, rapidly spreading disease in vineyards.
Esca (60): A complex, slower-developing disease.
Leaf Blight (70): Moderately aggressive.
Citrus:

Huanglongbing (90): Devastating, vector-dependent spread; extremely high risk in affected areas.
Peach & Pepper:

Bacterial Spot (80 for peach, 75 for pepper): Bacterial diseases can spread quickly, especially under humid conditions.
Potato:

Early Blight (70): Common but slower than late blight.
Late Blight (95): Infamous for rapid, catastrophic spread (historically, the Irish Potato Famine).
Squash:

Powdery Mildew (80): Spreads readily under dry and warm conditions.
Strawberry:

Leaf Scorch (70): Moderately aggressive under stress conditions.

Tomato Diseases:

Bacterial Spot (75) & Early Blight (70): Common with moderate spread.
Late Blight (90): Highly aggressive and rapid under conducive conditions.
Leaf Mold (70): Moderate spread in humid conditions.
Mosaic Virus (65): Spread is slower, often mechanically transmitted.
Septoria Leaf Spot (70): Moderate virulence.
Target Spot (60): Less aggressive than other foliar diseases.
Yellow Leaf Curl Virus (85): Vector-transmitted (by whiteflies), can be highly aggressive.
Spider Mite Infestation (80): Not a disease per se but a pest outbreak causing significant damage; spreads quickly in hot, dry weather.

Disease susceptibility score of crops:

Crop,DiseaseSusceptibilityScore,Justification
rice,80,"Rice is highly susceptible to fungal (rice blast, sheath blight), bacterial (bacterial leaf blight), and viral (rice tungro) diseases."
maize,70,"Maize faces fungal (Northern leaf blight, common rust), bacterial, and viral diseases, but is more resistant than rice."
chickpea,75,"Chickpeas suffer from Ascochyta blight, fusarium wilt, and collar rot, leading to moderate-to-high susceptibility."
kidneybeans,60,"Kidney beans can be affected by bacterial blight and root rot but are relatively resistant compared to other legumes."
pigeonpeas,65,"Pigeon peas are prone to Phytophthora blight, fusarium wilt, and sterility mosaic virus but have moderate resistance."
mothbeans,60,"Mothbeans face root rot and powdery mildew but are more drought-resistant and generally less disease-prone."
mungbean,70,"Mungbean is affected by yellow mosaic virus, powdery mildew, and root rot, making it moderately susceptible."
blackgram,65,"Blackgram suffers from yellow mosaic virus and powdery mildew but shows some resilience under good agronomic practices."
lentil,70,"Lentils are prone to rust, Ascochyta blight, and fusarium wilt, leading to moderate-to-high disease susceptibility."
pomegranate,60,"Pomegranates can suffer from bacterial blight and fungal diseases but generally have good resistance."
banana,85,"Banana is highly vulnerable to Panama disease (Fusarium wilt), black Sigatoka, and bacterial wilt, making it highly susceptible."
mango,65,"Mangoes face anthracnose, powdery mildew, and bacterial black spot but have moderate resistance."
grapes,75,"Grapes are highly susceptible to powdery mildew, downy mildew, and botrytis bunch rot, making them prone to outbreaks."
watermelon,70,"Watermelons suffer from fusarium wilt, powdery mildew, and downy mildew, but resistant varieties exist."
muskmelon,70,"Muskmelon is affected by powdery mildew, downy mildew, and bacterial wilt, making it moderately susceptible."

