UTM

UNIVERSITI TEKNOLOGI MALAYSIA

SECJ3553 - SEC 16
Artificial Intelligence
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Progress-3
Agriculture - AgriNINE.11

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0.1 INTRODUCTION

Agriculture is crucial to maintaining both economic stability and food security. However, choosing crops, managing a farm, weather variations, and soil conditions are just a few of the many intricate choices that modern farming requires. Accurate decision-making is difficult, particularly when data is fragmented or incomplete.

Agricultural decision-making can now be supported by data-driven methods thanks to the development of artificial intelligence. AI systems can assist in identifying hazards, increasing productivity, and promoting sustainable farming methods by evaluating agricultural data.

AgriNINE-11 is a smart agricultural decision support system developed as an academic project to apply artificial intelligence concepts to real-world agricultural challenges. The system aims to assist farmers and agricultural stakeholders by analyzing soil, environmental, and farm-related data to provide clear and useful recommendations. Through this approach, AgriNINE-11 seeks to support better farming decisions while reducing risks and improving overall farm management.

0.2 PROBLEM STATEMENT

Decisions about crop health, weather patterns, soil conditions, and general farm management must be made frequently in modern agriculture. Crop performance, final yield, and resource use are all directly impacted by these choices. Nonetheless, a lot of farming methods still rely on manual observation, experience, or data from disparate and unrelated sources to make decisions.

This leads to a number of real-world difficulties, such as:

- Delayed response to issues, such as poor soil quality, water stress, or early signs of crop disease
- Inefficient use of resources, especially water, fertilizer, and time
- Limited ability to prioritize actions, since data is not analyzed together
- Increased risk of crop damage or yield loss due to late or inaccurate decisions

Farmers are frequently unable to make prompt and well-informed decisions due to ineffective integration or analysis of pertinent agricultural data. This amply illustrates the necessity of a data-driven decision support system that can integrate data pertaining to farms, soil, and the environment and offer concise, practical suggestions to promote improved agricultural management.

1.0 DASHBOARD: Main Page

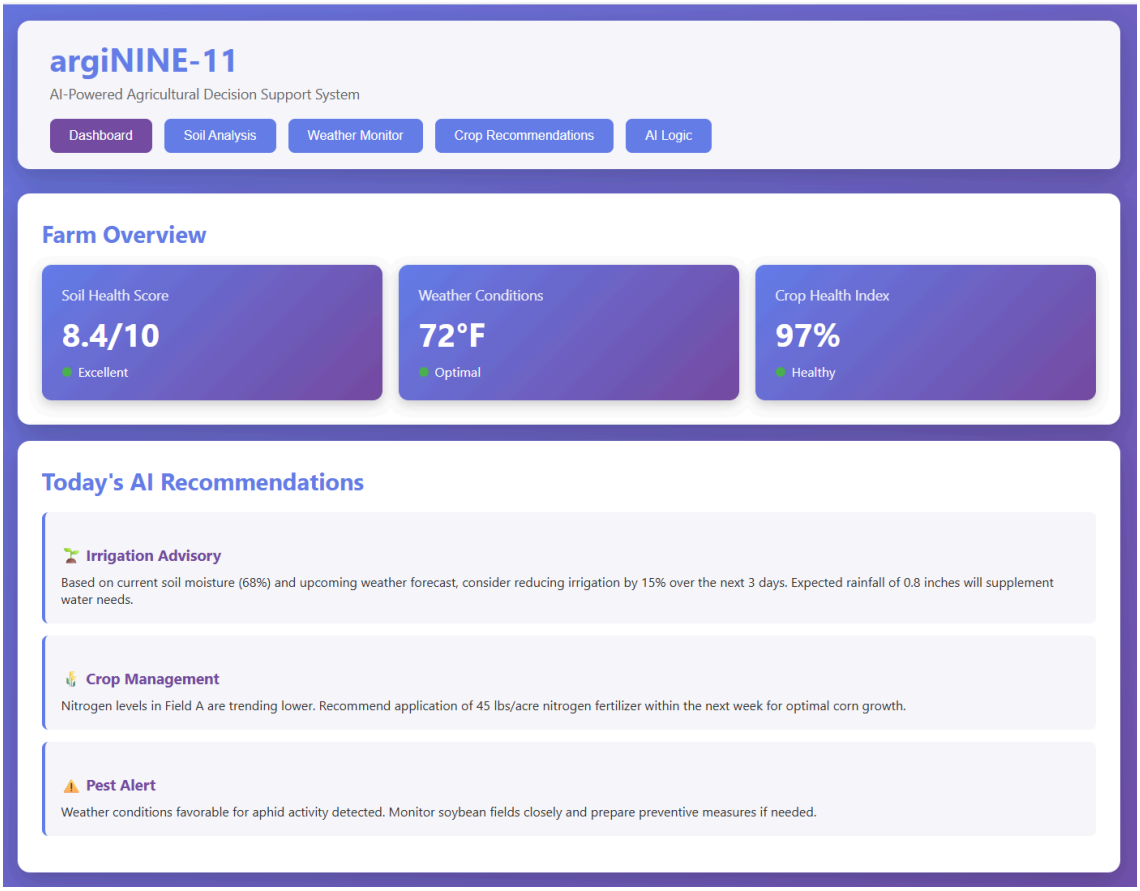


Figure 1. Main dashboard of the AgriNINE-11 system showing farm overview metrics and AI recommendations.

I. System Header (Top Section)

System Name & Description

- argiNINE-11 is displayed at the top to clearly identify the system.
- The subtitle "AI-Powered Agricultural Decision Support System" explains the purpose of the platform:
  to help farmers make better decisions using artificial intelligence.

