



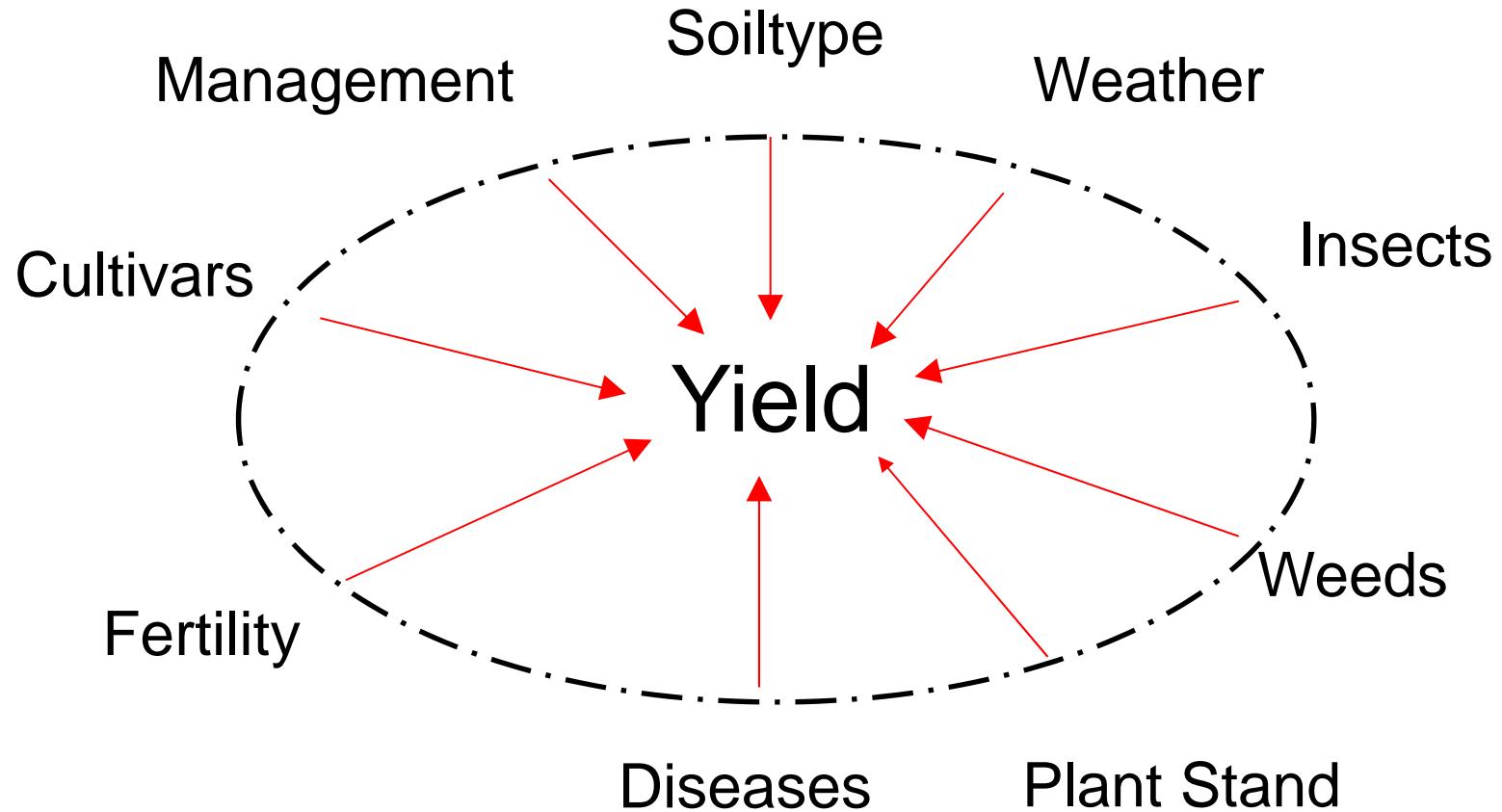
Dealing with climate and yield variability: the role of precision agricultural technologies and crop models

