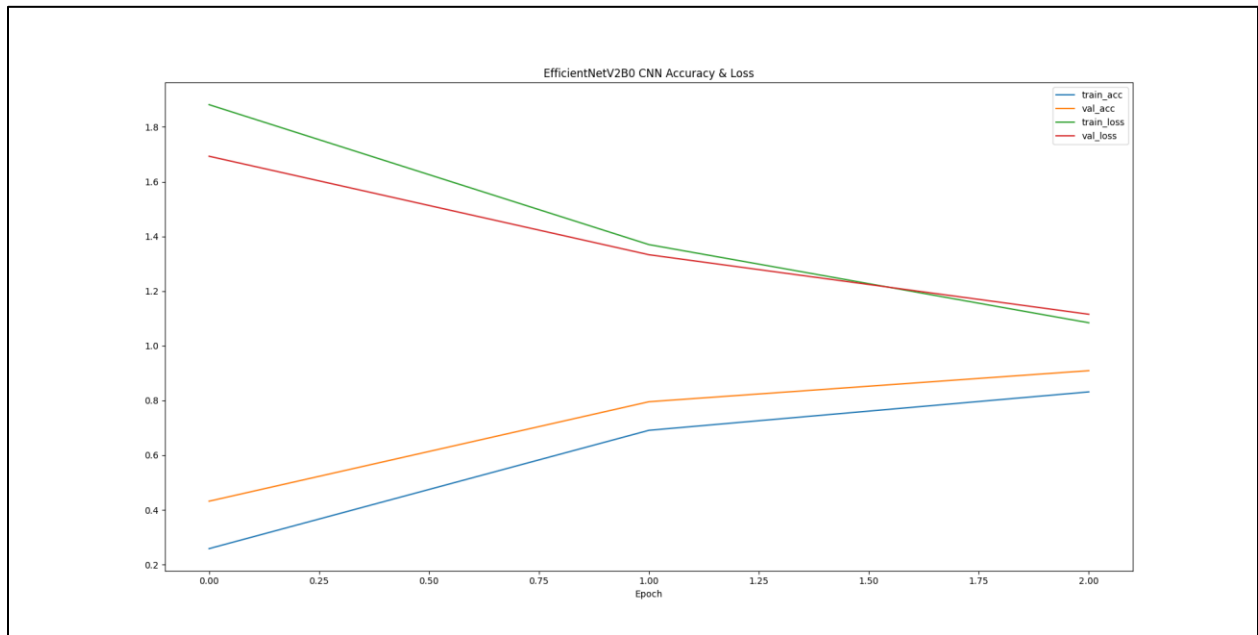
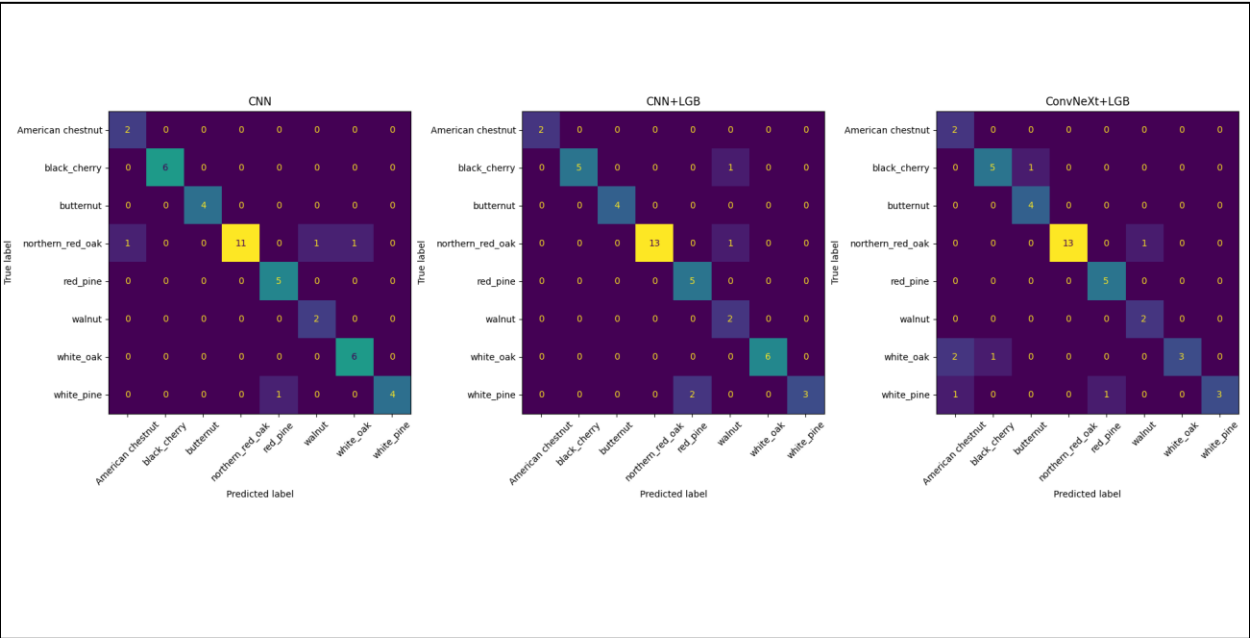
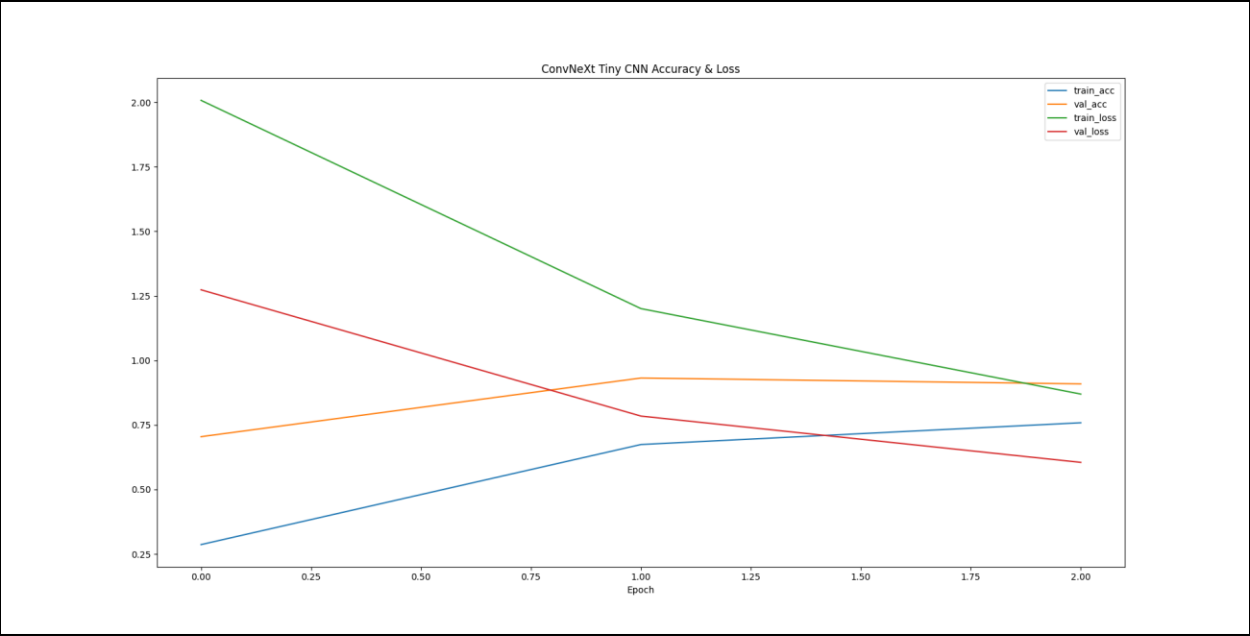


