Variable rate fertilizer applications on irrigated fields

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  - ACIDF
  - Agrium
  - Alberta Canola Producers Commission
  - Alberta Innovates Bio-Solutions
- Ag Tech Centre
- Lethbridge Agronomy Team

Variable rate fertilization project

- Chose sites with varying topography because of soil moisture and soil physical/chemical properties
- Included an irrigated site, but landform low slope positions often under water
- Do not have good irrigated site data

Yield variability

- Yield varies within a field because of:
  - Soil variability (texture, organic matter, topography)
  - Past history and management
  - Problems: past erosion, drainage, salinity, hard pan/compaction
  - Localized pests
- Yield varies between fields for similar reasons
- Yield varies from year to year because of precipitation/weather and pests

Managing yield

- Traditional approach has been to accept yield variability as a fact and manage all areas of the field the same way.
- Another approach has been to manage identified problem areas separately from the rest of the field.
- Current technology now makes it possible to address yield variability

Optimize fertilizer applications

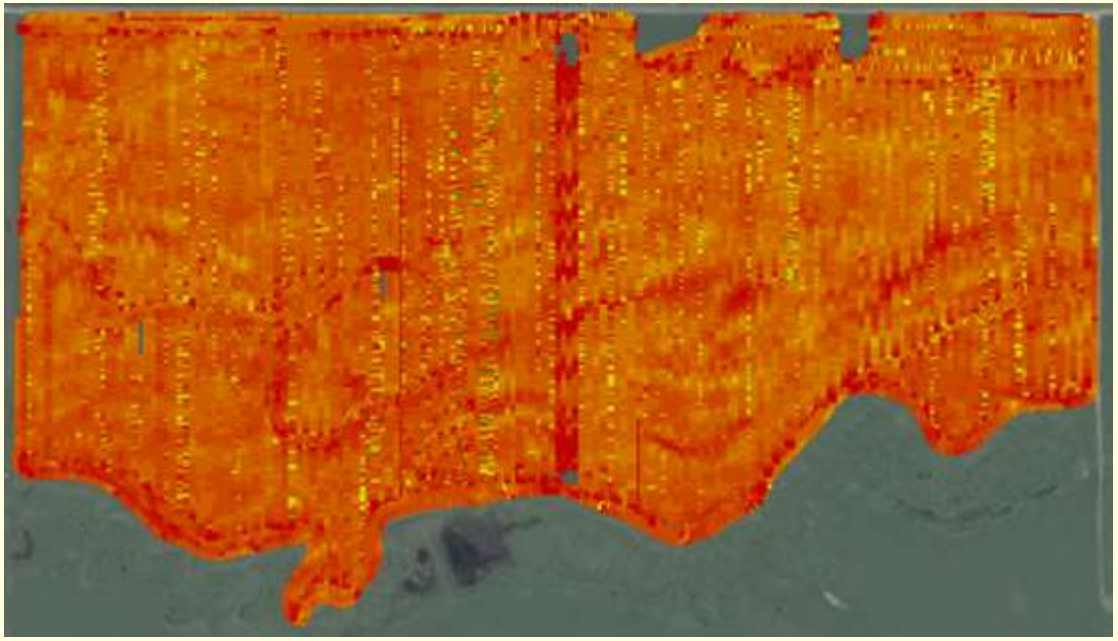
- Can we do better than single rate fertilization across the whole field?
- Should more fertilizer be placed on higher yielding areas of fields?
- Should less fertilizer be applied on areas of fields that often yield well below average?
- Should more fertilizer be applied on low yielding areas to increase productivity?

Fertilization by management zone

- Inputs and management are based on smaller units of a field, a management zone, rather than treating all areas of the field the same
- Some current ways to identify management zones:
  - Yield maps
  - Satellite or aerial imagery
  - Soil factors: texture, topography, fertility, salinity

Management zone approach to VRF

- Approach ***assumes*** that the differences between identified management zones are due to soil fertility
- This approach also ***assumes*** that each management zone will respond to fertilization differently than the other zones (either more or less responsive)
- Both of these assumptions must be valid – otherwise variable rate fertilization is pointless



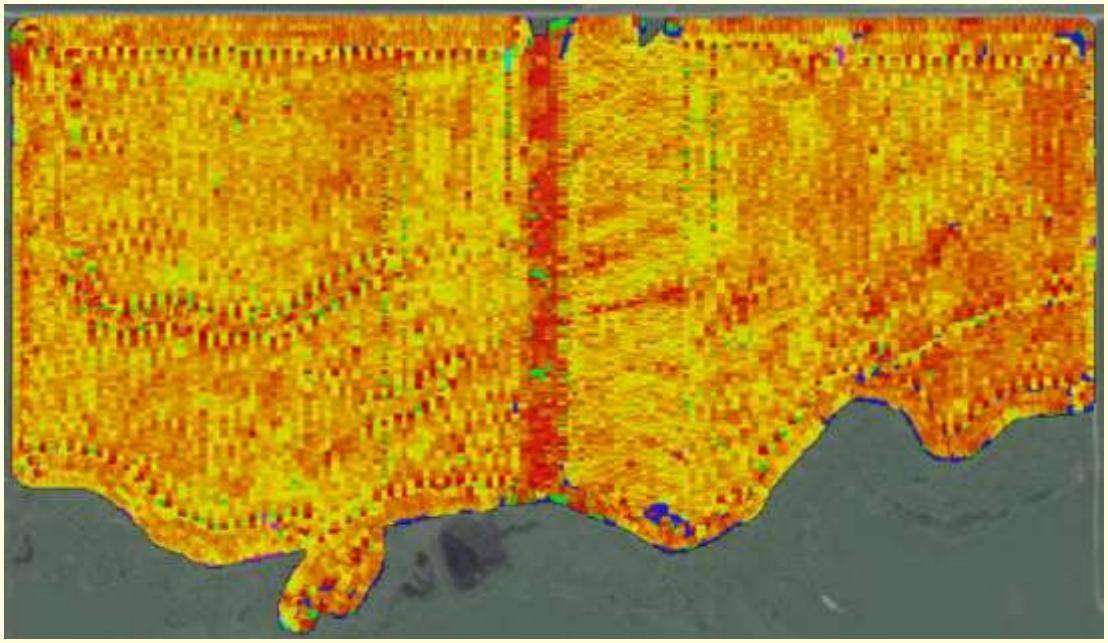
Yield map courtesy Western Tractor Lethbridge/Taber

>60% available water until about July 10 (0-40 cm) Mid-Slope

Wheat in 2011

Avg yield 44 bu/ac (282 ac)
71 ac yielded 44-49 bu/ac
69 ac yielded 37-44 bu/ac
50 ac yielded 49-55 bu/ac
46 ac yielded 29-37
15 ac yielded > 55 bu/ac
31 ac yielded <29 bu/ac
Fertilizer rate: 86-25-0 (actual N and P_2O_5 lb/ac)

Month	Rainfall
	mm
April	Not Recorded
May	66.3
June	82.1
July	15.1
August	10.5
September	16.7
October	0
Total	190.7



