EVALUATING THE IMPACT OF IMAGE RESOLUTION ON YIELD STABILITY MAP

John Salako[1,2], Ruben Ulbrich[1], Launa Di Carlo[1], Lydia Price[1], Bruno Basso[1]

(1) Earth and Environmental Sciences Department, Michigan State University
(2) Computational Mathematics, Science, and Engineering Department, Michigan State University

Summary

- Crop yields are highly variable over space and time (Basso et al., 2007). The yield stability map combines spatial and temporal variability in one layer (Basso et al., 2019).

- In this study, we created the yield stability map using Landsat, Sentinel, and Planet and compared its results and performance to a measured yield map.

- Our research shows that satellite spatial resolution plays a vital role in the accuracy of the yield stability map, as the level of accuracy increased with the satellite spatial resolution.

- The stability zone is inconsistent between Medium + Stable and High + Stable, and if combined, they could result in about 100 % accuracy between the calculated stability map and the measured yield map.

Background

Basso et al. (2019) introduced the Yield Stability map calculation using vegetation index (NDVI) after an initial study by Maestrini and Basso (2018) showed that NDVI maps derived from Landsat images in July positively correlated with actual yield data.

The benefits of Yield Stability map include:
- Identifying areas with consistently low or high yields
- Effective Field Management
- Optimization of input use, and
- Improvement of crop production
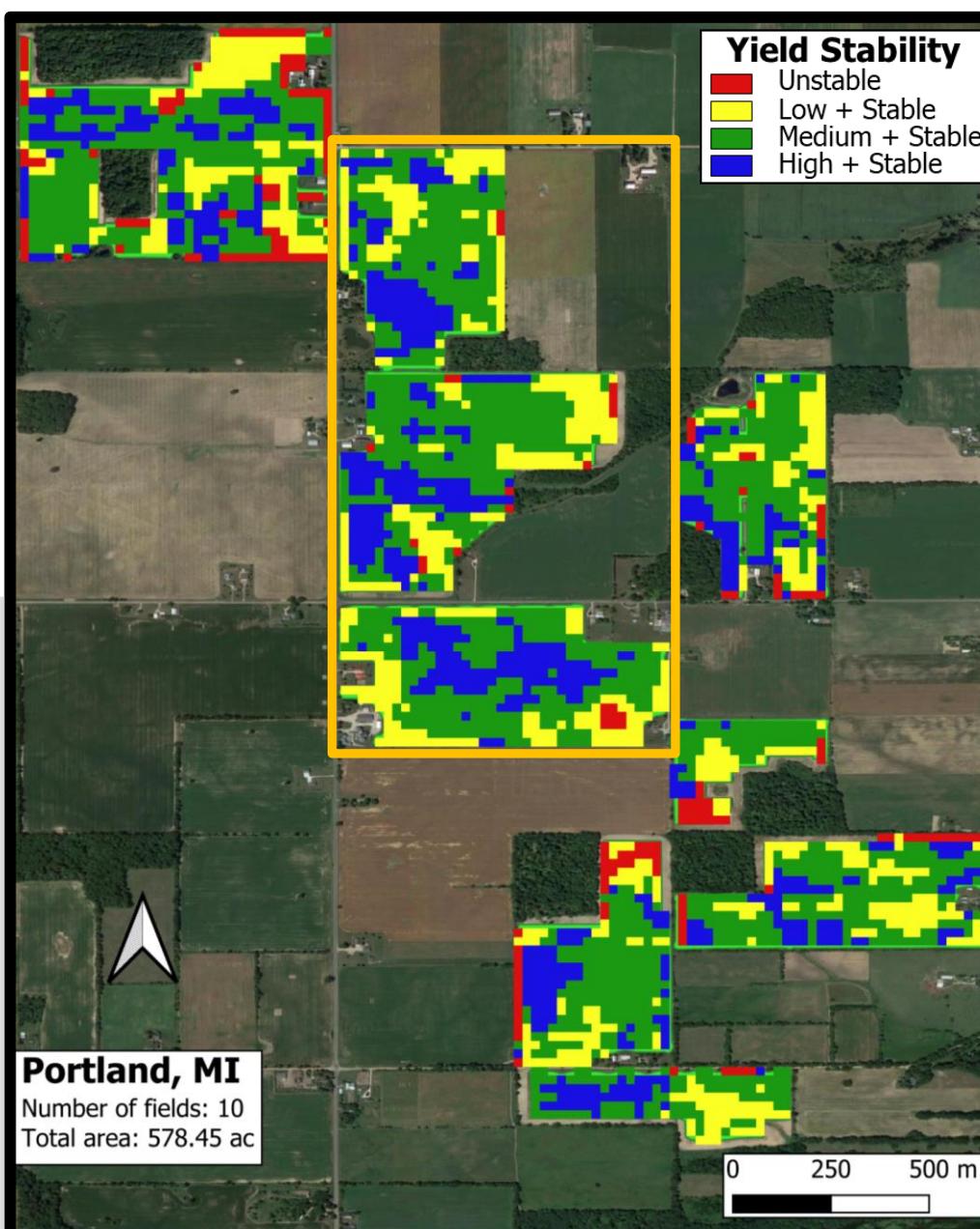
Method
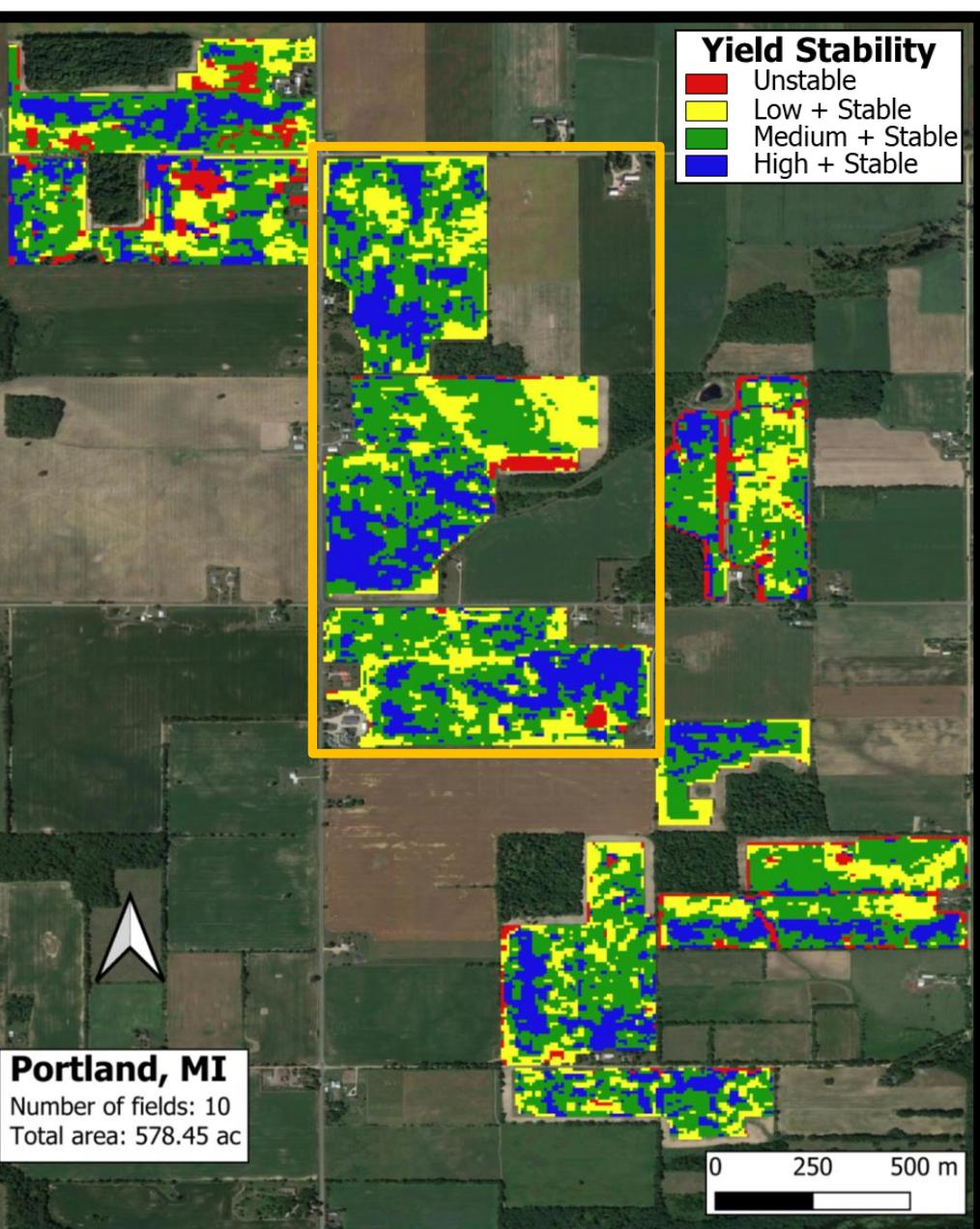
- The yield stability map was created by adapting the algorithm in Basso et al. (2019).

- Planet data were downloaded from PlanetScope, while Landsat and Sentinel-2 data were processed and downloaded via Google Earth Engine

- The NDVI images were selected before the signal saturated (July).

- Five years (2019 – 2023) of NDVI data were used and compared with the same years of yield data.

- The stability zones were selected such that Low+ Stable represented values less or equal to 25% of the calculated mean raster, High + Stable represented values greater than 75%, and Medium + Stable were the values in-between Low and High Stable.

- A standard deviation value of 0.2 was used in thresholding the unstable zones.

