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Plant Disease Prediction System for Sustainable Agriculture

Learning Objectives

- Understand the role of **Artificial Intelligence (AI) and Deep Learning in Agriculture** 🌱.
- Learn **Image Classification** using **Convolutional Neural Networks (CNNs)** and **EfficientNetB0** 🧠.
- Implement **image preprocessing techniques** such as augmentation, normalization, and resizing 🖼️.
- Optimize model performance with **transfer learning, dropout layers, and fine-tuning techniques** ⚙️.
- Evaluate model performance using **Precision-Recall Curves, ROC Curves, and Grad-CAM Visualization** 📊.
- Deploy a **real-time Plant Disease Prediction Web App** using **Streamlit** 🚀.
- Develop an end-to-end **AI-powered agricultural tool** that is accessible, scalable, and beneficial for farmers 🌍.

Tools and Technology used

🛠 Tech Stack & Libraries:

- **Programming Language:** Python 🐍
- **Deep Learning Framework:** TensorFlow & Keras 🤖
- **Image Processing:** OpenCV & PIL 🖼️
- **Data Handling:** Pandas & NumPy 📊
- **Visualization:** Matplotlib, Seaborn & Grad-CAM Heatmaps 🔥
- **Web Application Framework:** Streamlit 🌐
- **Dataset Source:** KaggleHub 📥

💡 Additional Tools Used:

- **Google Colab** (for Model Training)

Methodology

1. **Data Collection** – Kaggle dataset with multiple plant diseases 🌿
2. **Data Preprocessing** – Rescaling, augmentation, normalization 🖼️
3. **Model Selection** – EfficientNetB0 for superior feature extraction 🔍
4. **Training & Fine-Tuning** – Dropout layers, learning rate optimization ⚙️
5. **Model Evaluation** – Accuracy, loss curves, Precision-Recall 📊
6. **Model Explainability** – Grad-CAM for heatmap visualization 🔥
7. **Deployment** – Streamlit Web App for user-friendly predictions 🌍

Problem Statement:

📌 **Challenge:**

•Farmers struggle with identifying plant diseases early, leading to **crop losses and reduced yield**.

•Traditional disease detection methods are **time-consuming and inaccurate**.