Navigation Menu

The navigation bar allows users to move between different system modules:

- Dashboard – Main summary page (current page)
- Soil Analysis – Detailed soil data and nutrient analysis
- Weather Monitor – Weather tracking and forecasts
- Crop Recommendations – AI-suggested crops and actions
- AI Logic – Explanation of how AI rules and logic work

This layout improves usability by separating features into clear sections.

II. Farm Overview Section

This section provides a high-level summary of the farm's current condition using visual cards.

Soil Health Score

- Displays a score of 8.4 / 10
- Indicates overall soil quality based on factors such as:
    - pH level
    - Moisture
    - Nutrient balance
- Status shown as "Excellent" using a green indicator

Purpose: Helps users quickly understand whether the soil is healthy.

Weather Conditions

- Shows the current temperature (72°F)
- Labeled as "Optimal"
- Uses a green indicator to show favorable weather

Purpose: Allows farmers to assess if weather conditions are suitable for farming activities.

Crop Health Index

- Displays 97%
- Status marked as "Healthy"

Purpose: Represents the overall condition of crops based on combined soil and weather data.

III. Today's AI Recommendations Section

This is the core intelligence section of the system.
It shows AI-generated advice based on real-time data and predefined logic rules.

Irrigation Advisory

- The AI analyzes:
  - Soil moisture level (68%)
  - Upcoming weather forecast

- Recommendation:
  - Reduce irrigation by 15% over the next 3 days
  - Expected rainfall will help meet water needs

Purpose: Prevents over-irrigation and saves water.

Crop Management Recommendation

- Detects that nitrogen levels are decreasing
- Advises applying 45 lbs/acre of nitrogen fertilizer
- Recommendation is specific to Field A

Purpose: Helps maintain optimal crop growth and nutrient balance.

Pest Alert

- AI detects weather conditions favorable for aphid activity
- Advises:
  - Close monitoring of soybean fields
  - Preparing preventive pest control measures

Purpose: Acts as an early warning system to reduce crop damage.

IV. Design & User Experience Considerations

- Card-based layout makes information easy to read
- Color indicators (green) quickly show healthy or optimal conditions
- Icons and section titles improve clarity
- The page is designed for fast decision-making, even for non-technical users

1.1 DASHBOARD: Soil Analysis

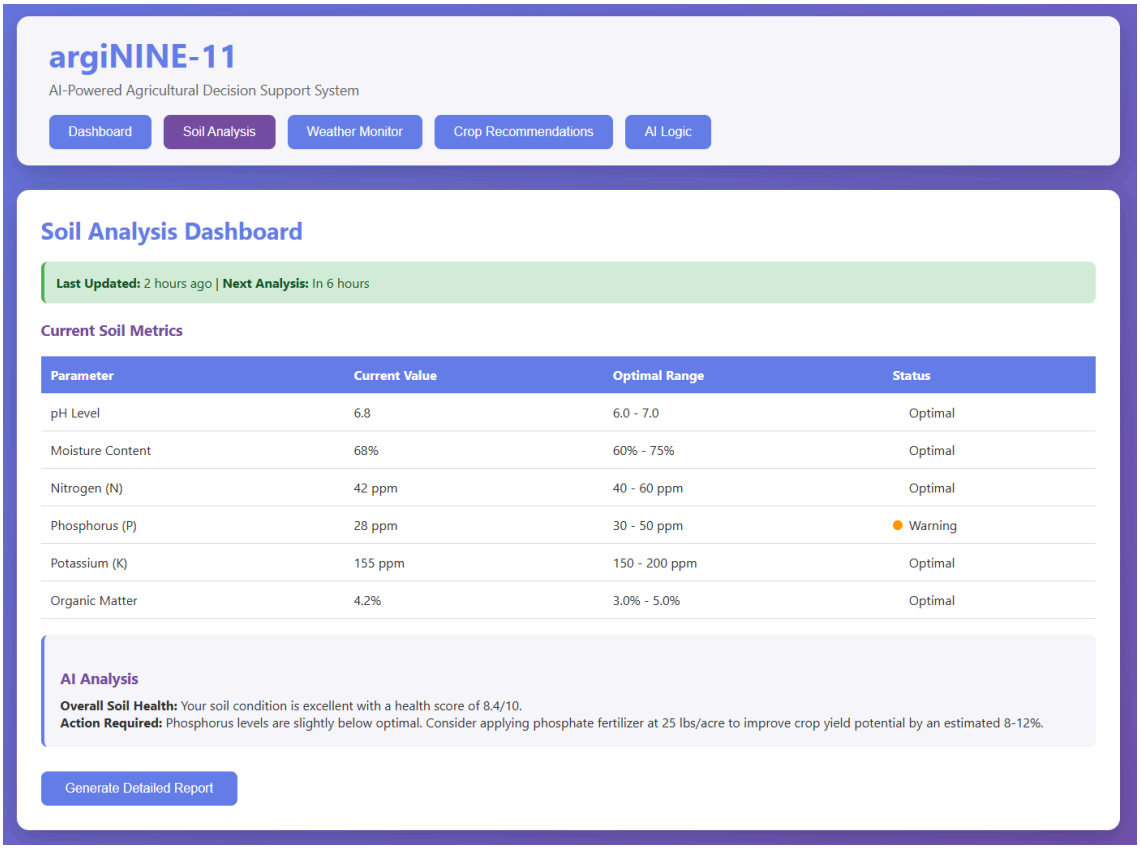


Figure 2. Soil Analysis Dashboard of the AgriNINE-11 system displaying soil parameters, status indicators, and AI analysis results.

This page is the Soil Analysis Dashboard of the AgriNINE-11 system.
It provides detailed information about the current condition of the soil to help users understand soil health and identify issues that may affect crop growth.

Soil Data Overview

The page displays:

- Last update time and next scheduled analysis to indicate data freshness
- Key soil parameters including pH level, moisture, nutrients, and organic matter
- Optimal ranges and status indicators for each parameter

Most soil values are within the optimal range, while phosphorus is slightly low and marked with a warning.

