HarvestNet 2.0: Improved Detection of Harvest Piles in Ethiopia

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1 Smallholder farming systems in the Global South

- Smallholder farming is the most common form of agriculture in the developing world which makes it the **primary source of food** for many.
- Reinforces the need to **accurately map farming activity** to monitor food security and to fuel **agriculture extension and development policies**.

2 Detection of Harvest Piles

- A paper from Stanford (Xu et al., 2024) proposes a dataset containing satellite images from the **Tigray and Amhara regions in Ethiopia**.
- Used **ResNet-50** to **detect harvest piles** from them, indicating the presence of smallholder farming activity.
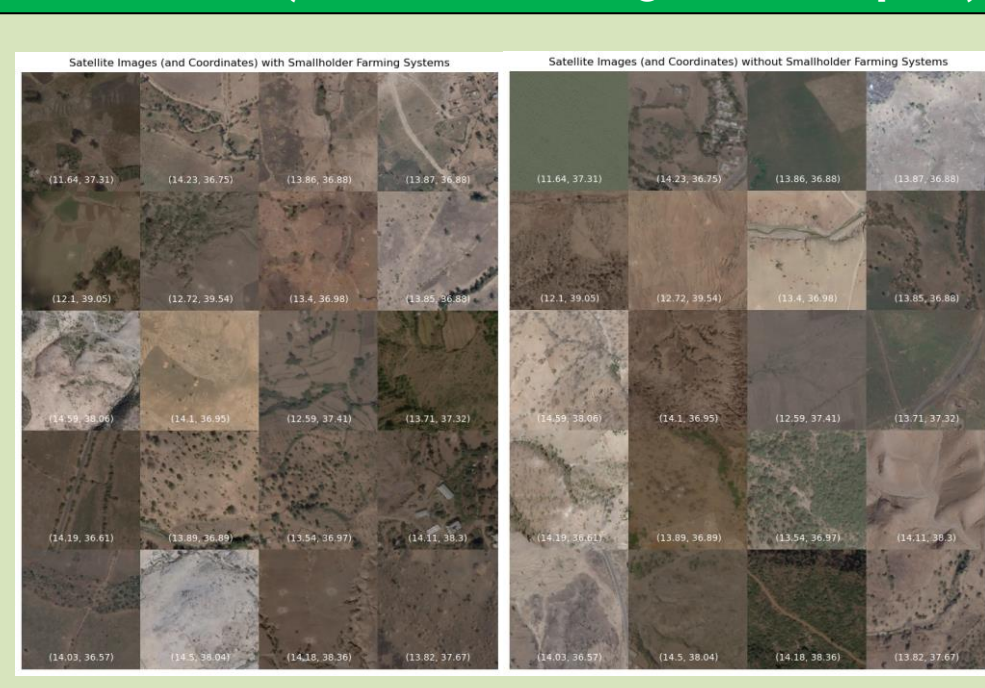
3 Limited data and computational resources

Unfortunately, countries like Ethiopia have **limited access to GPUs and hardware accelerators** for model training and inference. Moreover, it is **expensive to collect ground truth data**. Thus, we worked on simultaneously **compressing and improving the model and the dataset**.
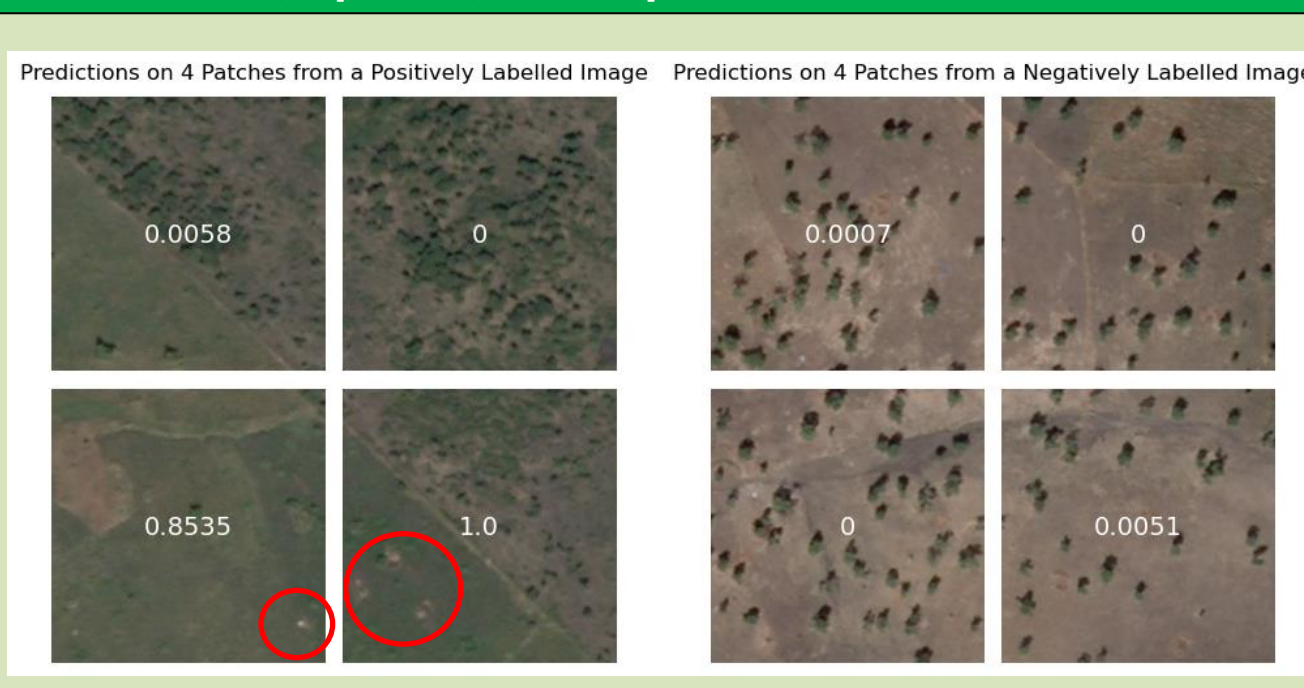
4 HarvestNet vs. HarvestNet 2.0