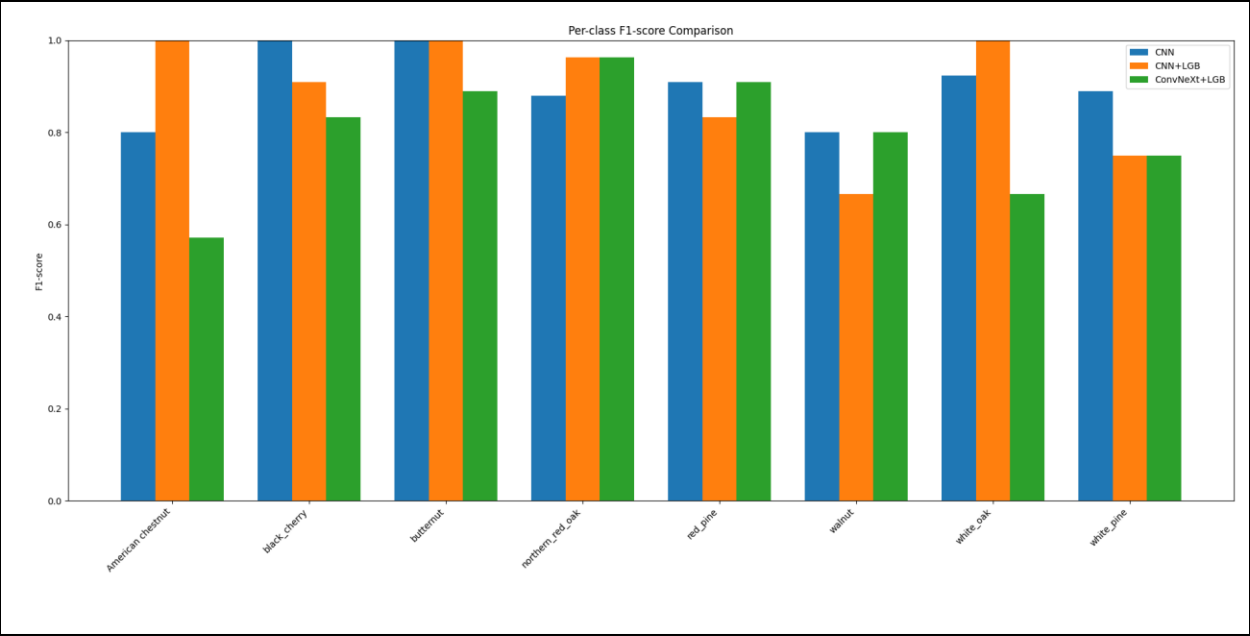
# First Run :

```
Found 222 files belonging to 8 classes.
Using 178 files for training.
2025-09-13 23:18:16.761764: I tensorflow/core/platform/cpu_feature_guard.cc:210] This TensorFlow binary is optimized to use available CPU instructions in performance-critical operations.
To enable the following instructions: AVX2 AVX_VNNI FMA, in other operations, rebuild TensorFlow with the appropriate compiler flags.
Found 444 files belonging to 8 classes.
Using 444 files for validation.
WARNING:tensorflow:From C:\Users\darsh\AppData\Local\Programs\Python\Python312\Lib\site-packages\keras\src\backend\tensorflow\core.py:284: The name tf.placeholder is deprecated. Please use tf.compat.v1.placeholder instead.

Epoch 1/3
12/12 ----- 18s 419ms/step - accuracy: 0.2483 - loss: 1.9333 - val_accuracy: 0.4318 - val_loss: 1.6930
Epoch 2/3
12/12 ----- 2s 153ms/step - accuracy: 0.6736 - loss: 1.3963 - val_accuracy: 0.7955 - val_loss: 1.3329
Epoch 3/3
12/12 ----- 2s 152ms/step - accuracy: 0.8290 - loss: 1.1099 - val_accuracy: 0.9091 - val_loss: 1.1152
Epoch 1/3
WARNING: All log messages before absl::InitializeLog() is called are written to STDERR
I0909 00:00:1757785731.349294 2856 service.cc:146] XLA service 0x2211975f060 initialized for platform Host (this does not guarantee that XLA will be used). Devices:
I0909 00:00:1757785731.349954 2856 service.cc:150] StreamExecutor device (0): Host, Default Version
I0909 00:00:1757785731.396297 2856 device_compiler.h:188] Compiled cluster using XLA! This line is logged at most once for the lifetime of the process.
12/12 ----- 118s 9s/step - accuracy: 0.2167 - loss: 2.2869 - val_accuracy: 0.7845 - val_loss: 1.2735
Epoch 2/3
12/12 ----- 97s 8s/step - accuracy: 0.6342 - loss: 1.2747 - val_accuracy: 0.9318 - val_loss: 0.7844
Epoch 3/3
12/12 ----- 99s 8s/step - accuracy: 0.7106 - loss: 0.9720 - val_accuracy: 0.9091 - val_loss: 0.6850
```







=== Overall Metrics Comparison ===

Model	Accuracy	F1-avg
CNN	0.9091	0.9001
CNN+LGB	0.9091	0.8903
ConvNeXt+LGB	0.8409	0.7978

=== Per-class F1-score Comparison ===

Class	CNN	CNN+LGB	ConvNeXt+LGB
American chestnut	0.8	1	0.5714
black_cherry	1	0.9091	0.8333
butternut	1	1	0.8889
northern_red_oak	0.88	0.963	0.963
red_pine	0.9091	0.8333	0.9091
walnut	0.8	0.6667	0.8
white_oak	0.9231	1	0.6667
white_pine	0.8889	0.75	0.75

