Residue Density Segmentation for Monitoring and Optimizing Tillage Practices

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Past management decisions in the US have depleted soil organic carbon (SOC) by over **70 billion tons**

157 million hectares

of US Cropland with the capacity to sequester **45-98 TgCarbon/year**

R Lal et al. Soil management and restoration for c sequestration to mitigate the accelerated greenhouse effect. *Progress in Environmental Science*, 1(4):307–326, 1999.
Adam Chambers, Rattan Lal, and Keith Paustian. Soil carbon sequestration potential of us croplands and grasslands: Implementing the 4 per thousand initiative. *Journal of Soil and Water Conservation*, 71(3):68A–74A, 2016.
Rattan Lal. Sequestering carbon and increasing productivity by conservation agriculture. *Journal of Soil and Water Conservation*, 70(3):55A–62A, 2015.

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Carbon Sequestration and Tillage Practices

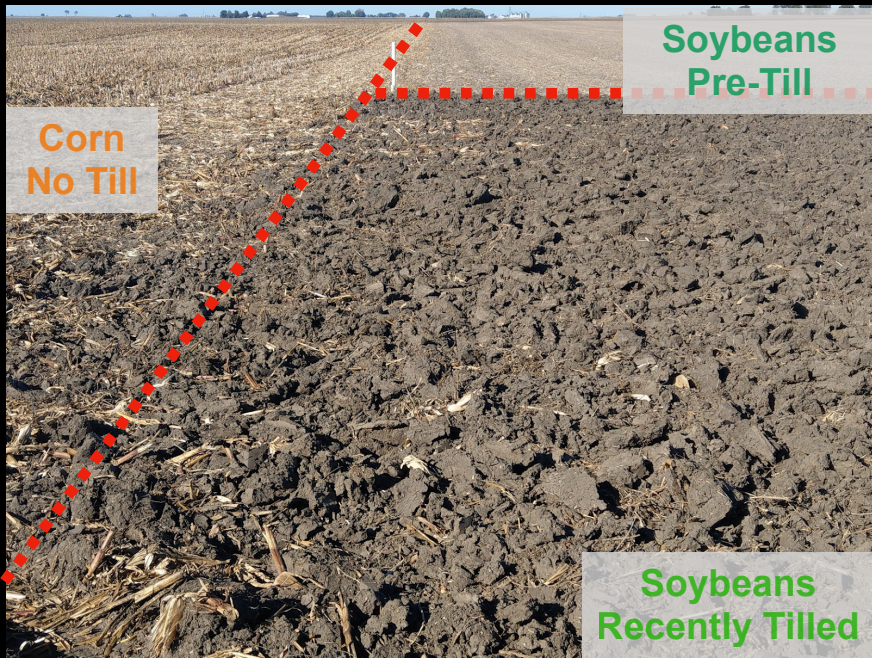## Traditional Till

No Till

No residues present

Residue nutrients reincorporated into soil
Soil carbon released back into atmosphere
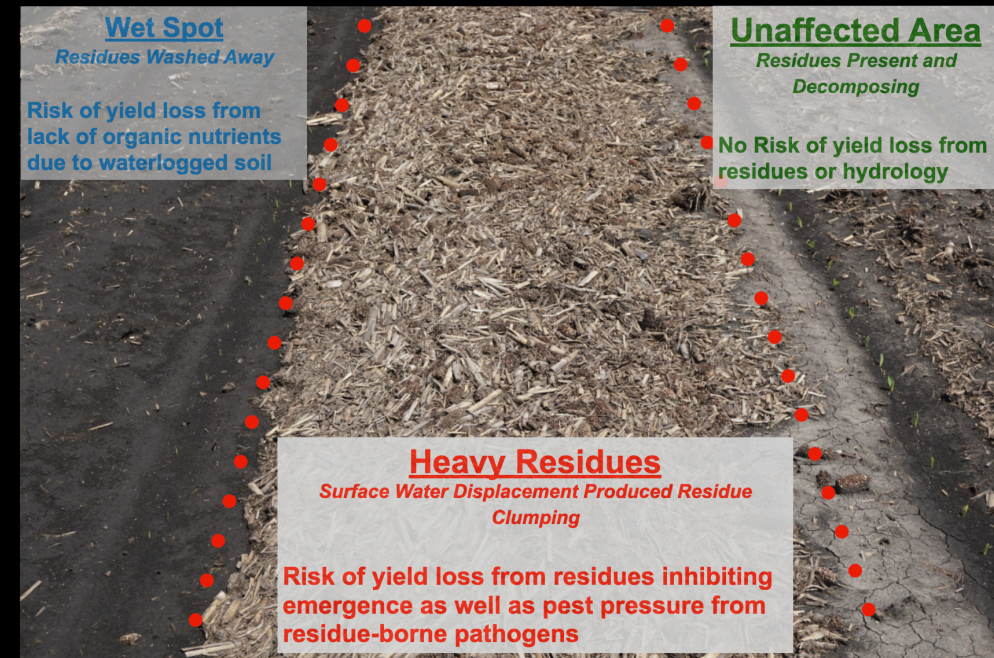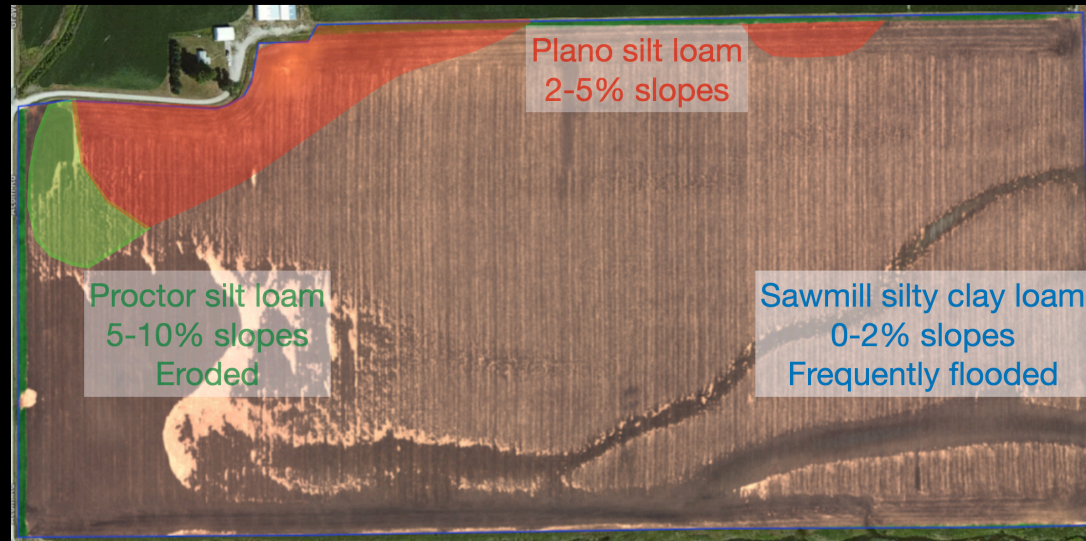Increased compaction which can inhibit growth

Residues left behind

Less reincorporation of residue nutrients
More carbon remains stored in the soil
Heavy residues can harbor disease and pests