Bruno Basso¹, G.Phillip Robertson¹ and Jerry Hatfield²

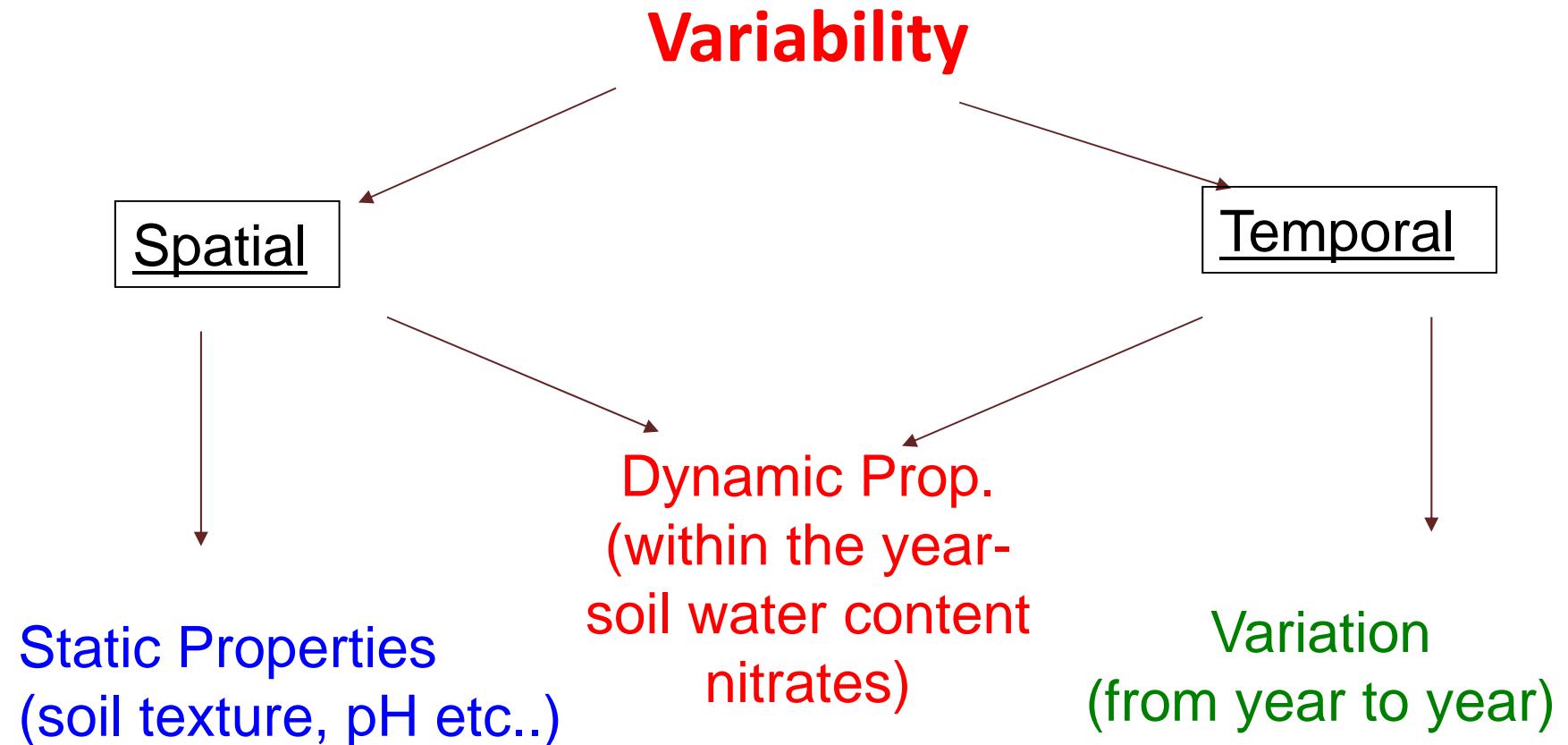


Montpellier
March 16-18, 2015

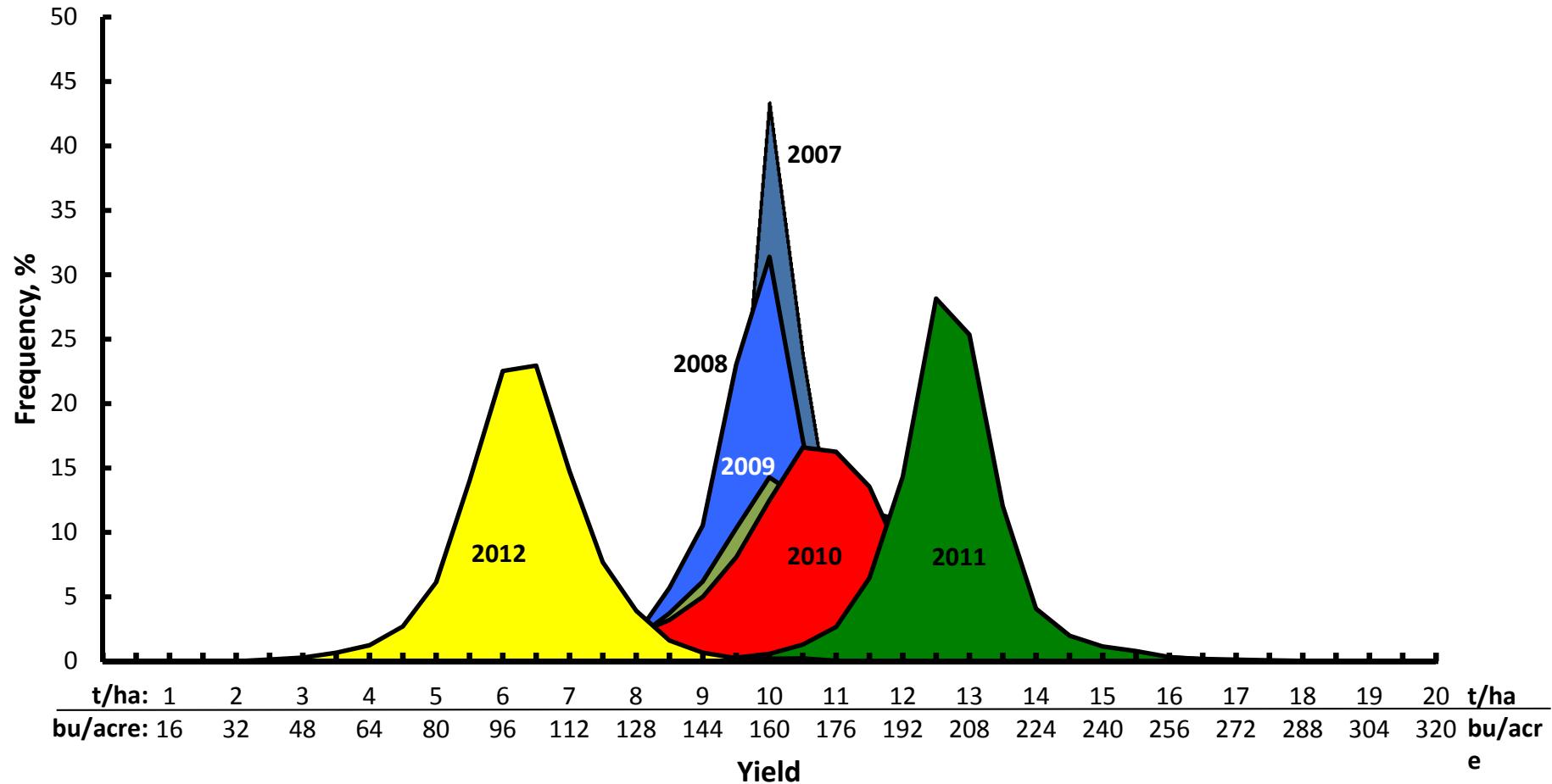
Yield Results from Complex Spatial and Temporal Interactions



Decision making in today's agricultural environmental is a volatile process (i.e. prices of products and input, weather).

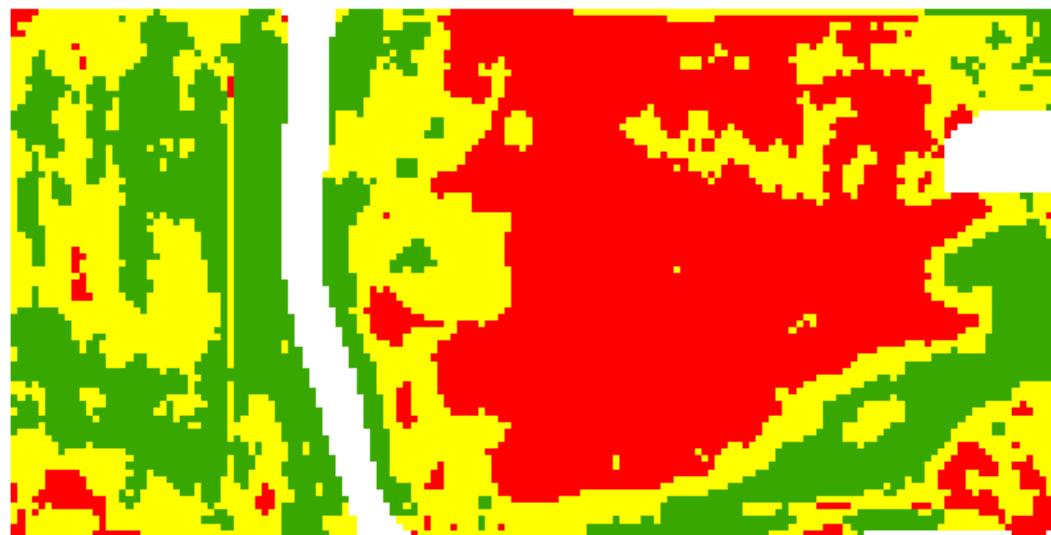


6 Years of Yields in a Single Field



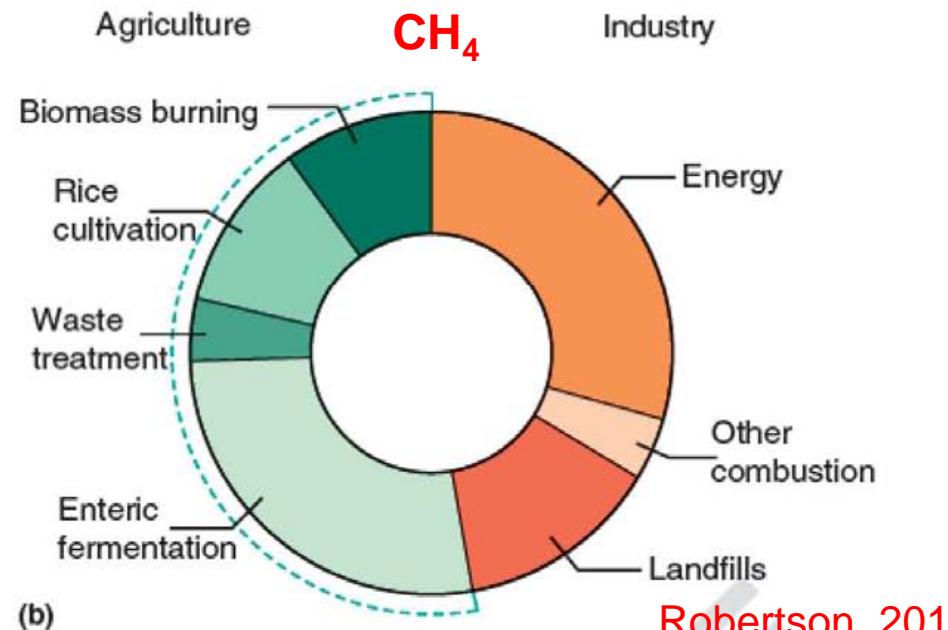
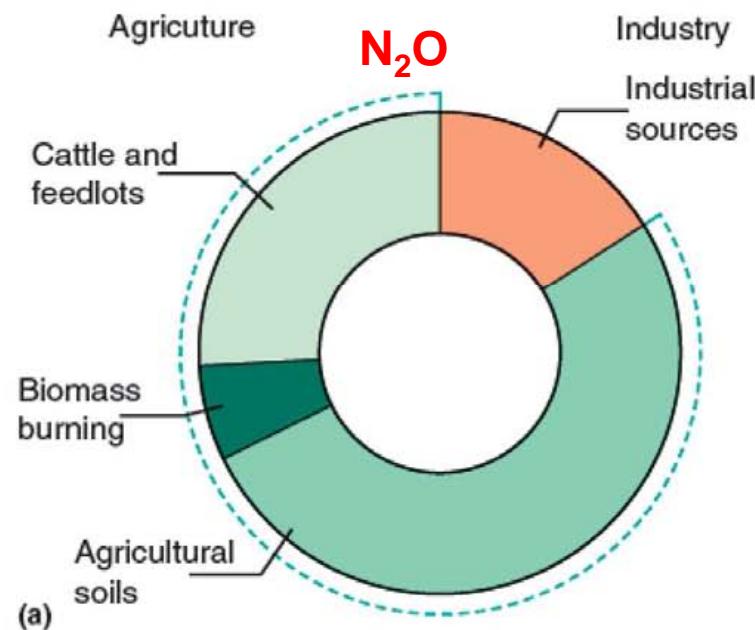
Stability map

- Low Yield and Time Unstable (LU)
- Average Yield and Time Stable (AS)
- High Yield and Time Stable (HS)



Primary Greenhouse Gases - Global Warming Potential

Agriculture is directly responsible for approximately 10%–14% of total annual global anthropogenic greenhouse gas emissions