Yield map courtesy Western Tractor Lethbridge/Taber

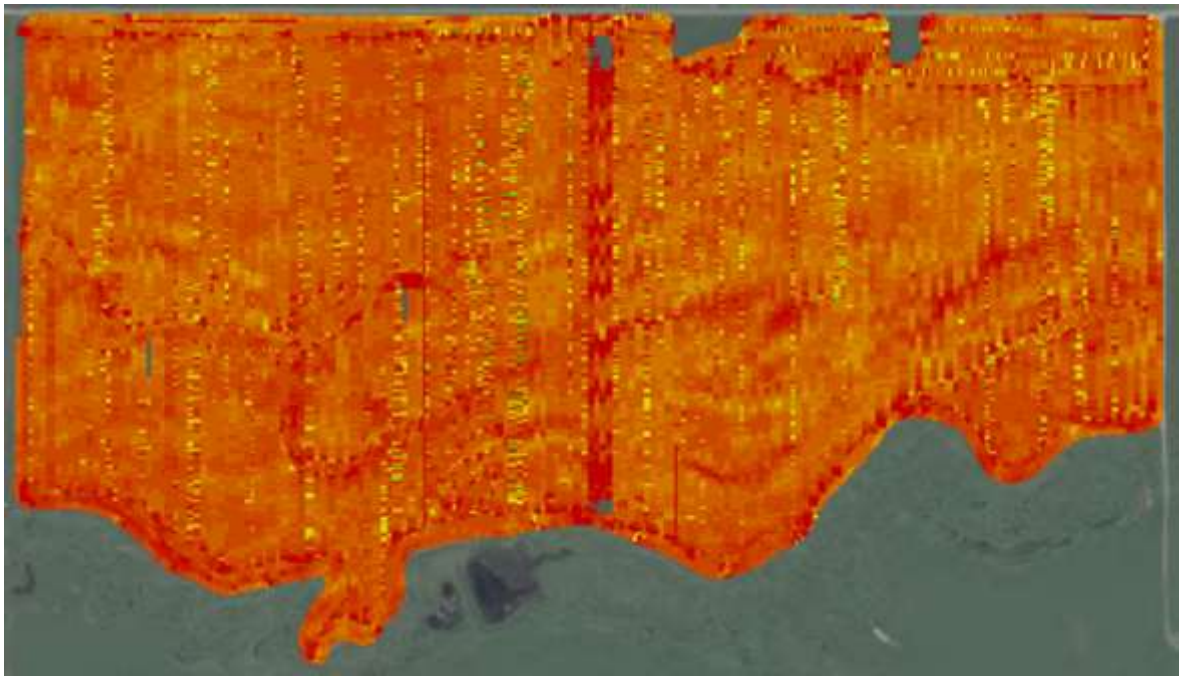
>60% available water until last week of July (0-40 cm) Mid-Slope

Wheat in 2012

Avg yield 61 bu/ac (283 ac)
67 ac yielded 60-65 bu/ac
64 ac yielded 54-60 bu/ac
49 ac yielded 65-71 bu/ac
50 ac yielded 47-54
15 ac yielded > 71 bu/ac
38 ac yielded <47 bu/ac
Fertilizer rate: 95-25-0 (actual N and P_2O_5 lb/ac)

Month	Rainfall mm
April	48.7
May	54.3
June	114.8
July	30.2
August	17.6
September	7
October	51.8
Total	324.4

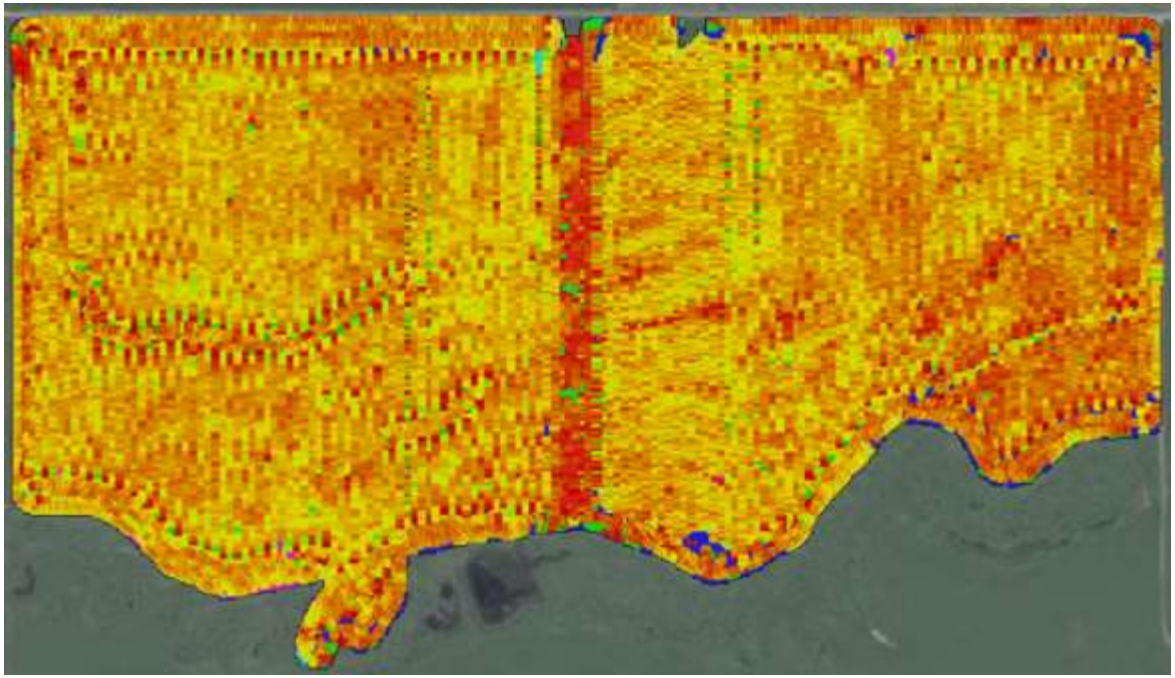
Yield-based continuous management zones



Red low yield; yellow high yield. Map courtesy Western Tractor Lethbridge/Taber

- 100s to 1000s of zones per field
- Fertilization often based on prior crop removal rate or yield goal for next crop
- Fertilizer rate constantly changes over very short distances

