

# Mapping Soil Fertility Characteristics with Multiple Linear Regression

Cost reduction opportunities through a non-  
traditional approach



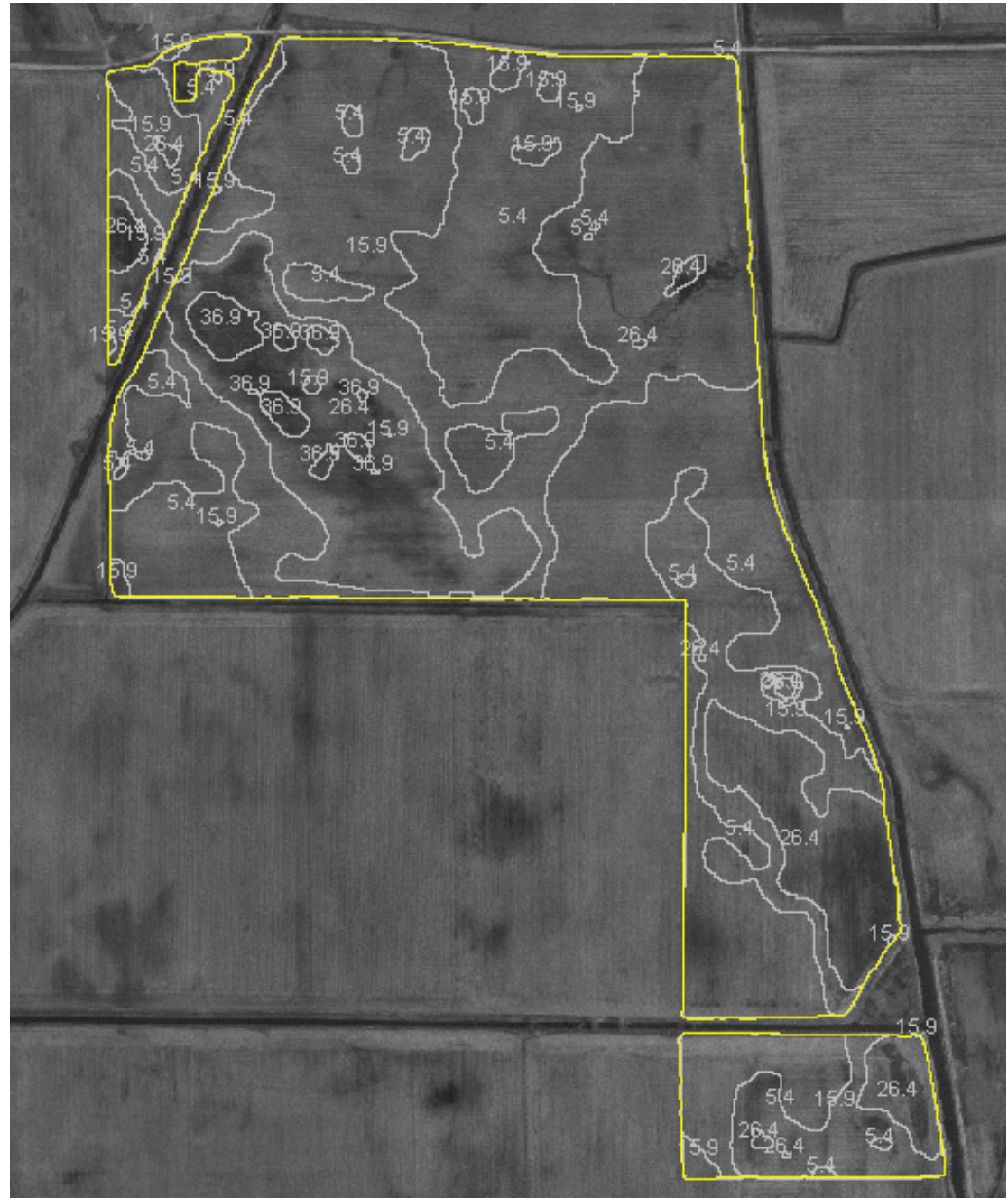
Zeise Farm- Indiana

Spencer Field, 230 acres.

