Field of Invention:

AgroSense enhances precision farming through real-time monitoring, automation, and data-driven insights. It features weed detection, soil moisture and climate analysis, water footprint tracking, and crop health assessment. The system automates irrigation, leverages ML-based image analysis for weed and disease detection, and provides AI-driven recommendations. With real-time alerts and a user-friendly interface, AgroSense optimizes crop yield and resource management efficiently.

Prior Art and problem to be solved:

Traditional agricultural monitoring systems rely on manual inspections and outdated techniques for weed detection, soil moisture assessment, and crop health monitoring. While some modern precision agriculture solutions integrate basic IoT-based soil sensors and automated irrigation systems, they often lack AI-driven analytics, real-time decision-making capabilities, and adaptive water management based on climate conditions. Existing weed detection methods mainly use manual identification or conventional image processing techniques, which struggle with accuracy and scalability. Additionally, most irrigation control systems operate on preset timers rather than real- time soil moisture and climate data, leading to inefficient water usage. The lack of real- time water footprint monitoring also makes it difficult. for farmers to optimize their resource consumption effectively. Crop health monitoring is another area where traditional methods fall short. Many farmers still rely on visual inspections, which are prone to human error and delays in disease identification. While some advanced farms use drone-based monitoring, these systems often lack AI-powered remedy recommendations, forcing farmers to rely on external expertise. Agrosense addresses these challenges by integrating IoT sensors, machine learning models, and real-time analytics. The system: Uses AI-powered image analysis for accurate weed detection and crop health monitoring, reducing reliance on manual inspections. Automates irrigation through real-time soil moisture detection, triggering the water pump only when necessary. Incorporates climate humidity tracking and water footprint monitoring to optimize water usage and sustainability.Provides AI-driven remedy suggestions for early disease management and improved crop yields. By combining these features into a unified smart farming system, Agrosense enhances efficiency, reduces resource wastage, and supports data-driven decision-making for farmers.

Objects of the invention:

- To develop an AI-powered weed detection system using image processing and machine learning to accurately identify and classify unwanted plants in agricultural fields.
- To implement an automated irrigation system that monitors real-time soil moisture levels and activates a water pump when moisture is low, optimizing water usage.
- To integrate climate humidity and water footprint monitoring, providing real-time insights into environmental conditions affecting crop growth and water consumption.
- To develop an AI-driven crop health monitoring system that detects diseases, pests, and nutrient deficiencies and provides automated remedy suggestions to farmers.
- To create a user-friendly dashboard for remote monitoring, real-time alerts, and data- driven decision-making, improving efficiency and sustainability in farming operations.

Background of the invention:

Agriculture plays a crucial role in food production, but farmers face numerous challenges that impact crop yield and resource efficiency. Some of the major issues include uncontrolled weed growth, inefficient irrigation, unpredictable climate conditions, and undetected crop diseases. These factors not only reduce productivity but also lead to wastage of resources such as water, fertilizers, and pesticides.

Traditional farming methods rely heavily on manual monitoring and decision-making, which can be time-consuming, labor-intensive, and prone to errors. Farmers often struggle to identify weeds, soil moisture levels, climate changes, and crop diseases at the right time, leading to delayed actions and significant yield losses. Additionally, existing agricultural solutions lack real-time weed detection, adaptive irrigation mechanisms, and AI-driven crop health monitoring, making it difficult to implement precision farming effectively.

To address these limitations, AgroSense integrates IoT sensors, machine learning, and real-time analytics to create a smart and automated farming system. It provides automated weed detection, intelligent irrigation control, continuous climate monitoring, and AI-powered crop health assessment. By leveraging real-time data and AI-driven insights, AgroSense enables farmers to make informed decisions, optimize resource usage, and improve crop productivity sustainably. This innovative approach enhances efficiency, reduces manual labor, and promotes sustainable farming practices, ensuring better agricultural outcomes.

Summary of Invention:

Agrosense is a smart agricultural monitoring system that leverages IoT, machine learning, and real-time analytics to optimize farming practices. It integrates AI- powered weed detection, automated irrigation, climate and soil monitoring, and crop health assessment to improve efficiency and sustainability. Using image processing and sensor data, Agrosense detects unwanted weeds and crop diseases, providing farmers with automated remedy suggestions. The system also monitors soil moisture in real-time, activating the water pump only when needed, ensuring optimal water usage. Climate and water footprint tracking further help in resource management. With a user-friendly dashboard and real-time alerts, Agrosense empowers farmers to make data-driven decisions, enhancing productivity and reducing resource wastage

Brief Description of Drawings:

Detailed Description:

The **Fig.1** represents the AgroSense system, an AI-driven solution designed to improve agricultural efficiency through machine learning, IoT, and geospatial technologies. The system is structured into multiple layers, each responsible for different tasks to ensure accurate analysis and real-time decision-making. The Input Layer / Data Collection Layer (101) gathers data from multiple sources, including sensor data, Kaggle datasets, and user-input data. The sensor data includes soil moisture levels, temperature, and humidity, while the image datasets are used for crop health and weed detection. After data collection, the Data Integration Layer(102) processes the data using fusion techniques and ENVI software, which integrates geospatial data for enhanced decision-making. ENVI is particularly useful for analyzing satellite imagery to assess vegetation health, soil moisture levels, and land conditions. The Data Processing Layer (103) includes four major components: Unwanted Plant Detection, which uses an R-CNN-based convolutional neural network to differentiate between crops and weeds; Water Footprint Calculation, which classifies water consumption into blue, green, and gray footprints to improve irrigation efficiency; Soil Moisture Sensing, which employs sensor-based control systems to monitor soil conditions; and Crop Health Monitoring, which leverages a CNN-based deep learning model to detect nutrient deficiencies, diseases, and crop stress. The User Interface Layer (104) allows farmers to interact with the system through an intuitive dashboard featuring icons for different functionalities, enabling easy access to real-time insights. The final output includes visual interfaces displaying water footprint calculations, analysis results in graphical format, and weed detection outputs, providing actionable insights to enhance decision-making. By integrating these advanced technologies, AgroSense aims to enhance crop productivity, optimize water usage, and promote sustainable agricultural practices.

In **Fig 2** illustrates a computer vision-based approach for plant leaf classification using deep learning. The process begins with image acquisition[201], where field crop images are captured and stored in a leaf image dataset. The images then undergo pre-processing, including cropping, filtering, and segmentation, to enhance their quality. Next, [202] the dataset is split into training, validation, and test sets for model development. The deep learning model is trained using the training and validation datasets[203] to learn features necessary for classification. Once trained, the model undergoes performance assessment[202A] before being used for plant leaf classification, identifying diseases or other characteristics based on the input images[204].

The **Fig.3** shows how a soil moisture sensor system works in farming. It has different parts that work together to check soil moisture and control watering automatically. At the top, [300] represents the overall system. Inside it, [301] is the main unit that includes sensors. There are two types of sensors: [301] is the soil moisture sensor, which checks the water level in the soil and connects to a water pump that turns on when needed. the DHT sensor, which measures temperature and humidity.The next part, labeled [302] is where the data from the sensors is analyzed in real time. This step helps understand the soil condition and decide whether watering is needed. Finally, in section [303] the system gives results based on the analysis. It shows how different components, like microcontrollers and circuits, work together to send data and control the water pump. Overall, this system helps farmers by automatically checking soil moisture and controlling watering, saving water and improving plant growth.

The **Fig.4** represents a Water Footprint Monitoring System, which calculates and analyzes water usage for agriculture. The system begins with the user[401] inputting key agricultural parameters, including crop name, land area, water requirement (mm/day), irrigation efficiency (0-1), and growing period (days). These inputs[401A] are processed in the calculation module, where the system computes the total water usage[403] for the specified conditions. The results are then displayed, showing water usage data and recommendations for optimizing irrigation practices. Finally, the processed information is presented on a dashboard[404], helping users make informed decisions about sustainable water management in agriculture.

In **Fig.5** represents The Weed Detection System utilizes dataset from a Data Provider to identify and classify crops and weeds. It retrieves dataset images[501], processes them, and applies machine learning models for classification. The results are then displayed for the System User, enabling efficient monitoring and weed management in agriculture. The Weed Detection System[502] employs the RCNN (Region-Based Convolutional Neural Network) method with a VGG16 model to classify crops and weeds from satellite imagery. The process begins with retrieving high-resolution agricultural images[502A] from a data provider. These images undergo preprocessing steps such as resizing, normalization, and noise reduction to enhance model performance. Using the RCNN method, the system generates region proposals[502B], identifying potential areas in the image that may contain crops or weeds. These regions are extracted and resized to match the input size required by the VGG16 model, which then performs feature extraction and classification. The extracted features are passed through fully connected layers to classify[502C] the regions as either weed or crop. Finally, the results are displayed on a dashboard interface, allowing system users to view the weed detection outcomes[503] and make informed decisions. This approach enhances weed detection accuracy, promoting precision agriculture by optimizing herbicide use, reducing manual labors, and improving overall crop yield.