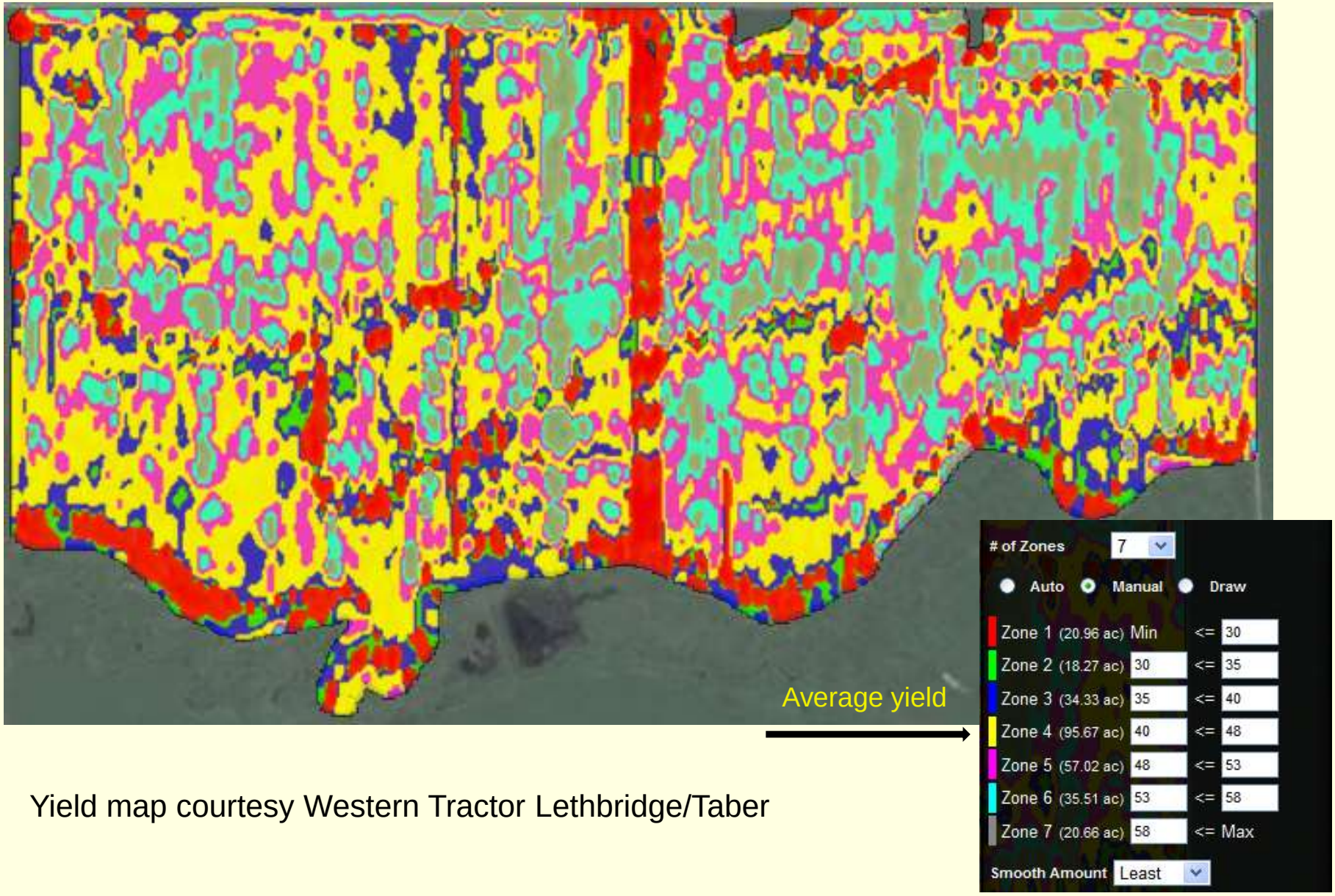
Yield-based continuous management zones



Red low yield; yellow high yield. Map courtesy Western Tractor Lethbridge/Taber

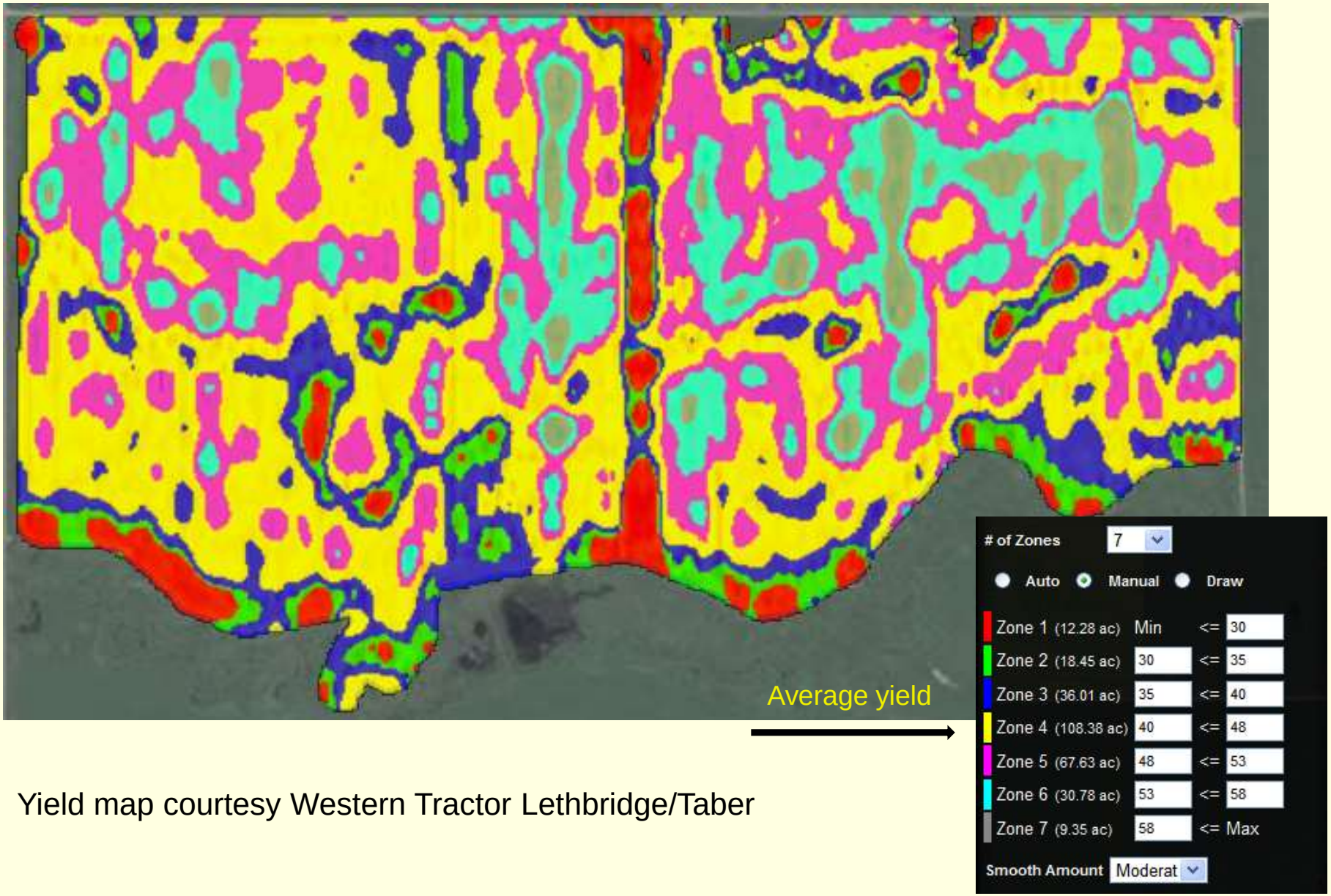
- May work in theory
- But high yield and low yield are often very close together
- Assumes a wide air-seeder can hit a small target (that may move annually)
- Potential for high frequency of fertilizer misapplication