Planted in corn 2006.

Background is bare soil (from  
Terraserver).

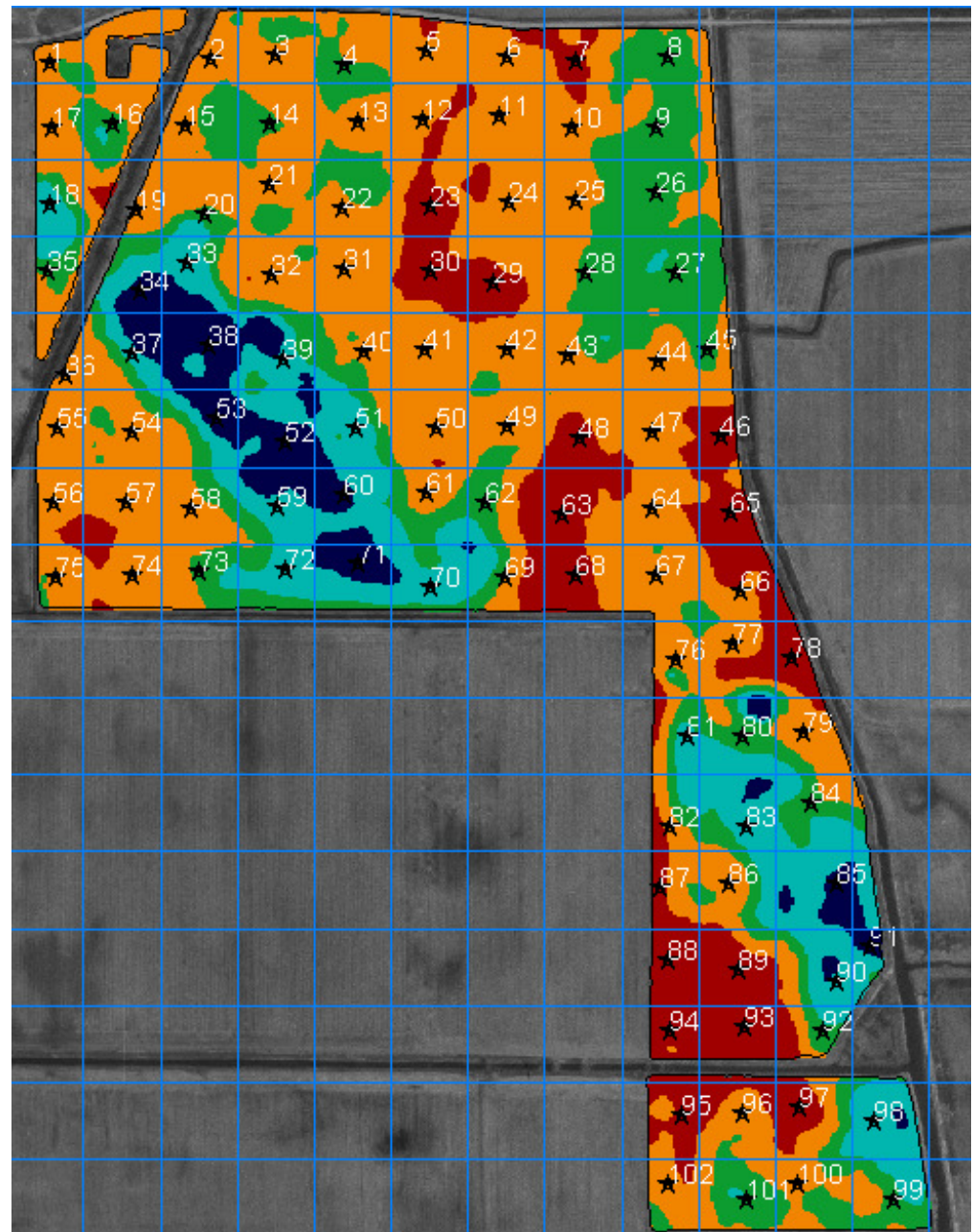
Overlaid polygons are a  
segmentation of EC Deep  
readings collected with Veris.



