Applications of Precision Agriculture in Rural Communities

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Pre-mechanization

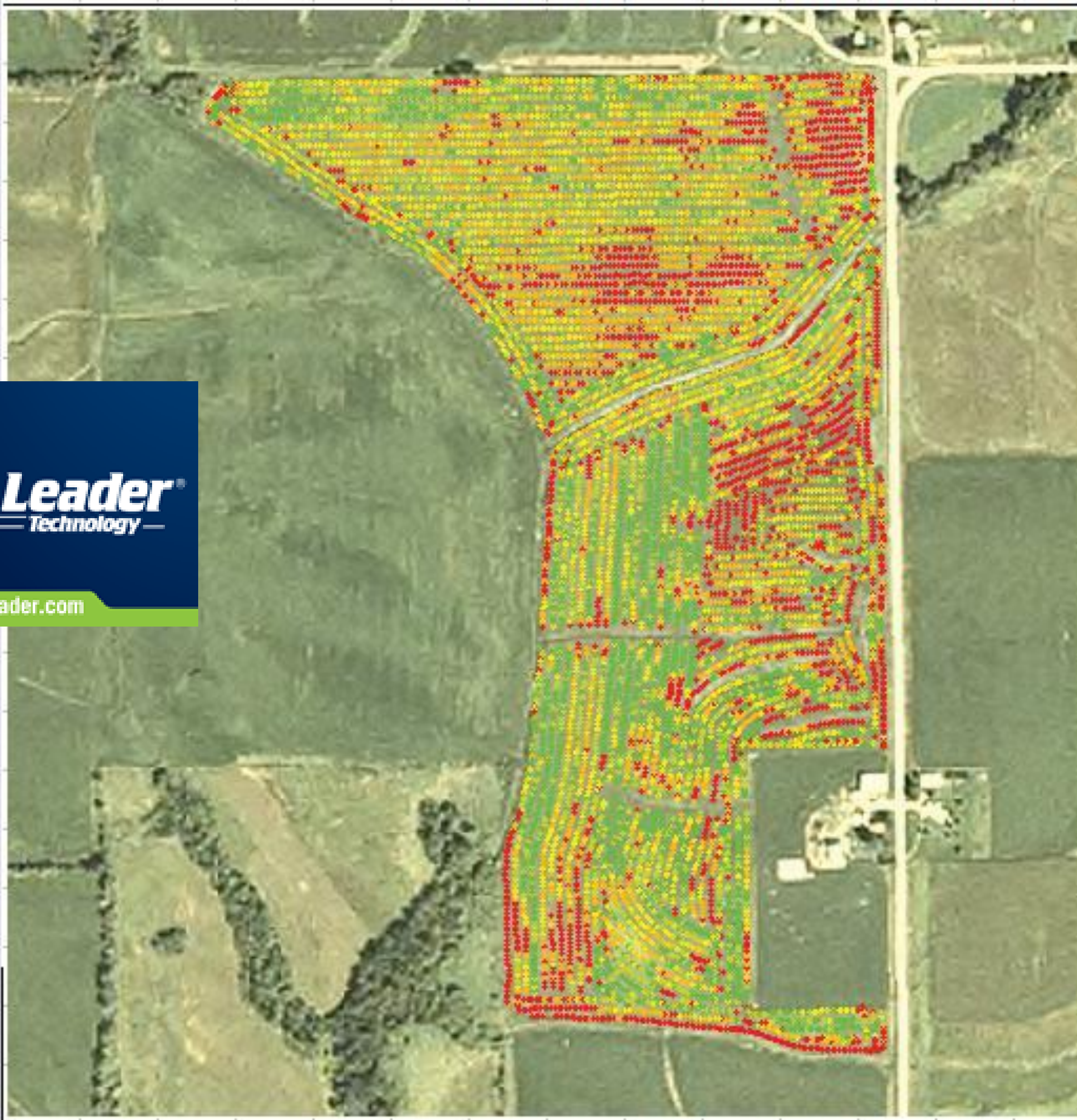
- Farming operations done by hand or with small-scale equipment
- Differing performance of different pieces of ground was an incentive to diversify treatment
- Essentially precision farming