We improved the dataset by subdividing the images into **four (4) equally-sized patches, upscaling** them to attain the original dimensions **(linear interpolation)** and **relabeling the positive samples** using our baseline ResNet-50 model.

### HarvestNet (Positive and Negative Samples)

Subdivide, upscale, and implement Baseline ResNet-50

Predictions on 4 Patches from a Positively Labelled Image — Predictions on 4 Patches from a Negatively Labelled Image
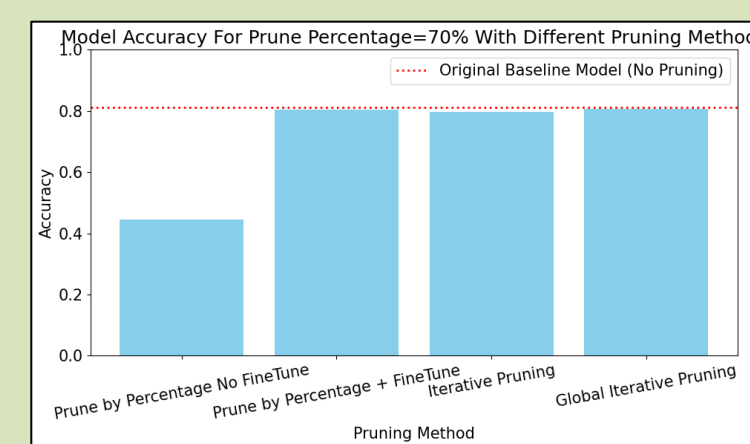
5 Model improvements and HarvestNet 2.0 Performance

PRUNING

- Pruned the baseline ResNet-50 model using Pruning by Percentage, Prune + FineTuning, Iterative Pruning, and Global Iterative Pruning
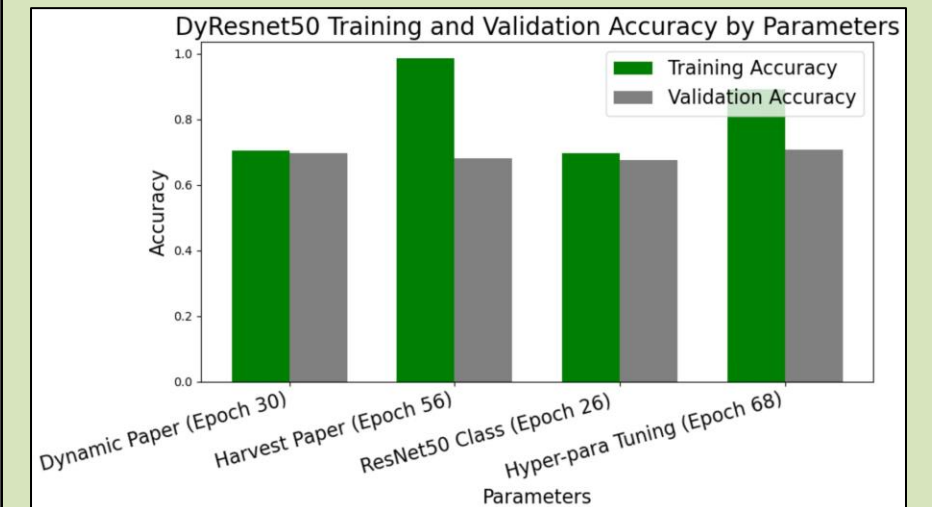- Achieved **~80% validation accuracy** with **70% sparsity**.
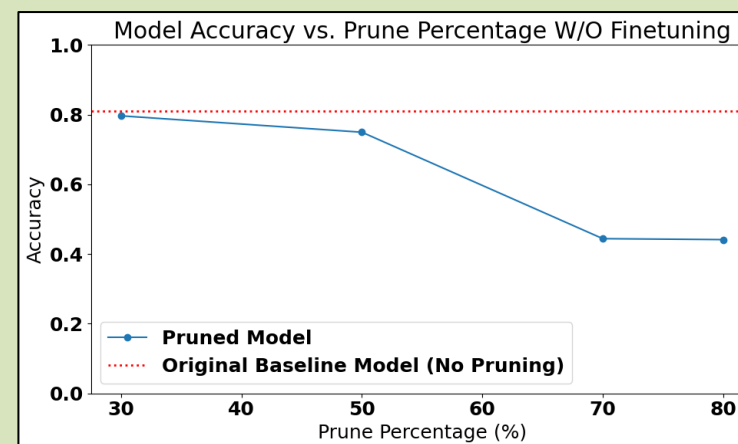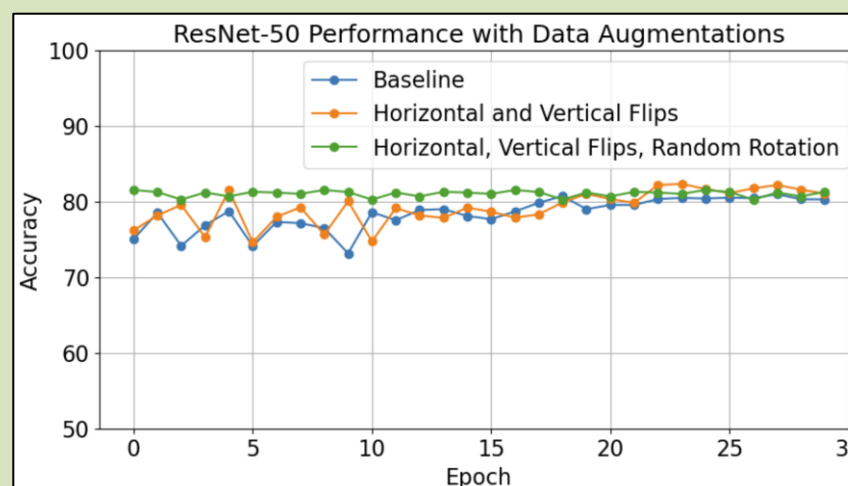