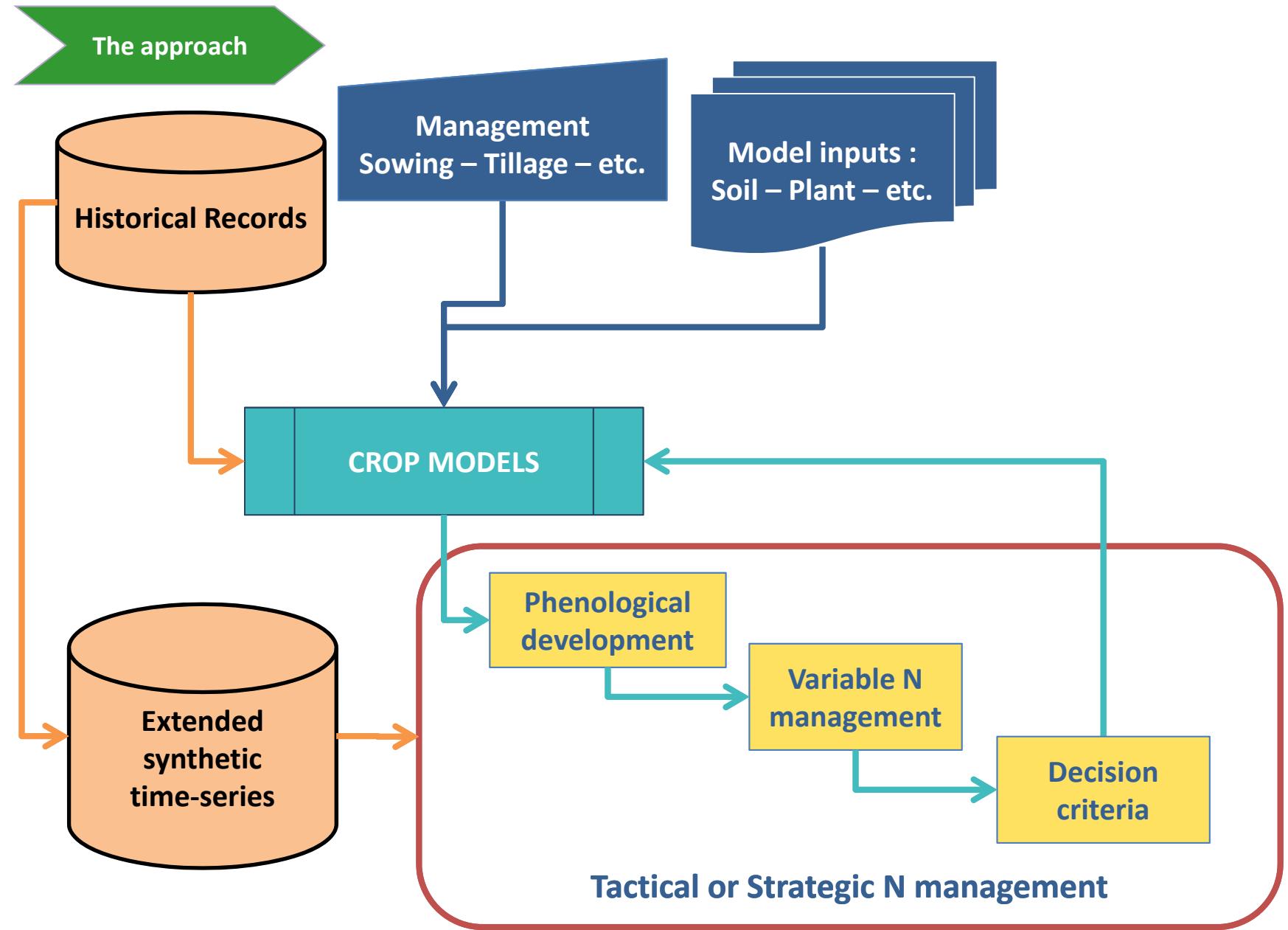


Robertson, 2014

Hypoxia in Lake Erie



Satellite image of 2011 bloom, the worst bloom in recent years, which impacted over half of the lake shore. (Credit: MERIS/ESA, processed by NOAA/NOS/NCCOS)

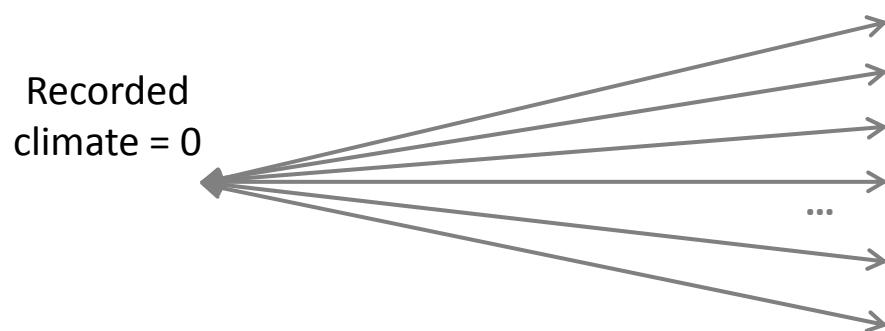


From strategic to tactical approach using crop models

The **strategic** focuses on a **long-term objective**



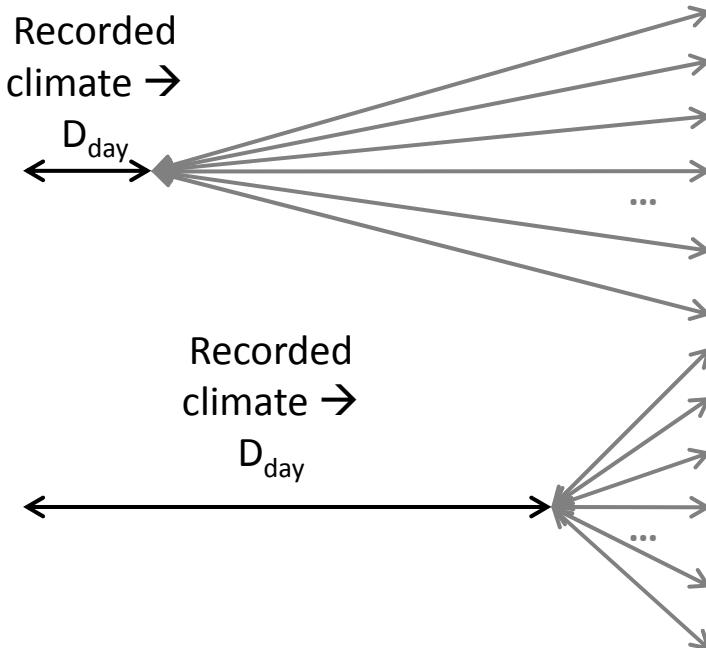
Inter-year analysis



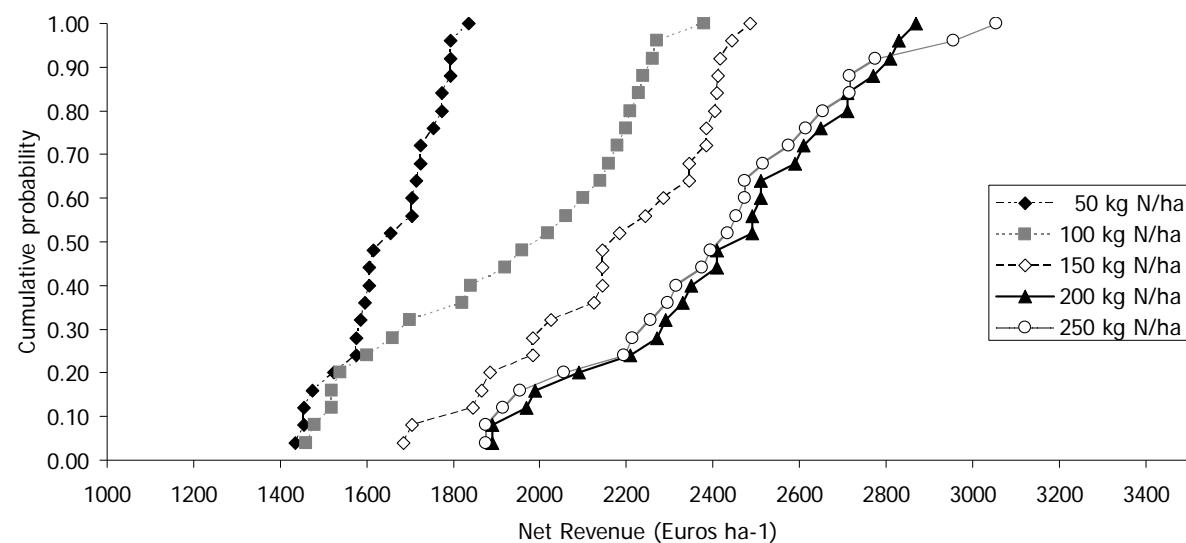
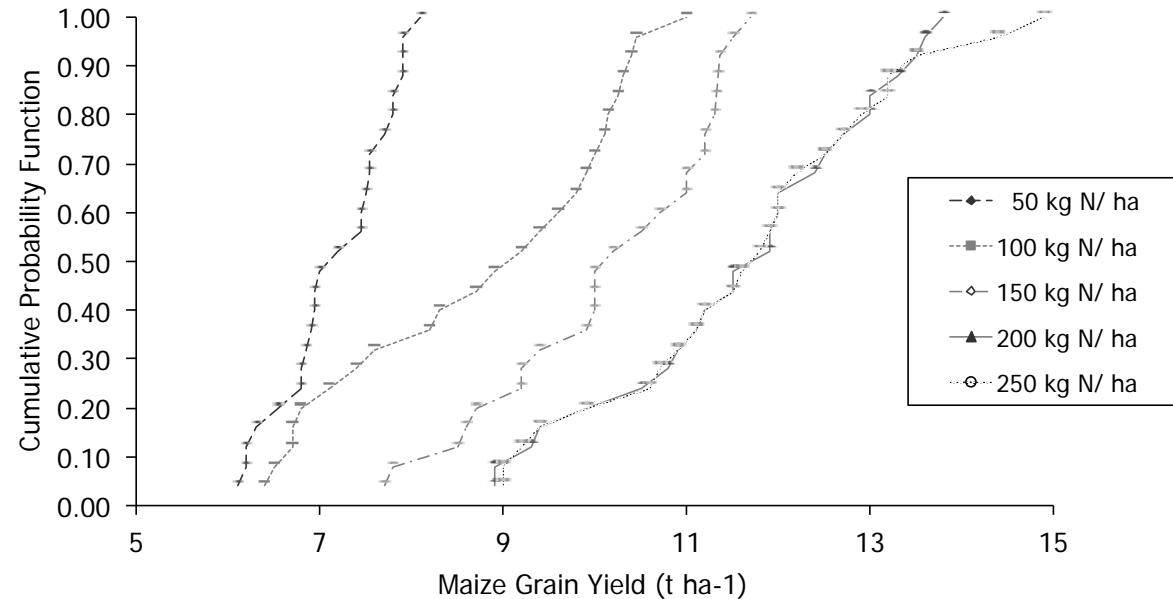
The **tactical** addresses a **within season decision**