Post-mechanization

- Higher efficiencies of labor and time than in non-mechanized systems
- “Industrial scale” operations
- Equipment and management treat large areas uniformly
- Farming by averages

Credit: Mike Haley, Twitter @farmerhaley

Grain Harvest - East Boender - Low Moist Corn



Grower : Donald Dean

Farm : Boender Farm

Field : East Boender

Operation : Grain Harvest

Crop / Product : Low Moist Corn

Op. Instance : Harvest - 1

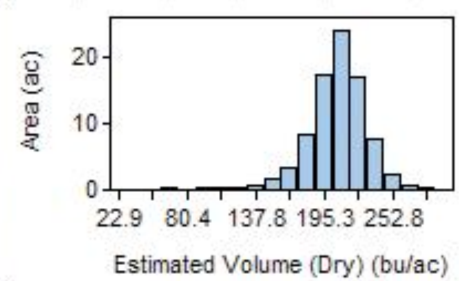
Area : 86 ac

Avg. Yield : 205 bu/ac

Avg. Moisture : 16 %

Estimated Volume (Dry)
(bu/ac)

Above	228	(15 ac)
215 -	228	(17 ac)
204 -	215	(18 ac)
190 -	204	(18 ac)
0 -	190	(18 ac)



Examples of crop development variability in central Iowa US, during 2012 drought

CVI

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What's in Your Field?
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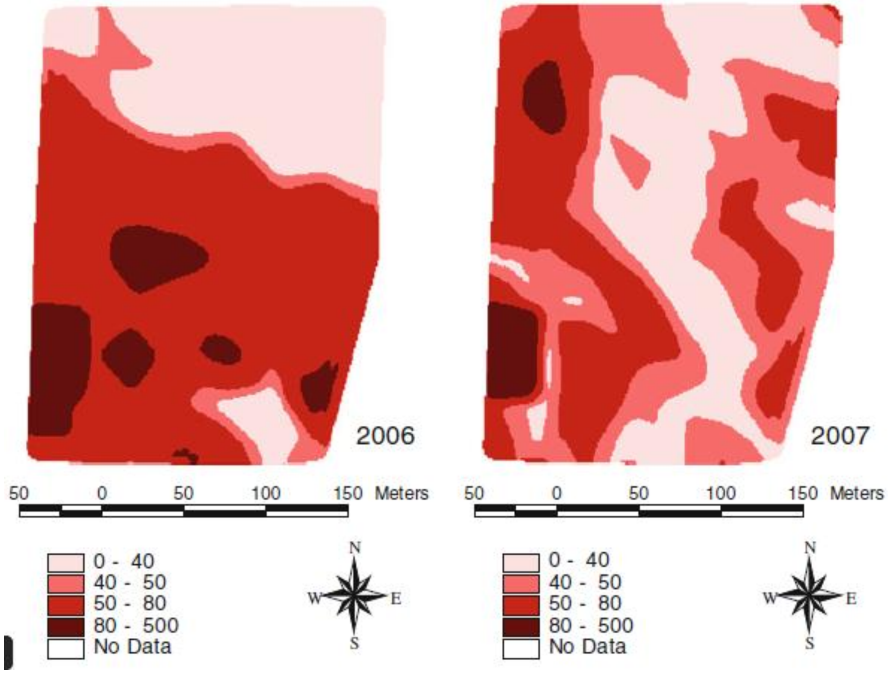
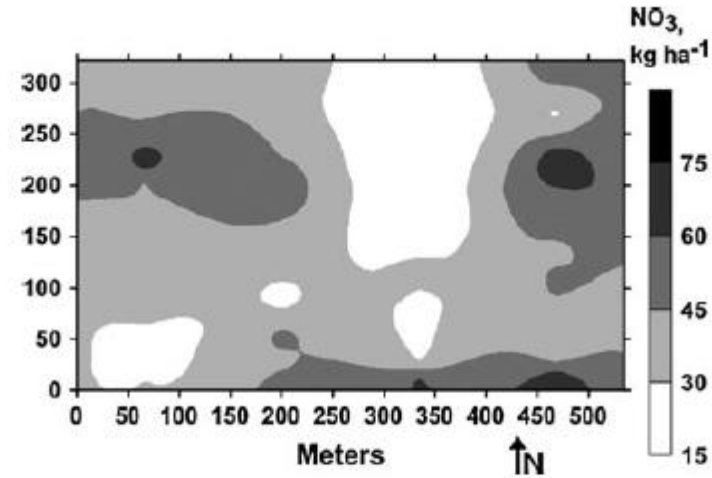
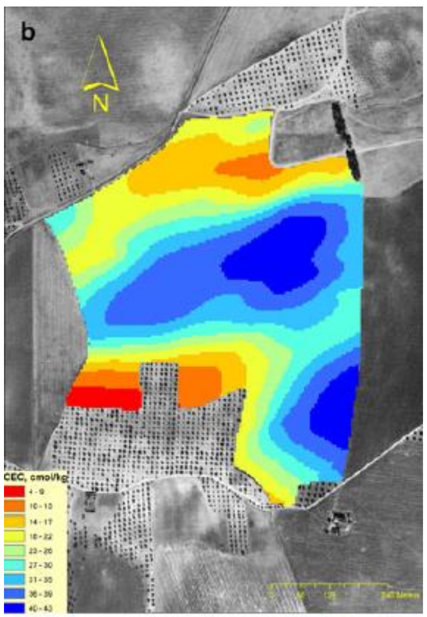