Results
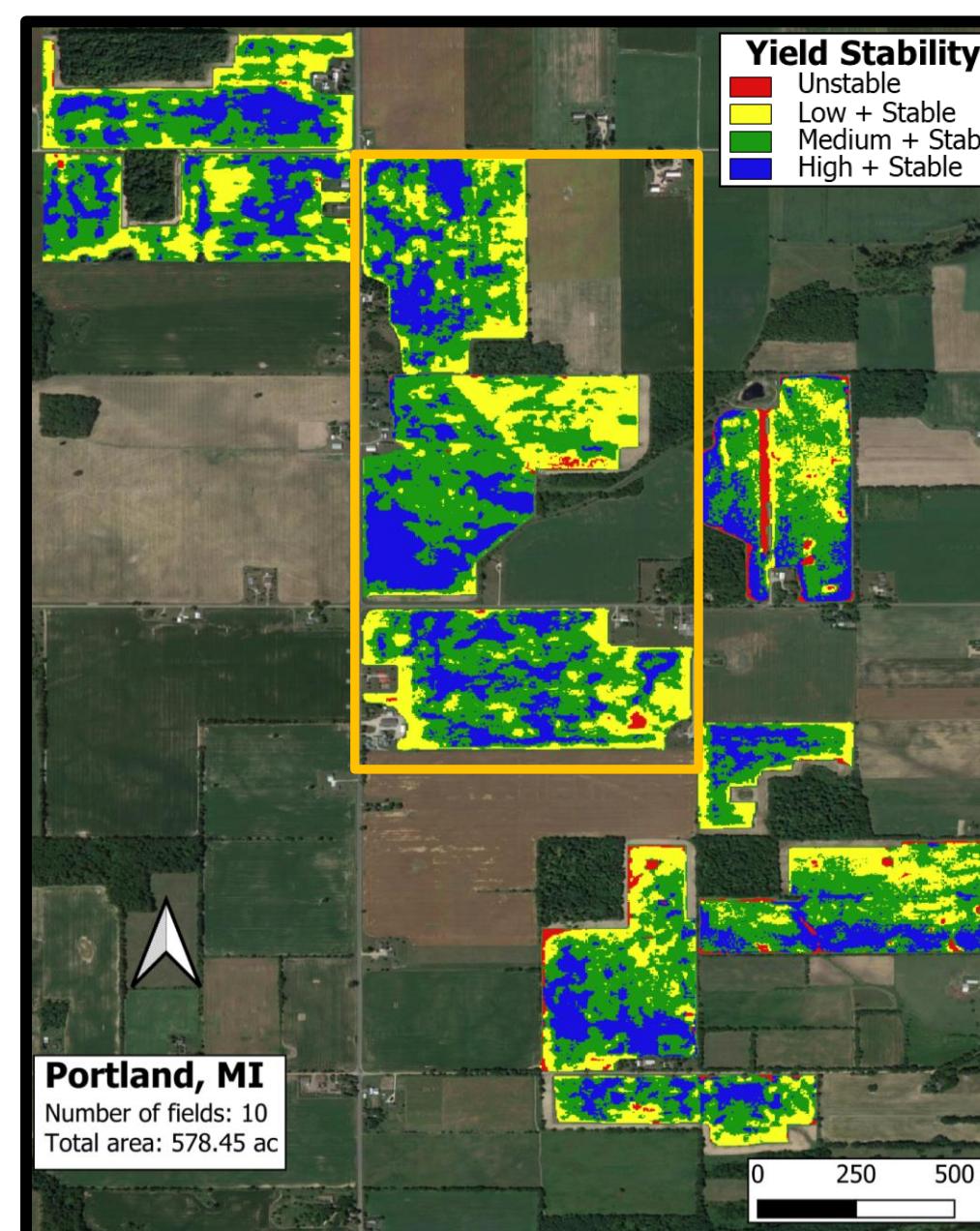