“Least” smoothing 2011 (44 bu/ac avg yield)



Yield map courtesy Western Tractor Lethbridge/Taber

“Moderate” smoothing 2011 (44 bu/ac avg yield)



Yield map courtesy Western Tractor Lethbridge/Taber

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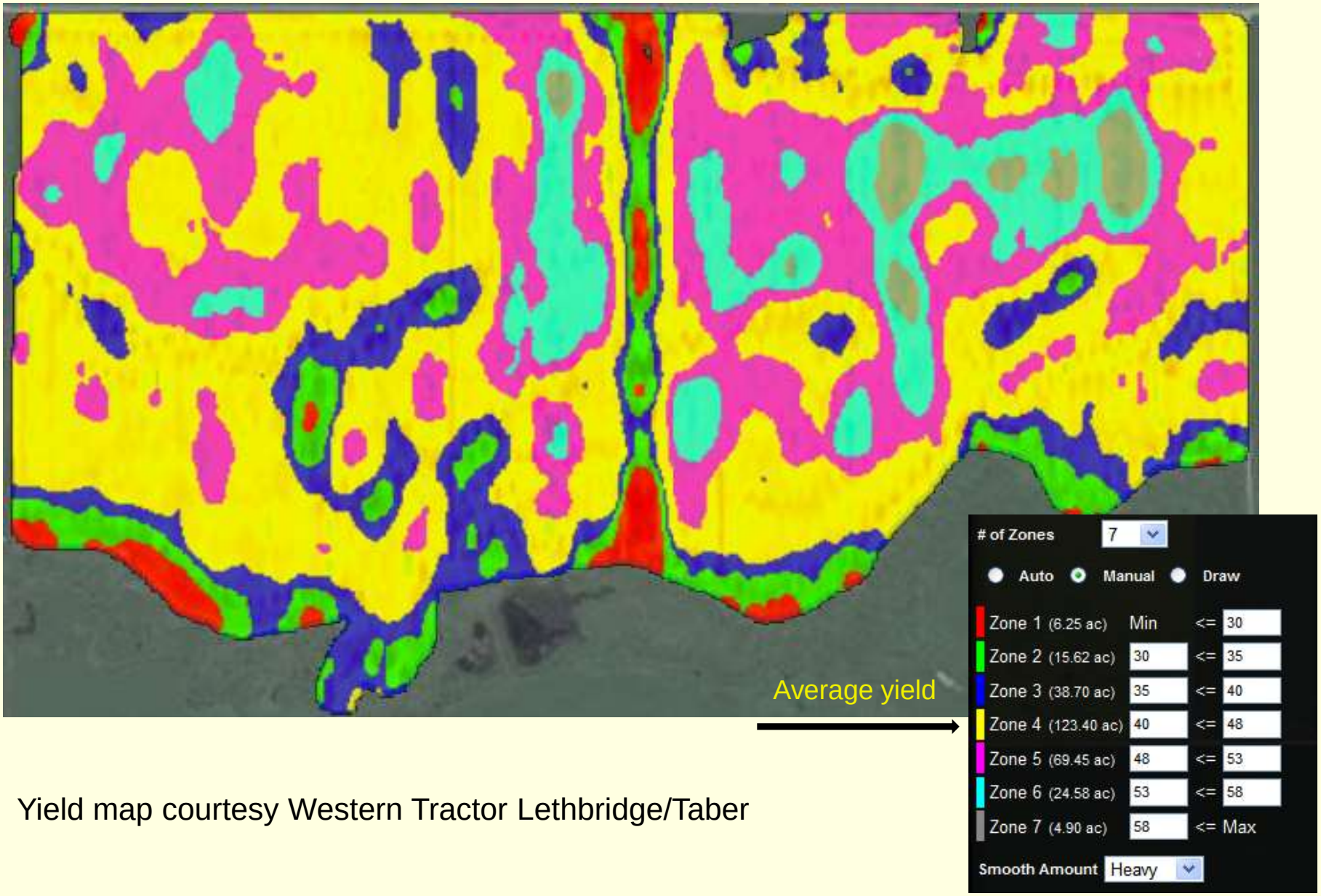
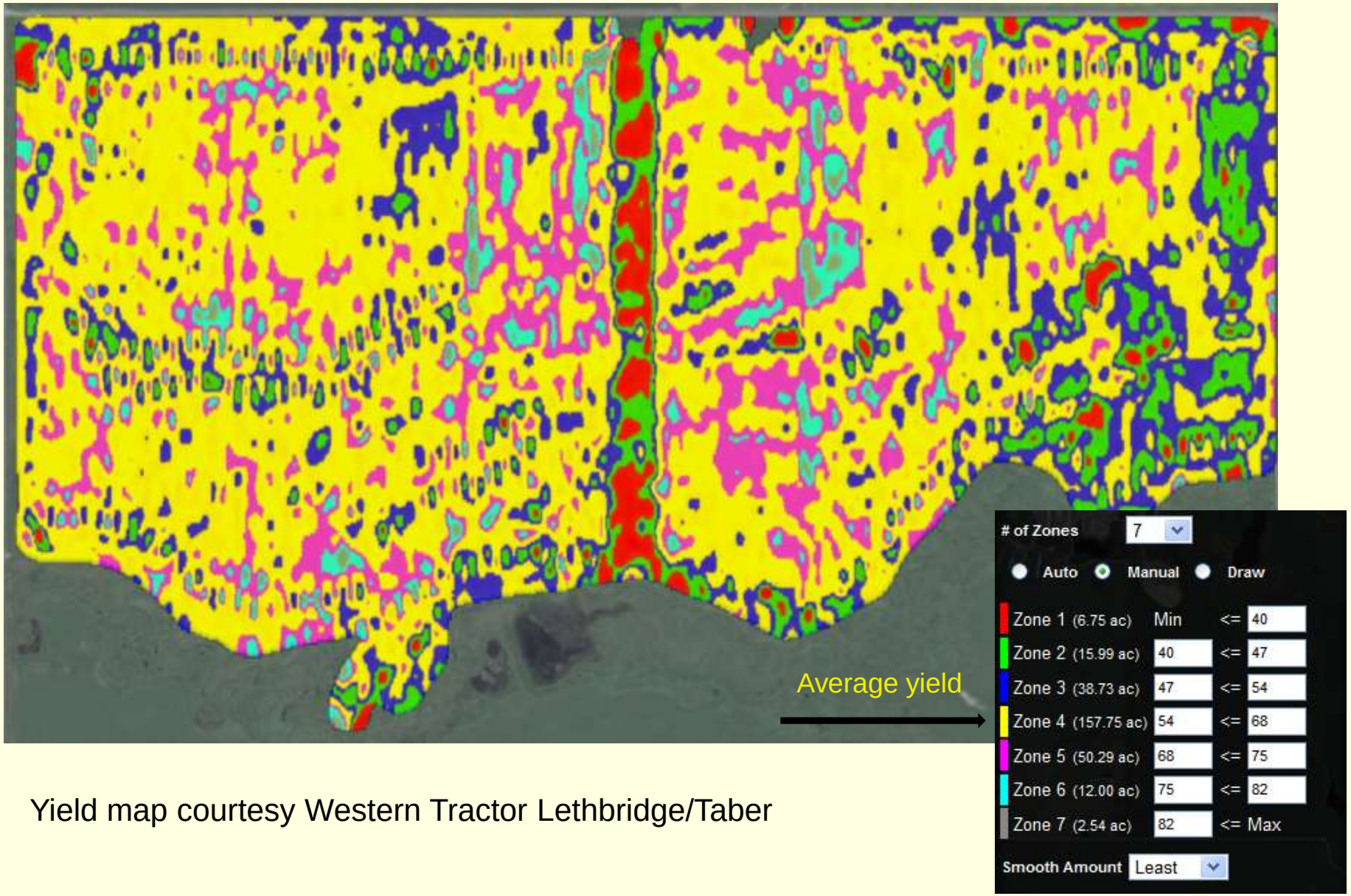


