**Introduction**

Coffee leaf rust, caused by *Hemileia vastatrix*, is a major threat to coffee production. The disease's impact is intensified by climate change, which shortens the latency period between infection and the appearance of symptoms. Early detection is crucial to manage the disease and mitigate economic losses and job displacement in affected regions. This report explores a novel approach to early detection using convolutional neural networks (CNNs) trained on low-resolution images.

**Short Summary**

The paper investigates the use of deep learning models, specifically CNNs, to detect early-stage coffee leaf rust in low-resolution images. The proposed method involves preprocessing images with a high-pass filter to enhance lesion-leaf contrast. This approach addresses the limitations of resource-intensive high-resolution imaging and large data requirements. The CNN achieved over 90% in precision, recall, F1-score, and Dice coefficient, demonstrating its effectiveness

**Critical Analysis**

The study presents a significant advancement in the early detection of coffee leaf rust by leveraging deep learning and image preprocessing. The high-pass filtering technique is particularly innovative, as it enhances the visibility of early-stage lesions in low-resolution images, making it feasible for use in regions with limited resources. The CNN's strong performance across various resolutions highlights the method's robustness and adaptability.

However, the approach also has limitations. The reliance on a relatively small dataset (around 600 images) may affect the model's generalizability. Additionally, while high-pass filtering improved performance, other preprocessing methods like histogram equalization were less effective, indicating that further optimization is needed. The study could benefit from exploring unsupervised labeling techniques

**Conclusion**

This study demonstrates that CNNs, combined with innovative image preprocessing, can effectively detect early-stage coffee leaf rust in low-resolution images. This method offers a practical solution for early disease detection in resource-limited environments, potentially reducing the economic impact of coffee leaf rust. Future research should focus on enhancing the model's robustness and exploring alternative preprocessing techniques to further improve detection accuracy.