Corn
No Till

Soybeans
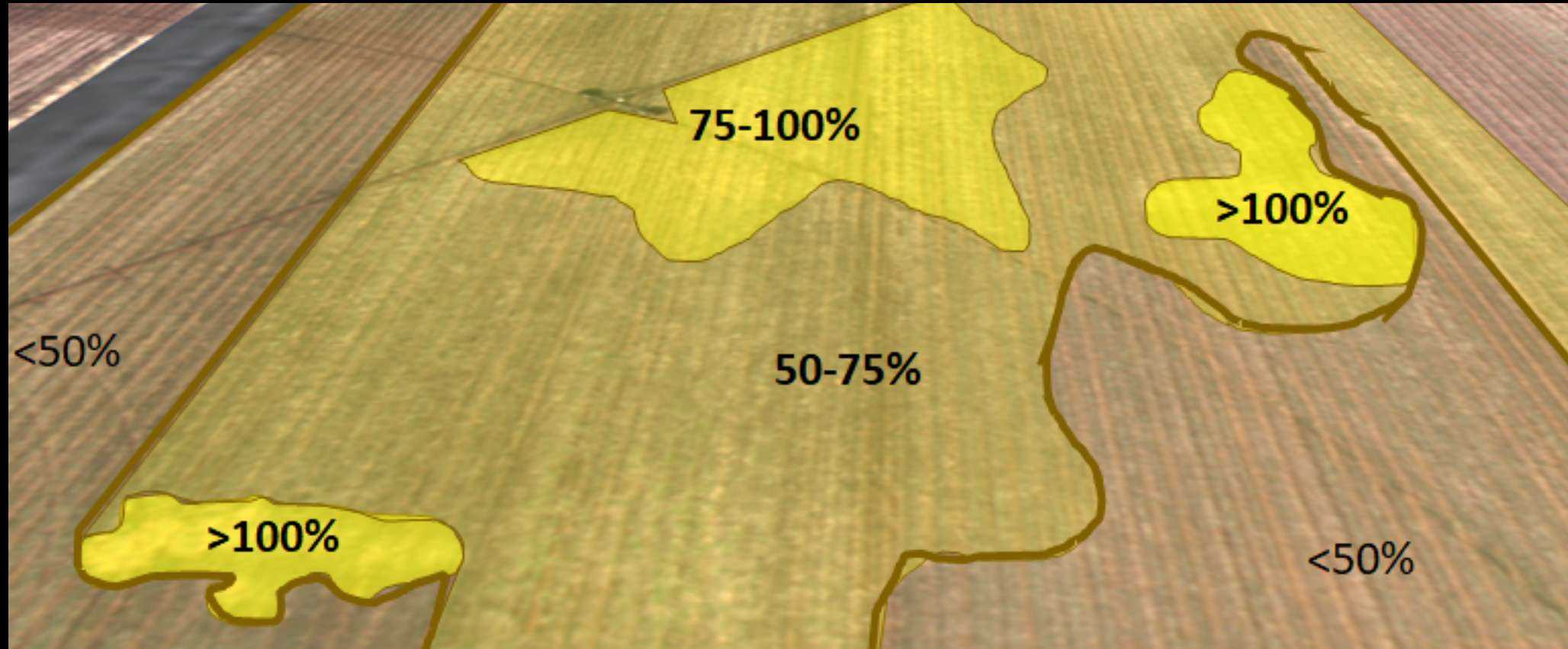Pre-Till

Soybeans
Recently Tilled

Wet Spot
Residues Washed Away

Risk of yield loss from
lack of organic nutrients
due to waterlogged soil

Unaffected Area
Residues Present and
Decomposing

No Risk of yield loss from
residues or hydrology

Heavy Residues
Surface Water Displacement Produced Residue
Clumping

Risk of yield loss from residues inhibiting
emergence as well as pest pressure from
residue-borne pathogens