AI Analysis & Recommendation

At the bottom of the page, the AI Analysis section summarizes the overall soil condition and provides a clear recommendation to improve phosphorus levels.

Purpose:

Allows users to quickly understand soil status and take appropriate corrective action.

1.2 DASHBOARD: Weather Monitor

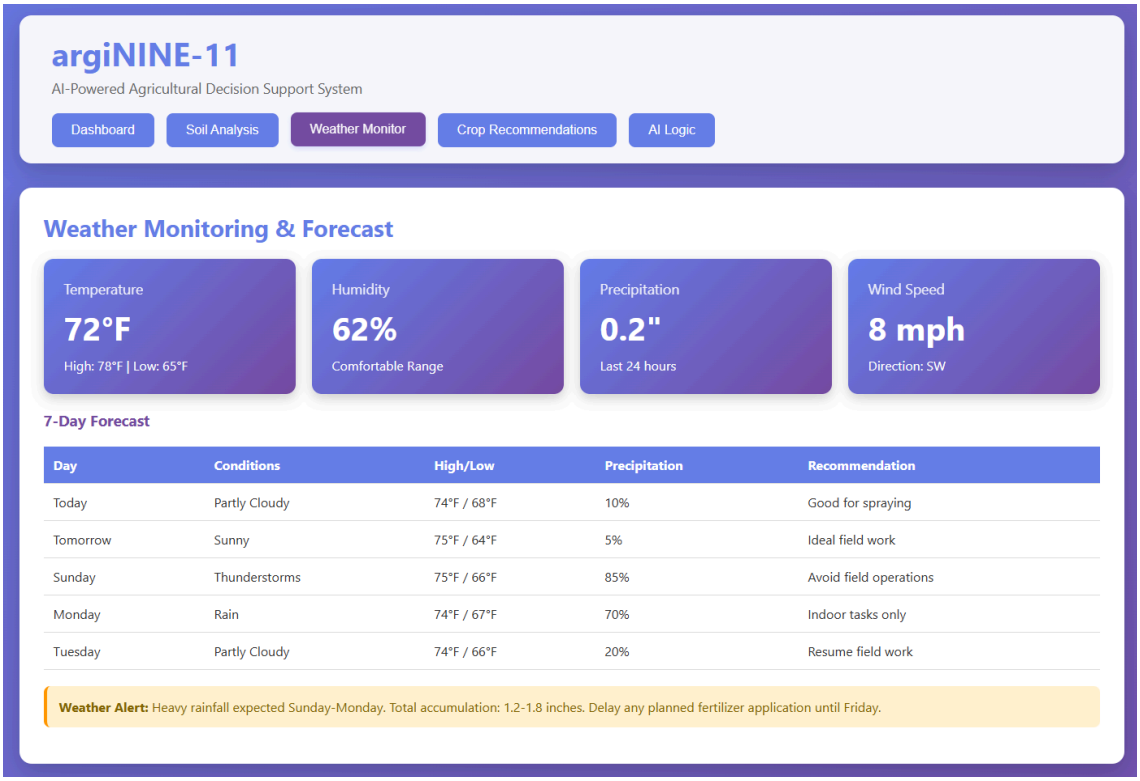


Figure 3. Weather Monitoring and Forecast dashboard of the AgriNINE-11 system presenting current weather conditions and short-term forecasts.

This page is the Weather Monitoring and Forecast module of the AgriNINE-11 system.
Its purpose is to provide current weather conditions and short-term forecasts to support planning of farm activities.

Current Weather Indicators

The page displays real-time weather data including:

- Temperature
- Humidity
- Precipitation
- Wind speed

Additional information such as daily high and low temperatures and wind direction is shown to improve accuracy in decision-making.

7-Day Forecast & AI Guidance

A seven-day forecast table presents:

- Upcoming weather conditions
- Expected temperatures
- Precipitation chances
- AI-generated recommendations for each day

These recommendations guide users on the suitability of activities such as spraying, field work, and fertilizer application.