Soil Sample Sites. Manual placement of 102 sites. A 2.5 acre grid was overlaid and then a point was placed on the dominant EC value in the grid division. Humans do this very well.

This represents a traditional, 'directed grid sample' scheme.

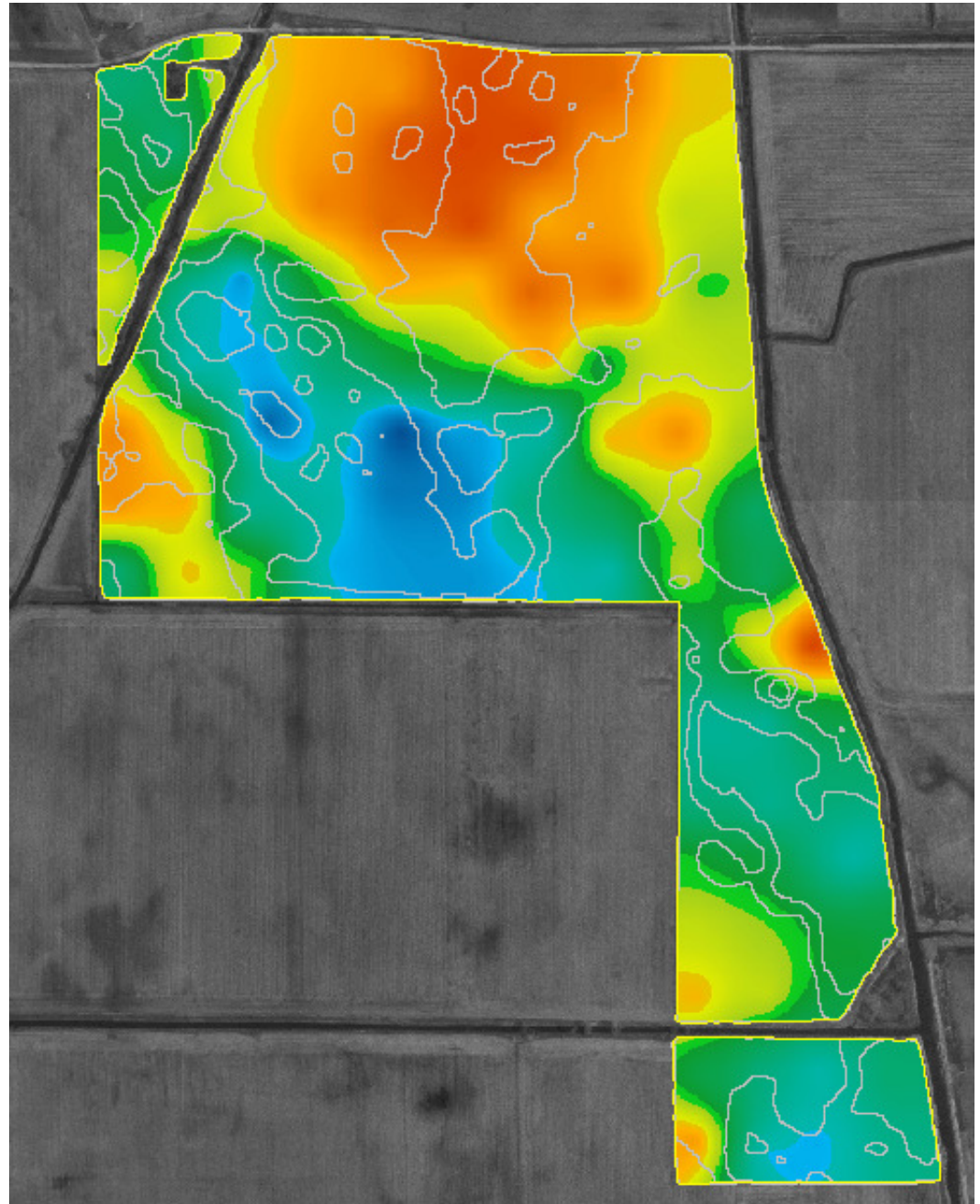
Samples are collected, bagged, tagged and sent to the lab.

