Saving Rice from Diseases: An AI-Based Detection and Solution System for Cambodian Farmers

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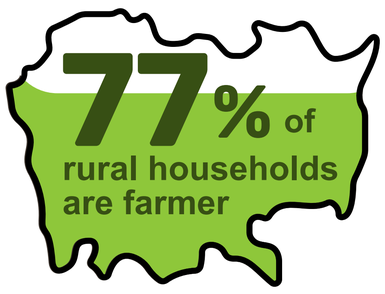
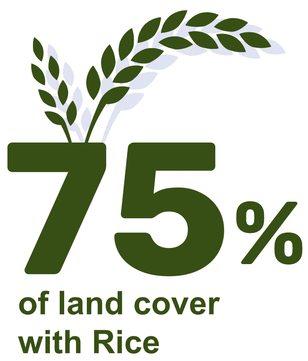
Background





10~30%
Loss of Annual Rice Yield

Cambodia's economy heavily relies on agriculture, with 77% of rural households engaged in farming, and rice covering 75% of agricultural land. However, pathogens and pests cause 10%–30% annual yield losses, while many farmers struggle to identify diseases due to limited knowledge and digital literacy. **A simple and reliable diagnostic tool is crucial to mitigate losses and enhance productivity.**

Problem Statement

A farmer from Chambak village reported that traditional methods remain the primary approach to managing rice diseases. Common practices include spreading salt or ash over affected areas. However, in many cases, farmers are unable to identify the specific diseases. When they observe unusual symptoms in their crops, they typically seek advice from fellow villagers and implement similar treatments. Additionally, their decision-making process heavily relies on past experiences and knowledge inherited from previous generations. When necessary, they may also consult agricultural suppliers or sellers for further guidance.

Objective

Proving a service that helps farmers identify crop diseases and recommend effective solutions for better disease management and prevention.

What is RiceCue?

RICECUE

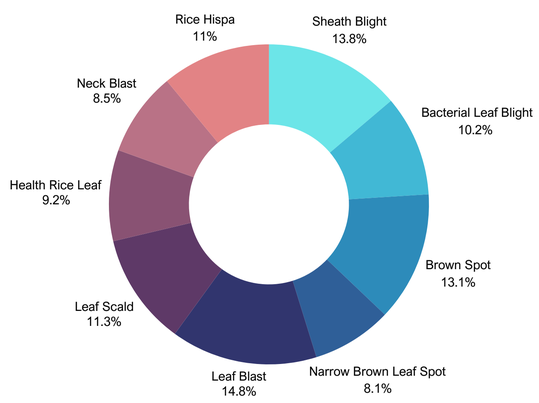
Don't Worry, RiceCue will rescure your rice!

RiceCue, a combination of "**Rice**" + "**Cue**" symbolizing its role in saving rice crops from diseases, is an AI-powered system designed to detect and classify rice diseases. It analyzes images of affected rice plants, identifies the disease type, and provides recommended solutions or preventive measures to help farmers manage crop health effectively.

Dataset

The "**Rice Leaf Diseases Detection**" dataset from **Kaggle** is curated for detecting and classifying nine types of rice leaf diseases. It contains annotated images for each disease, providing a rich source of data to train and evaluate machine learning models. This dataset enables the development of automated solutions for early diagnosis and effective management of rice crop health. Researchers and agricultural technology enthusiasts can leverage it to advance disease detection techniques and improve rice farming practices.

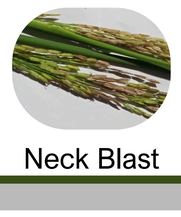
Distribution of each class

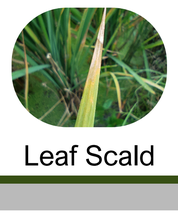


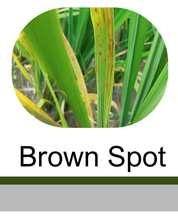
9 Most Common Rice Diseases


Sheath Blight


Healthy


Neck Blast


Leaf Scald


Brown Spot


Narrow brown spot


Rice Hispa


Bacterial leaf Blight


Leaf Blast

Application Features

- **Image Upload:** Users can upload images of rice leaf showing symptoms of disease.
- **Disease Classification:** The app utilizes trained **deep learning models** to classify the uploaded images into specific disease categories.
- **Disease Infomation:** Each classified disease comes with detailed information, including **symptoms**, **causes**, and **recommended treatments**.
- **User-Friendly Interface:** The app is designed to be intuitive, making it accessible for users with varying levels of technical expertise.
- **Ecommerce:** Farmers can buy chemical products from trustable suppliers.