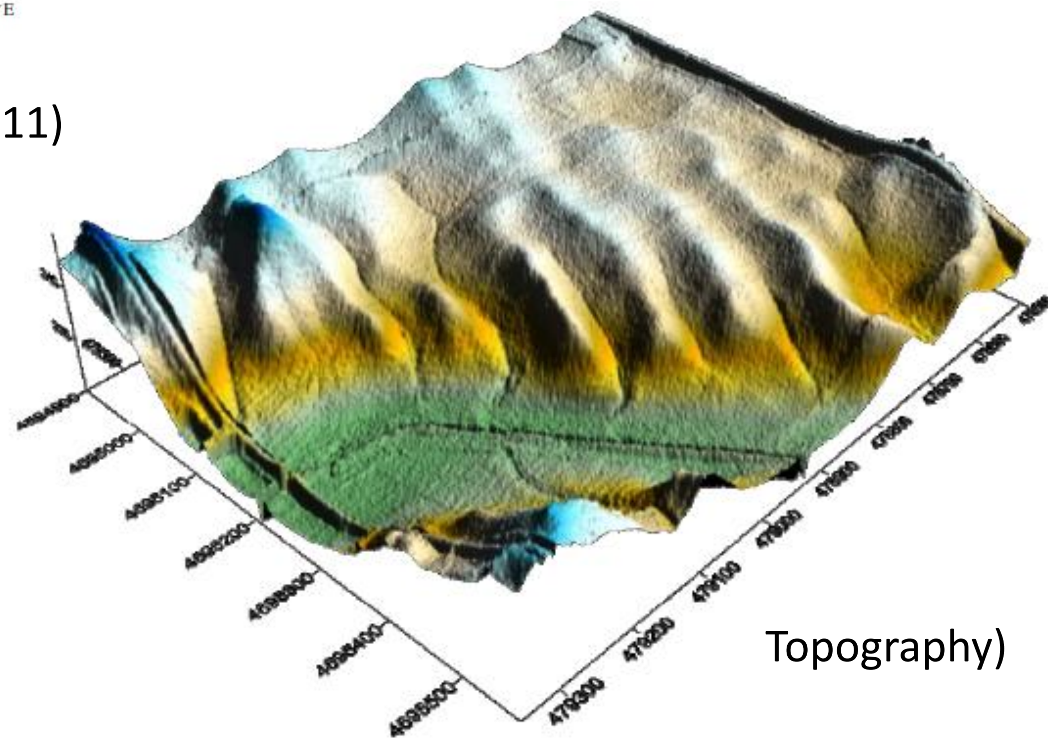
Phosphate concentration (Serrano et al. 2011)