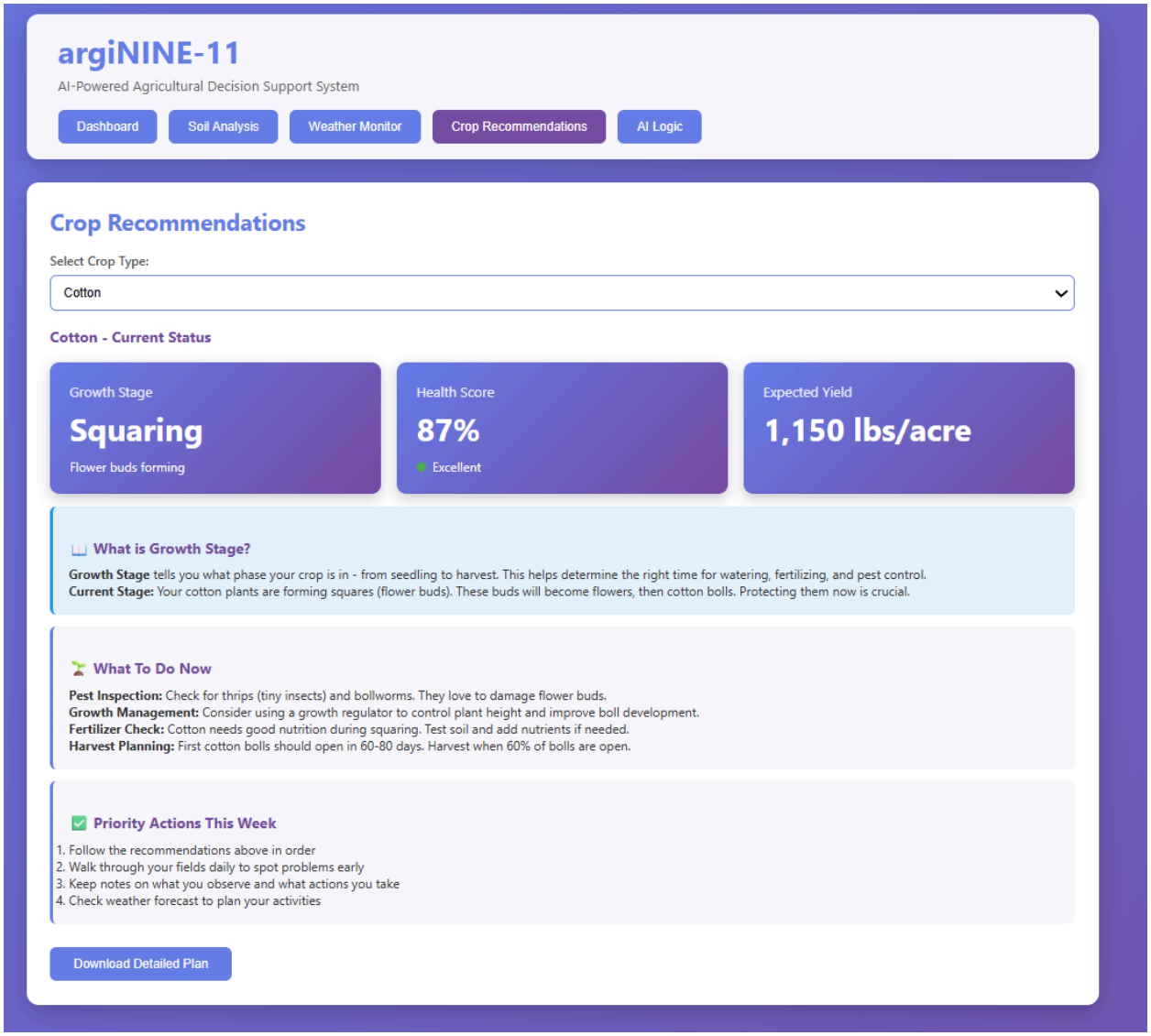
Weather Alert

At the bottom of the page, a weather alert highlights expected heavy rainfall and advises delaying certain farm operations.

Purpose:

Helps users anticipate weather changes and plan agricultural tasks more effectively.

1.3 DASHBOARD: Crop Recommendations



This is the Crop Recommendations module of the argiNINE-11 system. It is also meant to offer crop-specific information depending on the type of crop chosen and the user can get specific advice on how to manage the crop better.

On the upper part of the page, the user is allowed to choose a type of crop and in this instance, it is cotton. After the selection, the system shows the present condition of the crop, the level of its growth, its health rating, and its expected harvest. The stage of growth displayed is the squaring stage which implies that flower buds are developing. The health score of 87 percent indicates a very good crop condition and the yield expected gives an estimate of the production per acre.

Under this, the page describes the meaning of the current stage of growth so that the users can know what is happening in the lifecycle of the crop. The system then gives viable suggestions on what needs to be done at this level, which include pest inspection, growth management, fertilizer checks, and harvest planning. Such recommendations assist farmers to concentrate on the most significant tasks at the appropriate time.

The page also shows priority actions in the week, which directs the users on how to monitor daily and plan activities. Lastly, a download plan option is offered, where the user can save or read the recommendations offline. On the whole, this page converts crop information into understandable practical recommendations that can help manage crops.

2.0 AI Logic

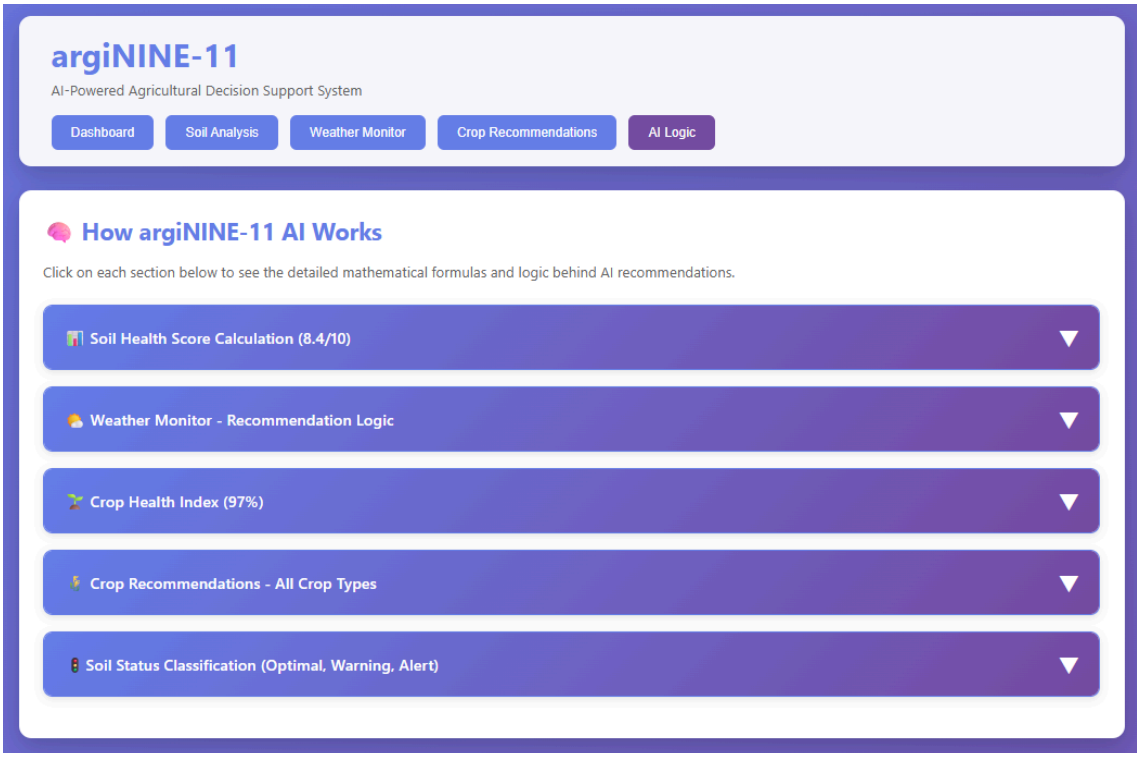


Figure 4. AI Logic page of the AgriNINE-11 system showing the algorithms and decision rules used across system functions.

