

AgriVolT: Climate Aware Multi-Modal Transformer for Commodity Prices

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Motivation/Background

Climate extremes increasingly disrupt global food production, causing volatility in crop prices and threatening food security. At 2 °C of warming, 10–31% of crop output falls outside its safe zone. Traditional econometric models fail to capture nonlinear links between climate and market fluctuations.

AgriVolT aims to forecast U.S. staple crop prices by unifying climate reanalysis, satellite imagery, crop yield statistics, and market data — offering early warnings of food price shocks.

Data Overview

Source	Modality	Example Variables	Purpose
ERA5, CMIP6	Climate	Temp, Precipitation, Drought Index	Weather signals
Sentinel-2	Satellite Imagery	NDVI, Vegetation cover	Crop stress
USDA NASS	Production	Yield, acreage	Context features
USDA ERS / Market Data	Economics	Price per bushel	Prediction target

We combine four data sources covering 2015–2023 for U.S. wheat, corn, and soybean:

Problem Statement

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Model Architecture

AgriVolT extends MMST-ViT for price forecasting with (1) cross-modal fusion layers, (2) temporal encoders for season dynamics, and (3) an economic context head.

Training and Baselines

Training data (2015–2023) divided by marketing year to prevent temporal leakage.

Baselines for comparison:

- ARIMA, Prophet: Classical time series
- Naïve: Previous-year persistence
- XGBoost: Tabular ML
- AgriFM: Deep multimodal baseline

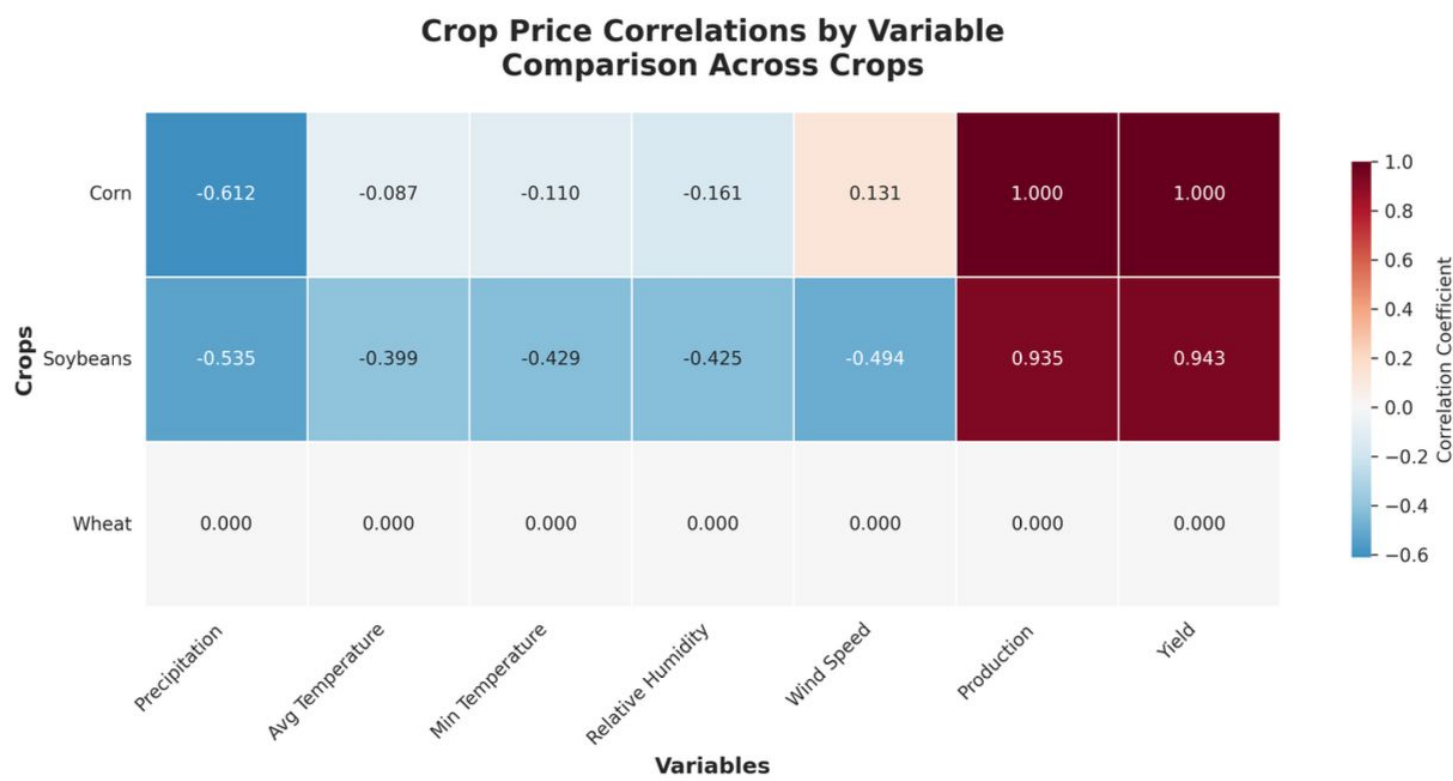
Metrics: MAE, RMSE, MAPE, SMAPE (3-run average).