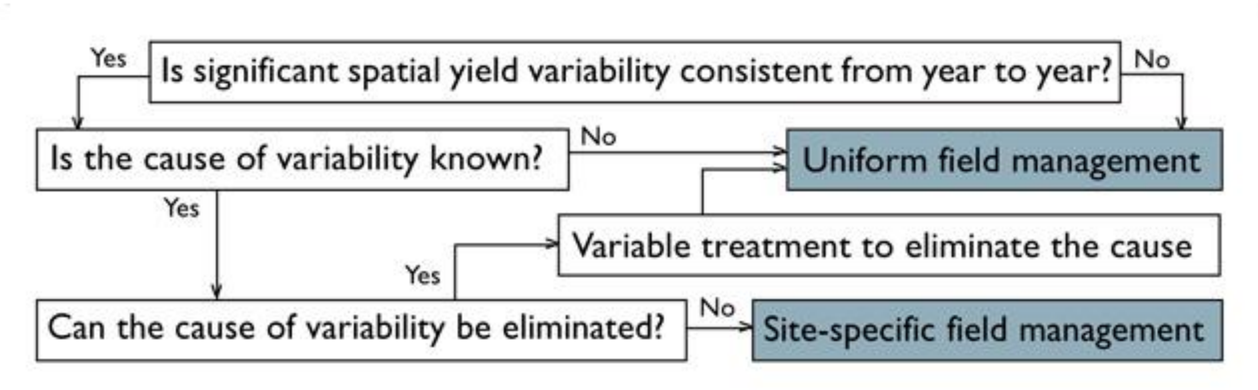
Soil nitrate concentration (Franzen et al. 2011)



Cation exchange capacity (Terron et al. 2011)



Topography)



Is there variability?

↓

Of course there is.

↓

Determine the cause s and effects of the variability

↓

Determine the most appropriate response to the variability

Optimize the production system – consider productivity, profitability, and environmental impact

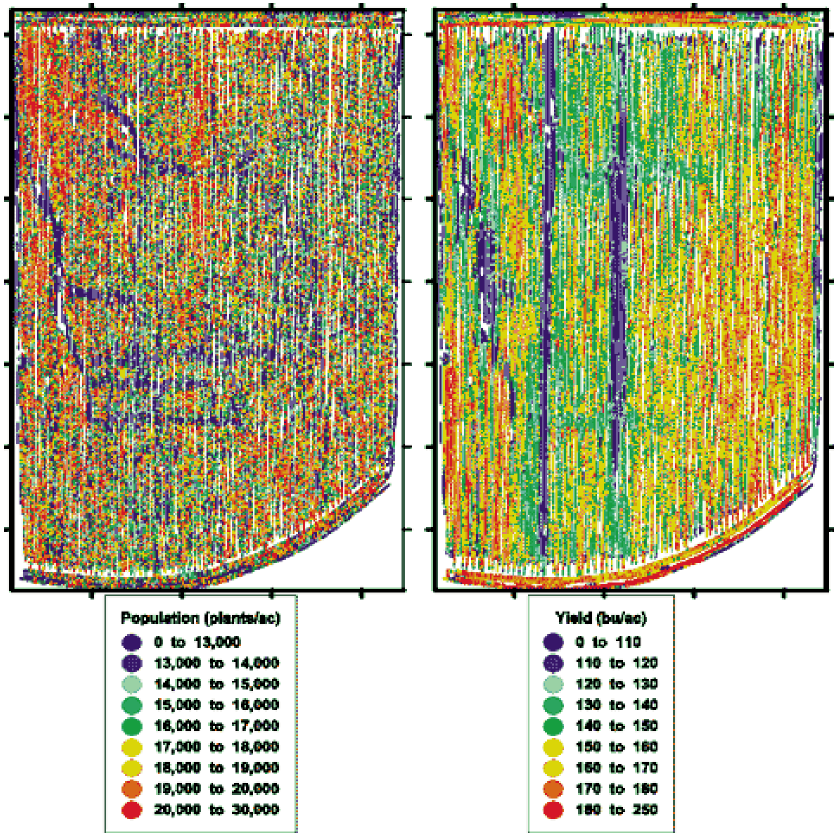
Credit: http://www.simplot.com/farmers/products/technology/yield_monitoring

What will it take?

