Technical Stack for RootSense: AI-Powered Soil Health Microchip

1. Hardware Stack

- ESP32: Main microcontroller for sensor reading and data transmission (WiFi/BLE/LoRa).
- Soil Sensors: Capacitive moisture, pH, NPK, Temperature (DS18B20), Conductivity sensors.
- LoRa/BLE: Communication module for long-range or local data transfer.
- Power Supply: Thin-film battery or Microbial Fuel Cell (MFC) for sustainable power.
- Biodegradable Casing: PLA/Mycelium shell to protect electronics and degrade in soil.

2. Software Stack

- Firmware: Arduino C++ code running on ESP32 to read sensors and handle communication.
- Mobile App: React Native + Expo app for farmers to view soil health and AI suggestions.
- Voice Output: Google Text-to-Speech or Expo TTS for local-language audio guidance.
- Offline Support: SQLite/AsyncStorage for caching sensor data on phone.

3. Backend Stack

- Firebase Firestore: Real-time database for storing sensor and user data.
- Firebase Cloud Functions: Processes incoming sensor data and triggers AI.
- MQTT/Firebase Sync: Handles real-time device-to-cloud communication.

4. AI / Advisory Stack

- Python + Scikit-learn/TensorFlow: Analyzes historical soil data and builds crop models.
- GPT-3.5/4 (via API): Generates regenerative farming tips based on soil status.
- HuggingFace + Local TTS: Translates AI tips into local languages and speech.