=== Best Model Per Class (F1-score) ===

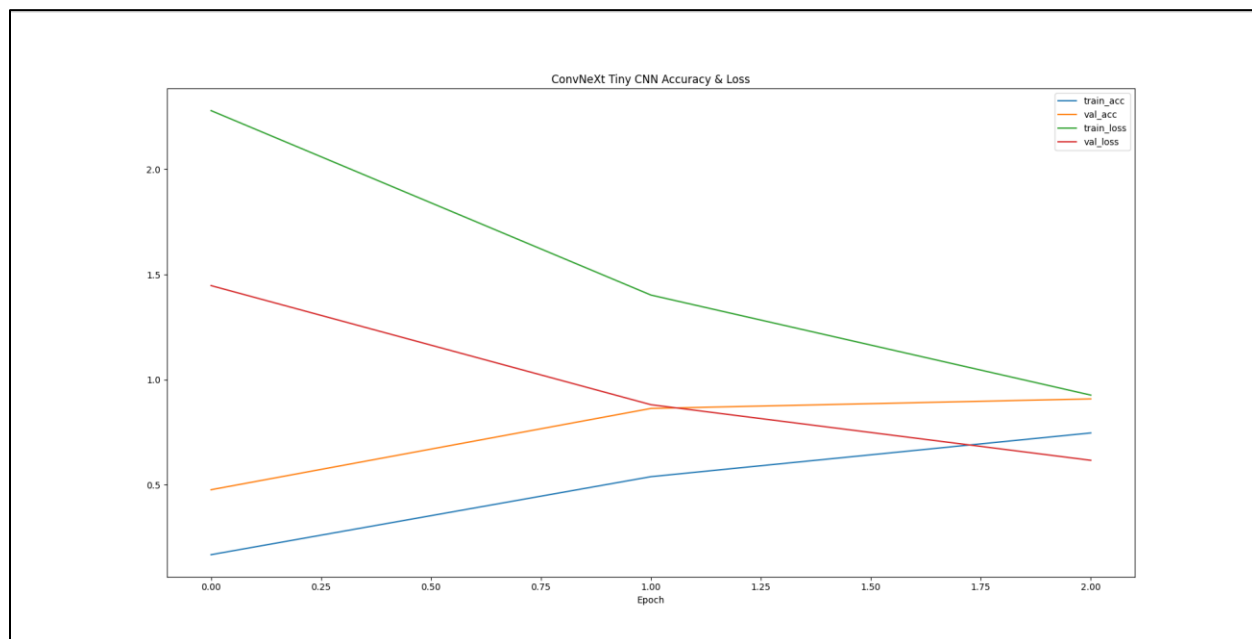
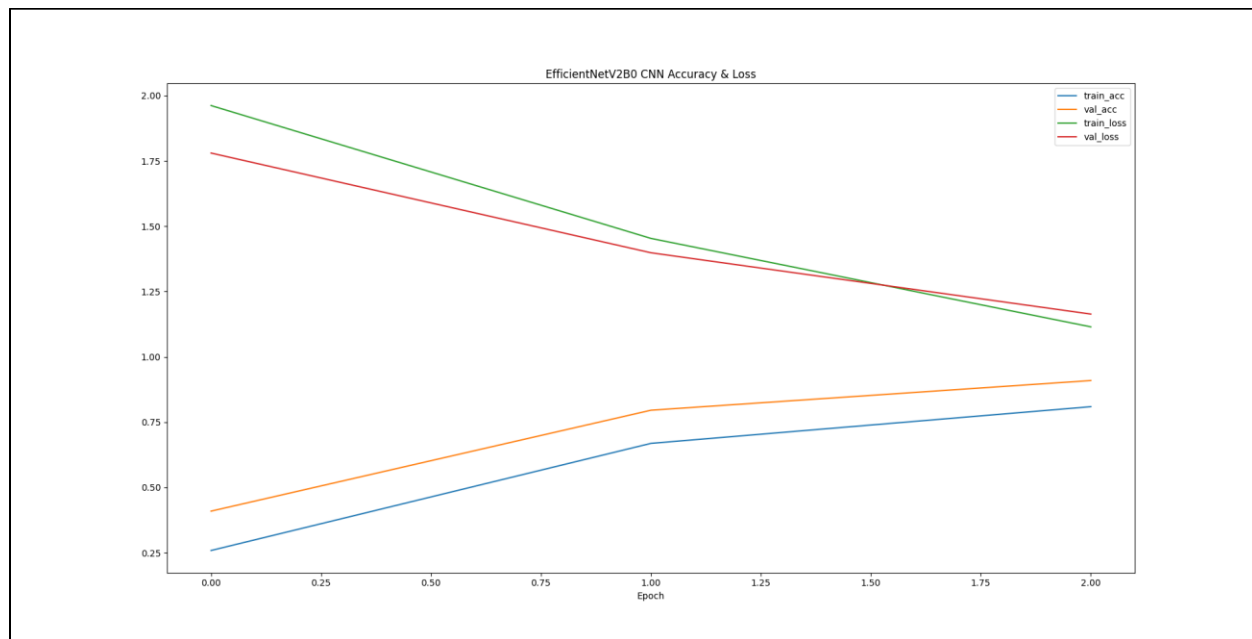
American chestnut: Best + CNN+LGB (1.0000)  
black\_cherry: Best + CNN (1.0000)  
butternut: Best + CNN (1.0000)  
northern\_red\_oak: Best + CNN+LGB (0.9630)  
red\_pine: Best + CNN (0.9091)  
walnut: Best + CNN (0.8000)  
white\_oak: Best + CNN+LGB (1.0000)  
white\_pine: Best + CNN (0.8889)