- Be able to sense and monitor more data
- Know which data is most important under which circumstances
- Know what management will be the most appropriate response
- Have the technology to vary the management accordingly

Sense and monitor

Robust, inexpensive, smart sensors, both remote and *in situ*



Observations:

Soil water content and temperature

Soil chemistry (esp. nutrients and salts)

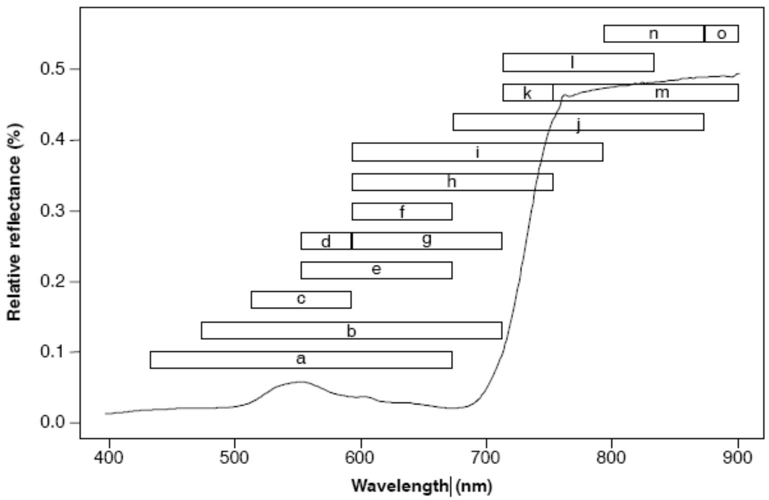
Soil texture

Plant biomass

Plant health

Crop growth stage

Equipment performance

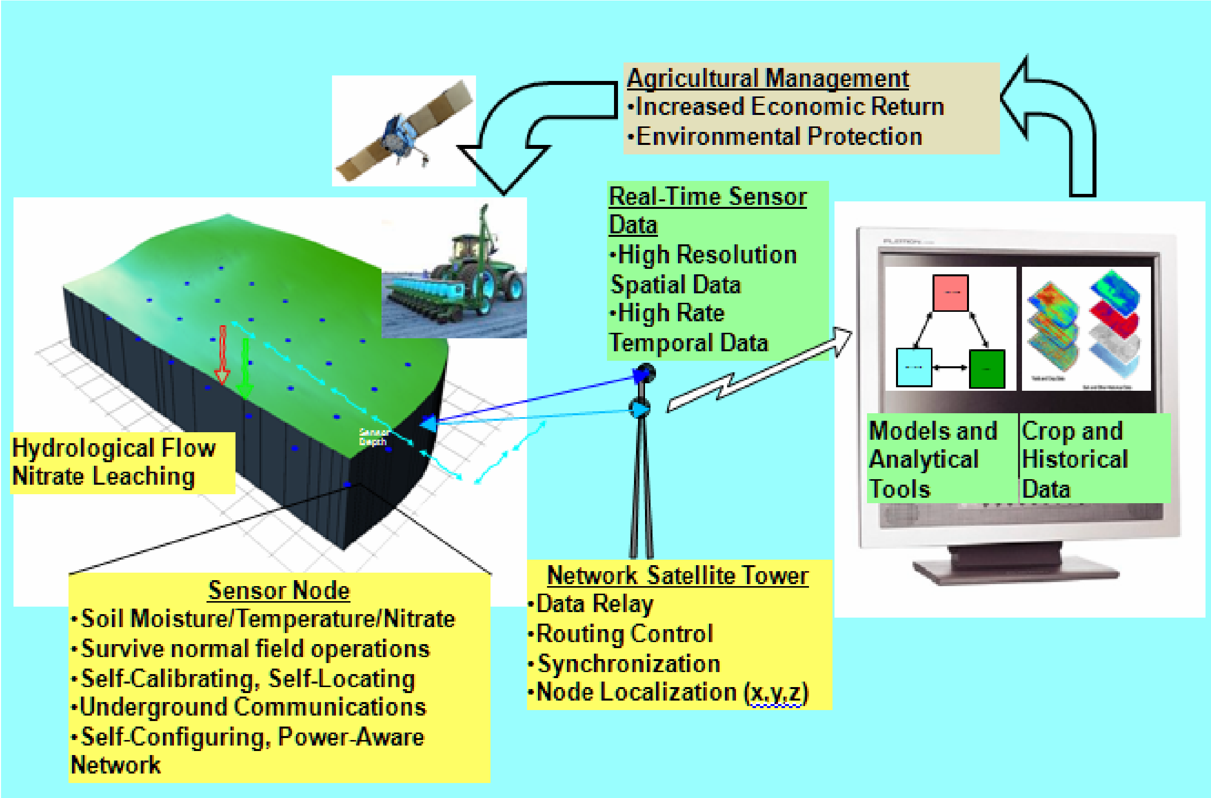


Different spatial and temporal resolutions needed for different observations

Communicate data

Communication networks

- From sensor(s) point of decision
- From point of decision to point of response