Numerous factors at play

Impact the capacity to store carbon

Plano silt loam
2-5% slopes

Proctor silt loam
5-10% slopes
Eroded

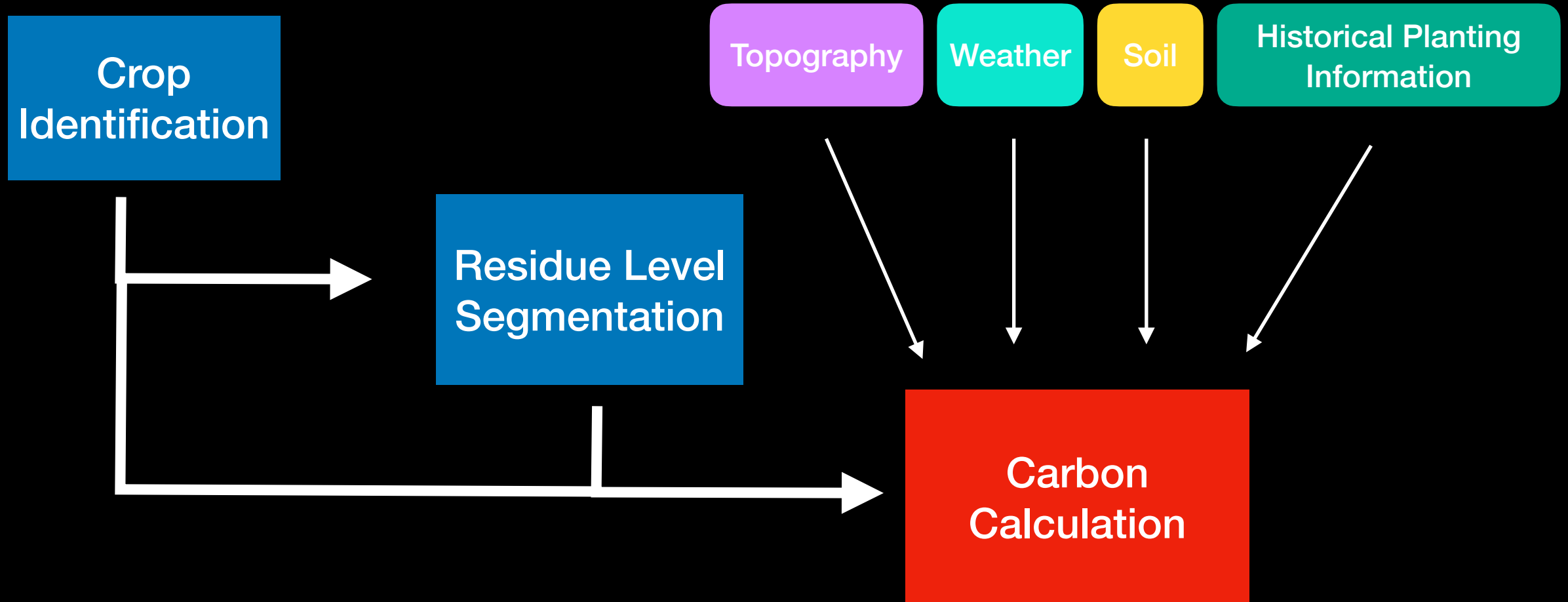Sawmill silty clay loam
0-2% slopes
Frequently flooded

Impact the appearance of tilling practices

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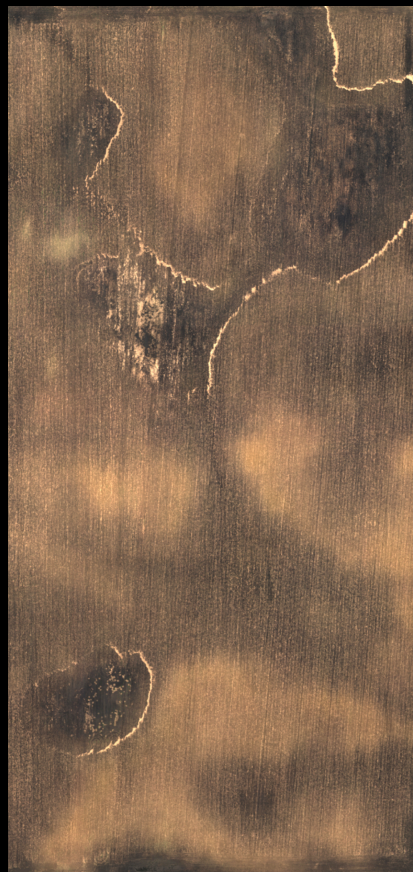# Goal: Segmentation of Residue Density Regions

More precise and informative than simply classifying a field as "till" or "no-till"