Intra-year analysis

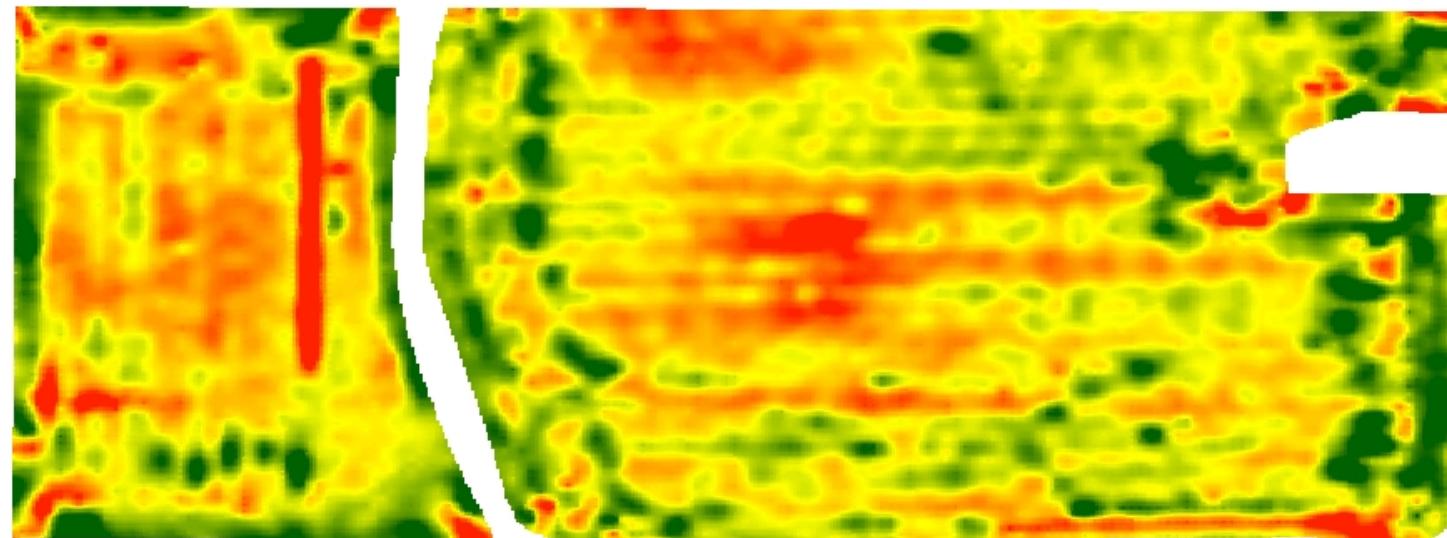


Developing a fertilization strategy

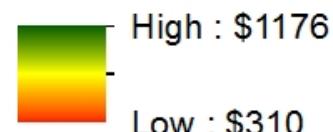


Measured profit 2011

Green: Profit Red: Lower Profit Avg: \$740/acre

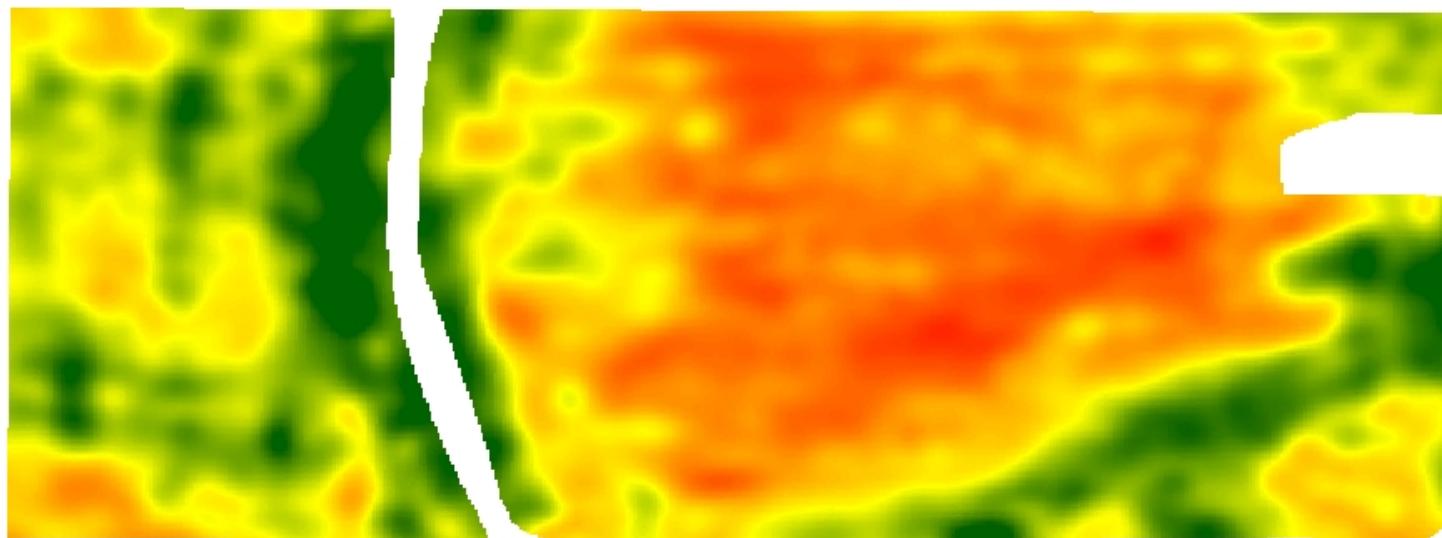


Net Profit (dollars/acre)



Measured profit 2012

Green: Profit Red: Loss Avg: \$194/acre



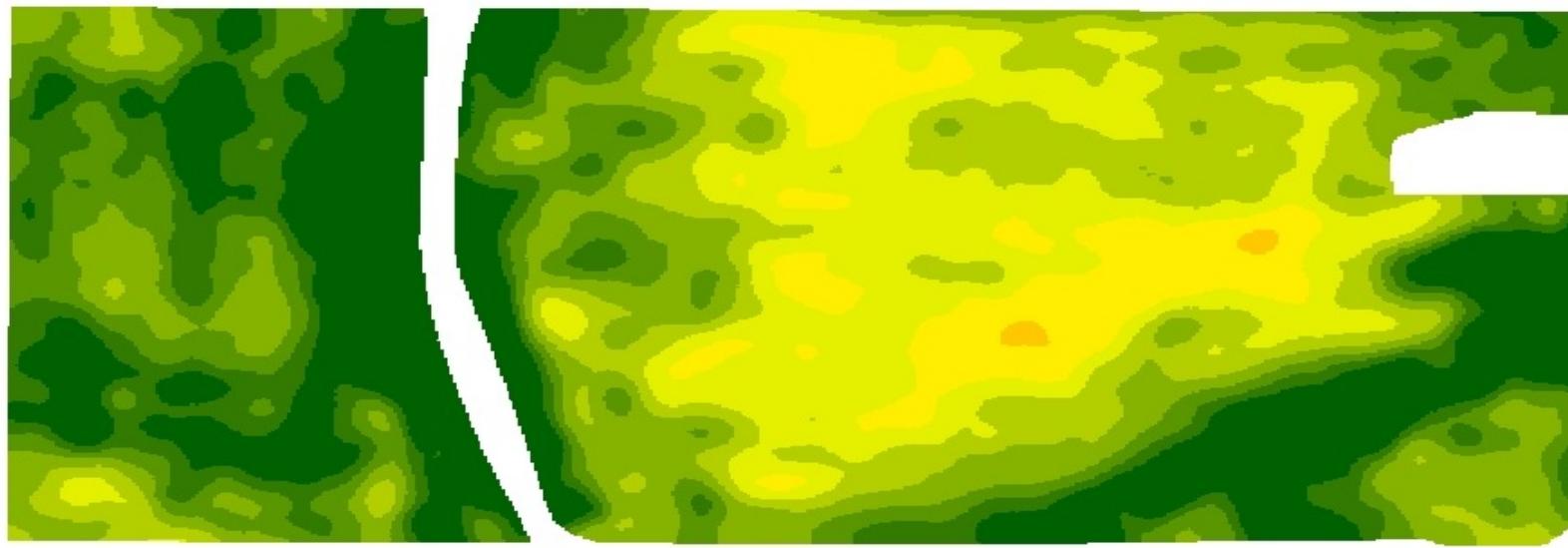
Net Profit (dollars/acre)