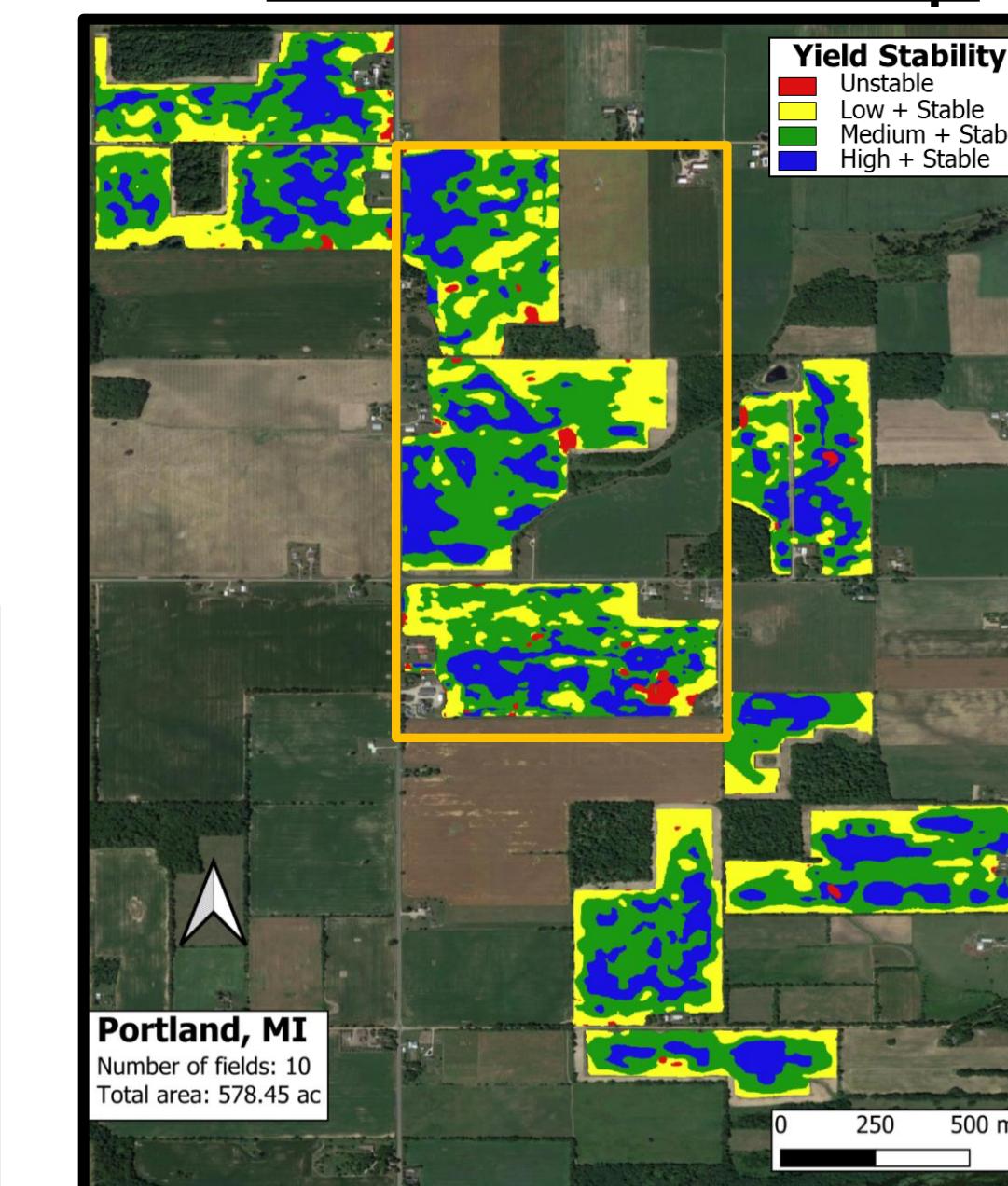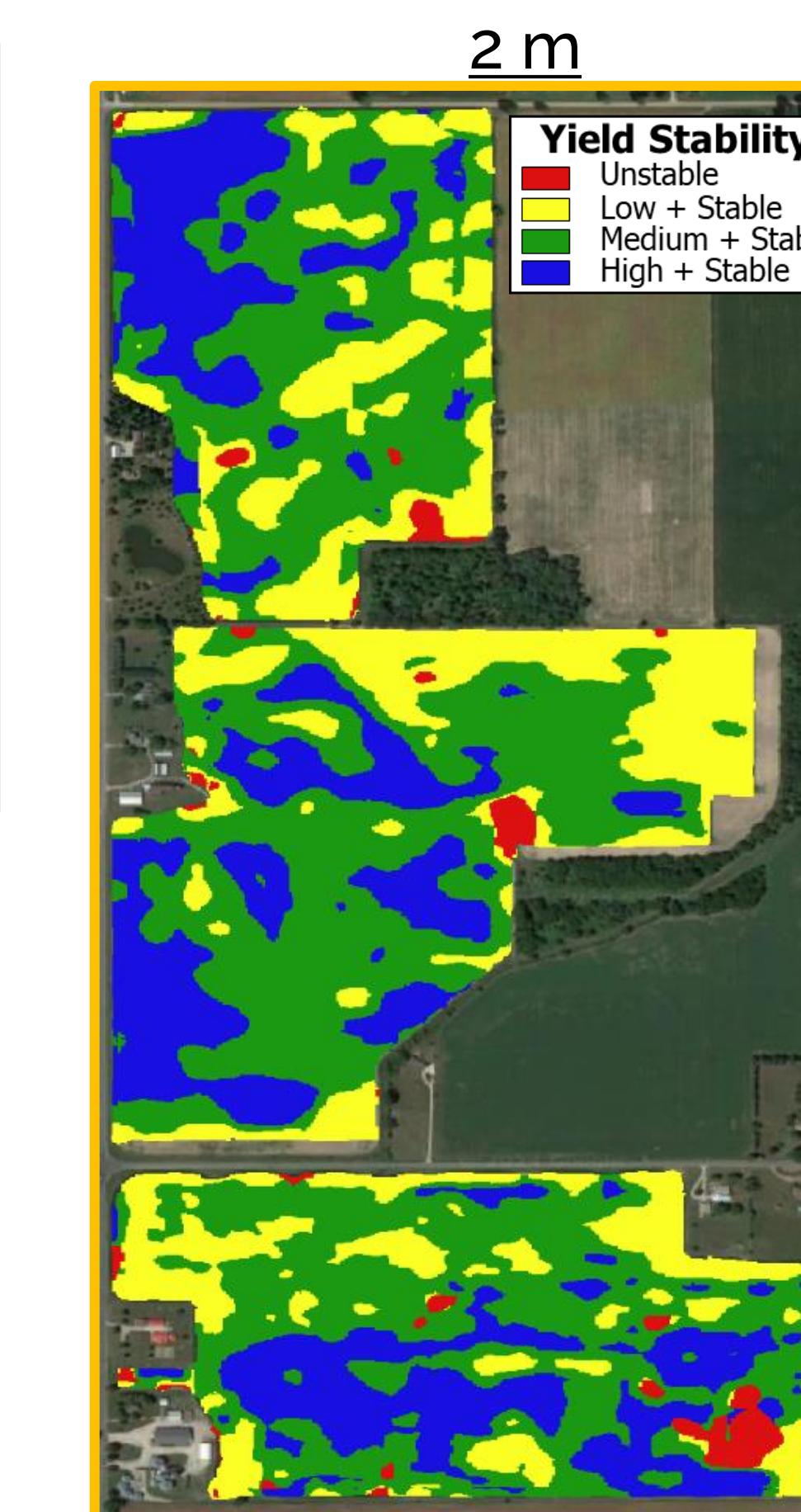