Residue levels and other information can be combined into more precise and accurate carbon calculations
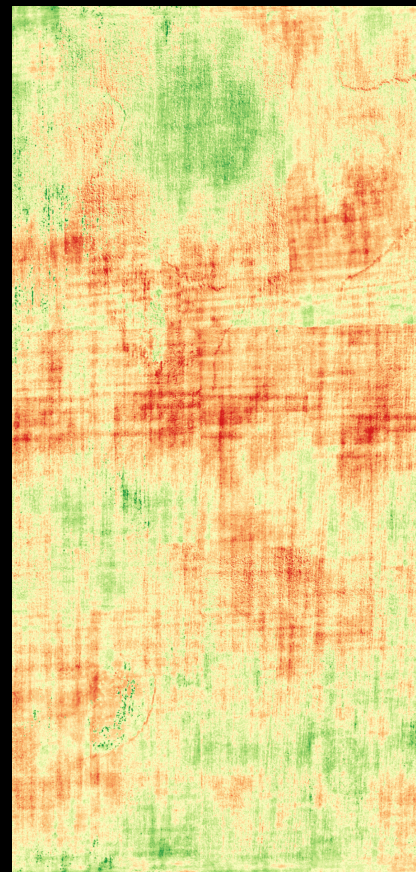
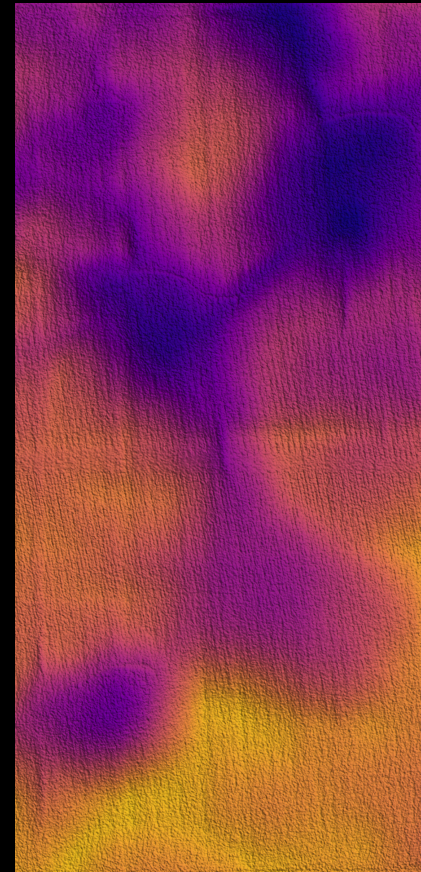# 1. High-Resolution (<1m/pixel) Aerial Imagery and Other Channels