This is the AI Logic page. This page contains all the algorithms that power all the functions on the dashboard. It has a step-by-step explanation as well as the formulas that are behind each function and calculation.

2.1 AI Logic: Soil Health Score Calculation

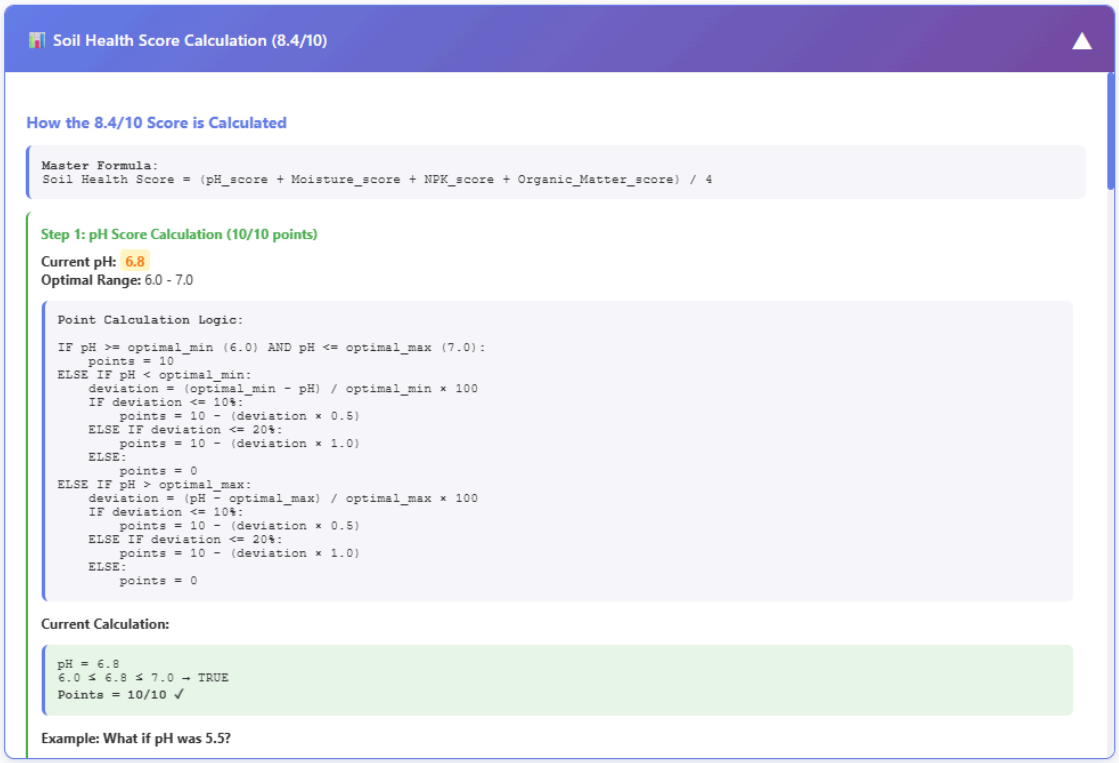


Figure 5. Soil Health Score calculation logic in the AgriNINE-11 system illustrating the step-by-step scoring process and formula used.

The argiNINE-11 system uses a combination of various important soil factors to form one score out of 10 to determine the soil health score. The system initially determines the pH of the soil, the moisture content, the nutrient content (nitrogen, phosphorus and potassium), and organic matter separately. All these elements are rated on a scale of 0 to 10 according to the proximity of the measured value to its optimal value. These four component scores are then averaged to obtain the basic soil health score.

In the case of soil pH, the system verifies that the pH value is within the ideal pH range of 6.0 to 7.0. In case it does, the soil will be rated at full marks in pH. When the pH is slightly above or below the optimum range, the points are deducted gradually depending on the degree of deviation whereas extreme deviations lead to a zero point. The pH of 6.8 in this case is in the optimal range and therefore it will be given the highest score.

The same is done with the moisture score. When the soil moisture is 60-75 percent it is regarded as ideal and gets full marks. In case of moisture being either too dry or too wet, the score is

decreased accordingly depending on the extent to which it is out of the optimal range. It also gets full marks as the present moisture level is 68, which is in the optimal range.

The nutrient score is determined by assessing the nitrogen, phosphorus and potassium individually. All the nutrients are graded on their own scores based on whether they are within their ideal range. Nitrogen and potassium are at their optimum levels and score 100 points, whereas phosphorus is a little below the optimal level and thus loses a few points. The system then averages the three nutrient scores to come up with a total NPK score.

The last evaluation is on organic matter. Should the percentage of organic matter lie in the range of 3.0 to 5.0, the soil is awarded all the points. The score is decreased by values that are not within this range based on the extent of deficit or excess. The level of organic matter in this case falls within the range of the best score, hence it scores the highest.

Once the basic soil health score has been computed using these four components, the system uses real time adjustment factors to represent the real field conditions. These aspects explain the compaction of the soil, the efficiency of the drainage and the recent weather conditions like heavy rainfall. All of the factors slightly decrease or increase the score to make the result more realistic. In the case of this farm, small soil compaction, drainage problems and recent rainfall decrease the basic score of 9.83 to an ultimate score of 8.4 out of 10.