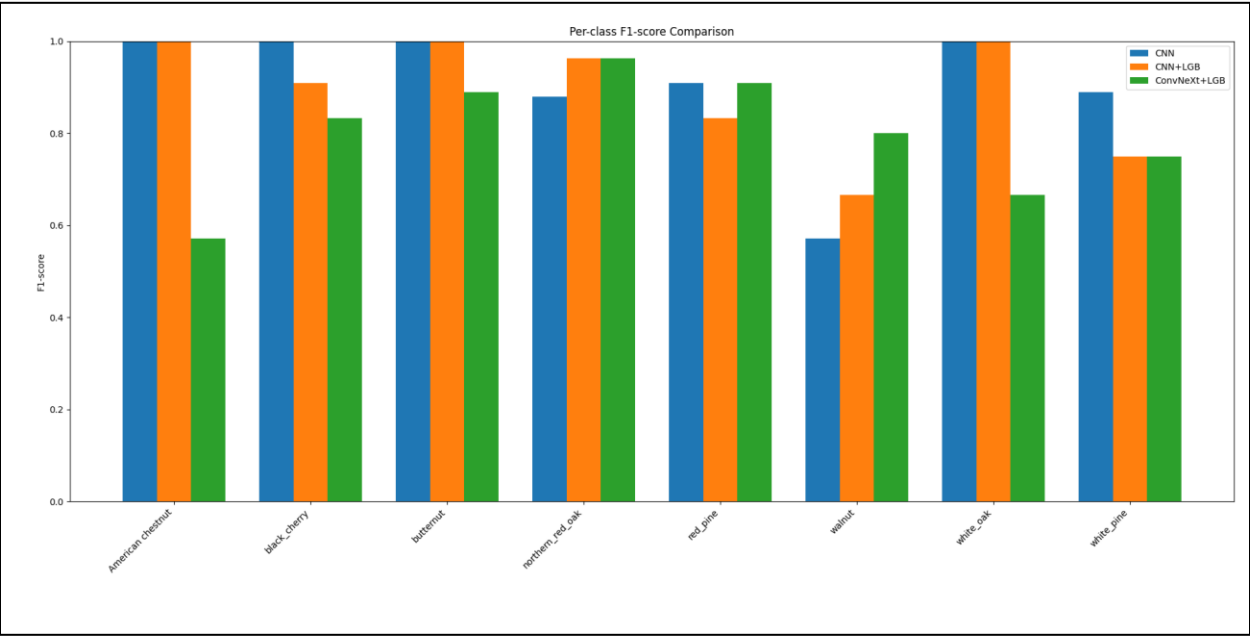
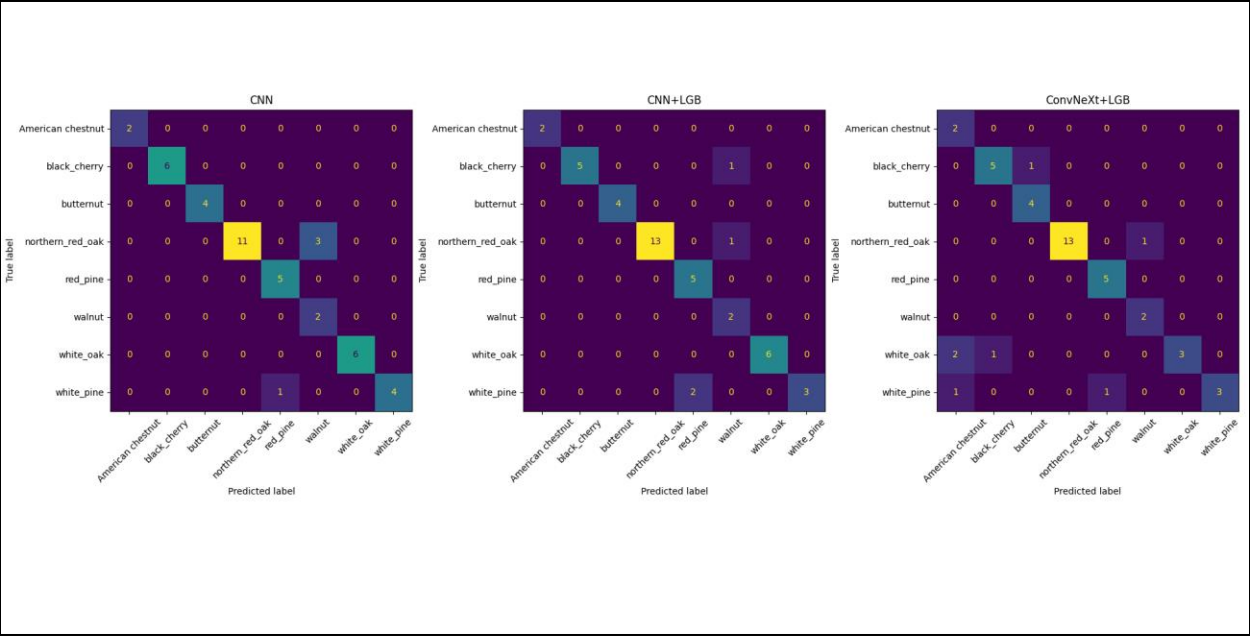
Second Run:

```

Epoch 1/3
12/12 ----- 26s 719ms/step - accuracy: 0.2584 - loss: 1.9619 - val_accuracy: 0.4091 - val_loss: 1.7801
Epoch 2/3
12/12 ----- 3s 265ms/step - accuracy: 0.6685 - loss: 1.4533 - val_accuracy: 0.7955 - val_loss: 1.3983
Epoch 3/3
12/12 ----- 4s 289ms/step - accuracy: 0.8890 - loss: 1.1147 - val_accuracy: 0.9091 - val_loss: 1.1636
Epoch 1/3
WARNING: All log messages before absl::InitializeLog() is called are written to STDERR
10000 00:00:1757826992.696334 11468 service.cc:146] XLA service 0x15d8b6718d0 initialized for platform Host (this does not guarantee that XLA will be used). Devices:
10000 00:00:1757826992.697834 11468 service.cc:154] StreamExecutor device (0): Host, Default Version
10000 00:00:1757826992.679859 11468 device_compiler.h:188] Compiled cluster using XLA! This line is logged at most once for the lifetime of the process.
12/12 ----- 152s 12s/step - accuracy: 0.1685 - loss: 2.2793 - val_accuracy: 0.4773 - val_loss: 1.4475
Epoch 2/3
12/12 ----- 135s 11s/step - accuracy: 0.5393 - loss: 1.4026 - val_accuracy: 0.8636 - val_loss: 0.8815
Epoch 3/3
12/12 ----- 128s 11s/step - accuracy: 0.7472 - loss: 0.9270 - val_accuracy: 0.9091 - val_loss: 0.6171