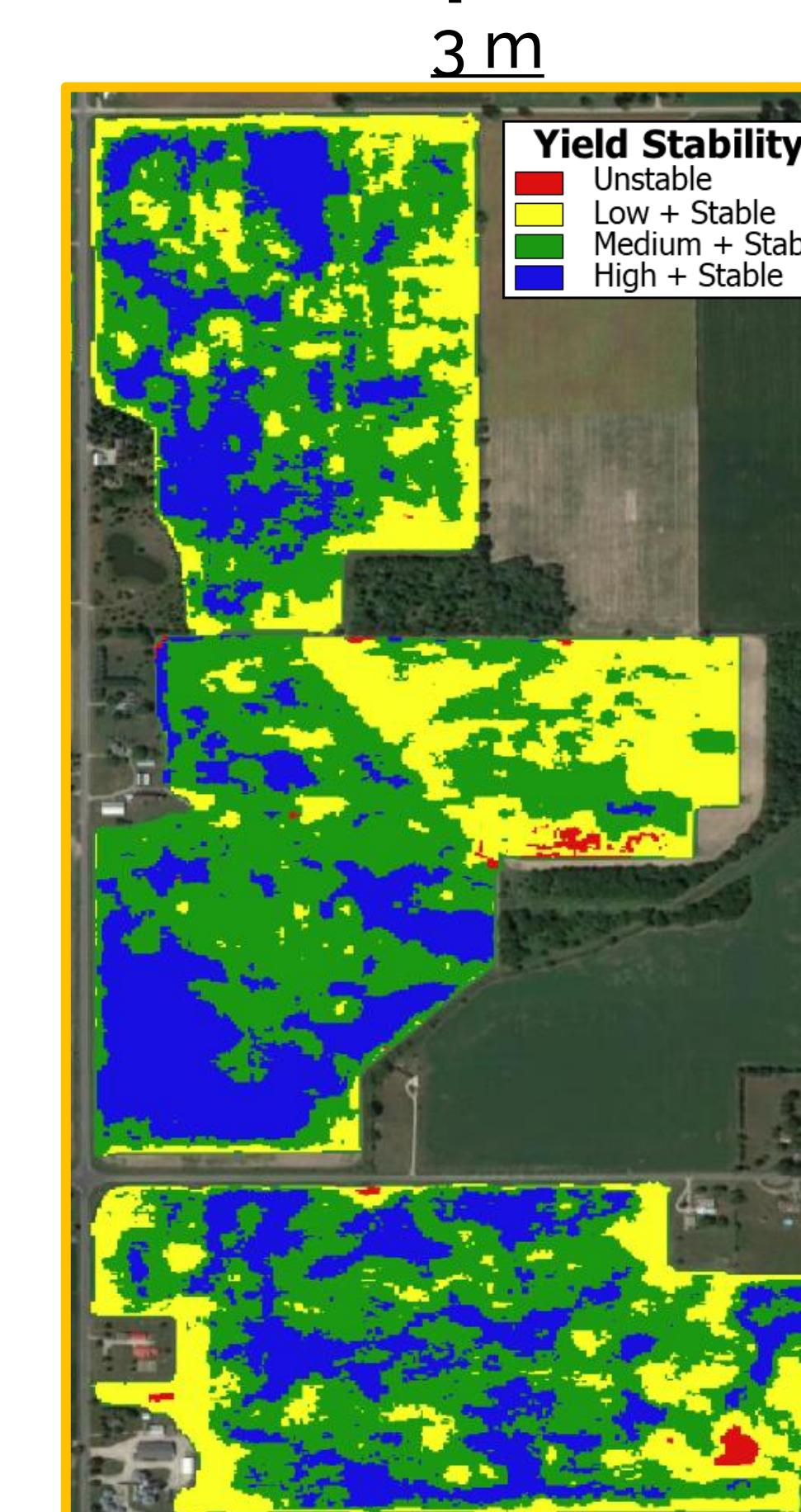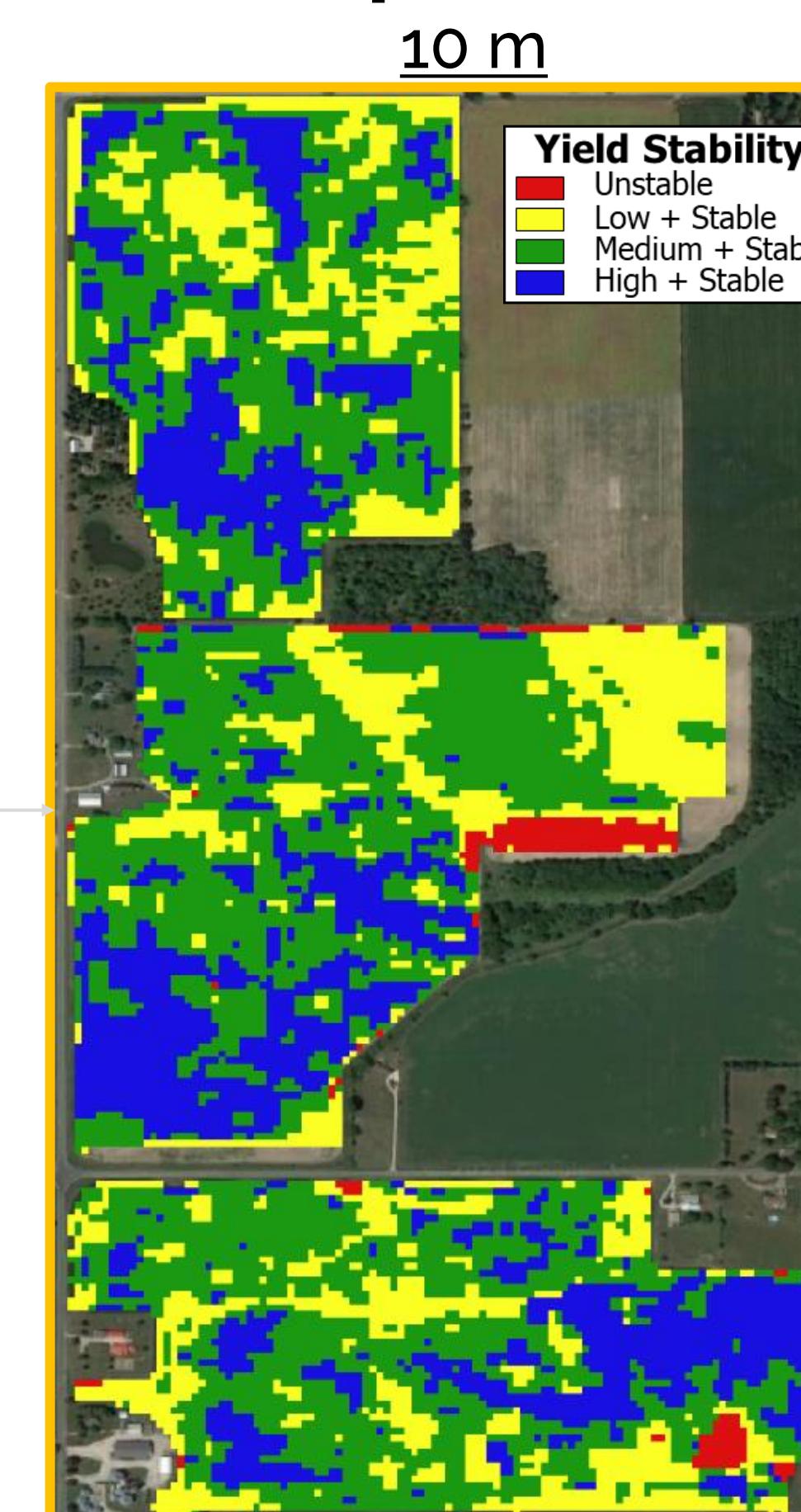
Consistent Crop Yield Pattern Across Varied Spatial Resolution