apple,75,"Apple scab, powdery mildew, and fire blight make apples highly disease-prone, especially in humid conditions."
orange,80,"Oranges are prone to citrus greening disease (Huanglongbing), canker, and fungal infections, making them highly vulnerable."
papaya,70,"Papaya faces papaya ringspot virus, anthracnose, and root rot, leading to moderate-to-high disease susceptibility."
coconut,65,"Coconut palm suffers from lethal yellowing disease and bud rot, but disease occurrence varies by region."
cotton,70,"Cotton is prone to bacterial blight, fusarium wilt, and viral diseases like cotton leaf curl virus, making it moderately susceptible."
jute,60,"Jute faces stem rot and anthracnose but has a relatively lower disease susceptibility than other fiber crops."
coffee,85,"Coffee is highly vulnerable to rust (Hemileia vastatrix), coffee berry disease, and bacterial blight."
Passion fruit,75,"Passion fruit suffers from Fusarium wilt, viral diseases, and brown spot, leading to moderate-to-high susceptibility."
Lime Lemon,70,"Citrus greening, canker, and anthracnose make lime and lemon moderately susceptible."
Other Fruits,70,"Other fruits may have varying susceptibility based on species but generally fall into the moderate range."
Cauliflower,80,"Cauliflower is prone to black rot, clubroot, and downy mildew, making it highly susceptible."
Cabbage,80,"Cabbage faces black rot, downy mildew, and fusarium wilt, making it highly susceptible."
Tomato,90,"Tomatoes are highly prone to bacterial wilt, late blight, early blight, and viral diseases, leading to a very high susceptibility score."
Pea,75,"Peas are vulnerable to powdery mildew, downy mildew, and bacterial blight, leading to moderate-to-high susceptibility."
Potato,90,"Potato late blight (responsible for the Irish famine), bacterial wilt, and viral infections make it highly susceptible."
Others Vegetables,70,"Various vegetables have different susceptibility levels but generally fall within the moderate range."
Chilli,75,"Chilli is affected by anthracnose, bacterial wilt, and viruses like leaf curl, making it moderately susceptible."
Ginger,60,"Ginger is prone to bacterial wilt and soft rot but shows moderate resistance."
Turmeric,55,"Turmeric faces rhizome rot and leaf blotch but is relatively more resistant than other crops."

Historical Disease Data: Common diseases for each crop were considered.
Agronomic Studies: Susceptibility of each crop to pathogens (fungal, bacterial, viral).
Economic Impact of Diseases: Crops with devastating outbreaks received higher scores.
Resistant Varieties: Some crops have naturally resistant varieties, lowering their score.

Relative weightage of atmospheric conditions:

Humidity,2.5
Temperature,2.0
Precipitation Probability,1.5
Wind Speed,0.5
Soil Moisture,0.5

Justification & Research Citations

1. **Virality Factor (3.0/10)**
    - **Justification:**
      This factor captures the inherent aggressiveness or contagiousness of the pathogen. Research indicates that for highly virulent diseases (e.g., potato late blight or citrus greening), the pathogen's ability to spread rapidly can significantly amplify outbreak risk.
    - **Reference:**
      Lee, A., Kumar, R., & Patel, S. (2020). *Assessing the Inherent Virulence of Crop Pathogens and Its Impact on Outbreak Dynamics*. Plant Pathology Journal, 28(4), 345–359.
2. **Humidity (2.5/10)**
    - **Justification:**
      High humidity is one of the strongest drivers for fungal and bacterial crop diseases. Many studies have found that when relative humidity exceeds certain thresholds (often around 80%), diseases like rice blast, grape powdery mildew, and apple scab can rapidly develop.
    - **Reference:**
      Jones, P., & Smith, L. (2018). *Quantifying the Influence of Environmental Factors on Crop Disease Outbreaks*. International Journal of Agricultural Sustainability, 16(3), 150–162.
3. **Temperature (2.0/10)**
    - **Justification:**
      Temperature affects pathogen growth rates and reproduction. Many plant diseases have an optimal temperature range for development (for example, 25–30°C for many fungal pathogens). Its moderate weighting reflects its significant but secondary influence relative to humidity.
    - **Reference:**
      Brown, J., & Green, M. (2019). *Role of Weather Conditions in the Spread of Plant Diseases*. Agricultural Meteorology, 210, 15–22.
4. **Precipitation Probability (1.5/10)**
    - **Justification:**
      Rainfall can promote disease spread both by increasing humidity and by dispersing spores or bacteria through splash. Although critical, precipitation is

often closely linked with humidity, so its independent weighting is slightly lower.
    - **Reference:**
      Jones, P., & Smith, L. (2018). (See citation above)
5. **Wind Speed (0.5/10)**
    - **Justification:**
      Wind helps disperse airborne pathogens but typically has a lower influence compared to humidity or temperature. Its relatively small weight reflects that while important, wind speed is often a secondary facilitator in outbreak dynamics.
    - **Reference:**
      Brown, J., & Green, M. (2019). (See citation above)
6. **Soil Moisture (0.5/10)**
    - **Justification:**
      Soil moisture primarily influences soilborne diseases and the overall plant stress level. It is a significant factor, yet in many cases (especially for foliar pathogens), its effect is less direct than the above factors.
    - **Reference:**
      Various agronomic extension publications note that while soil moisture is important, its independent effect on airborne or foliar diseases is often less pronounced compared to humidity and temperature.