Yield map courtesy Western Tractor Lethbridge/Taber

“Least” smoothing 2012 (61 bu/ac avg yield)



Yield map courtesy Western Tractor Lethbridge/Taber

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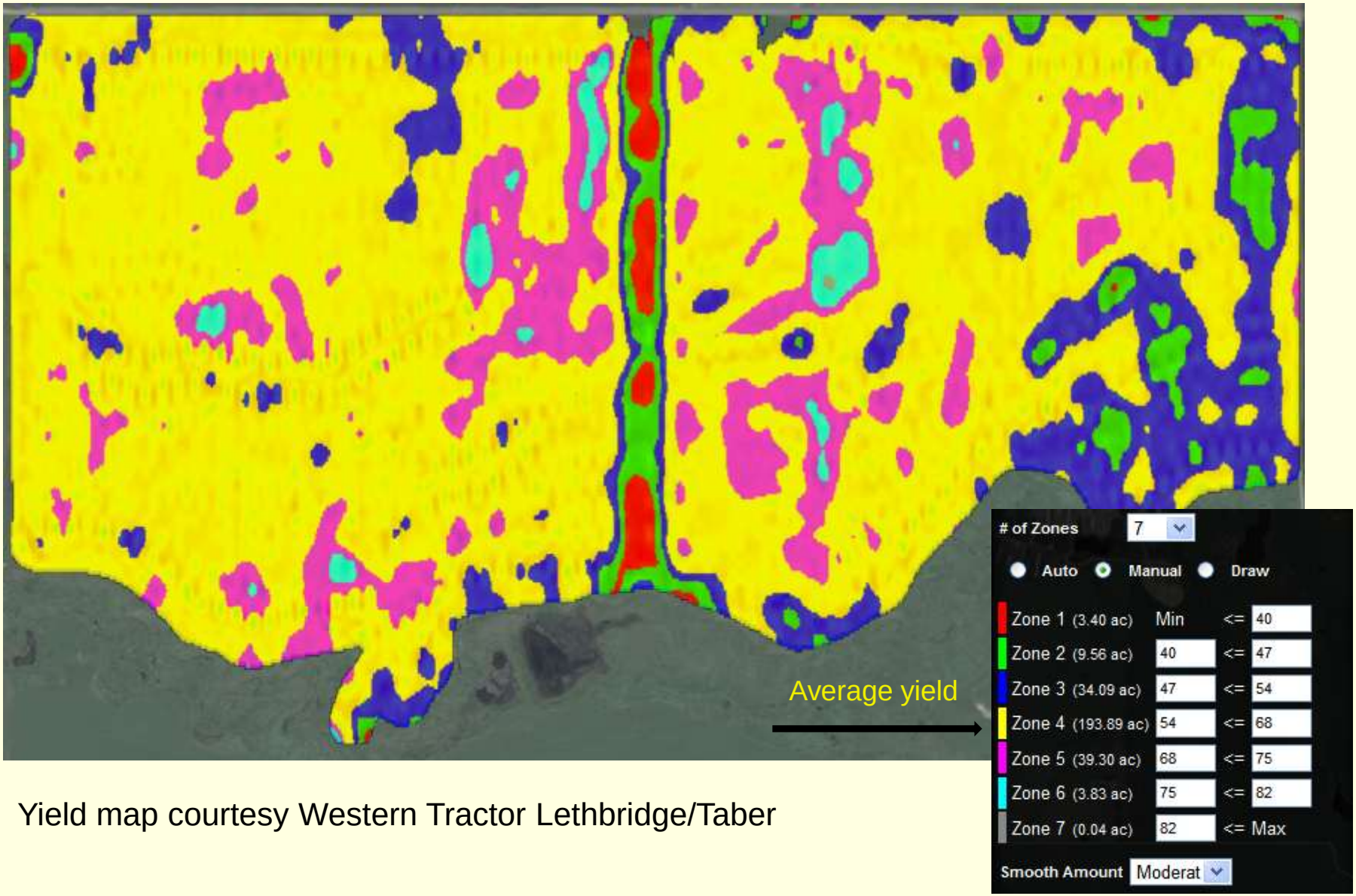