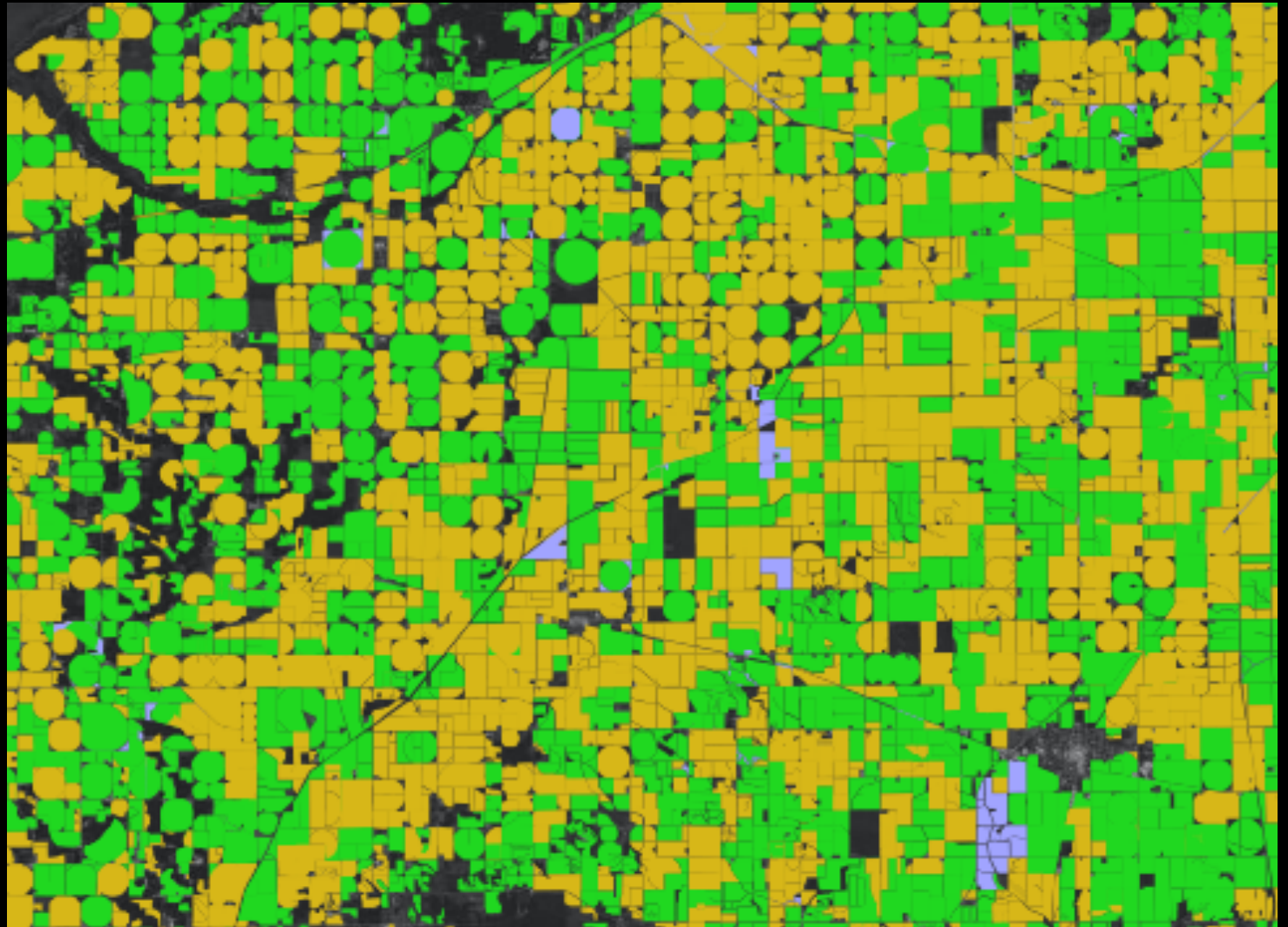