FORMATIVE ASSESSMENT -1 REPORT

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Department: IT

Subject: Deep Learning

Academic Year: 2025–26

Title: Formative Assessment Report – Deep Learning Mini Project

Student Name: Sadique Chand Nadaf

PRN: 125M1K014

Faculty Name: Mrs. Tanuja Patankar

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1.1 Objective

The objective of this assessment is to study and analyze recent (2022–2025) deep learning–based research papers related to potato disease detection, understand the datasets and methodologies used, identify research gaps in existing literature, and propose an innovative mini-project concept that can be implemented as part of the course. The focus is on evaluating different CNN, transformer, and hybrid models used for plant disease classification and understanding their strengths, limitations, and applicability in real-world agricultural settings.

1.2 Topic Selection

Chosen Topic: *Crop Disease Detection Using Deep Learning — Potato*

1.3 Literature Review Summary

Table: Summary of Reviewed Papers (2022–2025)

Sr. No.	Paper Title	Dataset Used	Methodology (DL Model)	Results / Metrics	Key Findings
1	*Potato Leaf Disease Detection Based on a Lightweight Deep Learning Model* (Chang, 2024)	PlantVillage & Potato Leaf Dataset (7 classes, RGB images)	RegNetY-400MF (lightweight CNN, transfer learning)	Accuracy ≈ **90.68%**	Efficient for mobile/edge devices; reduced model complexity with reasonable accuracy
2	*Optimized Deep Learning for Potato Blight Detection Using WWPASC* (Elshewey et al., 2024)	Potato blight leaf images; features extracted via AlexNet/ResNet	CNN feature extraction + Binary WWPASC optimization + MLP	Accuracy **99.5%**	Feature optimization significantly improves performance; multi-stage but highly accurate
3	*MDSCIRNet for Potato Leaf Disease Detection* (Reis, 2024)	PlantVillage-based potato disease datasets	MDSCIRNet (Transformer + depthwise separable CNN blocks)	Near SOTA accuracy	Global attention improves generalization, especially for complex features
4	*A Novel Dataset of Potato Leaf Disease in Uncontrolled Environments* (Shabrina et al., 2023/24)	3076 field images, 7 classes	Baseline CNN models for benchmarking	Lower accuracy than lab datasets	Real-world conditions make classification challenging; dataset useful for robust model training
5	*Research on Plant Disease Identification Based on CNN* (Sun, 2022)	NPDD (multi-crop dataset including potato)	FL-EfficientNet	High multi-crop accuracy	EfficientNet variants show faster convergence and better performance

1.4 Comparative Analysis

A. Comparative Table — Methodologies

Paper	Year	Deep Learning Model Used	Advantages	Limitations
Chang (2024)	2024	RegNetY-400MF	Lightweight, low FLOPs, edge-friendly	Slightly lower accuracy than heavy architectures
Elshewey et al. (2024)	2024	CNN features + WWPASC + MLP	Exceptional accuracy; strong feature selection	Multi-stage and computationally heavy
Reis (2024)	2024	MDSCIRNet (Transformer-CNN hybrid)	Better global feature extraction, high accuracy	Transformer blocks require tuning and GPU
Shabrina et al. (2023/24)	2023–24	Baseline CNN models	Real-world robustness testing	No advanced architectures tested
Sun (2022)	2022	FL-EfficientNet	High accuracy, fast training	Less optimized for mobile deployment

B. Comparative Table — Datasets

Paper	Dataset Used	Key Dataset Features	Dataset Strengths	Dataset Limitations
Chang (2024)	PlantVillage + Potato Dataset	Clean, uniform images; 7 disease classes	High accuracy; easy to train	Poor generalization to field images
Elshewey et al. (2024)	Blight leaf dataset	Disease-specific images	Good for blight detection	Limited class diversity
Reis (2024)	PlantVillage variants	RGB disease images	Suitable for benchmarking new models	Synthetic backgrounds
Shabrina (2023/24)	Field dataset (3076 images)	Natural lighting, noise, varied angles	Realistic and challenging	Imbalance and noise
Sun (2022)	NPDD	Multi-crop, multi-class	Broad generalization	Not crop-specific

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C. Innovation Summary — What Each Paper Adds

Paper	Novel Contribution	Innovation Summary
Chang (2024)	Lightweight model	Deployable on phones & drones
Elshewey et al. (2024)	AI-based feature selection	Highest reported accuracy
Reis (2024)	Hybrid architecture	Combines CNN depth + transformer attention
Shabrina (2023/24)	Real-world dataset	Essential for generalizable training
Sun (2022)	EfficientNet variant	Fast training, multi-crop capability

1.5 Proposed Mini Project Concept

Title of Mini Project:

PotatoLeafNet: A Lightweight Deep Learning Model for Real-World Potato Disease Detection

Problem Statement:

Existing potato disease detection systems achieve high accuracy on controlled datasets but perform poorly on real-world field images due to variations in lighting, leaf orientation, environmental noise, and background clutter. There is a need for an efficient, lightweight, and robust deep learning model that can perform consistently on both lab and field datasets and can be deployed on low-cost agricultural devices.