```





```
=== Overall Metrics Comparison ===
+-----+-----+-----+
| Model | Accuracy | F1-avg |
+-----+-----+-----+
| CNN | 0.9091 | 0.9062 |
+-----+-----+-----+
| CNN+LGB | 0.9091 | 0.8903 |
+-----+-----+-----+
| ConvNext+LGB | 0.8409 | 0.7978 |
+-----+-----+-----+

=== Per-class F1-score Comparison ===

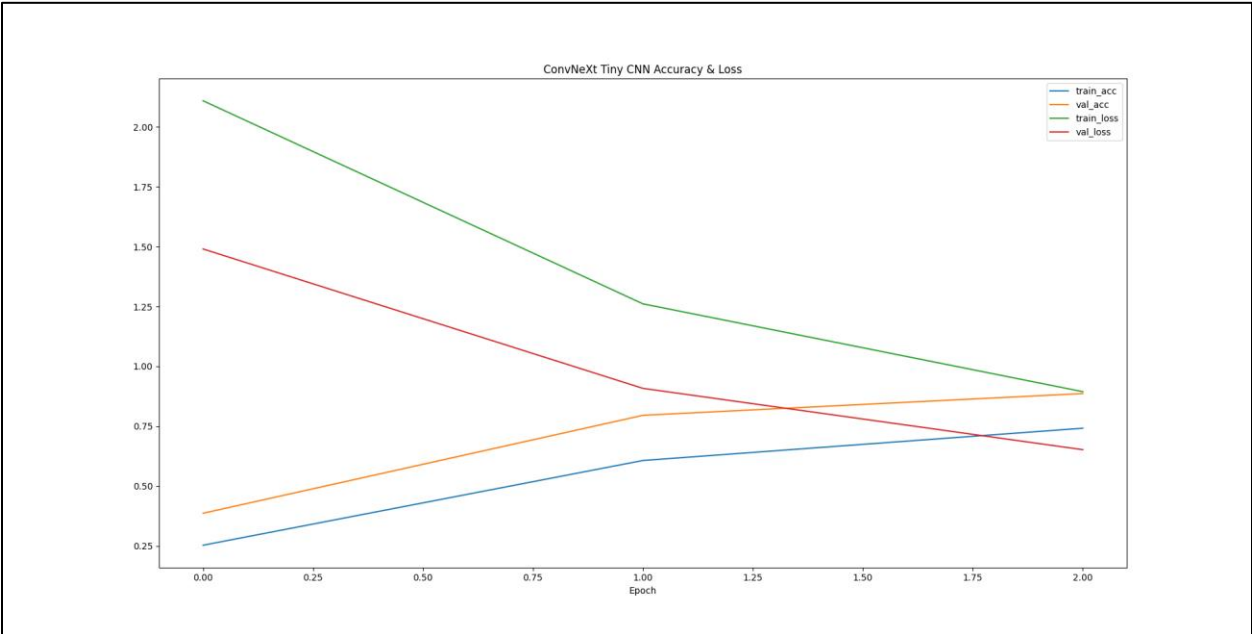
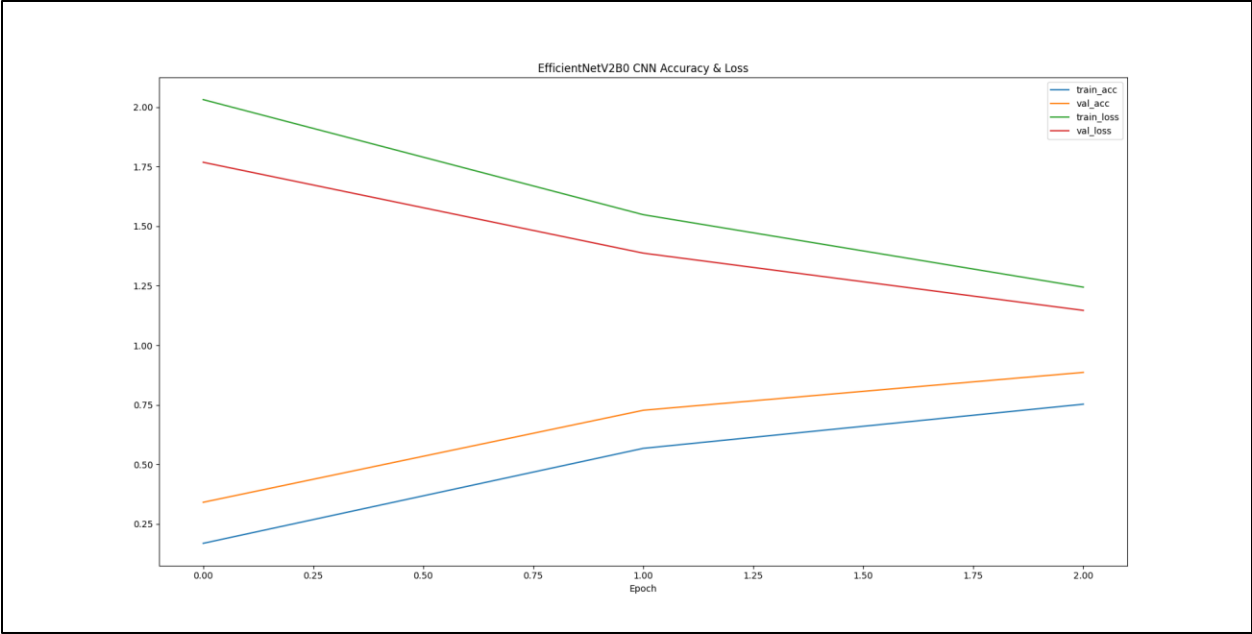

| Class             | CNN    | CNN+LGB | ConvNext+LGB |
|-------------------|--------|---------|--------------|
| American chestnut | 1      | 1       | 0.5714       |
| black_cherry      | 1      | 0.9091  | 0.8333       |
| butternut         | 1      | 1       | 0.8889       |
| northern_red_oak  | 0.88   | 0.963   | 0.963        |
| red_pine          | 0.9091 | 0.8333  | 0.9091       |
| walnut            | 0.5714 | 0.6667  | 0.8          |
| white_oak         | 1      | 1       | 0.6667       |
| white_pine        | 0.8889 | 0.75    | 0.75         |

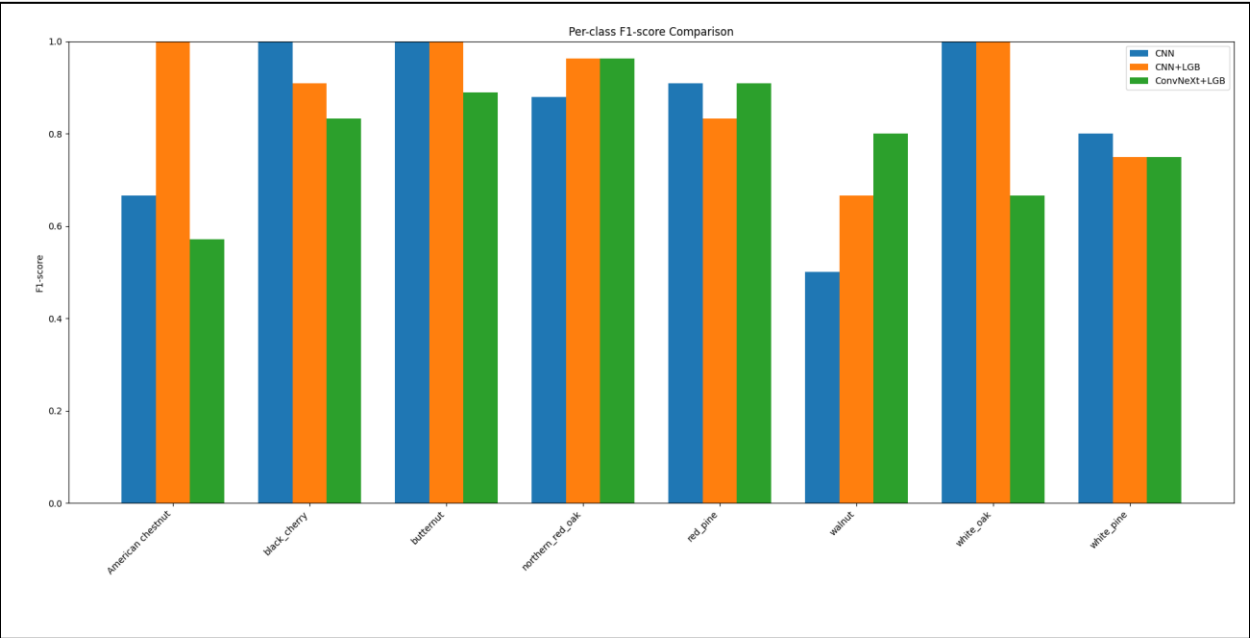
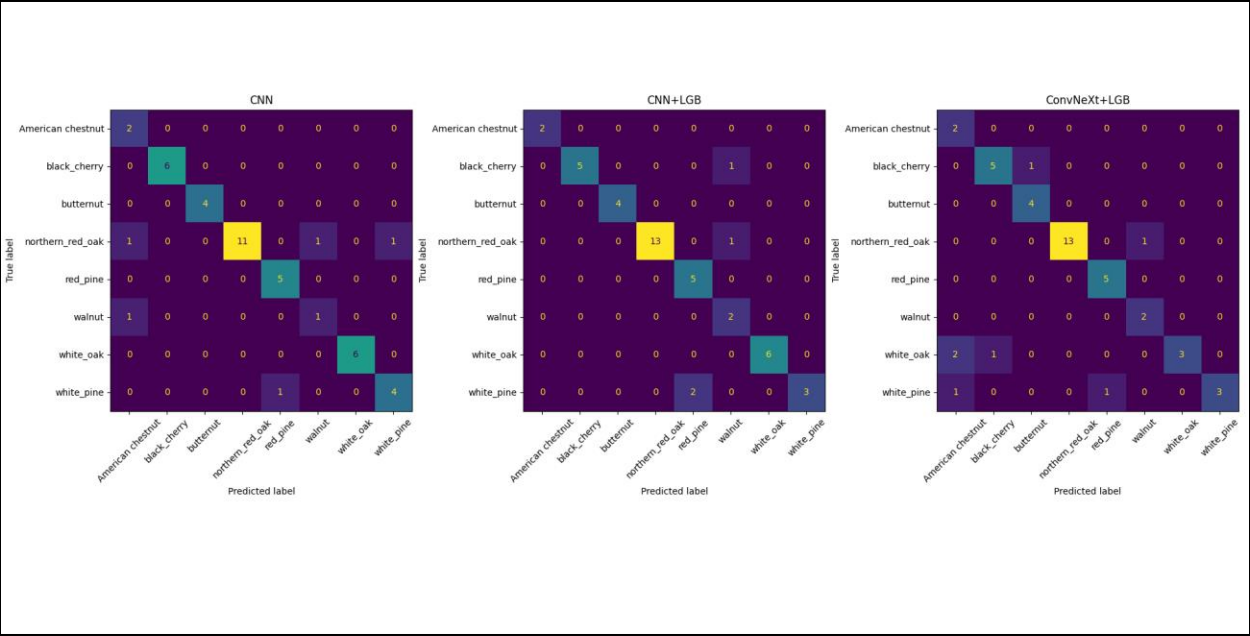


=== Best Model Per Class (F1-score) ===
American chestnut: Best + CNN (1.0000)
black_cherry: Best + CNN (1.0000)
butternut: Best + CNN (1.0000)
northern_red_oak: Best + CNN+LGB (0.9630)
red_pine: Best + CNN (0.9091)
walnut: Best + ConvNext+LGB (0.8000)
white_oak: Best + CNN (1.0000)
white_pine: Best + CNN (0.8889)
```