High : \$740
Low : -\$148



Green: Profit Red: Loss Avg: \$428/acres

2012, Only 30 # N/ac



Net Profit (dollars/hectare)

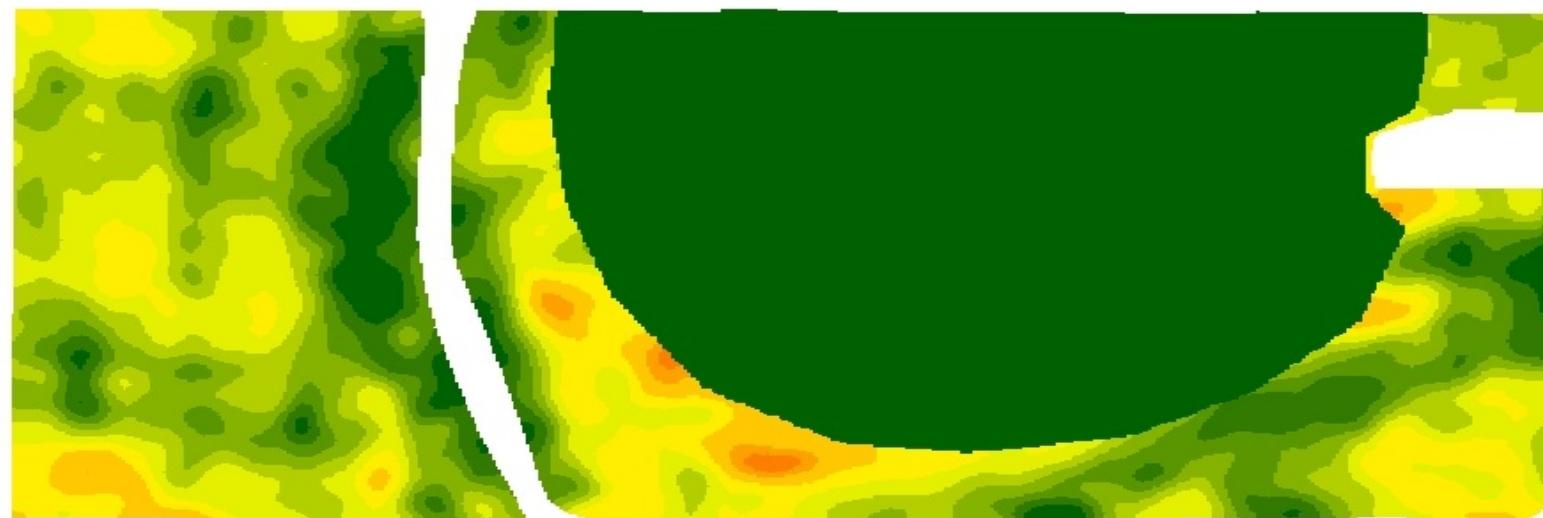
-\$400 to -\$300	\$0 to \$200	\$800 to \$1,000
-\$300 to -\$200	\$200 to \$400	\$1,000 to \$1,200
-\$200 to -\$100	\$400 to \$600	\$1,200 to \$1,400
-\$100 to \$0	\$600 to \$800	> \$1,400



0 0.1 Miles

Green: Profit Red: Loss Avg: \$980/acres

2012, Irrigated 200 # N/ac

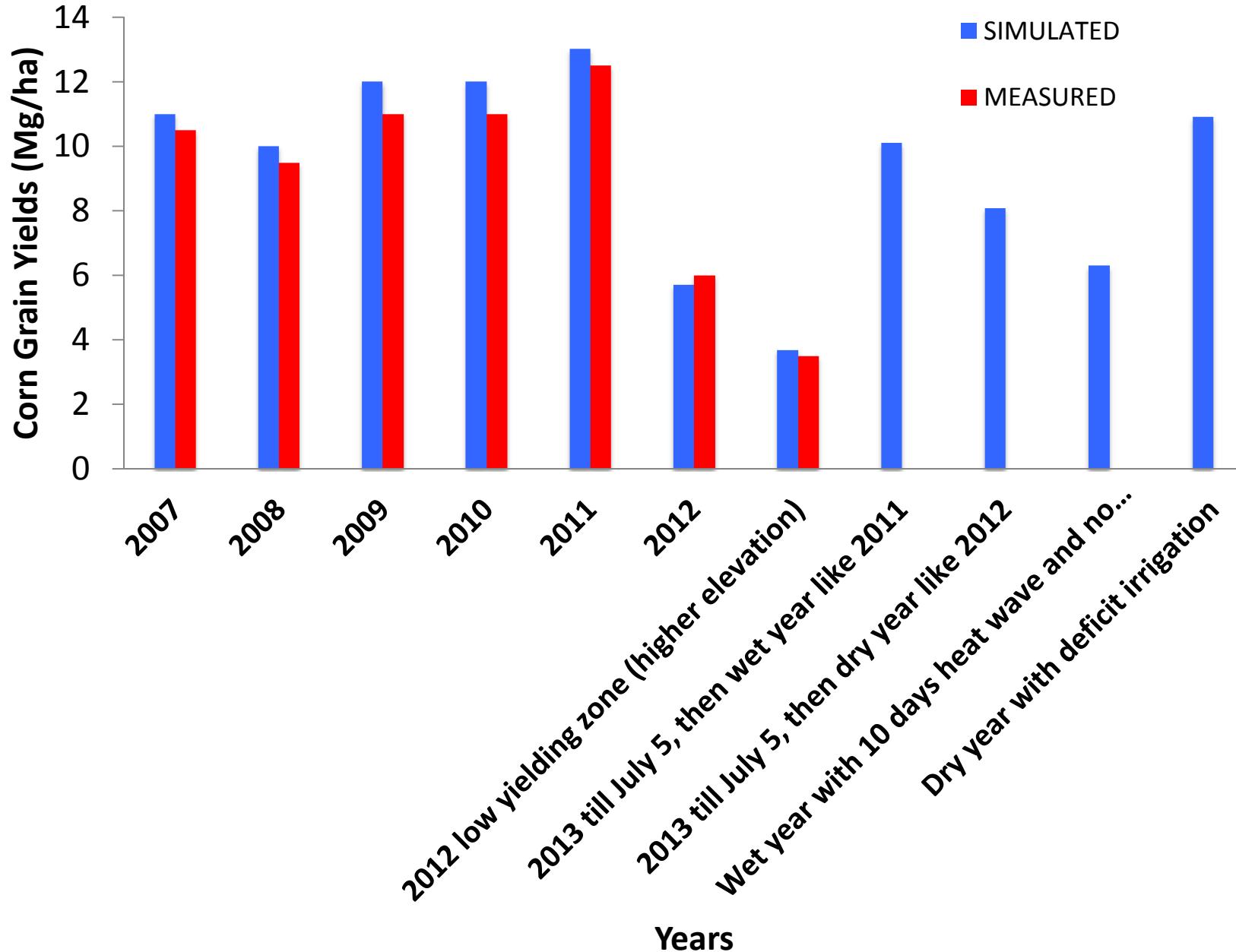


Net Profit (dollars/hectare)