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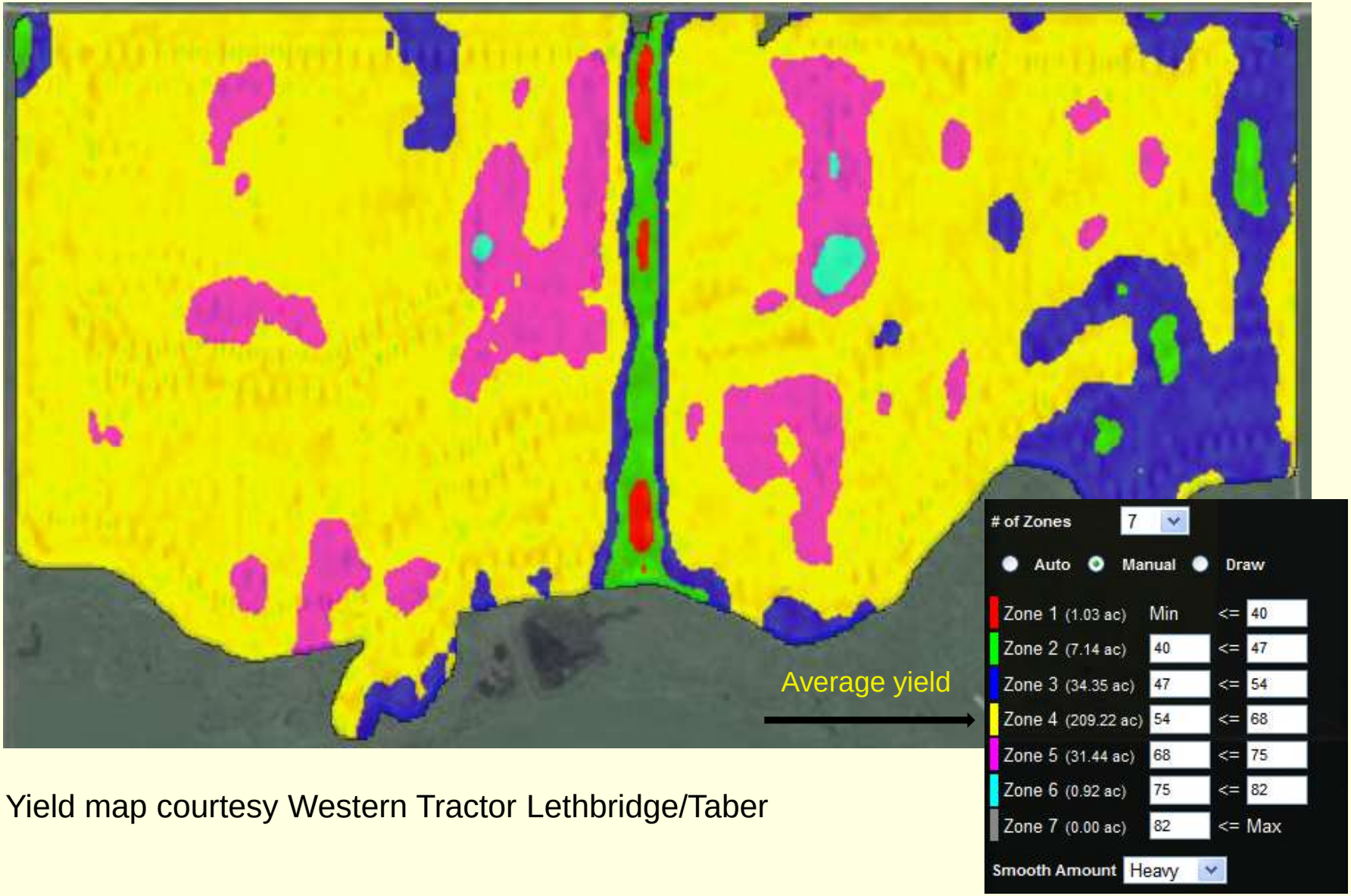
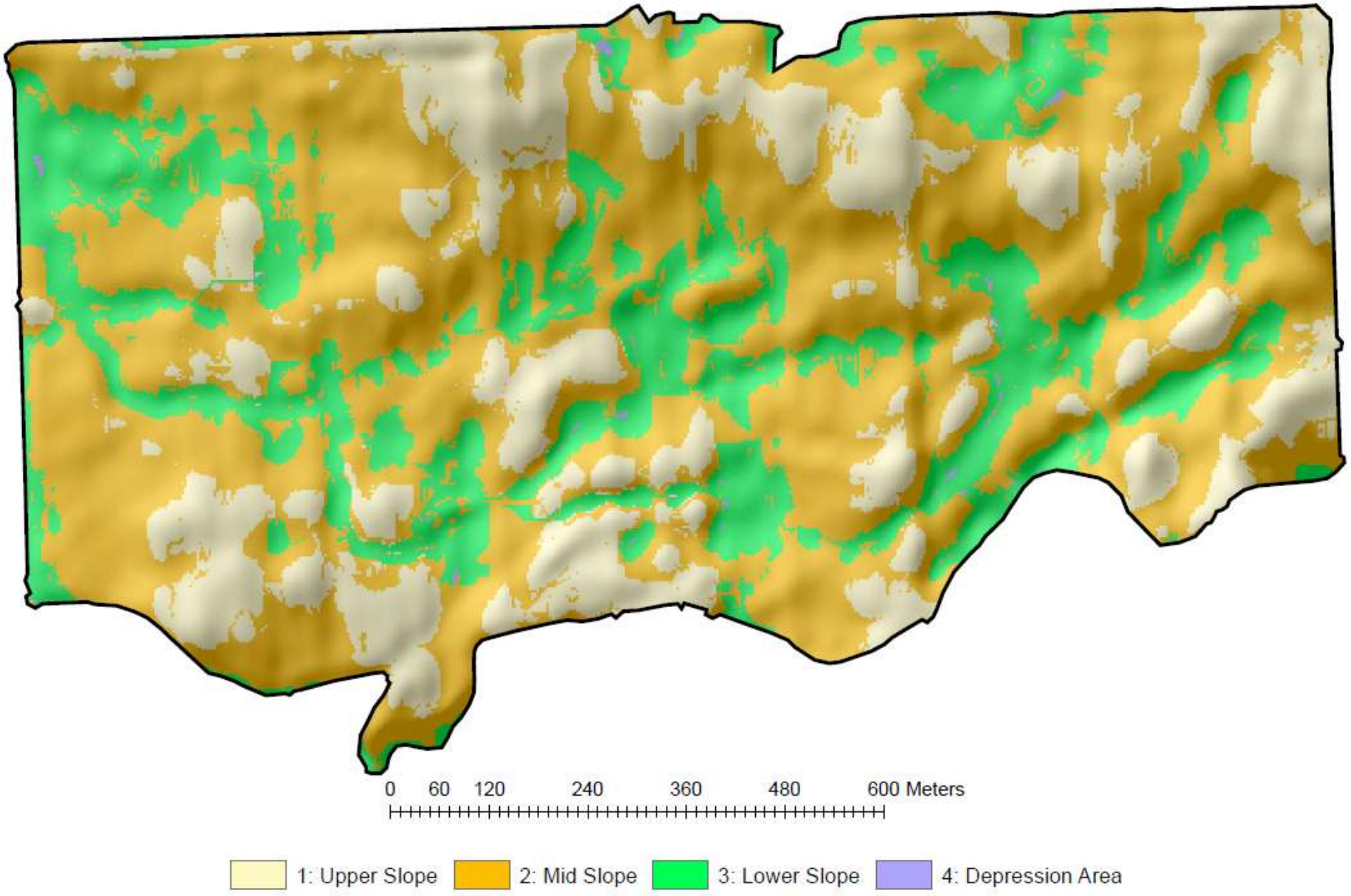


Yield map courtesy Western Tractor Lethbridge/Taber

Yield-based management zones

- When water was less limiting, much more of the field tended to be about average yield
- The “management zones” of a dry year changed in a wet year
- If water was not limiting, would the yield response to fertilization in these 2012 management zones be the same, or would the different zones respond similarly?