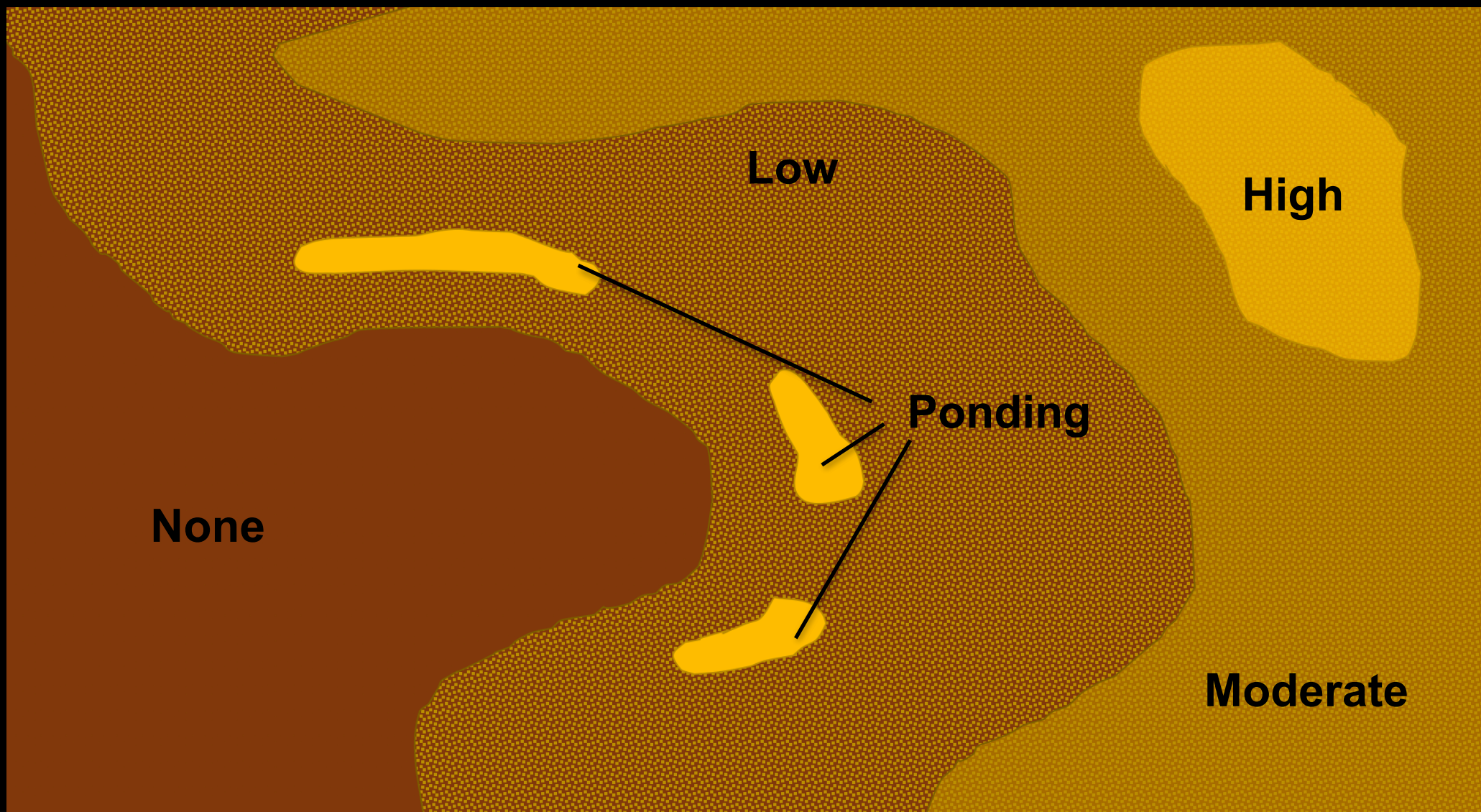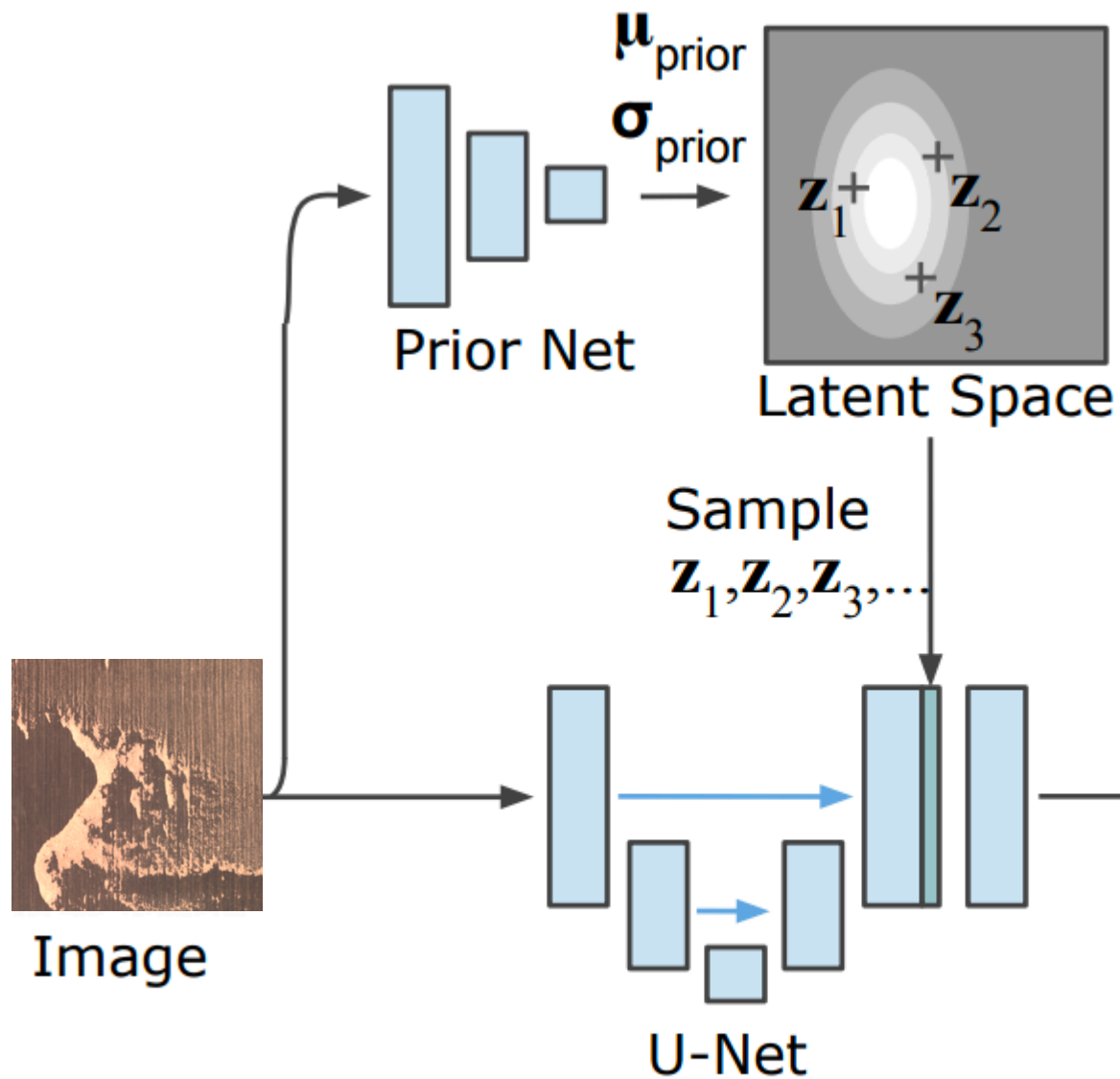RGB   CIR   NDVI   TOPO   SOIL