- To logger when necessary



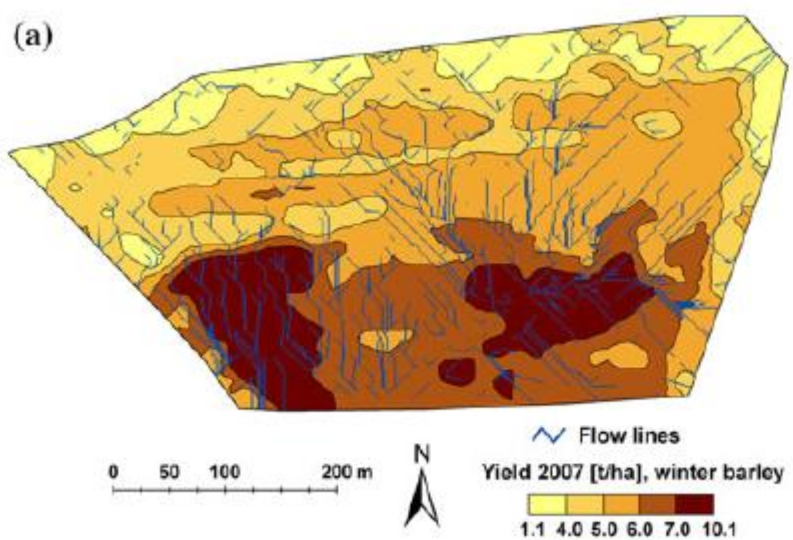
Frontier 2: Knowledge to Information

Internet of (Agricultural) Things

- Cataloging and tracking
- Historical maps for recurring trends;
- On-the-go maps for instantaneous conditions
- separating the stationary from the non-stationary
- Determination of management zones

Frontier 2: Knowledge to Information

Knowledge is half the battle.



Kumhalova et al. 2011

Knowing what to do with it is the other half.

- Finding relationships and making predictions in nonlinear systems
  - Machine learning;
  - Data fusion
  - Data assimilation
- Data → Action

Frontier 3: Nimble Decision & Response Systems

- Control systems
- Decision systems that can account for uncertainty
- Adaptable to new circumstances