On the whole, the ultimate soil health score is 8.4 which shows that the soil is in very good condition with few improvements required. The system shows that the phosphorus content is a little bit low and the correction of this problem may result in the further improvement of soil health and the score will be brought nearer to the ideal 10.

2.2 AI Logic: Weather Monitor

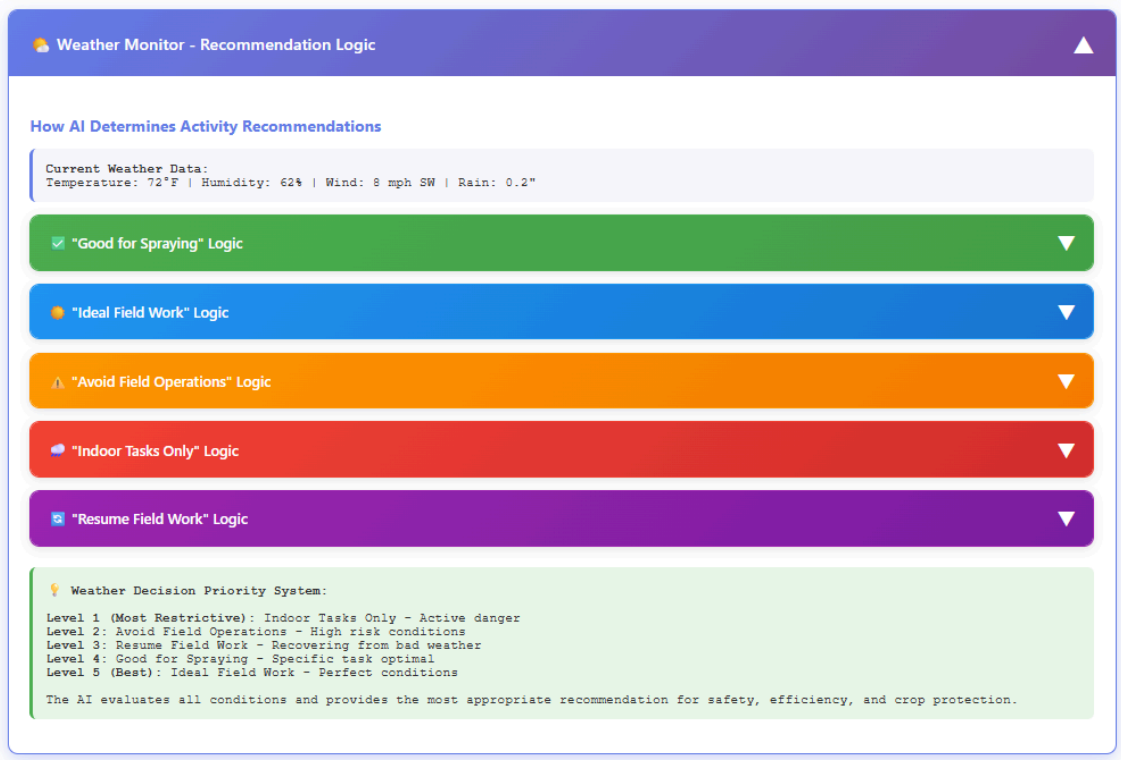


Figure 6. Weather Monitor AI logic in the AgriNINE-11 system showing rule-based activity recommendations under different weather conditions.

The argiNine-11 system weather condition AI logic is created to suggest the safest and most suitable farm activities in accordance with the existing and predicted weather conditions. The system is constantly analyzing the factors including rainfall, temperature, speed of wind, soil moisture, humidity, visibility and weather warnings to safeguard crops, equipment and safety of workers.

In case of dangerous weather, i.e. during active rainfall, high probability of rain, extreme temperatures, powerful winds or severe weather warnings the system suggests indoor activities only. This saves wastage of field work, damages of equipment and safety hazards.

When the conditions are not dangerous but still unfavorable like in thunderstorms, high rainfall probability or excessive soil moisture, the system suggests avoiding field work to minimize the chances of soil damage and machinery problems.

Following rainfall, the AI measures recovery conditions such as time since rain, soil moisture and temperature. It advises to resume field work when safe thresholds have been achieved. The

system under the best weather conditions determines the best field work periods that can be used to plant, harvest and other field work.

In the case of spraying, the AI is more strict to guarantee the effectiveness of the process and verifies the speed of the wind, temperature, humidity, the likelihood of rain, and the last rainfall. A decision structure that is based on priorities would ensure that safety related recommendations are always given priority over productivity hence safe and efficient farm management decisions are made.