About App

The app is designed to be **simple** and **accesible**, ensuring that farmers, even those unfamiliar with smartphone, can use it with ease. By incorporating the **Khmer lanuage**, we make **disease classification**, **treatment guidance**, and **purchasing argricultural product** more convenient. our goal to empower farmers with important information in a user-friendly way, helping them protect their crops and improve yields.

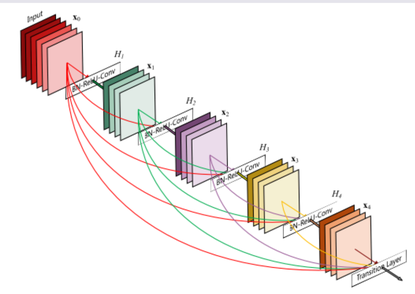
Modelling

The model is built using TensorFlow with a DenseNet121 backbone, pretrained on the ImageNet dataset, for feature extraction. The architecture consists of the following layers:

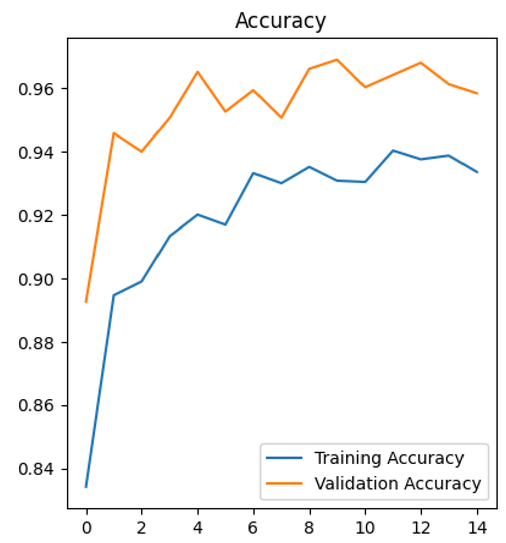
1. **DenseNet121**: A convolutional layer that extracts features from the input image. The model uses pre-trained weights from ImageNet and is set to not be trainable to preserve the learned features.
2. **Batch Normalization**: Applied after the DenseNet121 layer to stabilize and improve training.
3. **Flatten**: Converts the 2D feature map into a 1D vector for the dense layers.
4. **Dense Layer (256 units)**: Fully connected layer with ReLU activation to learn complex patterns.
5. **Batch Normalization**: Another normalization layer to further stabilize training.
6. **Dense Layer (9 units)**: The final softmax layer that outputs probabilities for 9 disease classes.

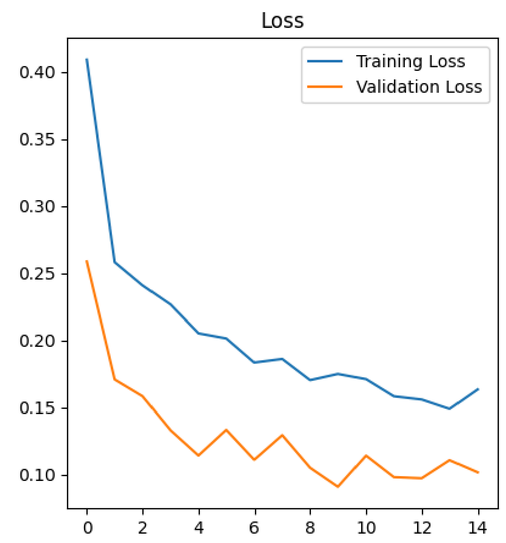
This architecture uses transfer learning to efficiently recognize rice diseases and classify them into the 9 predefined categories.