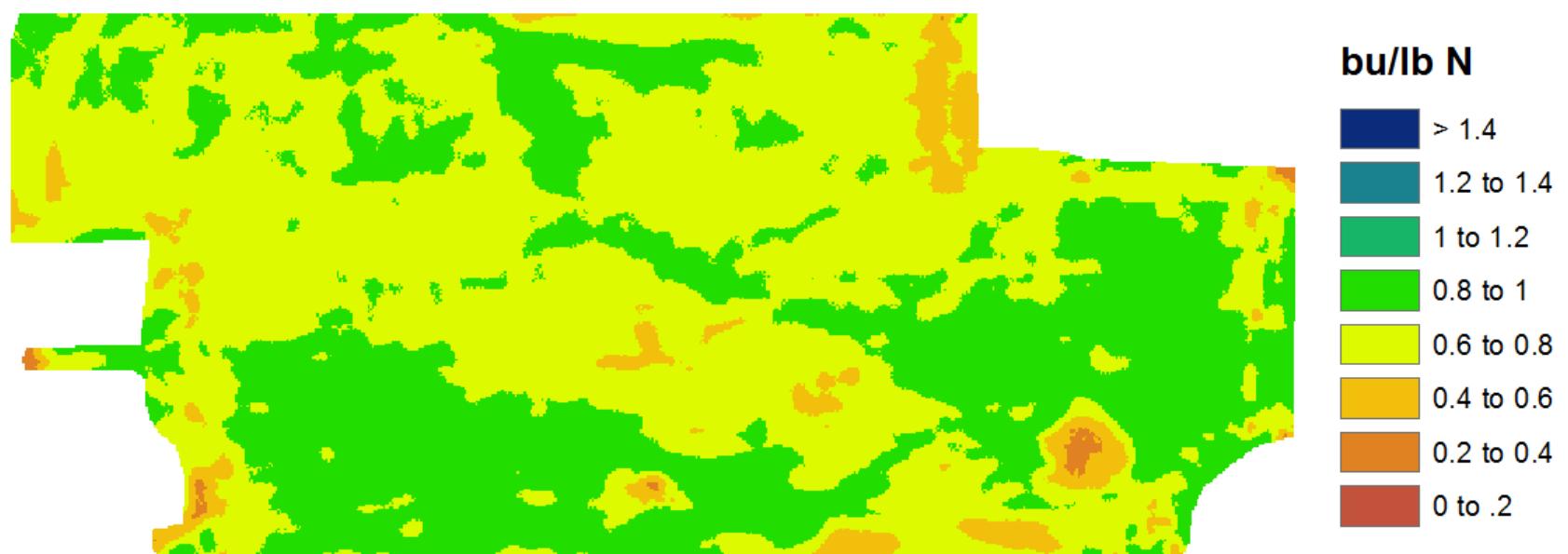
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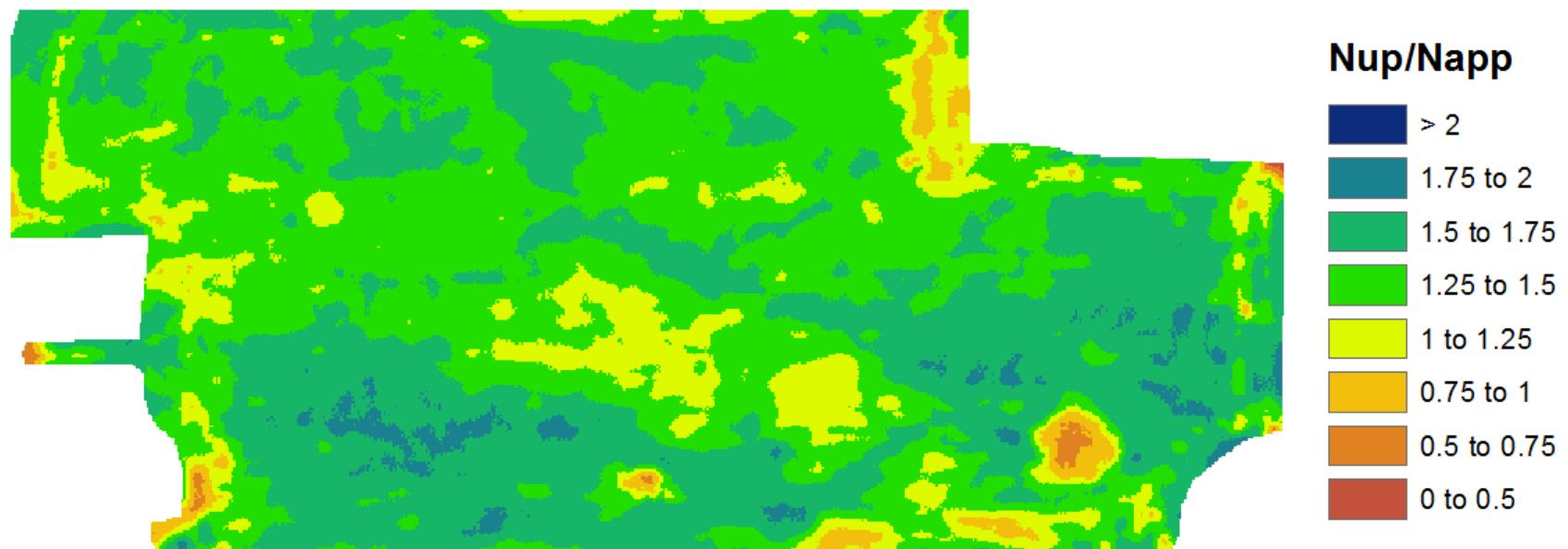
0 0.1 Miles



2014 Nitrogen Use Efficiency



2014 Nitrogen Fertilizer Efficiency





Agronomical criteria: Maximizing yield

Economical criteria: Maximizing farmers Marginal Net Revenues

$$MNR = (Y_N \cdot G_P) - (N \cdot N_P)$$

Y_N = Grain yield under N practice [ton.ha⁻¹]

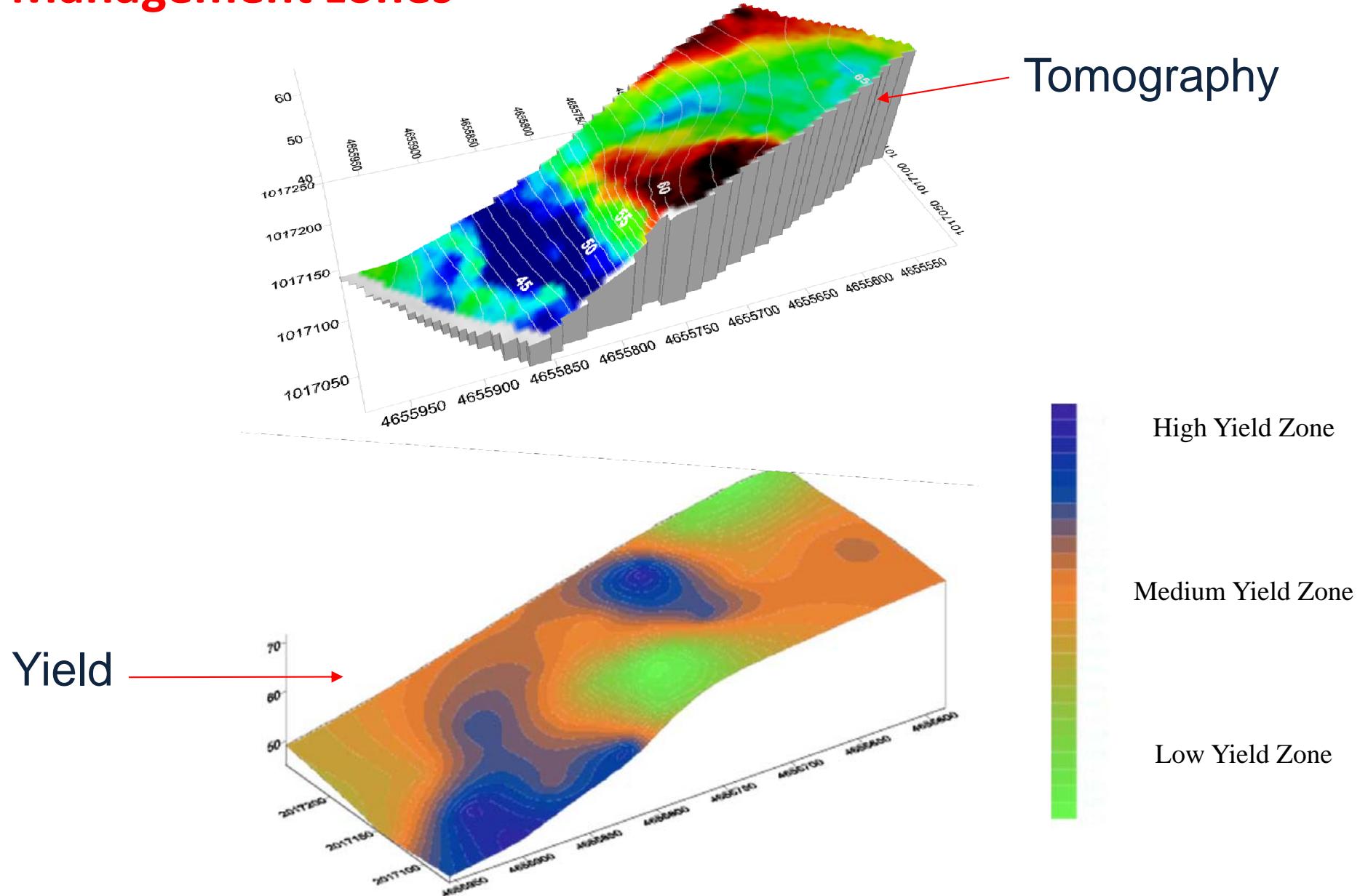
G_P = Grain selling price [€.ton⁻¹]

N = N fertilization amount [kgN.ha⁻¹]