Pruning (%) w/o finetuning

Improving pruned model

DYNAMIC CONVOLUTIONS
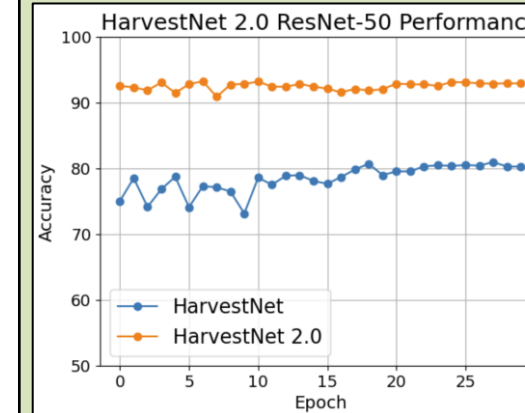

- Achieved **~70% accuracy** after tuning hyperparameters
- Dynamic convolution might **not work with homogeneous data**.
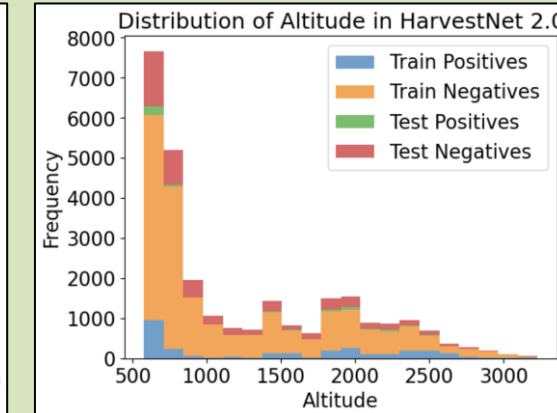
DATA AUGMENTATIONS

A **~2% increase in accuracy** is observed when data is augmented (flips and 5-deg random rotations).

HARVESTNET 2.0 PERFORMANCE

Validation accuracy performance

Distribution of positive and negative samples in train and test sets

- Achieved **~93% accuracy** but **low precision and recall (~60%)**
- An **unbalanced dataset** leads to worse true positive accuracy rates.

6 Summary and Future Work

Model	Acc	AUROC	Precision	Recall	F1
Baseline	0.8096	0.8857	0.8224	0.7247	0.7624
Pruning	0.8068	0.8874	**0.8443**	0.6792	0.7466
Dynamic Conv.	0.7050	-	-	-	-
Data Augment	0.8232	0.8986	0.8230	**0.7406**	**0.7885**
HarvestNet 2.0	**0.9327**	**0.9184**	0.7117	0.6229	0.6334

A compressed and improved model and dataset will help **democratize usage** to such technology in places that need it most. A **simpler model like ResNet-20** could be implemented on both HarvestNet and HarvestNet 2.0 datasets.

Check our repository containing our experiments and visualizations!

Original HarvestNet paper from Stanford's Ermon Research Group