Results and Interpretations

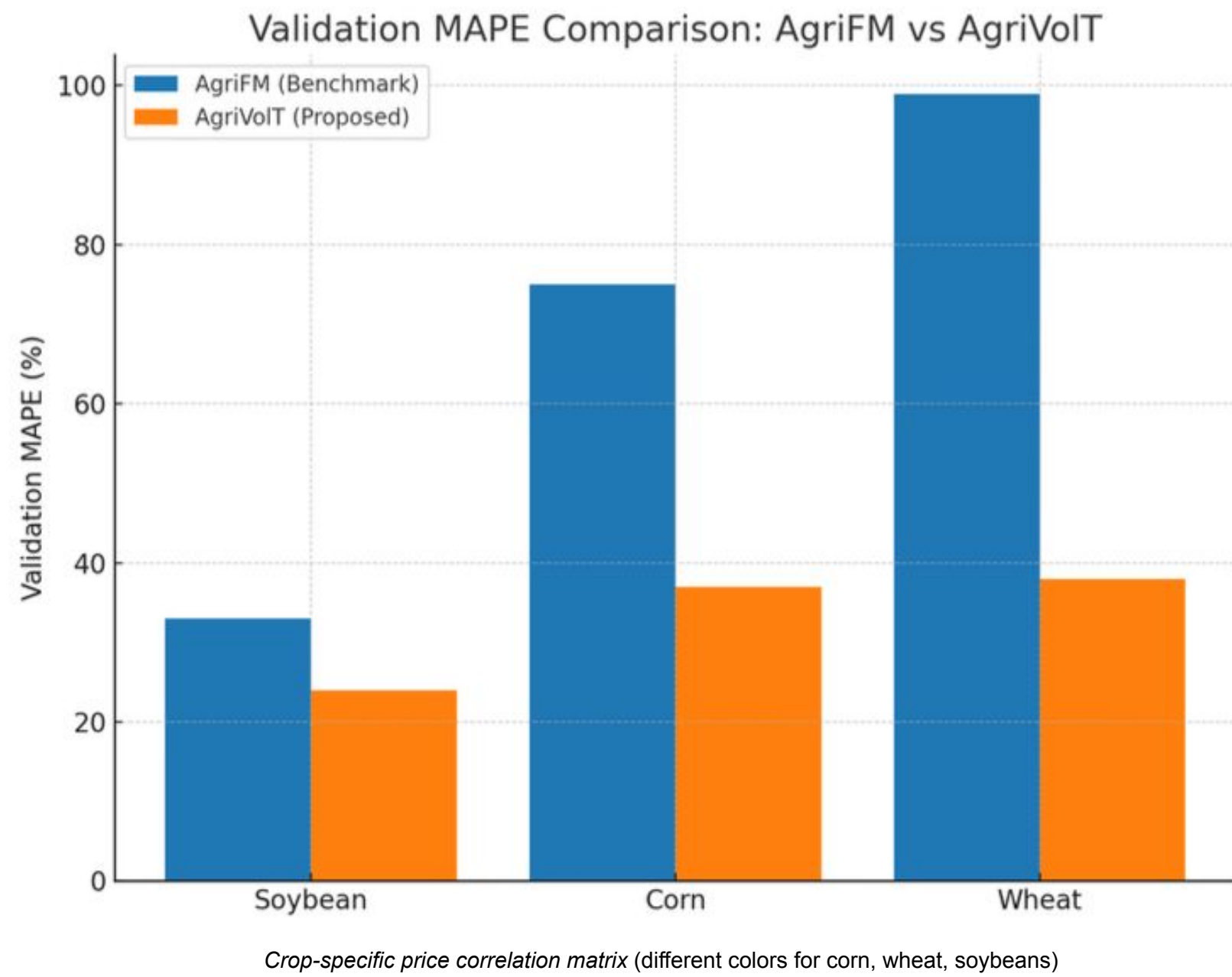
AgriVolT consistently improves accuracy across all crops:

- Soybeans:** ↓ RMSE by ~30% (4.65 vs > 5.4 in ARIMA)
- Corn:** Stable forecasts with 27% lower relative error
- Wheat:** Reduces volatility-driven error by ~20%

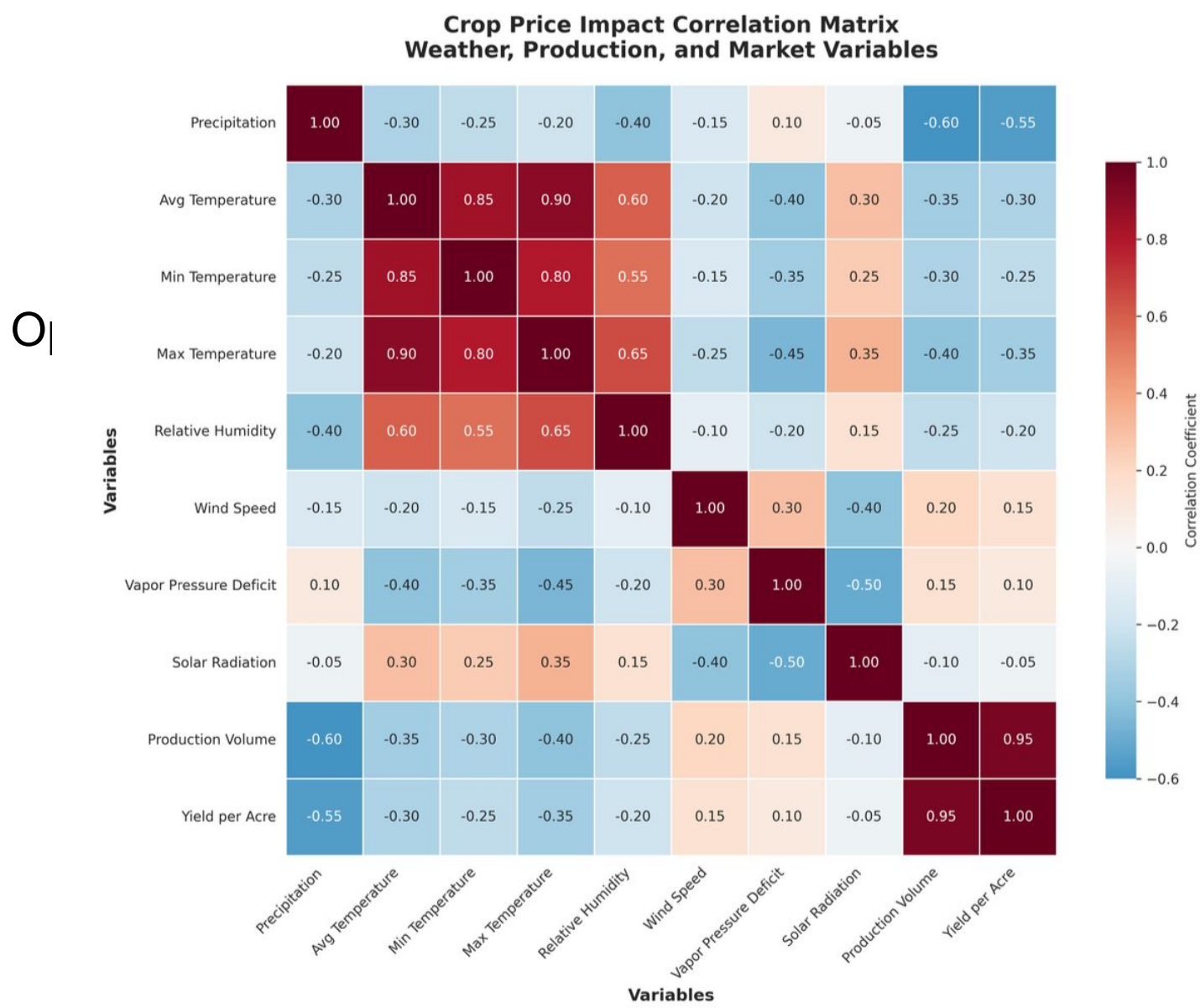
Cross-modal attention highlights key drivers — temperature anomalies and drought weeks — that precede price spikes.



MAPE Comparison between AgriFM and AgriVolT



Ablation Studies



Limitations

- Relies on historical, not real-time, market signals.
- Causality not explicitly modeled.
- Limited to three U.S. crops (corn, wheat, soy). Ignores trade policies and macroeconomics affecting volatility.