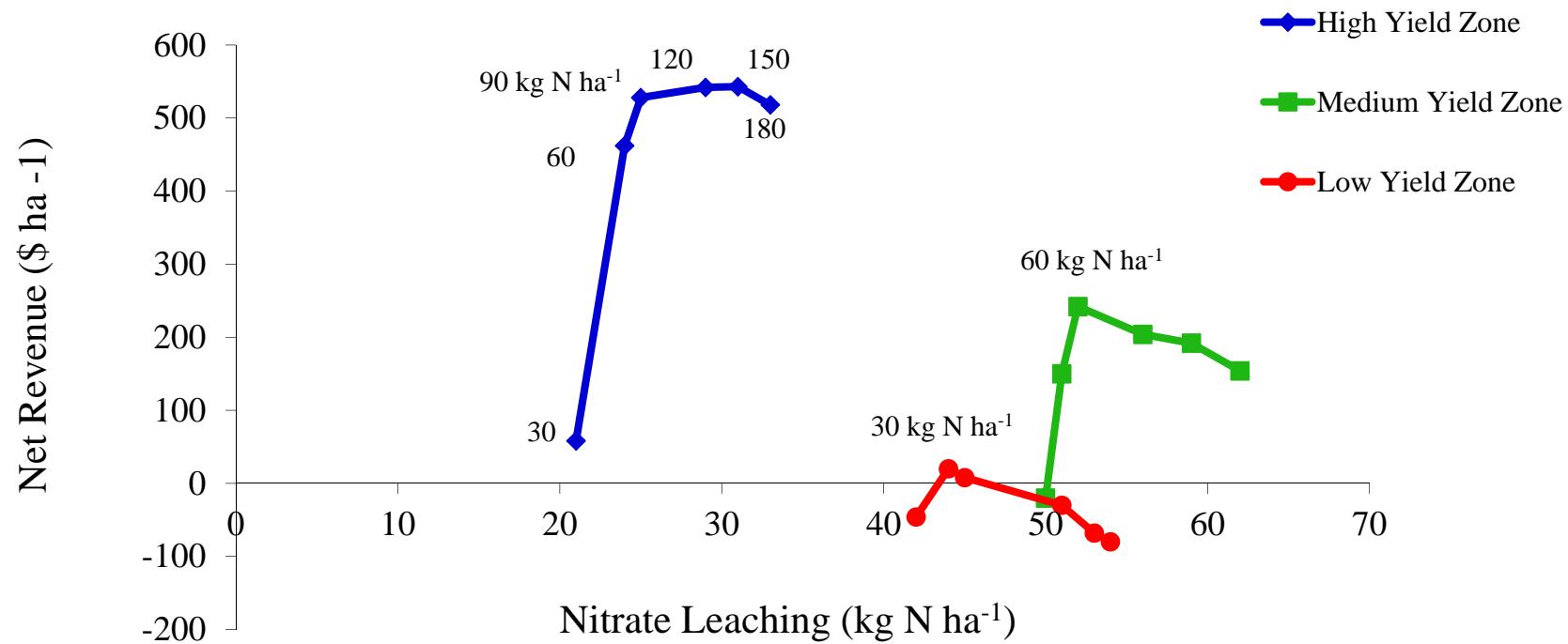
N_P = N price [€. kgN⁻¹]

Environmental criteria: Minimizing the Nitrogen Available for Leaching at the end of the season

Management zones



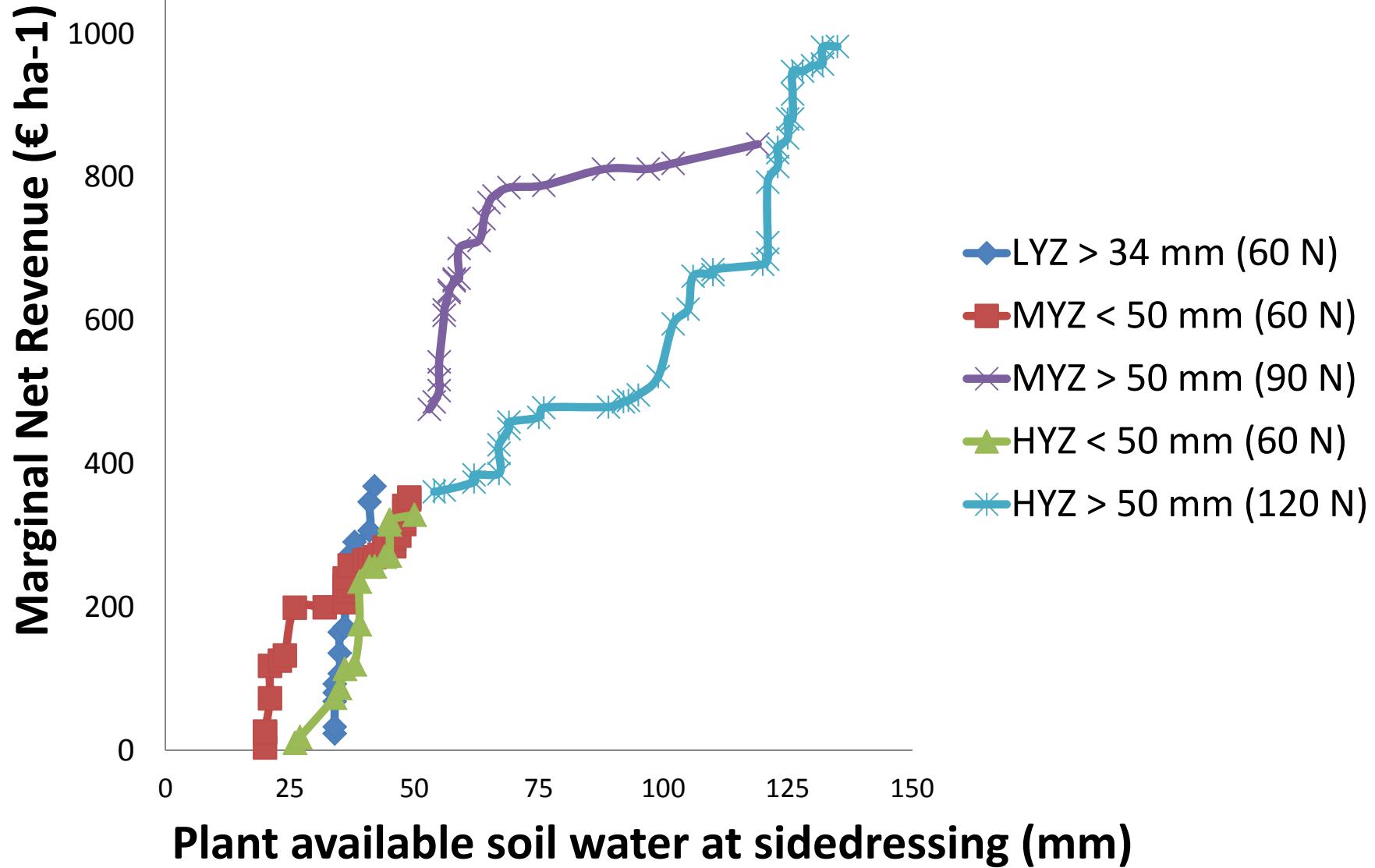
N management using spatially explicit crop modeling



Dual criteria optimization through tested model determines the N rate that minimizes nitrate leaching and increases net revenues for farmers

(Basso et al., 2011; Eur J. Agron 35:215–222)