2.3 AI Logic: Crop Health Index

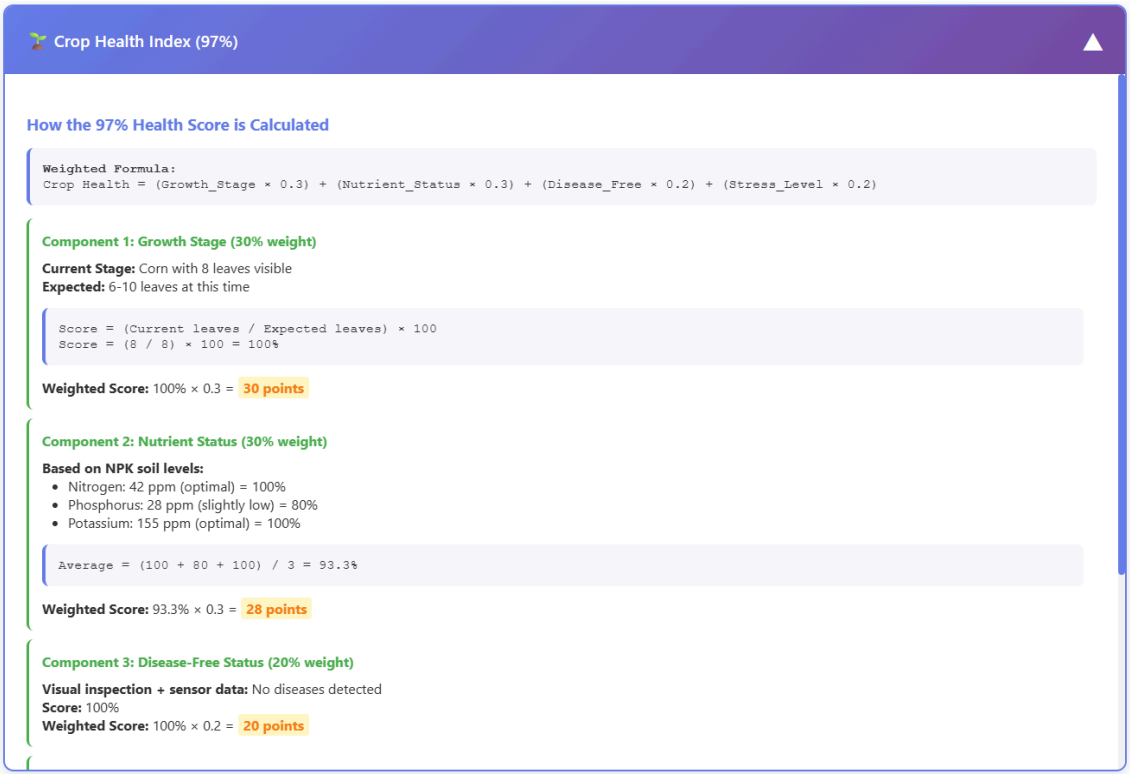


Figure 7. Crop Health Index AI logic in the AgriNINE-11 system showing weighted factors used to calculate overall crop health.

The Crop Health Index of the argiNINE-11 system is the percentage of the overall crop condition. It is determined based on a weighted model that is a combination of four important factors which are: growth stage, nutrient status, disease presence and stress level. All the factors will add a certain percentage to make sure that the final score will represent the development of plants as well as the environmental conditions.

The growth stage is adding 30 percent of the total score. The system makes a comparison of the existing crop development and the expected at that moment. The number of visible leaves in this case is eight, which is within the expected range of growth. Consequently, the crop gets the maximum marks on growth stage, which is the highest score in this aspect.

The nutrient status also makes a 30 percent contribution and is pegged on the levels of soil nitrogen, phosphorus and potassium. Nitrogen and potassium are in optimal ranges and score maximum points, whereas phosphorus is a little lower than optimal and scores a little less. These nutrient values are averaged in the system to give a nutrient health score which is slightly less than the maximum yet indicates good nutrient availability.

The disease free status adds 20 percent of the total. This aspect is measured by visual and sensor data. No diseases are identified in the crop hence this component scores all marks, which means that there are healthy conditions of the plants with no disease stress.

The last 20 percent is attributed to the stress level component which takes into consideration the water stress, heat stress, and pest pressure. Water and temperature conditions are favorable and low pest pressure in this case. This leads to slight decrease in the score, which is a slight stress that does not have significant effects on crop health.

Having summed all the four weighted components, the system gives a final Crop Health Index of 97 percent. This score is high, which means that the crop is in a good condition, and there are only localized problems. The dashboard shows the average score of all the fields and this is why the value is not 100 percent.

2.4 AI Logic: Crop Recommendations

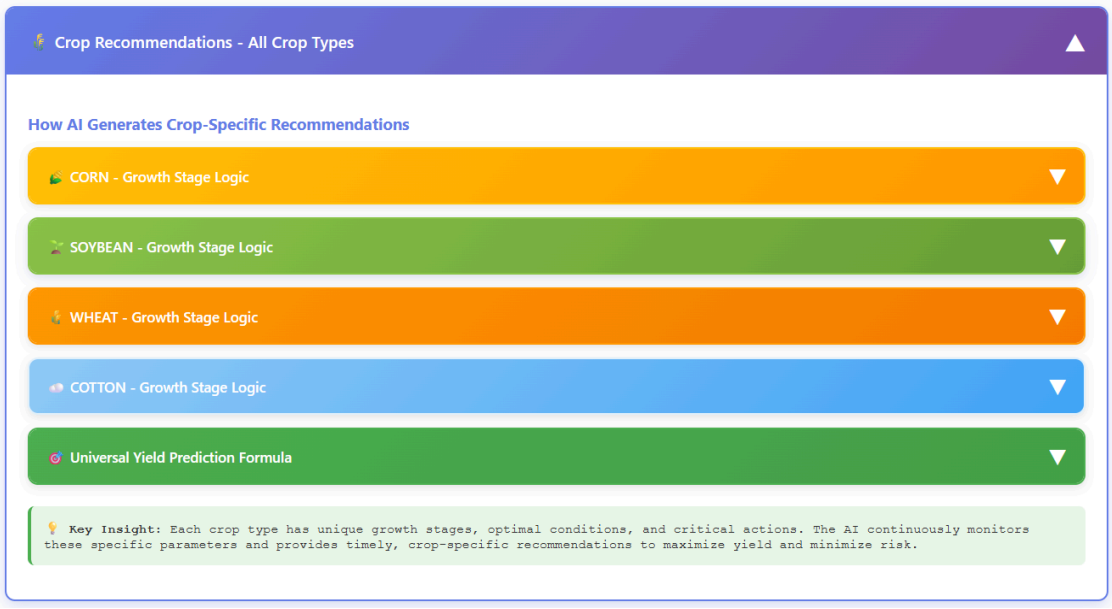


Figure 8. Crop recommendation AI logic in the AgriNINE-11 system illustrating crop-specific rules and yield prediction logic.

The argiNINE-11 system has a yield prediction logic that predicts the expected yield of a crop based on the historical data and real-time farm conditions. The system has a universal formula, which multiplies the base yield of a region and three factors of adjustment, which include crop health, weather conditions, and management practices. This enables the yield estimate to capture the long term averages and the on field performance.