# Third Run:

```
Epoch 1/3
12/12 ----- 25s 766ms/step - accuracy: 0.1685 - loss: 2.0318 - val_accuracy: 0.3409 - val_loss: 1.7686
Epoch 2/3
12/12 ----- 4s 289ms/step - accuracy: 0.5674 - loss: 1.5485 - val_accuracy: 0.7273 - val_loss: 1.3871
Epoch 3/3
12/12 ----- 4s 294ms/step - accuracy: 0.7528 - loss: 1.2442 - val_accuracy: 0.8864 - val_loss: 1.1466
Epoch 1/3
WARNING: All log messages before absl::InitializeLog() is called are written to STDERR
I0000 00:00:1757826948.477369 13080 service.cc:146] XLA service 0x1530b88567c0 initialized for platform Host (this does not guarantee that XLA will be used). Devices:
I0000 00:00:1757826948.478107 13080 service.cc:154] StreamExecutor device (0): Host, Default Version
I0000 00:00:1757826948.562413 13080 device_compiler.h:188] Compiled cluster using XLA! This line is logged at most once for the lifetime of the process.
12/12 ----- 147s 11s/step - accuracy: 0.2528 - loss: 2.1093 - val_accuracy: 0.3864 - val_loss: 1.4902
Epoch 2/3
12/12 ----- 133s 11s/step - accuracy: 0.6067 - loss: 1.2611 - val_accuracy: 0.7955 - val_loss: 0.9800
Epoch 3/3
12/12 ----- 138s 11s/step - accuracy: 0.7416 - loss: 0.8942 - val_accuracy: 0.8864 - val_loss: 0.6519
```







```
=== Overall Metrics Comparison ===
+-----+-----+-----+