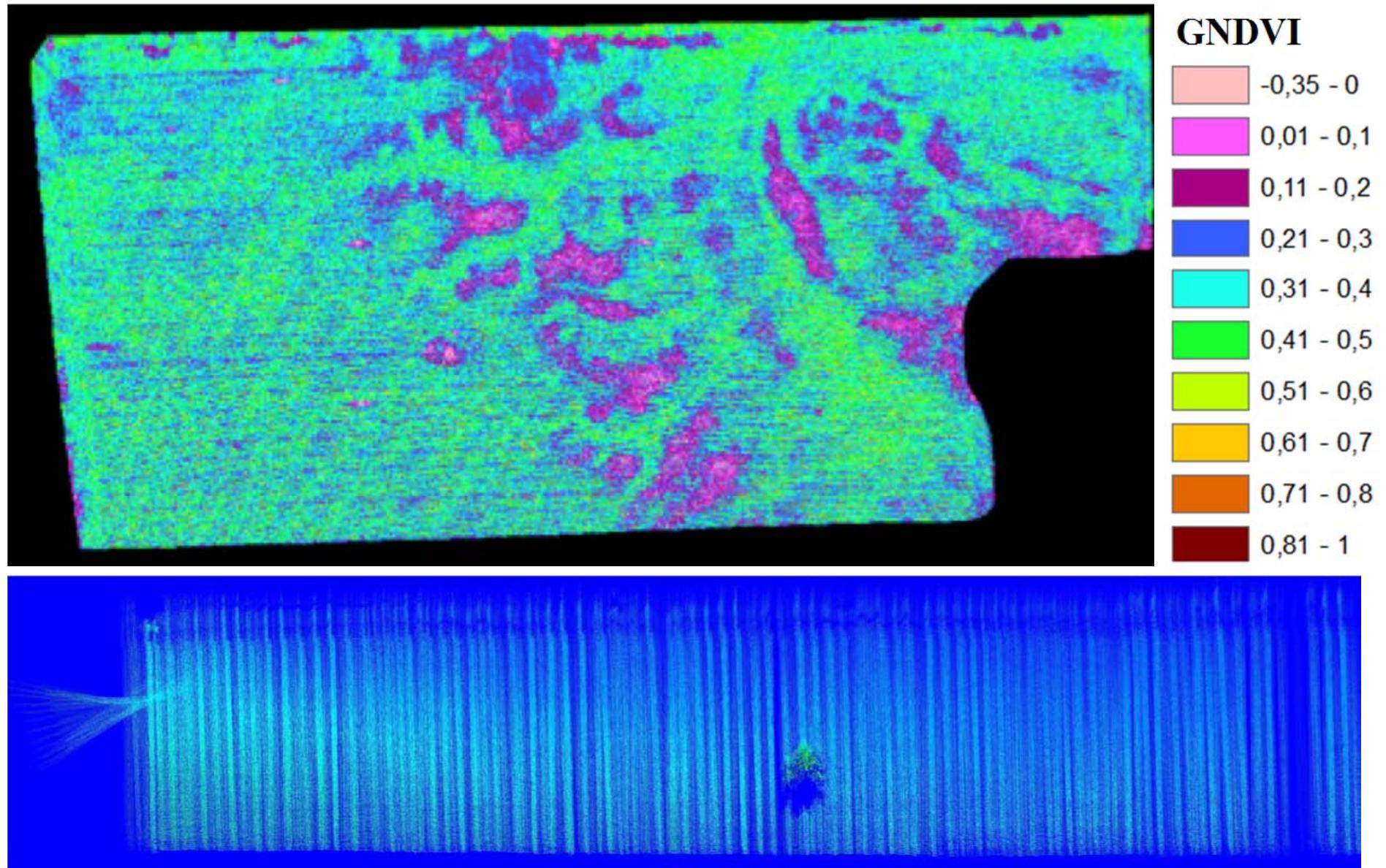
Tactical approach for optimal N rates



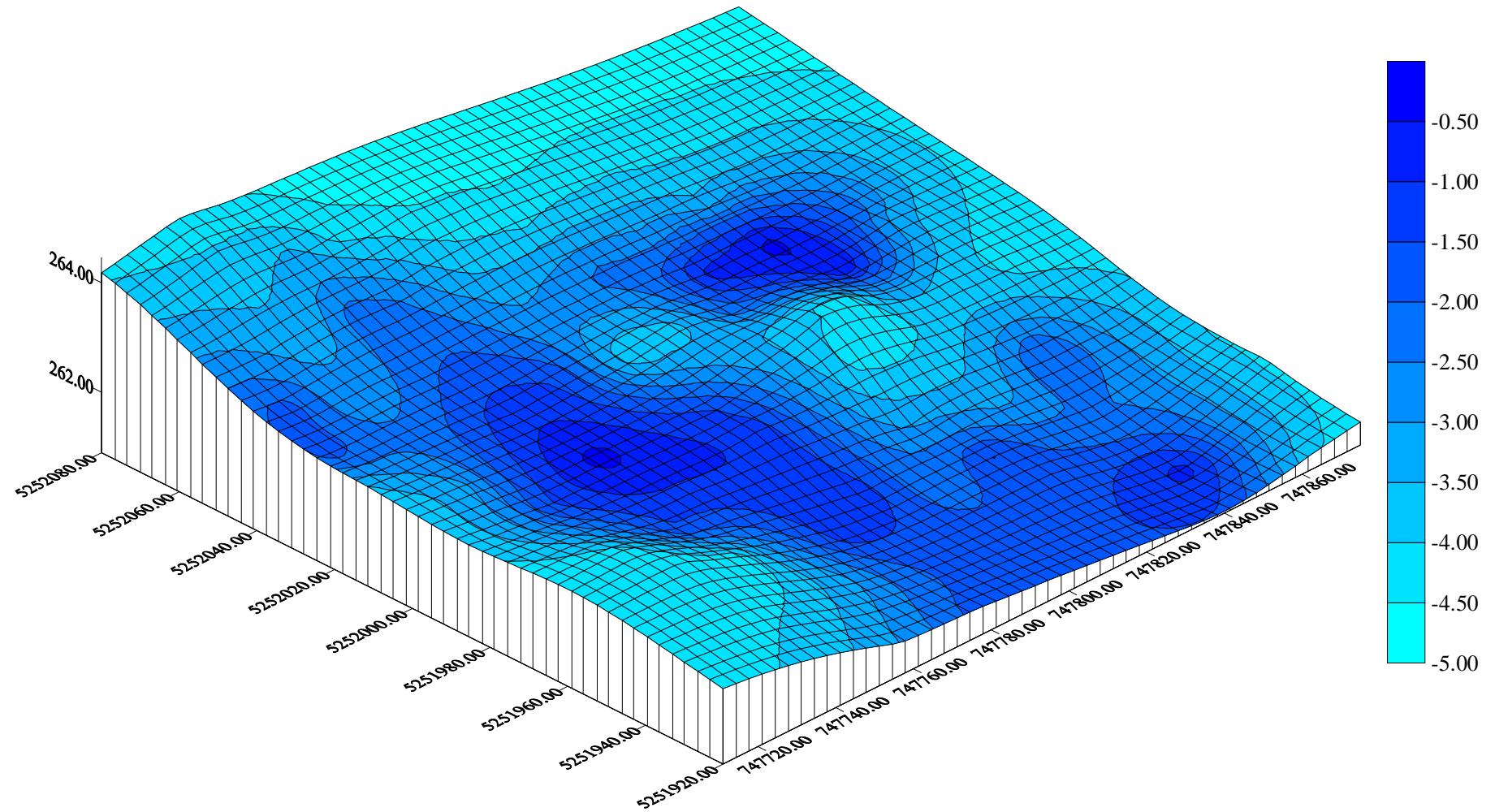
Visible image taken on August 13 using MSU drone



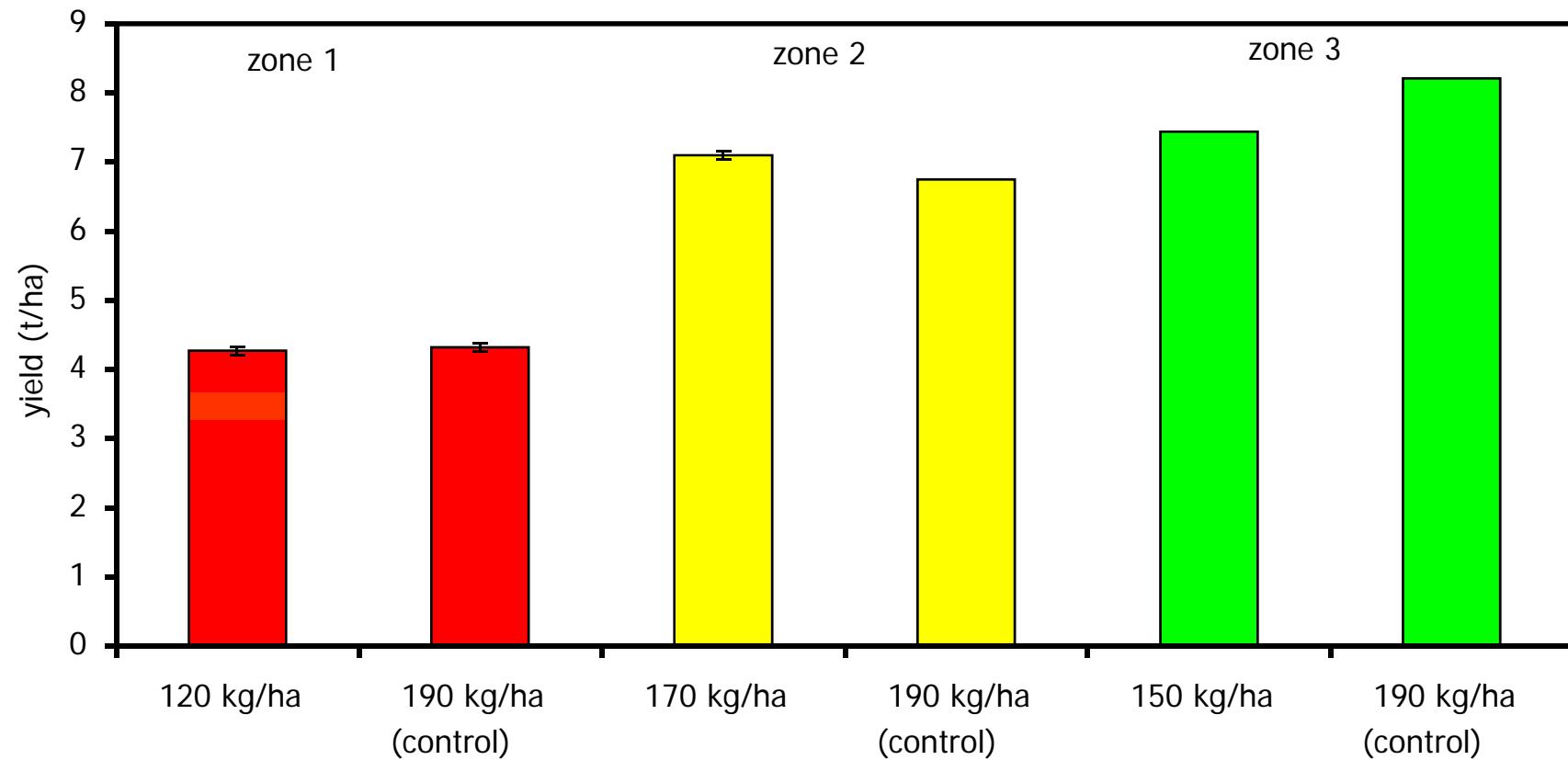
Multispectral and laser scanner image taken from MSU drone



Net surface flow (Runon-Runoff) in SALUS crop model



Observed Variable Rate Nitrogen



Precision agriculture when integrated with crop modeling can help farmers:

- adapt to climate variability and increase their resources use efficiency
- Gains in energy efficiency for farm operations that consume fuel, including mechanical operation such tillage, irrigation, fertilization etc..
- Gains in production or yield efficiency for grain, and other agricultural products
- Abatement of the GHG emission (N_2O) by better fertilizer use