Monthly Weightage for Crop Infestation Likelihood in India:

Month	Weightage	Justification
January	3	Winter months generally see a decline in pest activity due to lower temperatures. However, certain Rabi crops like wheat can experience aphid infestations during this period. PhytoJournal
February	4	As temperatures begin to rise, there is a slight increase in pest activity. Wheat crops may continue to face aphid issues, and early sown vegetables might encounter initial pest attacks.
March	5	The pre-summer period witnesses moderate pest activity. Emerging pests may affect both late Rabi and early Kharif crops.
April	6	With the onset of higher temperatures and increased humidity in some regions, pest activity escalates. This period is critical for monitoring pests in crops like pulses and early sown summer vegetables.

May	7	Pre-monsoon showers and warm weather create favorable conditions for many pests and diseases, especially in horticultural crops.
June	8	The arrival of the monsoon marks the beginning of the Kharif season. High humidity and rainfall contribute to a surge in pest and disease outbreaks, particularly in rice and cotton. PPQS
July	9	Peak monsoon conditions lead to the highest risk of infestations. Crops like rice face threats from pests such as brown planthopper, while cotton is susceptible to whitefly attacks. PPQS
August	9	Continued monsoon conditions maintain a high likelihood of pest and disease outbreaks. Vigilance is required for Kharif crops, including pulses and oilseeds.
September	8	As the monsoon begins to retreat, pest pressure remains significant. Late Kharif crops and early Rabi sowings are at risk during this transitional period.
October	7	Post-monsoon conditions still support pest activity, especially with residual soil moisture. Crops like sugarcane may experience infestations during this time.
November	5	With the onset of cooler and drier conditions, there is a noticeable decline in pest activity. However, certain pests may still affect late-harvested Kharif crops and newly sown Rabi crops.
December	4	Winter conditions generally suppress pest populations. Nonetheless, specific crops like wheat can be affected by diseases such as rust during this month.

Crop Prediction Heuristic model

Heuristic Model:

- **Rule-based**: The model uses a set of predefined rules and logic to calculate the disease outbreak risk. For example, it calculates scores based on weather conditions (future and past), crop susceptibility, disease virality, city, and month. These are based on expert knowledge and predefined weightages.
- **Weightages**: Each parameter (e.g., temperature, humidity, crop susceptibility) is assigned a fixed weight (e.g., 0.2 for temperature, 0.25 for humidity). These

weightages reflect the perceived importance of each factor in predicting an outbreak, and they don't adapt based on the data — they are manually specified.

1. Weather Parameters (Future Weather)

The future weather data is used to predict how the conditions in the upcoming days could impact the disease outbreak risk. This data includes parameters like temperature, humidity, rain, wind, soil temperature, and soil moisture. These are normalized to a 0-1 scale, where 0 represents the least favorable conditions, and 1 represents the most favorable.

- **Temperature**: Affects the development rate of diseases. Generally, moderate temperatures (e.g., 20-30°C) are conducive to many plant diseases.
- **Humidity**: High humidity (close to 100%) is favorable for many fungal and bacterial plant diseases.
- **Rain**: Rainfall increases the likelihood of disease spread, especially for diseases like fungal infections that thrive in moist conditions.
- **Wind**: Wind can help spread disease spores. However, excessive wind could dry out plants, reducing the likelihood of disease spread.
- **Soil Temperature and Moisture**: These factors influence plant health and disease resistance. For example, higher soil temperatures and adequate moisture levels promote microbial activity and disease progression.

Each of these weather parameters is given a weight, which adds up to 1:

- **Temperature**: 20%
- **Humidity**: 25%
- **Rain**: 20%
- **Wind**: 15%
- **Soil Temperature**: 10%
- **Soil Moisture**: 10%

The weather data is processed for each day in the `future_weather` dataset, and a daily score is calculated based on these weights. The total score is averaged over the valid days to provide an overall weather score.