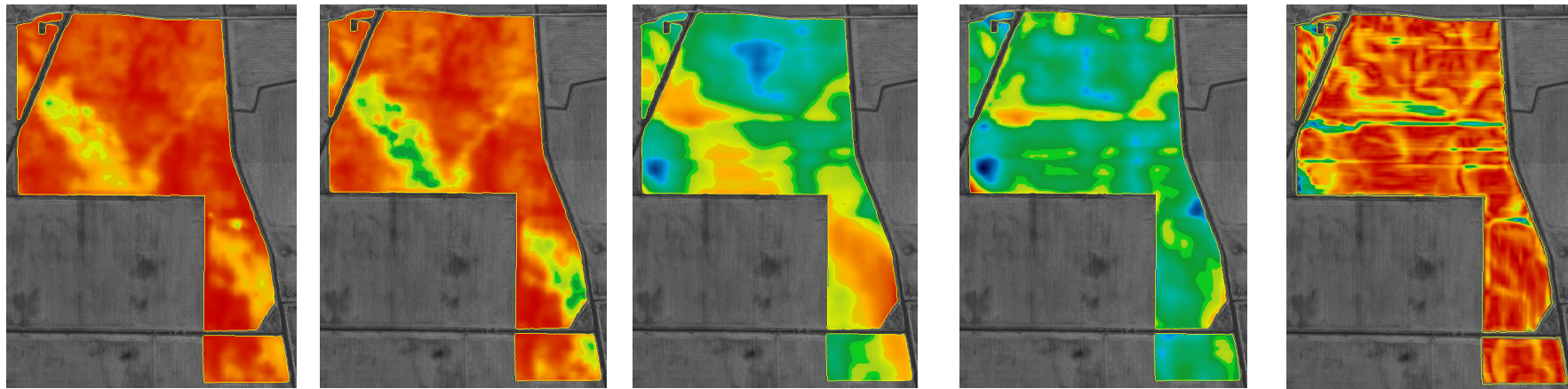


CEC map as the outcome of interpolation. 102 CEC values contribute to the estimate of CEC variability.

The interpolation technique is Exponential Decay. Substantial smoothing results from a low decay constant.

CEC Range is 4.1 to 41.5. Mean is 22.68. StdDev is 6.89. Color is thermal spectrum (red to blue).





EC Deep

EC Shallow

Elevation

LSP

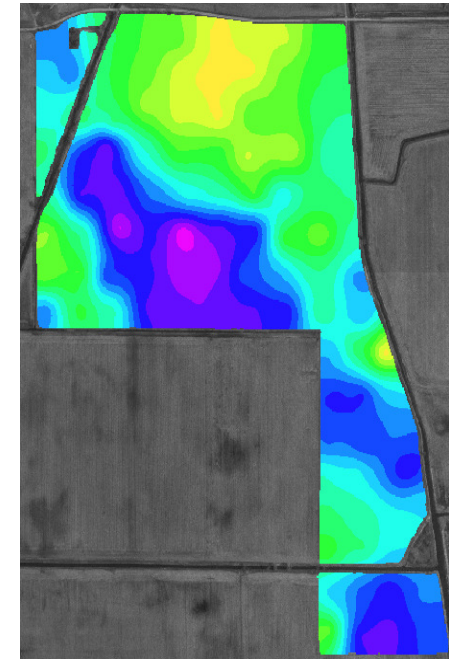
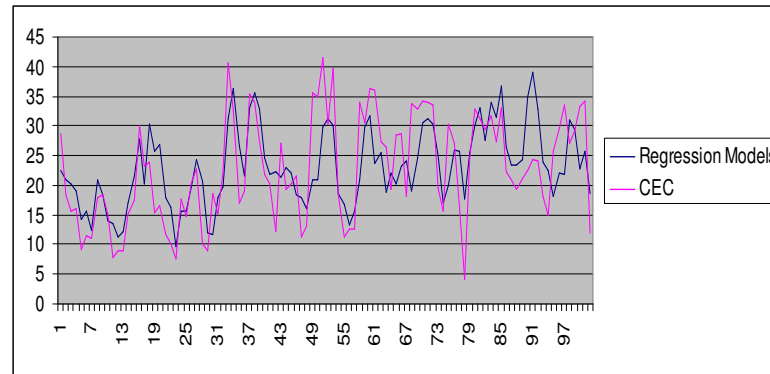
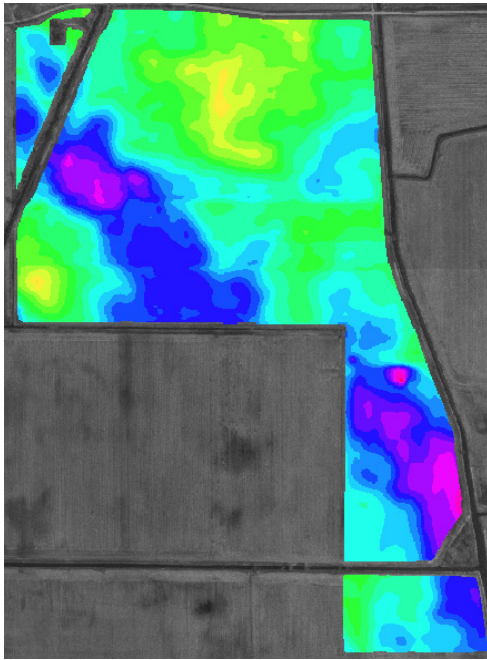
topo slope