The crop health factor is based on the Crop Health Index and is an indicator of the healthiness of the crop in relation to its optimal state. The weather factor modulates expectations of the yields depending on the recent and predicted pattern of rain and temperature whereas the management factor indicates the effectiveness and timeliness of farm operations like fertilization and pest control. Combined, these factors generate a realistic range of yield as opposed to a fixed value.

Besides prediction of yields, the system uses crop-specific logic of growth stage. Every crop, which includes cotton, wheat, soybean, and corn, has its growth indicators that define the level of development at a particular time. Depending on the observations such as the number of leaves, flowering, or grain formation, the AI recognizes the growth stage and outlines the important actions to be done at the stage.

The system also determines a health score of each crop based on weighted variables including the growth development, nutrient availability, pest pressure, water adequacy and disease risk.

The scores can be used to measure the condition of crops and make recommendations including fertilizer application, growth regulation, pest monitoring, or disease prevention.

All in all, this reasoning enables argiNINE-11 to produce precise yield forecasts and specific crop suggestions. The system helps in enhancing planning, productivity, and risk reduction in the farm operations by integrating crop growth data, environmental conditions, and timing of management.

2.5 AI Logic: Soil Status Classifications

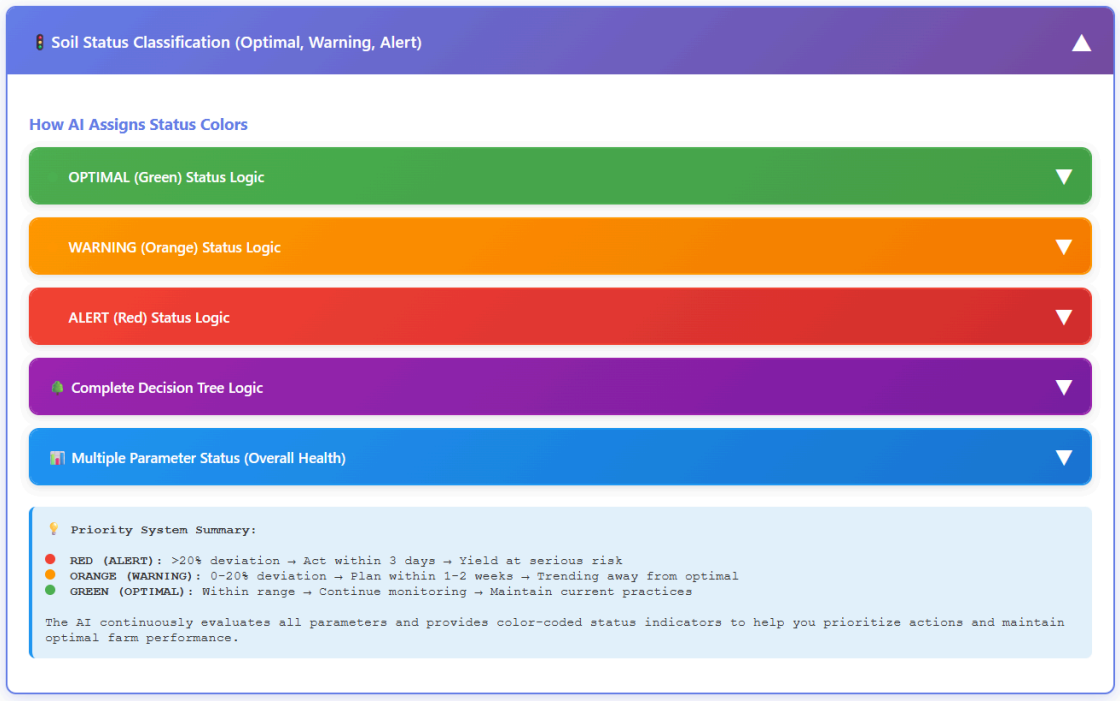


Figure 9. Soil status classification logic in the AgriNINE-11 system showing color-coded condition levels and priority rules.

The argiNINE-11 system has a logic of soil status classification based on color-coded method to provide a quick indication of soil condition and action priority. All soil parameters are measured against their optimal range and rated as Optimal (green), Warning (orange), or Alert (red) depending on the extent to which they are not at the ideal range.

When the parameter is within the optimal range, the status is green which means that no action is necessary and only routine monitoring is necessary. The orange status is applied when the value is slightly out of the optimal range and this indicates that corrective action is to be planned in a period of one to two weeks. The red status is activated when the deviation is extreme, that is, there is a need to take urgent measures within a limited period of time to avoid loss of yield.

In cases where more than two soil parameters are considered, the system will calculate the total soil health on a priority basis. When one of the parameters is in the alert category, the overall status turns to alert. In case of several warnings, the general condition is warning. In case most parameters are optimal and there is only one small problem, the soil is described as optimal. This categorization assists users to find out the most important issues fast and to prioritize the corrective measures effectively.

3.0 CONCLUSION

Altogether, the AgriNINE-11 system demonstrates how artificial intelligence can be effectively applied to support smarter, safer, and more informed agricultural decision-making. By integrating soil analysis, real-time and forecasted weather data, crop health monitoring, yield prediction, and rule-based AI logic, the system is able to process complex farm data and translate it into clear, practical, and actionable recommendations for farmers.

The use of health scores, color-coded status indicators, and priority-based decision rules allows users to quickly understand field conditions and identify potential issues before they escalate into serious problems. This enables timely interventions, reduces uncertainty in daily farm operations, and supports more efficient use of resources such as water, fertilizers, and labor.

Overall, AgriNINE-11 serves as a reliable and efficient agricultural decision support system that has the potential to improve farm productivity, minimize operational risks, and promote sustainable farming practices. By assisting farmers in making data-driven decisions, the system contributes to long-term farm resilience and responsible agricultural management.