Proposed Deep Learning Solution:

- Use a **lightweight CNN architecture** (MobileNetV3 or RegNetY-400MF) for efficient feature extraction.
- Train and evaluate on a **combined dataset** (PlantVillage + Shabrina field dataset).
- Apply augmentation techniques (brightness shift, rotation, noise injection) to increase robustness.
- Optionally add a **self-attention module** to improve detection of fine disease textures.
- Use performance metrics: accuracy, precision, recall, F1-score, confusion matrix.

Dataset Information:

Primary datasets:

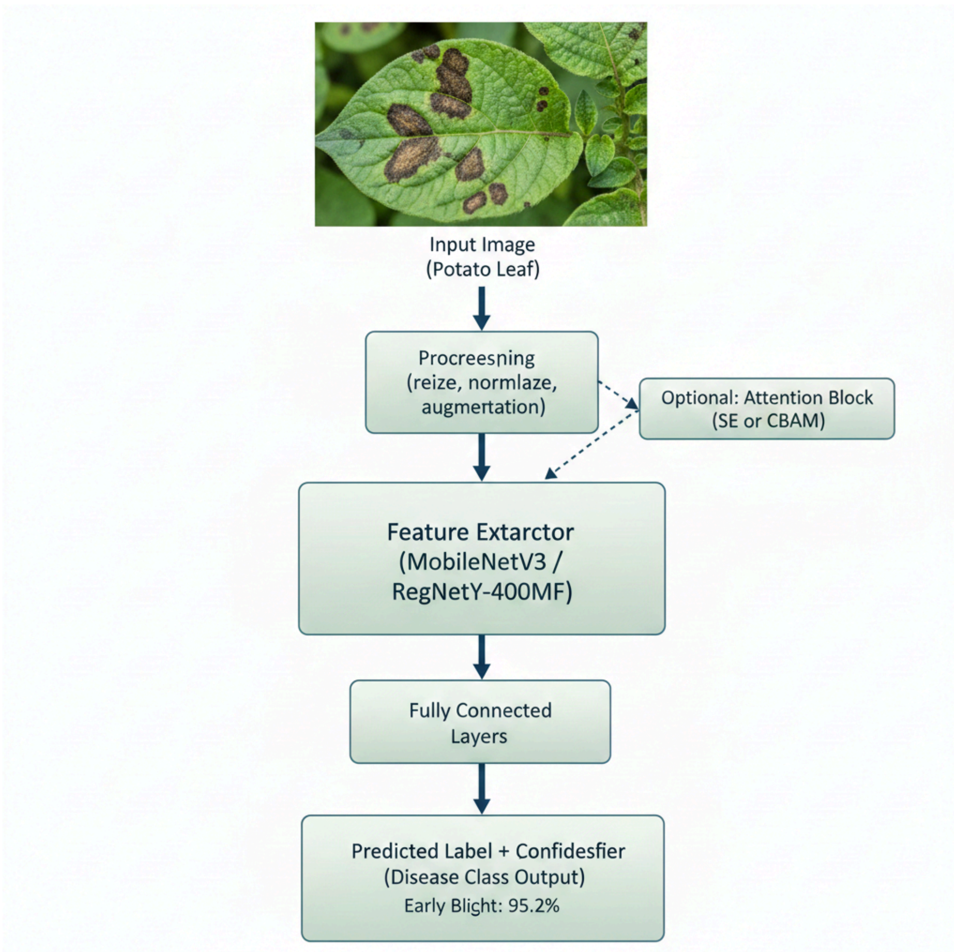
1. *PlantVillage Potato Subset* — Clean, controlled images
2. *Shabrina Potato Field Dataset (3076 images)* — Real-world, uncontrolled environment

These two datasets together will give both high-volume samples and field-level complexity.

Expected Outcome / Results:

- Achieve **90–95% accuracy** on mixed datasets
- Improved generalization across field images
- Model size < 20 MB for compatibility with mobile devices
- Demonstration of real-time inference capability

Conceptual Architecture Diagram:



1.6 Conclusion

The literature survey highlights that deep learning plays a major role in plant disease identification, especially for potato crops. Lightweight architectures such as RegNet and EfficientNet achieve good performance, while hybrid transformer-CNN models provide advanced feature extraction capabilities. A key problem identified is the **performance gap between controlled datasets and real field images**.

The proposed mini-project addresses this gap by focusing on a lightweight yet robust deep learning model trained on both clean and noisy datasets. This ensures real-world applicability and provides a strong foundation for future research in agricultural AI.

1.7 References

[1] C.-Y. Chang, "Potato Leaf Disease Detection Based on a Lightweight Deep Learning Model," *Machine Learning and Knowledge Extraction (MDPI)*, 2024.
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[3] H. C. Reis, "Potato Leaf Disease Detection with a Novel Deep Learning Model (MDSCIRNet)," *ScienceDirect*, 2024.
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[5] X. Sun, "Research on Plant Disease Identification Based on CNN," *ScienceDirect*, 2022.