The hypothesis is that CEC and other soil fertility properties vary as a function of terrain and conductivity properties. An idea that is not irrational.

The question is: Can we build fertility maps from fewer input samples using multiple linear regression? The answer is of course: You can feed anything to a statistical process and get a result. Re-phrased, the question is: Can we build *useful* fertility maps from fewer input samples using multiple linear regression? By ‘useful’ is meant an outcome that is a) similar to that of interpolation and b) as believable in terms of value and pattern and c) verifiable through in-fill testing (tbd).

This represents a departure from “traditional” practice. Why depart? Simply because fewer samples lower the costs associated with time in the field, shipping and handling and lab analysis fees and because the possibility of adding value to EC and terrain survey collections is attractive.





Regression outcome from a half sample (51 points instead of 102). The coefficient of variation ( $r^2$ ) is .50.  
 Mean CEC is 22.99. StdDev is 6.195.  
 Data Range is 7.87 to 40.93.

Interpolation of 102 sample locations.  
 Mean CEC is 22.68. StdDev is 6.89.  
 Data Range is 4.1 to 41.5.

Multiple Linear Regression (LHStat) produces an outcome with spatial patterns and basic statistics similar to the interpolation of a 'dense' sample. The process represents a potential cost reduction of ~ \$1.25 per acre.



## Notes:

1. In soil fertility mapping, more (samples) is better. 2.5 acre sample spacing is better than 5 acre spacing. 1 acre spacing is better than 2.5. However, 'better' becomes a fluid concept when costs are considered. In real calculations, fewer is better and trends are often as supportive as absolute values in VRT decisions.
2. The idea being proposed, that soil fertility properties can vary in relation to soil geo-physical properties, is not counter-intuitive.
3. We have produced similar outcomes in separated fields (Zeise and Obermeier Farms are over 20 miles apart)
4. Residuals HAVE NOT been examined/removed in these examples. Experiments show that removing points with high residuals from a sample set does have the expected effect (increase) on  $r^2$ .
5. Inter-correlation among independent variables has not been examined/applied in these examples. Experiments show that removing independents with high inter-correlation DOES NOT dramatically lower  $r^2$ . Some independents can be discarded.
6. That there are departures between interpolated and regression outcomes needs to be considered in the light of a general data quality question. How good, how consistent are lab outcomes? In the bad to less bad spectrum, where do the two fertility maps sit? Is it possible that the general trends displayed by both maps are a reasonable and useful approximation of reality? If so, LHStat is an economically attractive alternative to traditional approaches when and where EC and RTK terrain surveys are available.