Diagram representing DenseNet121 [1]

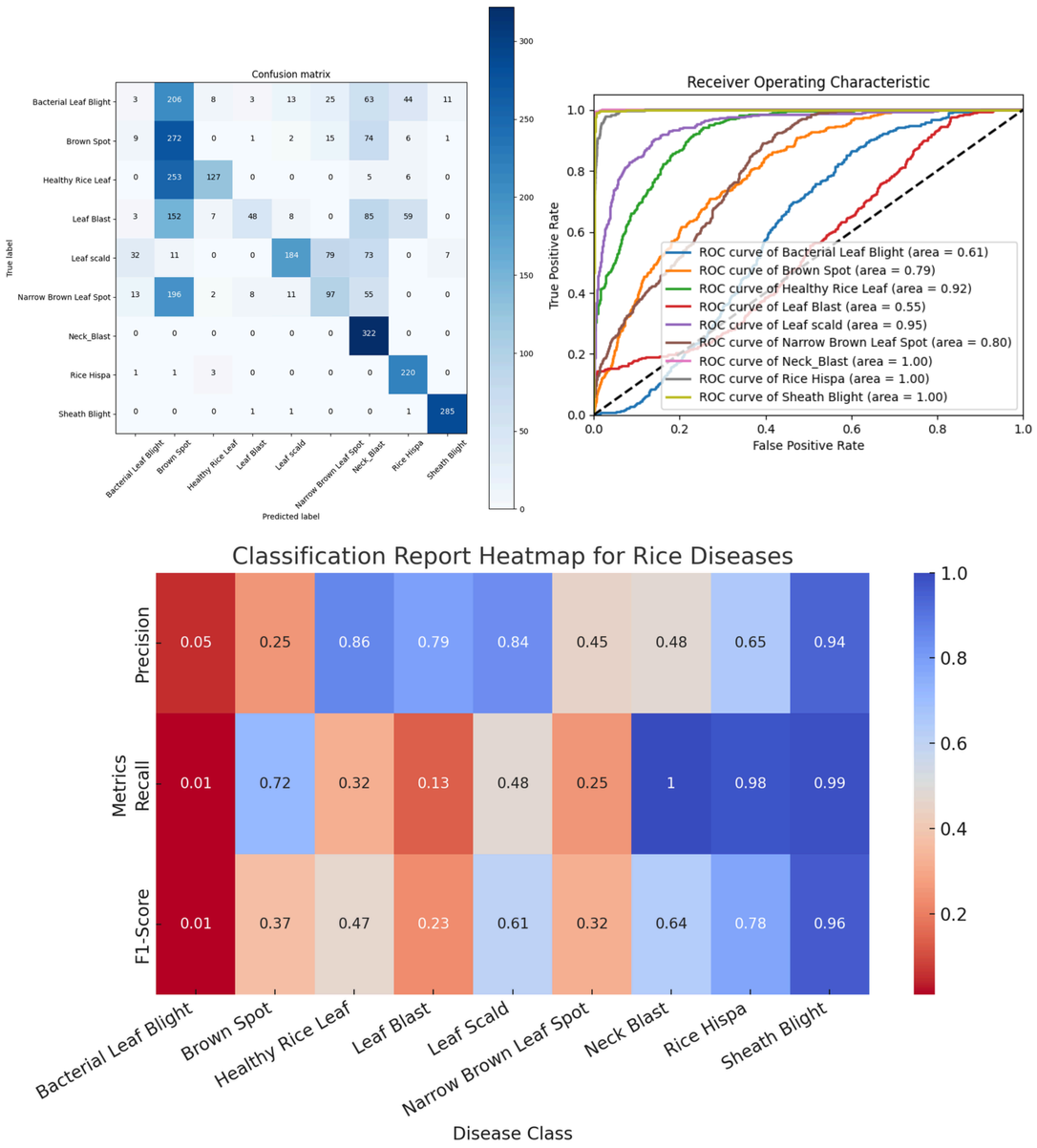


Evaluation





Evaluation (cont)



Despite achieving relatively high accuracy during training, the precision, recall, and F1-score values in the report indicate that the model struggles with distinguishing between certain disease classes. These results point to the model's inability to generalize effectively, as it fails to correctly identify many diseases, particularly those with overlapping symptoms. The overall **macro average** and **weighted average** F1-scores are also low, reinforcing the need for further improvements in the model to handle the complexity of real-world data more accurately.