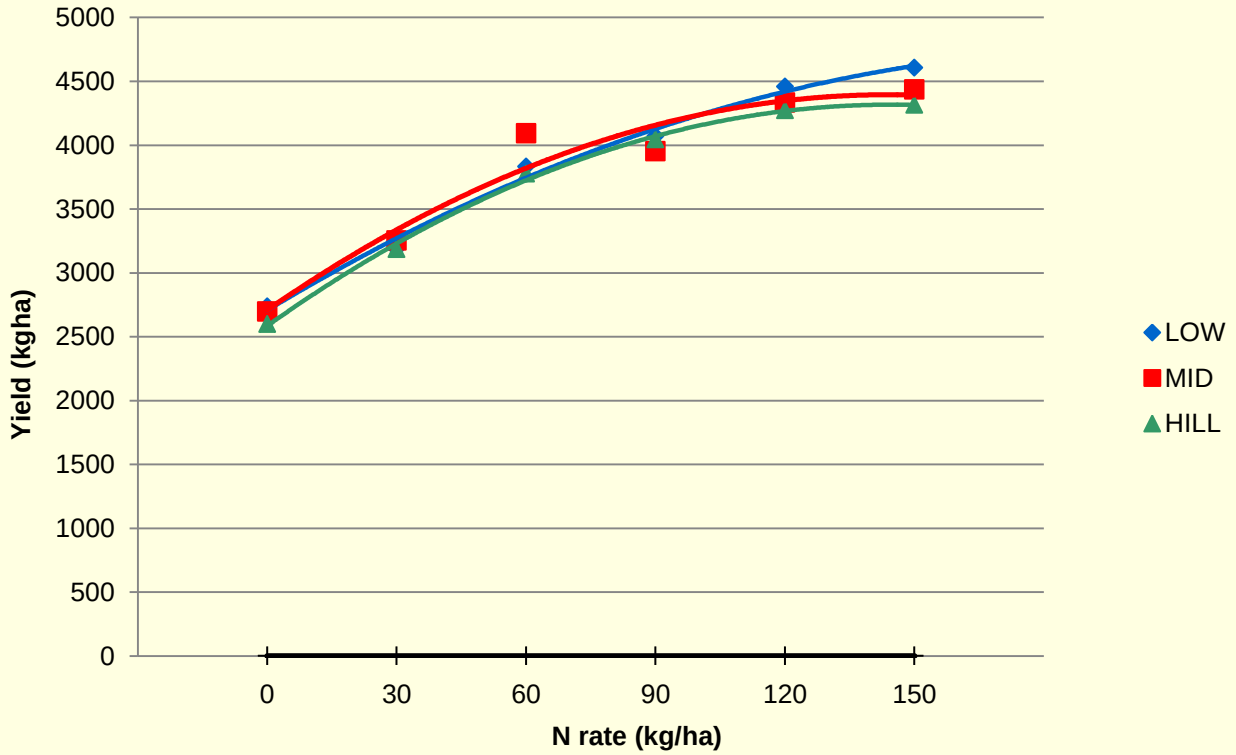


MacMillan landform map prepared by Land Use Section, ARD

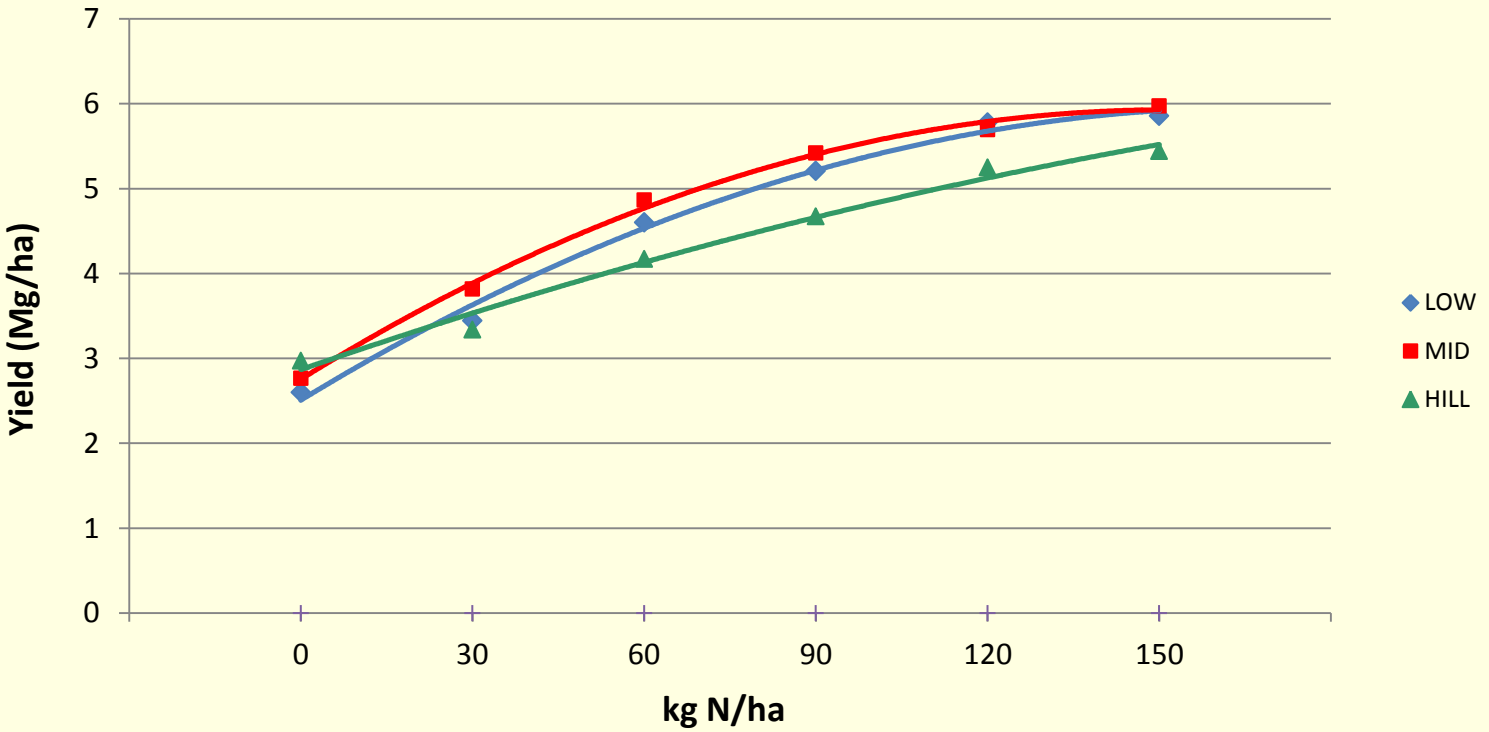
Landform-related soil variability

- P,K, pH, OM associated with landform position
  - P,K, OM low on upper slopes
  - pH high on upper slope
- Not seeing strong variations in soil N across landform positions
- Sulphur often quite low with an occasion high spike in low slope positions