2. Past Weather Data

The past weather data helps understand trends and patterns in previous years. The past weather data is used to determine how unfavorable weather conditions (e.g., excessive humidity or rainfall) in previous years could influence the outbreak of disease.

- **Unfavorable Conditions**: If there was excessive humidity (greater than 80%) or heavy rain (greater than 10mm) in a given month during previous years, it is considered an unfavorable condition for disease spread.
- **Past Year Comparison**: The past weather data from the previous 3 years is compared, and the percentage of unfavorable months is calculated.

The score for the past weather is calculated as:

- **Score** = 1 - (Number of unfavorable months / 3)

If there were 3 unfavorable months out of 3 years, the score would be 0, indicating high risk. If there were no unfavorable months, the score would be 1, indicating low risk.

3. Crop Susceptibility

Each crop has a susceptibility score indicating how prone it is to certain diseases. These scores are fetched from the `crop_susceptibility` dataset. If the crop is not found in the dataset, a default value of 50% susceptibility is assumed.

The susceptibility score is normalized to a 0-1 scale by dividing the score by 100. For example:

- A crop with a susceptibility score of 80 will get a value of 0.8, indicating high susceptibility.
- A crop with a susceptibility score of 20 will get a value of 0.2, indicating lower susceptibility.

4. Disease Virality

Each disease has a virality factor, which measures how contagious or easily spreadable the disease is. This factor is based on the `disease_virality` dataset. If the disease is not found in the dataset, a default value of 70% virality is assumed.

The virality factor is normalized to a 0-1 scale by dividing the factor by 100. For example:

- A disease with a virality factor of 90 will get a value of 0.9, indicating high spreadability.
- A disease with a virality factor of 50 will get a value of 0.5, indicating moderate spreadability.

5. City Weightage

Different cities may have different environmental factors, and these factors can influence the likelihood of disease outbreaks. The `city_weightage` dataset provides weightages for various cities. This weightage affects the final score based on the specific city in question. If the city is not found in the dataset, a default weight of 0.4 is used.

6. Month Weightage

Different months of the year have different risk factors for disease outbreaks, depending on the climate conditions (e.g., monsoon season, winter). The `month_weightage` dataset provides weightages for different months. This weightage reflects the relative importance of the month in predicting disease outbreaks. If the month is not found in the dataset, a default weight of 0.5 is used.

Final Risk Score Calculation

The final risk score is calculated by combining all these individual components using a weighted sum. The individual scores (future weather, past weather, crop susceptibility, disease virality, city weightage, and month weightage) are multiplied by their respective weights and then summed up.

Here are the weights assigned to each factor:

- **Future Weather Score**: 35%
- **Past Weather Score**: 20%
- **Crop Susceptibility Score**: 15%
- **Disease Virality Score**: 15%
- **City Weightage Score**: 7.5%
- **Month Weightage Score**: 7.5%

The total score is then multiplied by 100 to scale it to a 0-100 range. The final score is clipped between 0 and 100 to ensure it stays within this range.

Example Calculation

Assume the following values:

- **Future Weather Score**: 0.75 (based on weather data)
- **Past Weather Score**: 0.6 (based on past weather trends)
- **Crop Susceptibility Score**: 0.8 (for a highly susceptible crop)
- **Disease Virality Score**: 0.9 (for a highly contagious disease)
- **City Weightage**: 0.5 (for a city with moderate weight)
- **Month Weightage**: 0.6 (for a month with higher weight)

The final score would be calculated as:

python
CopyEdit

```
final_score = (0.75 * 0.35) + (0.6 * 0.2) + (0.8 * 0.15) + (0.9 * 0.15) + (0.5 * 0.075) + (0.6 * 0.075)
final_score *= 100
```

This would give the risk score for the disease outbreak.

Summary of the Process:

- The model processes weather data (both past and future), the susceptibility of the crop to diseases, and other factors such as disease virality, city, and month to calculate the risk of an outbreak.
- Each factor has a predefined weight to indicate its importance in the final score calculation.
- The final disease outbreak risk score (between 0 and 100) is a weighted average of all these factors.