2. Previous season **crop identification** from collected high-resolution or publicly available low resolution imagery

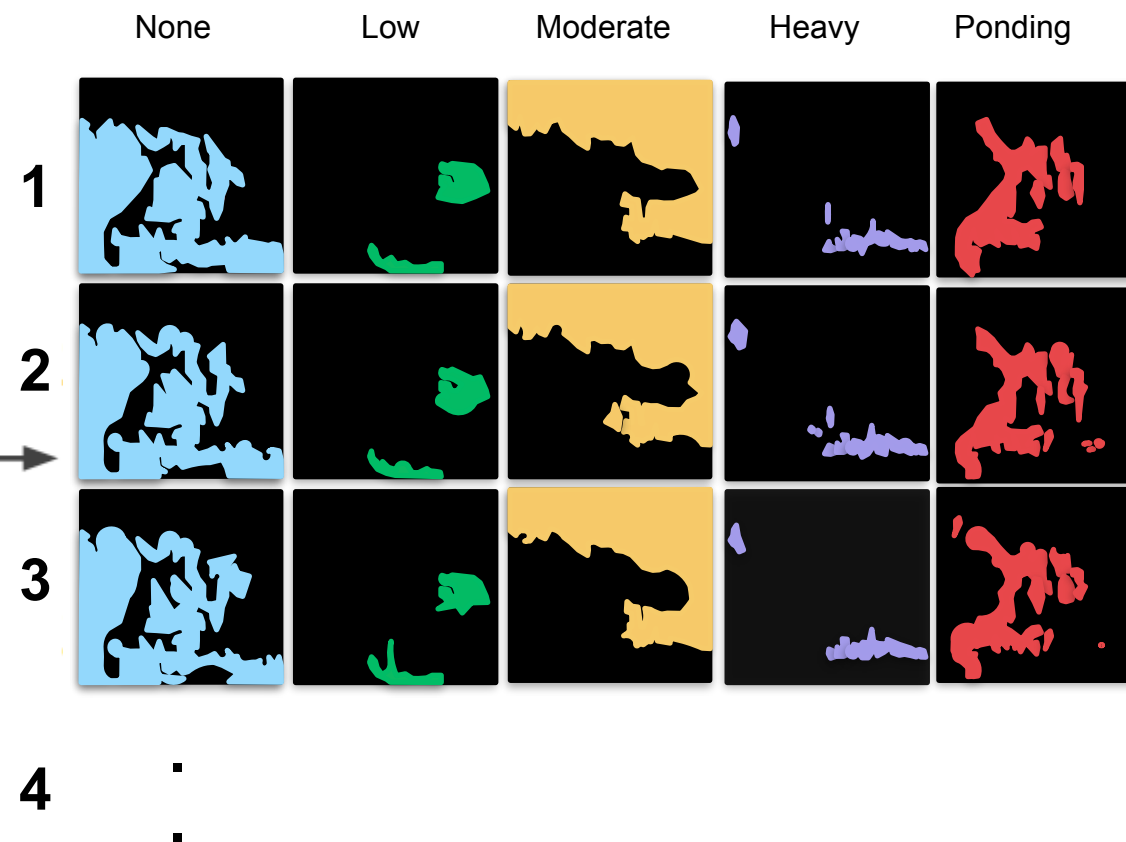# 3. Annotate residue density regions on the field

Low

High

Ponding

None

Moderate

METHOD

4. Segmentation using a Probabilistic U-Net[1]

[1]Adapted from Kohl, Simon, et al. "A probabilistic u-net for segmentation of ambiguous images." *Advances in neural information processing systems* 31 (2018): 6965-6975.

Key Benefits

More precise carbon calculations

Precision tillage: alert farmers to problematic areas

Build trust and adoption

Environmentally **and** economically sustainable management practices

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Please reach out to discuss with us further at the workshop!

Thank You