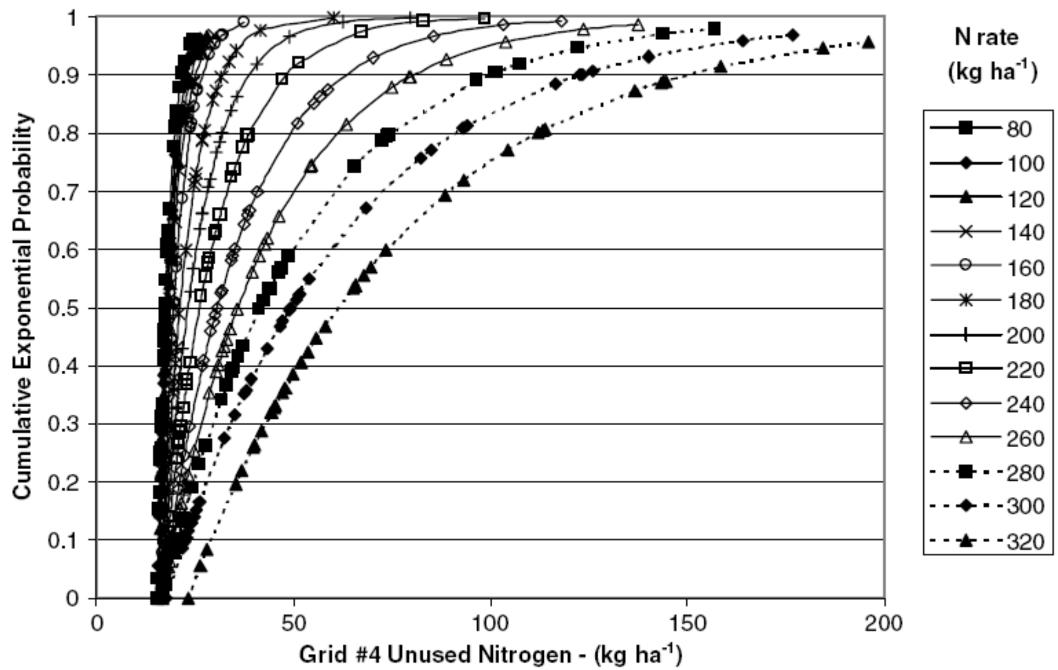
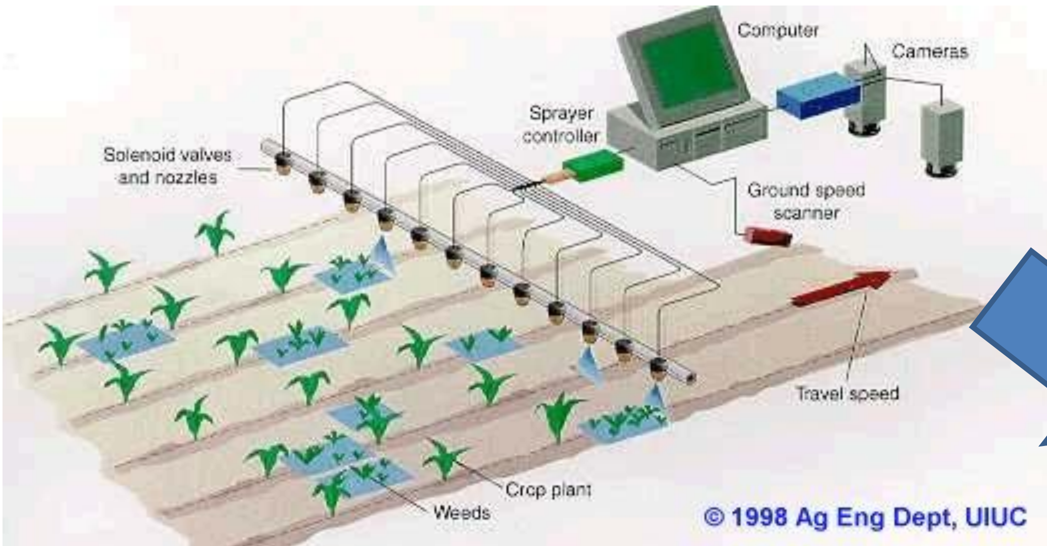


Fig. 7. Cumulative exponential probability of unused N in grid cell #4 for N rates of 80–320 kg ha^{-1}.

Thorp, et al. (2006)

Frontier 3: Nimble Decision & Response Systems



Smaller, more flexible equipment

Opportunities in the developing world

- Leapfrogging over uniform mechanized management
- Applications for smaller fields
- Capitalizing on local knowledge
- Adaptation to low-technology environment

Arago Galindo et al. 2012