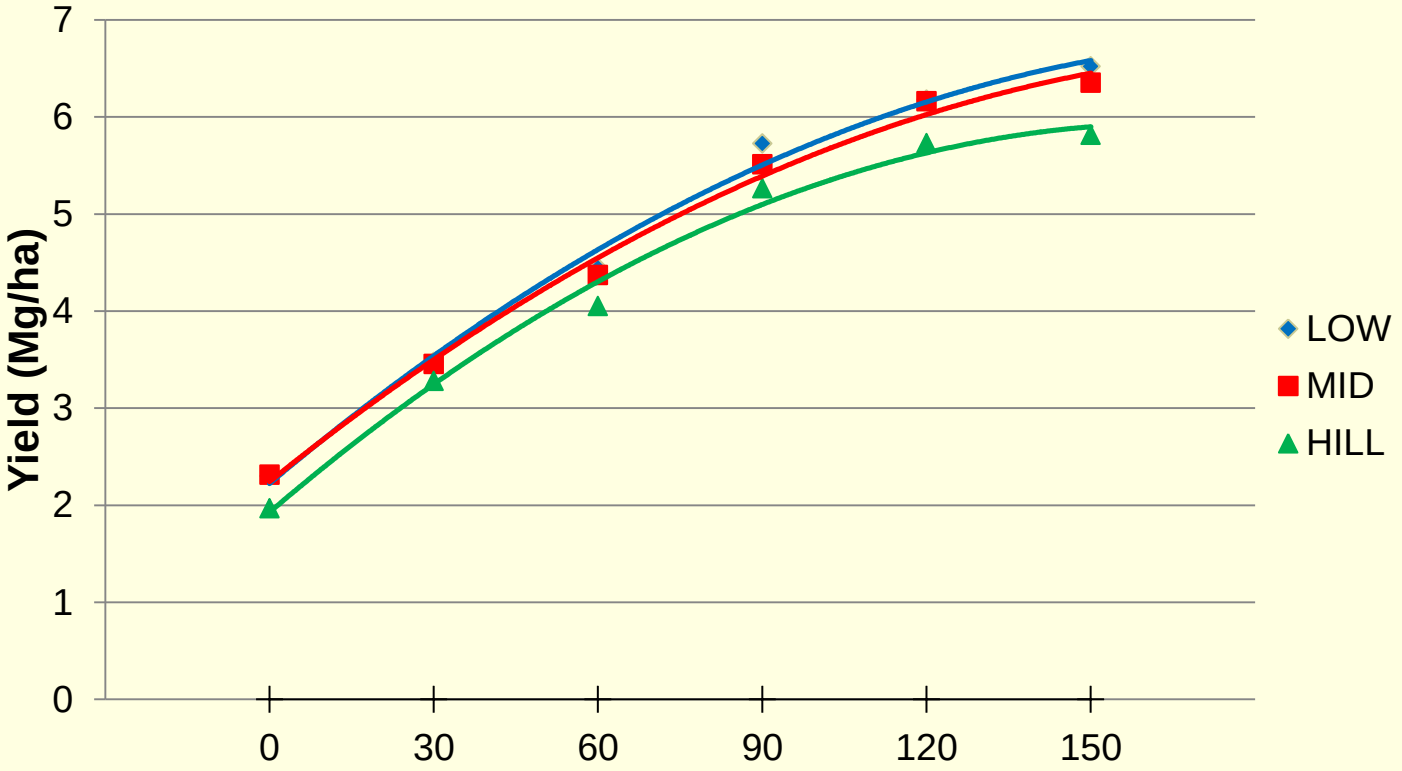
Wheat response to nitrogen: Magrath 2011



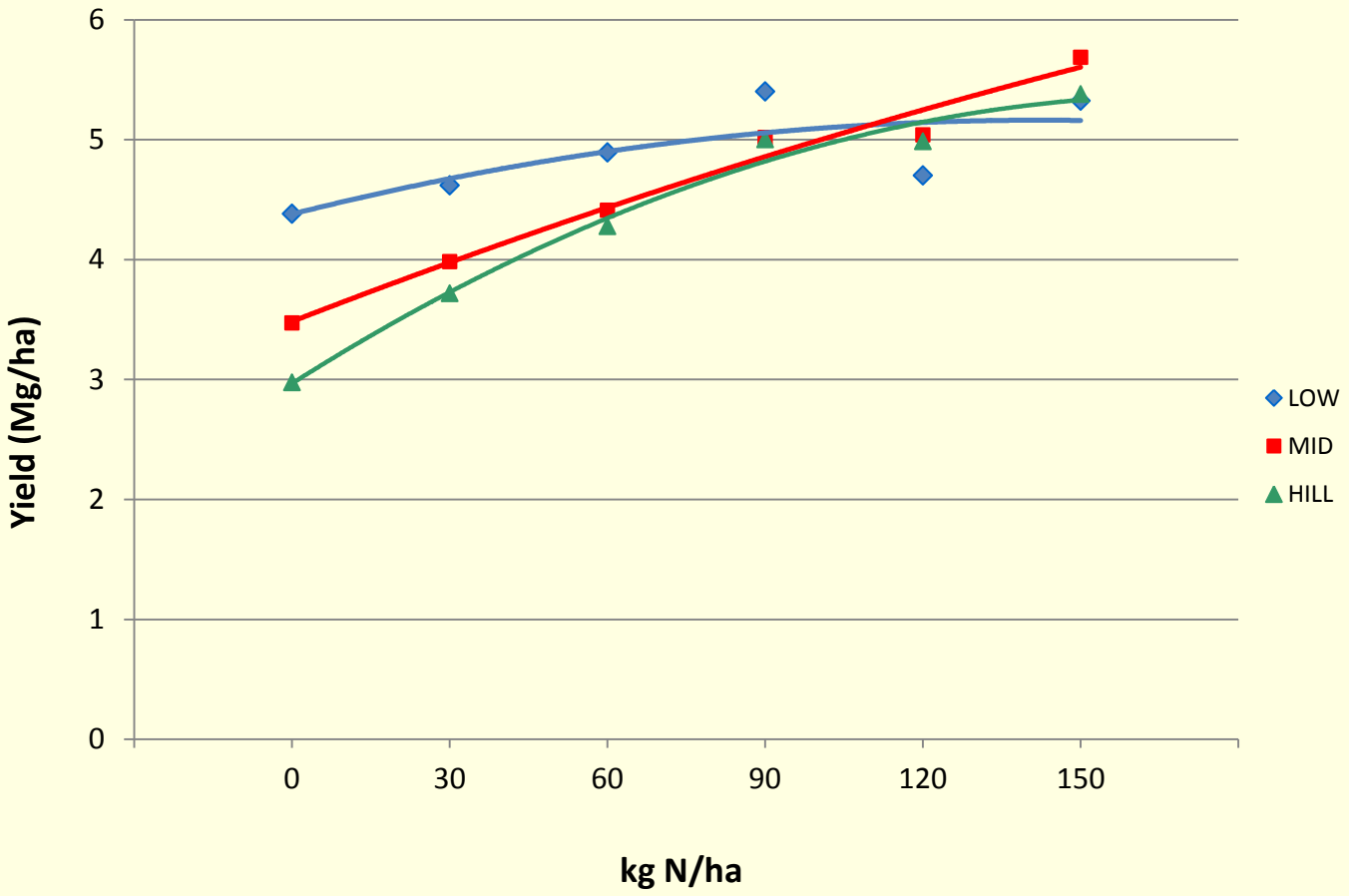
Wheat response to nitrogen: Magrath 2012



Barley response to nitrogen: Magrath 2013



Wheat response to nitrogen: Raymond 2012



Incomplete conclusions

- Yield variability appears to be minimized by “good” moisture conditions
- Yield in landform-based management zones seems to be driven by factors other than fertility
- I suspect/think/guess that variable rate irrigation, where water is not in excess or limiting may be more important than variable rate fertilization.