| Model | Accuracy | F1-avg |
+-----+-----+-----+
| CNN | 0.8864 | 0.8445 |
+-----+-----+-----+
| CNN+LGB | 0.9091 | 0.8903 |
+-----+-----+-----+
| ConvNeXt+LGB | 0.8489 | 0.7978 |
+-----+-----+-----+

=== Per-class F1-score Comparison ===

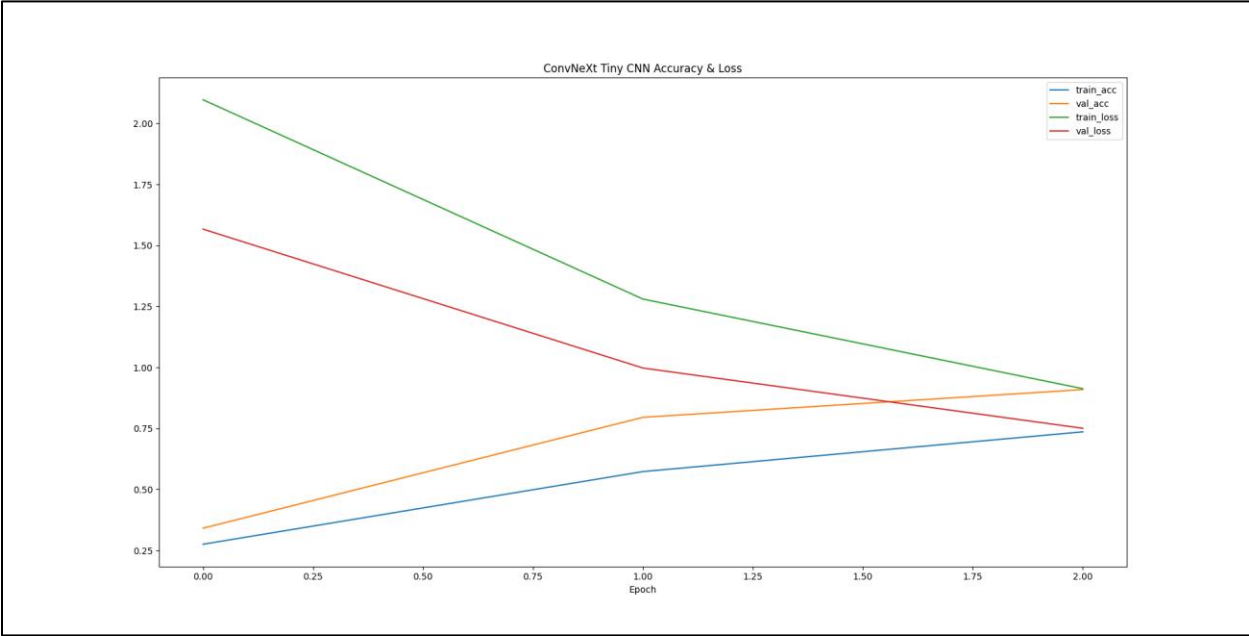
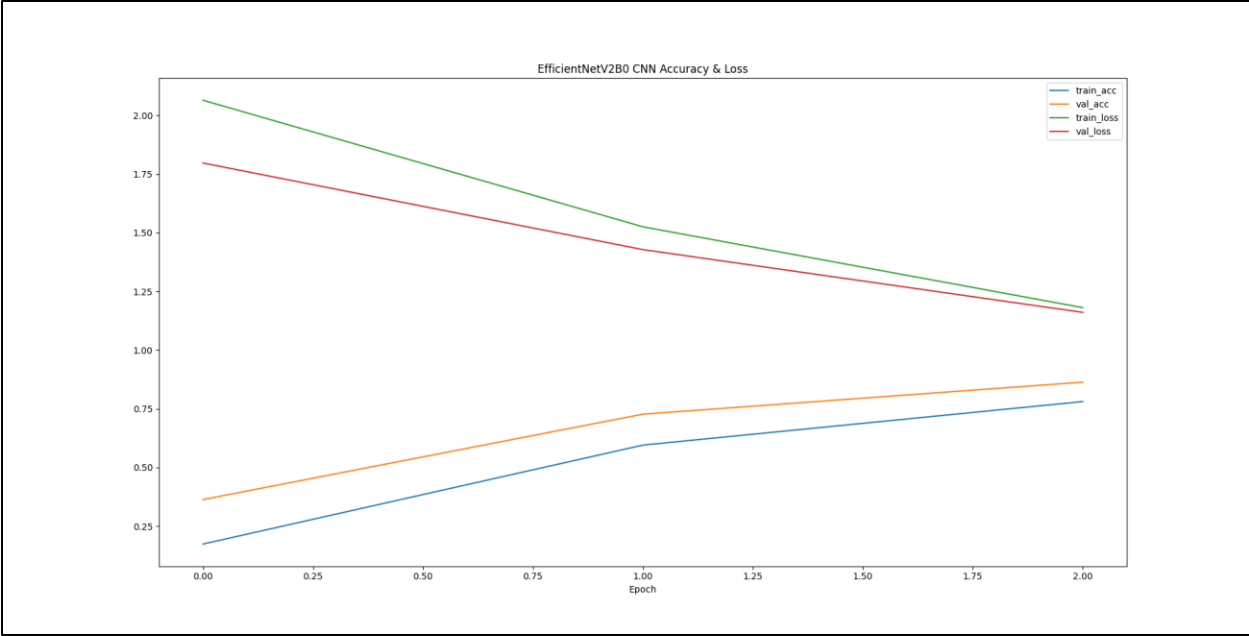

| Class             | CNN    | CNN+LGB | ConvNeXt+LGB |
|-------------------|--------|---------|--------------|
| American chestnut | 0.6667 | 1       | 0.5714       |
| black_cherry      | 1      | 0.9091  | 0.8333       |
| butternut         | 1      | 1       | 0.8889       |
| northern_red_oak  | 0.88   | 0.963   | 0.963        |
| red_pine          | 0.9091 | 0.8333  | 0.9091       |
| walnut            | 0.5    | 0.6667  | 0.8          |
| white_oak         | 1      | 1       | 0.6667       |
| white_pine        | 0.8    | 0.75    | 0.75         |

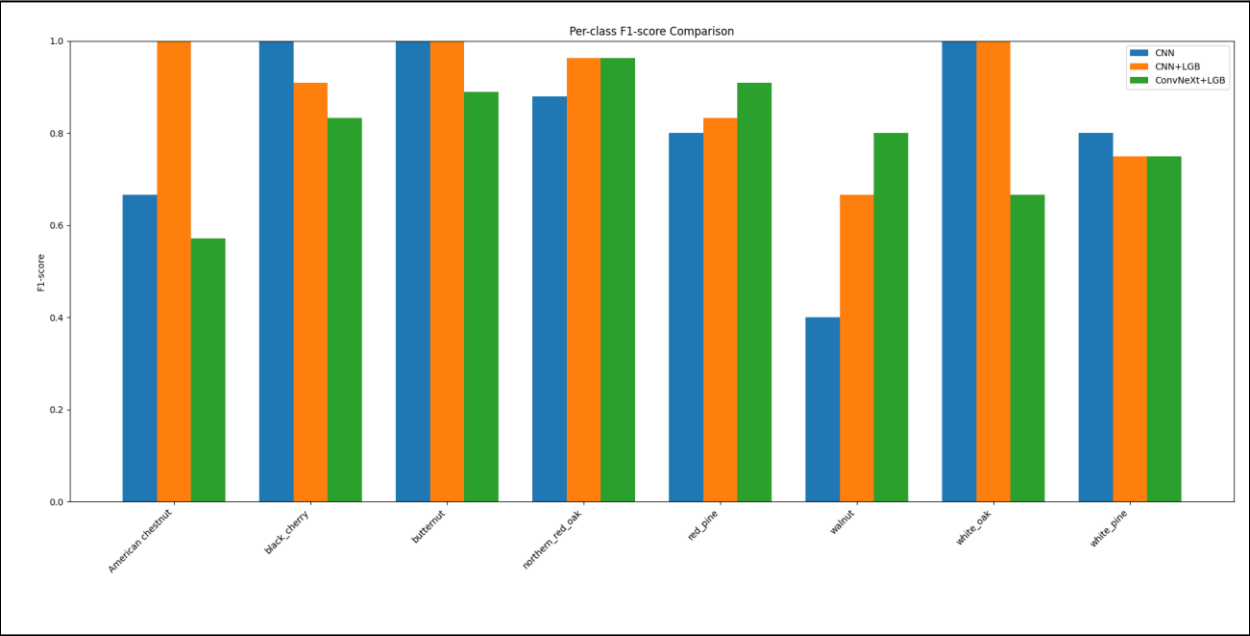
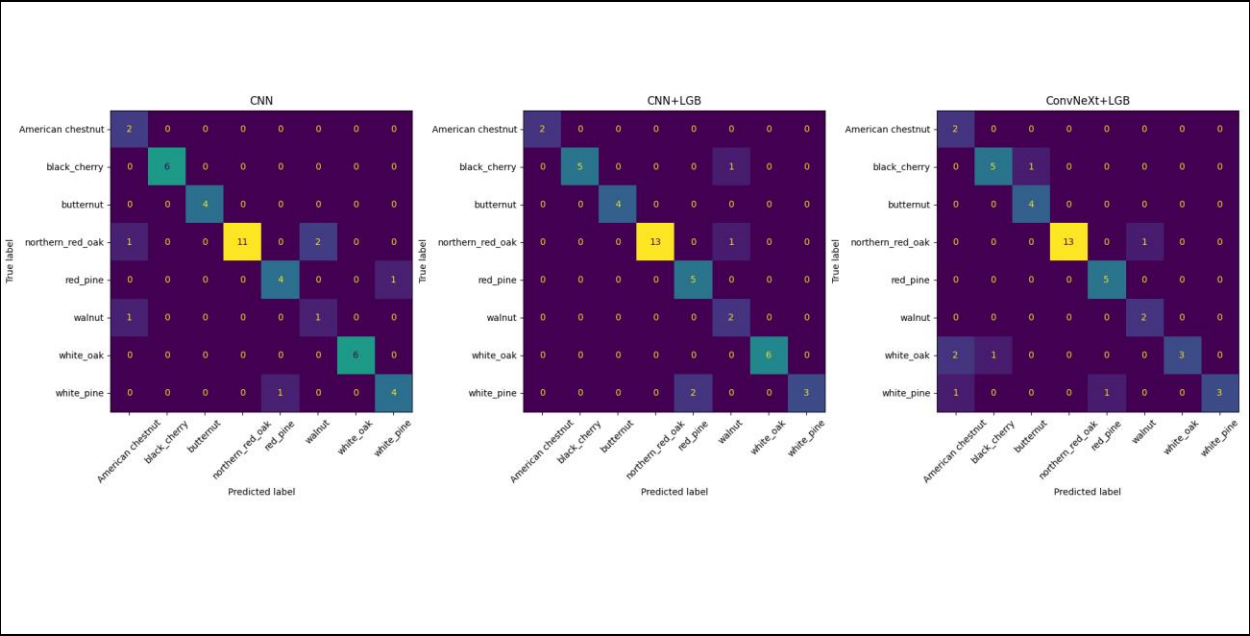


=== Best Model Per Class (F1-score) ===
American chestnut: Best → CNN+LGB (1.0000)
black_cherry: Best → CNN (1.0000)
butternut: Best → CNN (1.0000)
northern_red_oak: Best → CNN+LGB (0.9630)
red_pine: Best → CNN (0.9091)
walnut: Best → ConvNeXt+LGB (0.8000)
white_oak: Best → CNN (1.0000)
white_pine: Best → CNN (0.8000)
```