🔍 **Why It Matters?**

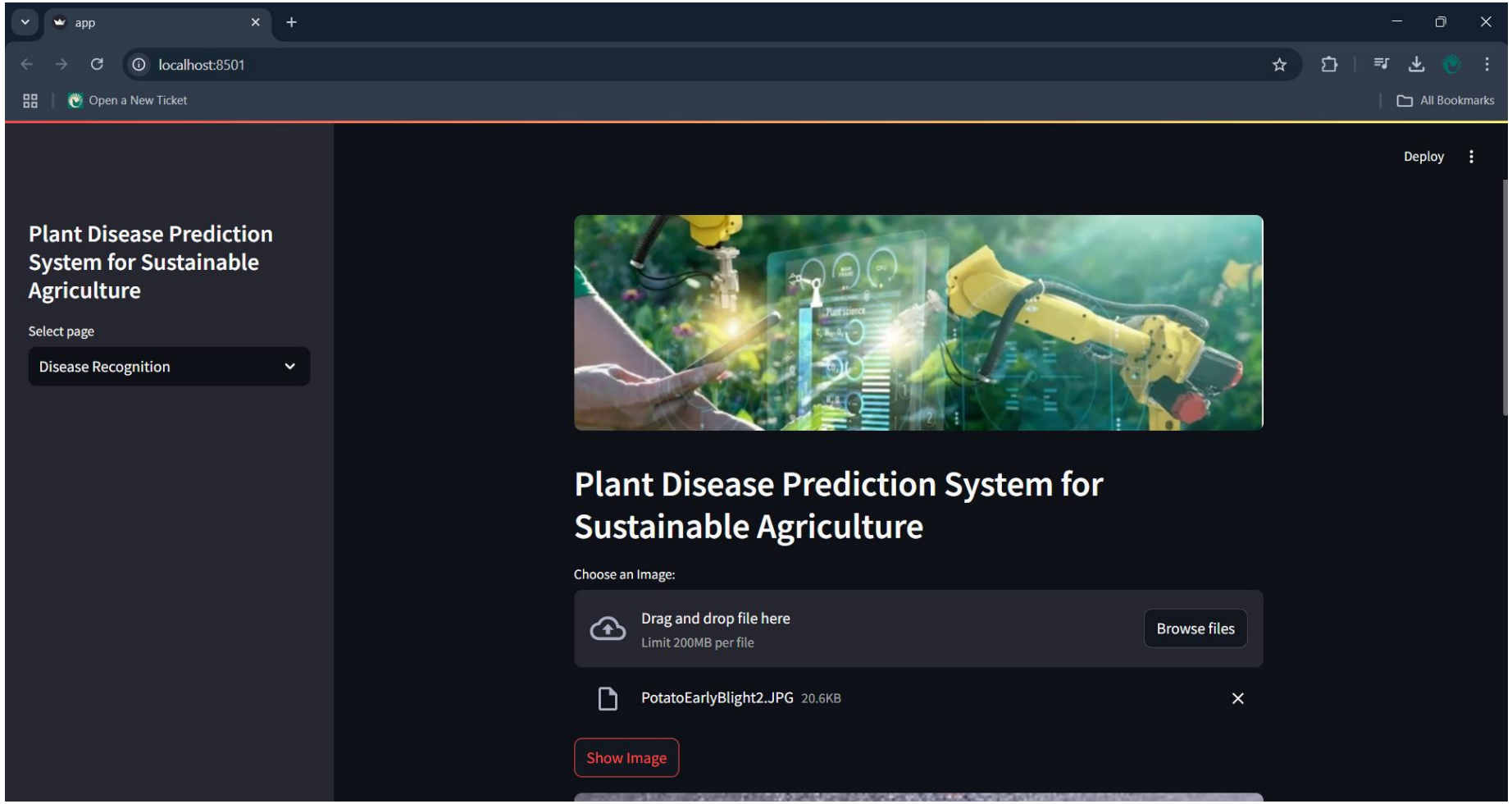
•Early disease detection helps in **timely intervention**, **higher yield**, and **sustainable agriculture**.

•A cost-effective, AI-powered solution can help farmers identify diseases early and prevent large-scale losses.

Solution:

- A **Deep Learning-based Plant Disease Detection System** to classify plant leaf images into **38 disease categories**.
- **Trained on Kaggle's New Plant Diseases Dataset**, ensuring high accuracy.
- Uses **EfficientNetB0**, a **state-of-the-art CNN model** known for high performance.
- Deployed as a **Streamlit Web App**, making it accessible **on any device**.
- Includes **Grad-CAM heatmaps** for transparency, showing **why** the model made a specific prediction.
- Provides **disease diagnosis along with confidence scores** to help farmers make informed decisions.

Screenshot of Output:



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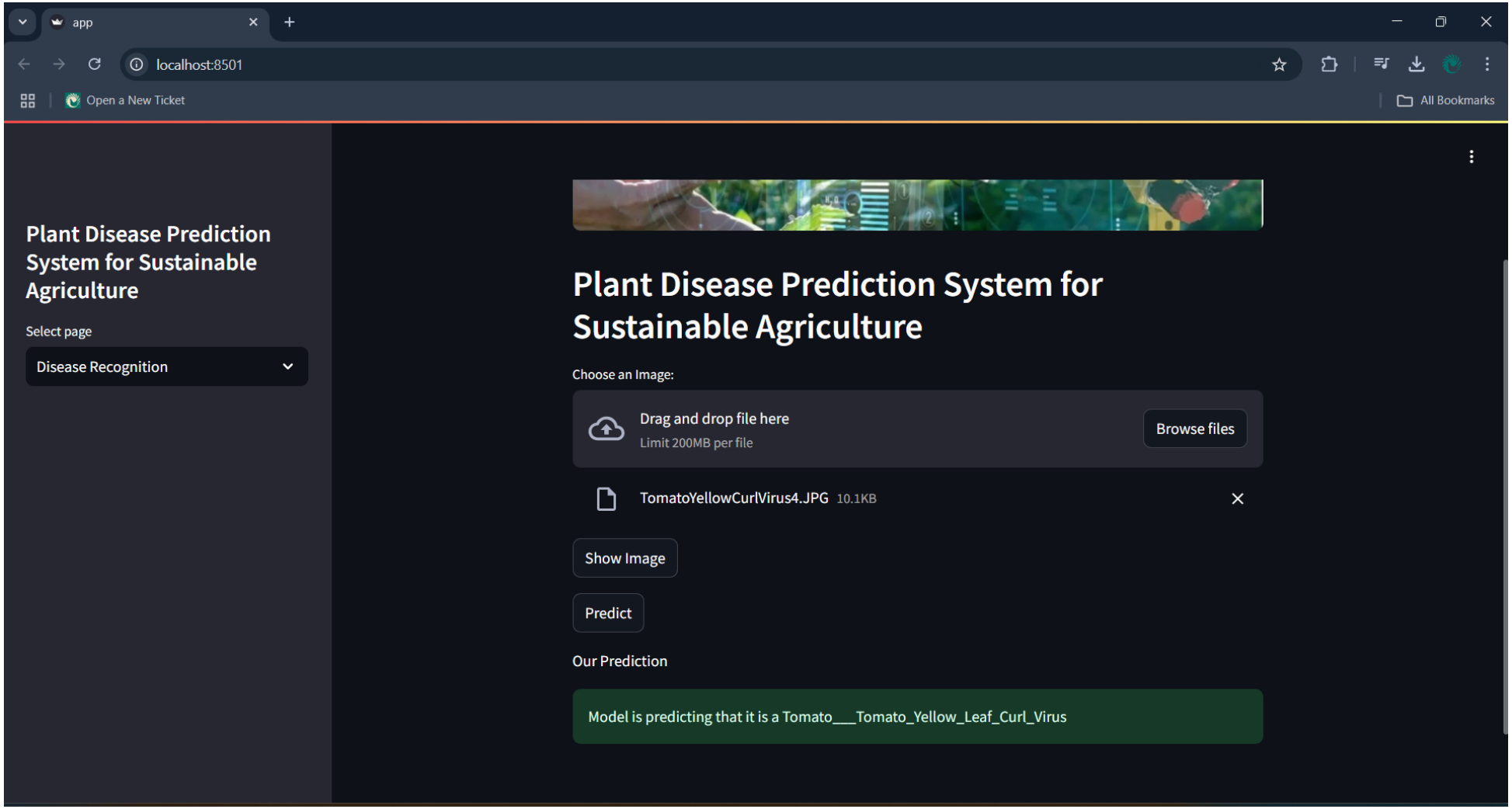
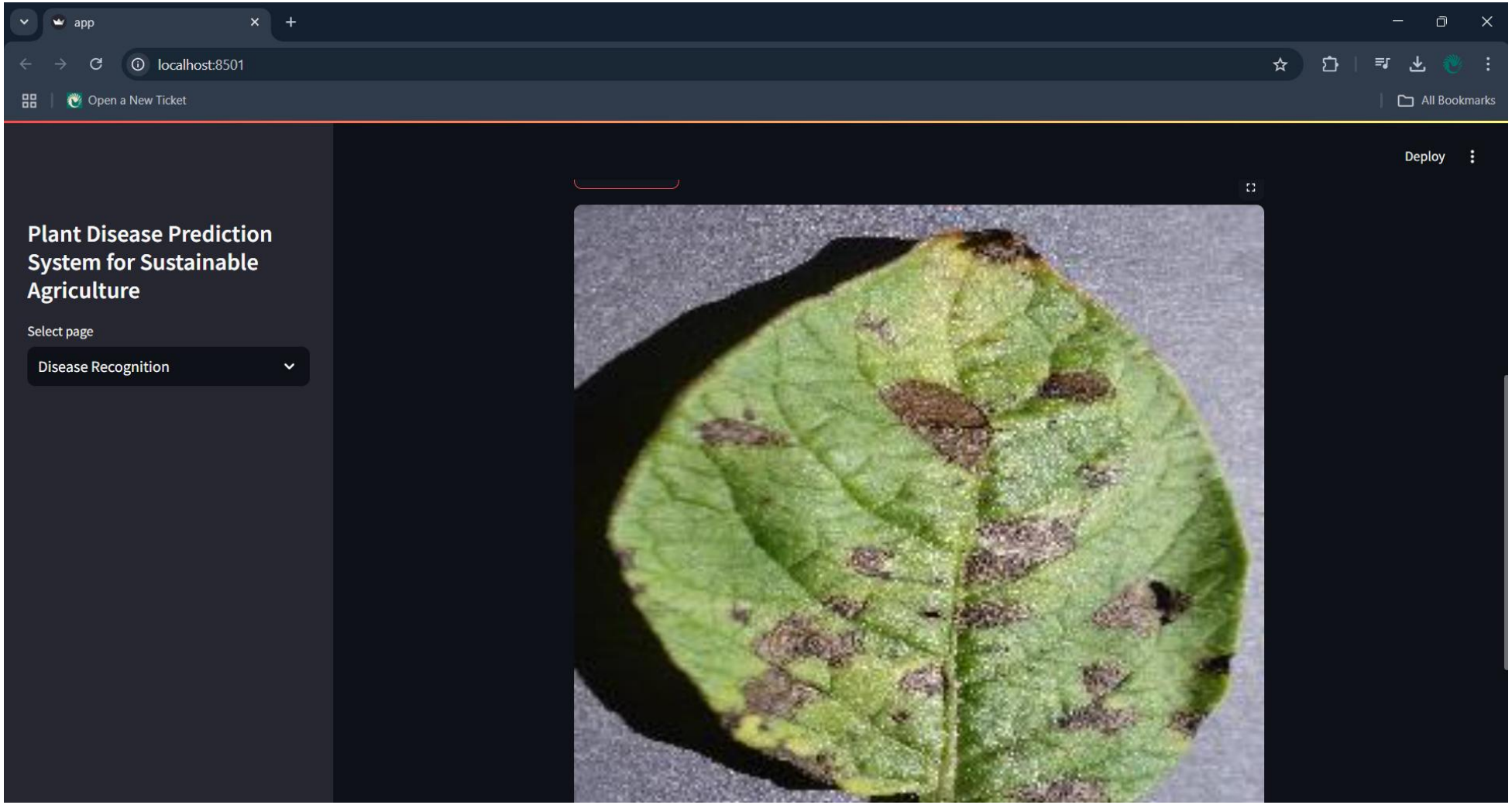
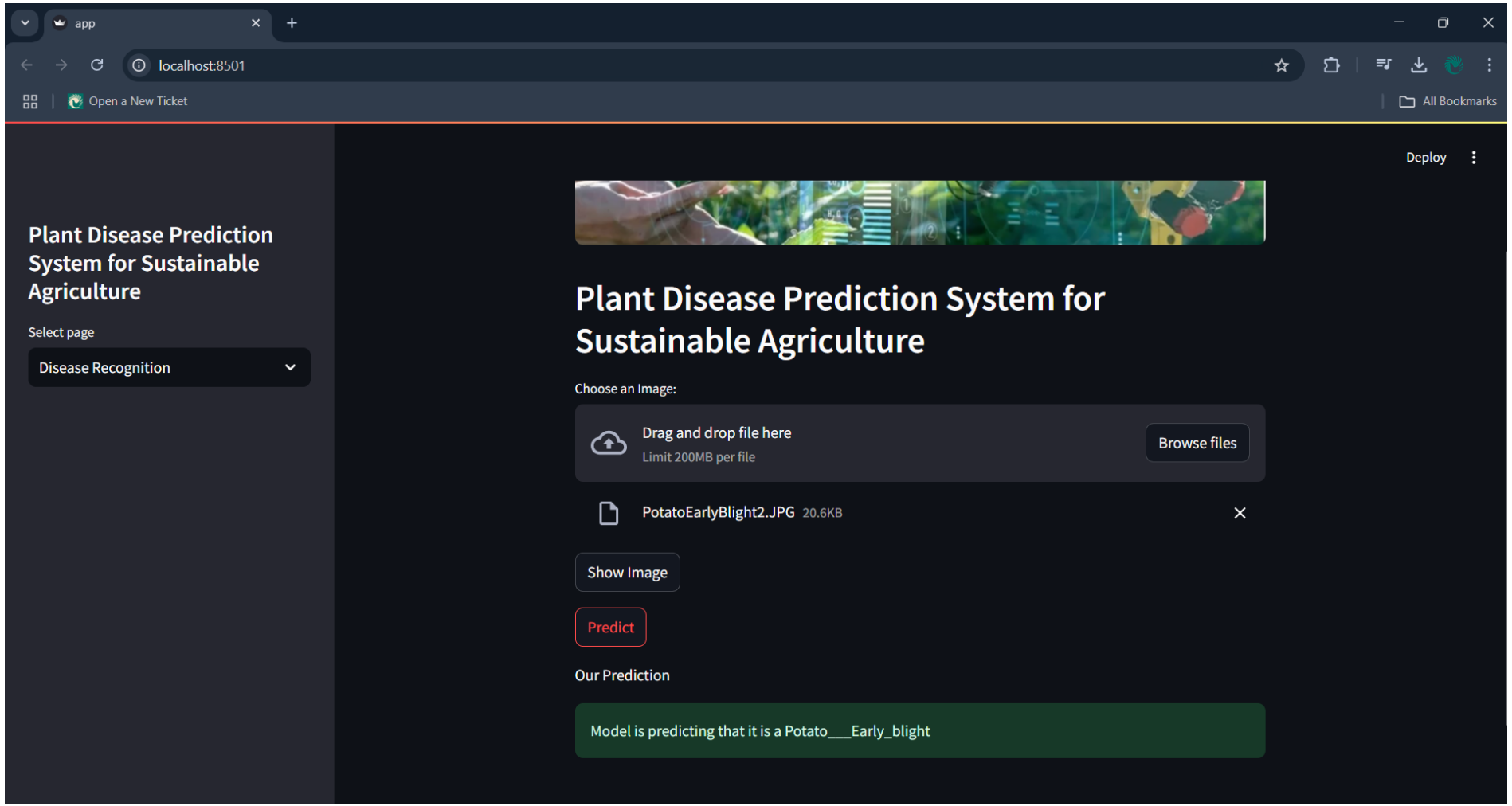


Screenshot of Output:



Screenshot of Output:



Conclusion:

Final Takeaways:

- Successfully developed an **AI-powered Plant Disease Classification Model**.
- Achieved **high prediction accuracy** using **EfficientNetB0** and fine-tuning techniques.
- Deployed the system as an **interactive web application** using Streamlit.
- Integrated **Grad-CAM visualization** to provide **explainability & trustworthiness** in predictions.

🚀 Future Scope & Improvements:

1. Expand dataset to include more crop varieties.
2. Optimize the model for mobile applications (TensorFlow Lite).
3. Real-time integration with drones or IoT-based agriculture systems.
4. Multi-language support for better accessibility among farmers.