Challenges

The model's poor performance is mainly due to confusion between diseases, with most images being misclassified as **Brown Spot**. Bacterial Leaf Blight only had 3 correct predictions, possibly because its symptoms are similar to other diseases. Rice crops often suffer from **multiple diseases** at once, leading to overlapping symptoms, such as **leaf blight** across different diseases. Additionally, diseases like **Leaf Blast** and **Narrow Brown Leaf Spot** share visual similarities with **Brown Spot**, making it harder for the model to differentiate them. The dataset might also have mixed disease stages, further complicating classification.

To improve performance, we could use **data augmentation**, implement **multi-label classification** for cases with multiple diseases, and **fine-tune** the model with more diverse data to better handle these complexities.

Brown Spot | **Leaf Blast** | **Narrow Brown Leaf Spot**

Future work

For future work, we aim to expand the app by transforming it into a community platform or forum where farmers can share their experiences, knowledge, and solutions for rice diseases. This will foster collaboration and provide valuable insights for better crop management. Additionally, we plan to improve the model by fine-tuning it with a more diverse and balanced dataset, incorporating multi-label classification for diseases that co-occur, and exploring advanced data augmentation techniques. These improvements, alongside new features like real-time disease detection and personalized recommendations, will help us evolve the prototype into a fully functional and reliable tool for farmers.

Business Model Canvas

Key Partners

- Farmers
- Community
- Suppliers

Key Activities

- Developing the product
- Communicating
- Preparing training
- Marketing

Value Proportions

- Quickly and accurately identify rice diseases
- Easy & Accessible
- Trustworthy
- Saving time

Key Resources

- AI Model & Dataset
- Mobile & Web Application
- Expert Knowledge Base
- Farmer & Community Network

Customer Segments

- Farmers who have rice fields
- Suppliers or providers

Cost Structure

- Technology &Development
- Training and Marketing

Customer Relationships

- Marketplace Integration
- Self-Service & Automation

Channels

- RiceCue Mobile App
- Facebook
- Telegram Chanel

Revenue Streams

- Commission on Product Sales: 3% of producta sold

Conclusion

In conclusion, the app offers significant potential for helping farmers manage rice crop diseases. By allowing farmers to easily identify the diseases affecting their crops through image-based disease detection, the app provides them with quick, accurate insights. It also offers tailored solutions and product recommendations to treat the diseases. Additionally, the app fosters a sense of community where farmers can share knowledge, experiences, and solutions. By coming together, they can reduce costs by purchasing products in bulk, ultimately making crop management more affordable and effective. The app aims to empower farmers, improve productivity, and enhance the overall health of rice crops.

References

[1] Huang, G., Liu, Z., Laurens, V. D. M., & Weinberger, K. Q. (2016, August 25). *Densely connected convolutional networks.* arXiv.org. https://arxiv.org/abs/1608.06993

[2] Yuji Itadori, *Rice leaf diseases detection.* (2023, December 11). Kaggle. https://www.kaggle.com/datasets/loki4514/rice-leaf-diseases-detection

[3] He, Z., Zhang, Z., Valè, G., San Segundo, B., Chen, X., & Pasupuleti, J. (2023). Editorial: Disease and pest resistance in rice. Frontiers in Plant Science, 14, Article 1333904. https://doi.org/10.3389/fpls.2023.1333904

[4] (n.d.). Diseases on Rice crop. https://elibrary.maff.gov.kh/assets/files/books/9afc5d621248595baf50c6e3d34b26501533112926.pdf