# Fourth Run:

```
Epoch 1/3
12/12 ----- 19s 522ms/step - accuracy: 0.1742 - loss: 2.0642 - val_accuracy: 0.3636 - val_loss: 1.7968
Epoch 2/3
12/12 ----- 2s 158ms/step - accuracy: 0.5955 - loss: 1.5253 - val_accuracy: 0.7273 - val_loss: 1.4281
Epoch 3/3
12/12 ----- 2s 161ms/step - accuracy: 0.7809 - loss: 1.1810 - val_accuracy: 0.8636 - val_loss: 1.1608
Epoch 1/3
WARNING: All log messages before absl::InitializeLog() is called are written to STDERR
10000 00:00:1757829493.135795 33120 service.cc:146] XLA service 0x2ae8b929650 initialized for platform Host (this does not guarantee that XLA will be used). Devices:
10000 00:00:1757829493.136434 33120 service.cc:156] StreamExecutor device (0): Host, Default Version
10000 00:00:1757829493.185144 33120 device_compiler.h:188] Compiled cluster using XLA! This line is logged at most once for the lifetime of the process.
12/12 ----- 112s 9s/step - accuracy: 0.2753 - loss: 2.0971 - val_accuracy: 0.3489 - val_loss: 1.5668
Epoch 2/3
12/12 ----- 107s 9s/step - accuracy: 0.5730 - loss: 1.2802 - val_accuracy: 0.7955 - val_loss: 0.9975
Epoch 3/3
12/12 ----- 98s 8s/step - accuracy: 0.7360 - loss: 0.9128 - val_accuracy: 0.9091 - val_loss: 0.7505
```





=== Overall Metrics Comparison ===

Model	Accuracy	F1-avg
CNN	0.8636	0.8183
CNN+LGB	0.9091	0.8903
ConvNet+LGB	0.8489	0.7978

=== Per-class F1-score Comparison ===

Class	CNN	CNN+LGB	ConvNet+LGB
American chestnut	0.6667	1	0.5714
black_cherry	1	0.9091	0.8333
butternut	1	1	0.8889
northern_red_oak	0.88	0.963	0.963
red_pine	0.8	0.8333	0.9091
walnut	0.4	0.6667	0.8
white_oak	1	1	0.6667
white_pine	0.8	0.75	0.75

=== Best Model Per Class (F1-score) ===

American chestnut: Best → CNN+LGB (1.0000)  
black\_cherry: Best → CNN (1.0000)  
butternut: Best → CNN (1.0000)  
northern\_red\_oak: Best → CNN+LGB (0.9630)  
red\_pine: Best → ConvNet+LGB (0.9091)  
walnut: Best → ConvNet+LGB (0.8000)  
white\_oak: Best → CNN (1.0000)  
white\_pine: Best → CNN (0.8000)