The maps show the results of the yield stability map using three satellite sources with different spatial resolutions: Landsat (30 m), Sentinel (10 m), and Planet (3 m). The actual yield data is measured on a 2 m field scale and was presented to validate the yield stability map. Ten fields were analyzed and evaluated for this study. Three fields are zoomed in for enhanced visual clarity.

Confusion matrix showing the % accuracy of each satellite pixel matching the actual yield data for the ten fields

	Low + Stable	Medium + Stable	High + Stable	Unstable
Low + Stable	34.72	39.36	11.77	14.15
Medium + Stable	20.61	53.75	22.21	3.43
High + Stable	16.027	51.81	31.38	0.79
Unstable	35.56	20	11.11	33.33

Yield vs. Landsat

	Low + Stable	Medium + Stable	High + Stable	Unstable
Low + Stable	37.91	39.06	13.63	9.40
Medium + Stable	20.12	54.26	21.88	3.74
High + Stable	12.63	49.51	34.76	3.10
Unstable	36.28	21.68	15.27	26.77

Yield vs. Sentinel
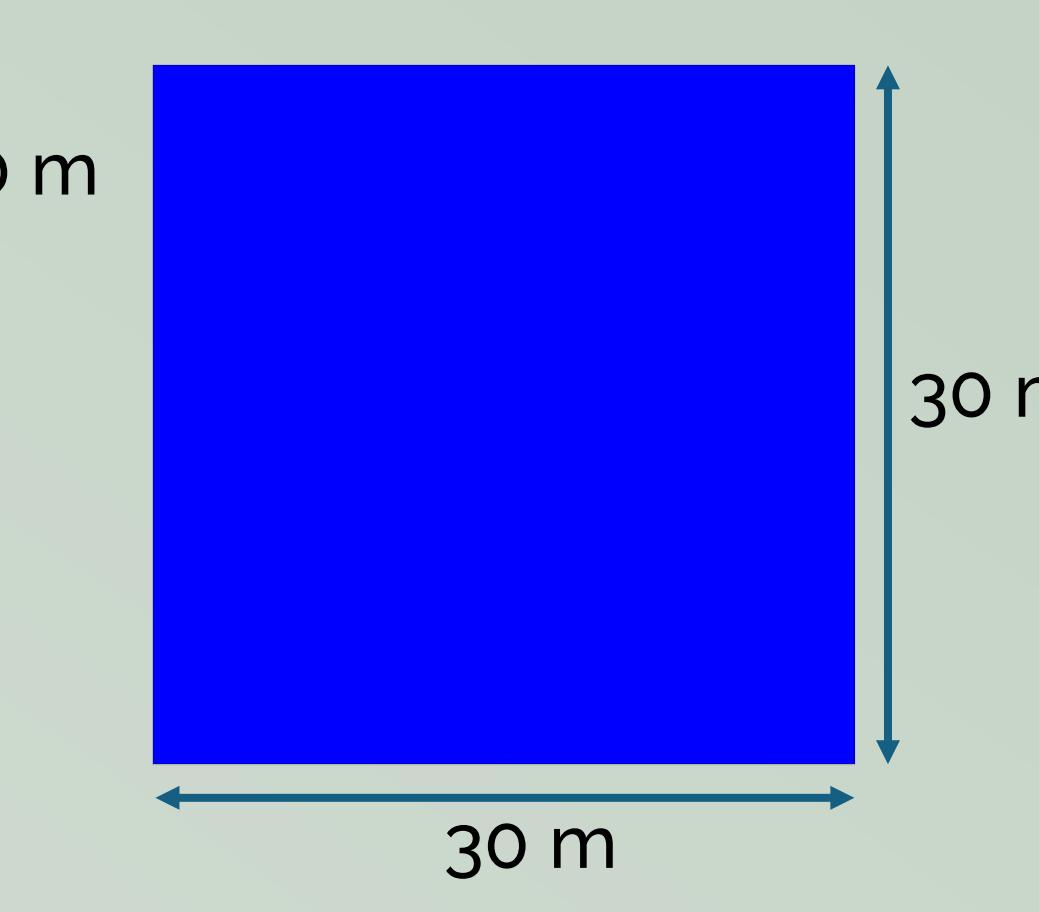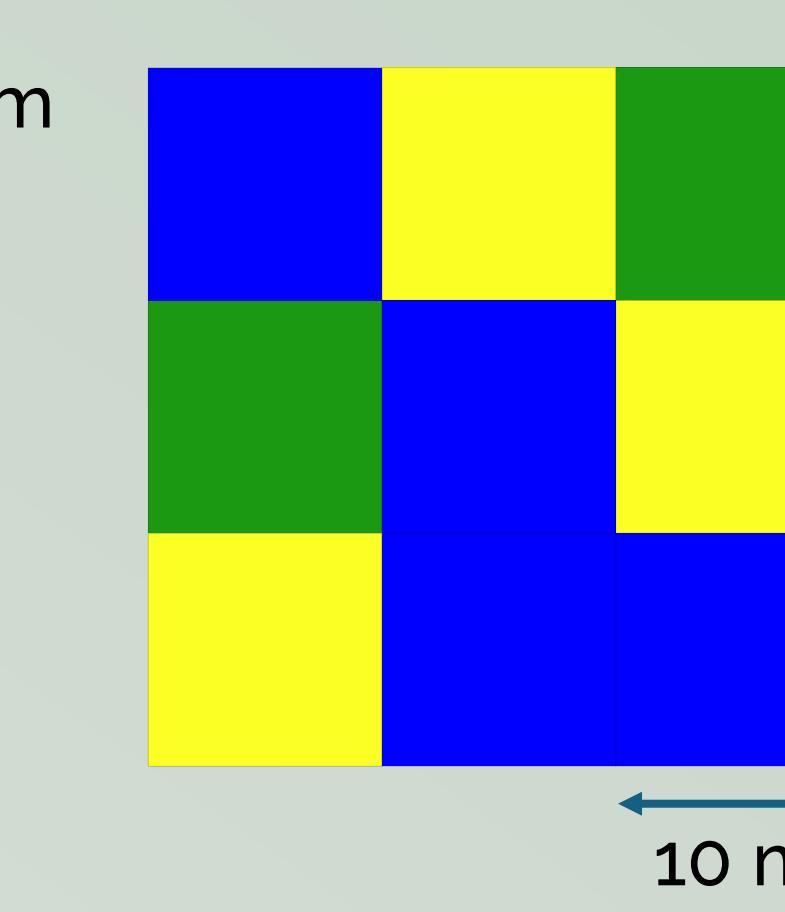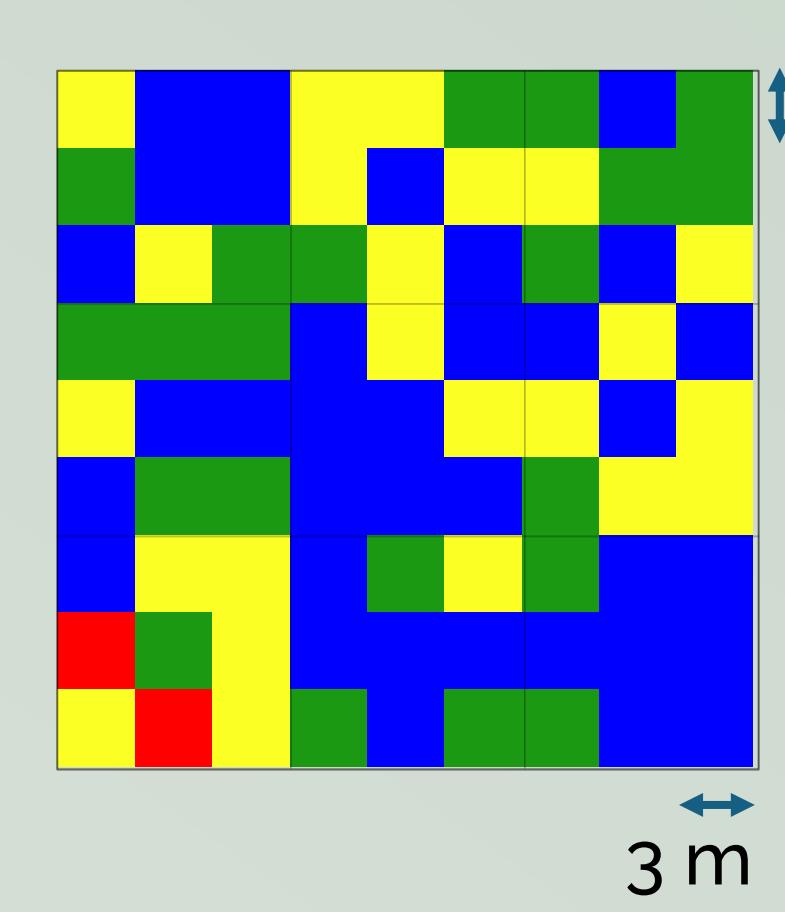
|	Low + Stable	Medium + Stable	High + Stable	Unstable
Low + Stable	49.70	35.49	10.19	4.62
Medium + Stable	17.92	59.80	21.56	0.72
High + Stable	8.08	46.48	45.07	0.37
Unstable	53.06	18.09	15.77	13.09

Yield vs. Planet

Conclusions

- Our analysis confirms that NDVI data accurately supports yield mapping.

- Yield stability maps reveal consistent crop yield patterns using data from three satellites with different resolutions.

- Spatial resolution affects stability zone boundaries.

- Confusion matrix analysis shows that high-stability zones from satellite data align with medium-stability zones in actual data, likely due to threshold variations in stability calculations.

Main Takeaway: The higher the spatial resolution, the more detailed the partitioning of the stability zones, and the more accurate the yield stability map is in comparison to the yield data.

NDVI DATA   PLANET   SENTINEL   LANDSAT

Reference

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SCAN ME

Dynamic Visualization of the Stability Zones