Irrigation vs. Rainfall...

- Irrigation is basically recycled rainfall re-applied to crops.
- Most of the production practices for high yielding corn under irrigation are similar to high yielding corn grown under adequate rainfall.
What is the greatest single obstacle to consistently achieving higher corn yields?

“Normal” Weather

“Normal” weather can be defined by an unpredictable number of unpredictable extreme weather events, each occurring unpredictably, with unpredictable severity.

Greater climate variability today = Higher frequency of extreme weather events
Consequently, our greatest agronomic challenge today is to stress-proof our crops against unpredictable, extreme weather events.

The unfortunate reality …

- Effects of unpredictable extreme weather on crop growth and yield are amplified by the existence of other yield limiting factors.
  - Excessive rainfall + poor soil drainage + compacted soil layers.
The opportunity…

Identifying and managing these other yield limiting factors can help improve the resilience of your crops against the uncertainty of Mother Nature.


http://msue.anr.msu.edu/program/info/irrigation
Grain yield is the product of the season-long development of the individual components of yield.

Optimizing yield requires optimizing each component.

High yields require attention to detail all season long...

Season-long development of yield components

Source of graphic: Nielsen’s imagination
The key to **consistently** producing high-yielding corn...

…is the ability to accurately identify AND successfully mitigate the Yield Limiting Factors (YLFs) specific to your farming operation.

If you fail to do so…
Low vs. high yielding areas…

- Some would say to not waste fertilizer dollars in the low-yielding areas.
  - When, in fact, maybe the area is low-yielding because it is deficient for soil nutrients and, therefore, actually needs more fertilizer than the higher-yielding areas.

Low vs. high yielding areas…

- Some would say to simply position a “defensive” hybrid in those low-yielding areas to address the problem.
  - Unless you have identified the underlying causes of the low yields, you cannot smartly choose the appropriate set of “defensive” hybrid characteristics necessary to address the problem.
How to identify YLFs?

- Spend time with your crops.
  - Learn all you can about important yield limiting factors.
  - Ask for help from experts.
  - Walk your fields, scout for problems, and take extensive notes throughout the entire growing season.
  - Document every aspect of your crop production.

Take advantage of handheld GPS technologies…

- …to map, GPS-tag & document problem areas in your fields.
  - Crop scouting & mapping “apps”
  - Simple note-taking “apps”
  - Smartphone cameras
  - Use with other GIS information to help diagnose possible causes of problems
Use yield monitor data...

...to help you visualize problem areas and then physically navigate to those areas using your handheld scouting “app” to diagnose or verify the causes.

Remotely sensed imagery

- Equipment-mounted crop sensors
  - e.g., GreenSeeker®, OptRx®
- Satellite imagery
- Aerial imagery
  - Handheld cameras
  - Professional cameras
  - Unmanned aircraft systems (UAS)
Remotely sensed imagery…

- ...supplements yield maps in identifying and locating problem areas within your fields.
- ...can identify problem areas prior to harvest.
  - May enable earlier & more accurate crop problem diagnostics and, possibly, in-season mitigation of crop problems (foliar fungicide, late N applic’s).
- ...does not, however, diagnose the causes of crop problems by itself.
  - E.g., light green corn is not always N deficient.

Use Precision Ag technologies to supplement, not replace, old-fashioned “boots on the ground” technology
Corn needs a lot of water

- From 20 to 25 inches (soil reserves + rainfall + irrigation).
  - An acre-inch of water equals 27,154 gallons; so an acre of corn requires as much as 678,850 gallons of water in a growing season.
  - Potential soil moisture reserve depends primarily on soil texture, but also on soil organic matter, rooting depth, & infiltration.

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**Range of Water Holding Capacities Among Soil Textures**

Source: Physical Properties of Soil and Soil Water. Univ of Nebraska; Plant & Soil Sciences eLibrary. 
http://passel.unl.edu/pages/printinformationmodule.php?tidinformationmodule=1130447039
Soil moisture availability…

- Also depends on the effective rooting depth of the crop.
- Root depth in corn is easily 3 to 4 ft; up to as much as 5 to 6 ft.
- However, “effective” rooting depth varies a lot one field to another.

Effective rooting depth in corn

- While inherent soil characteristics set the limit on potential rooting depth, other factors influence effective rooting depth.
  - Hybrids vary for root development.
  - Soil moisture & temperature influence roots.
  - Soil nutrient availability influences roots.
  - Natural hard pans limit root development.
  - Poorly-drained soils limit root development.
  - Soil compaction limits root development.
Improve soil drainage where needed and feasible

- Improved drainage reduces the risk of…
  - Ponding & saturated soils
  - Soil nitrate-N loss
  - Soil compaction from tillage, planter, & other field equipment operations
  - Cloddy seedbeds from tillage

- Enables successful root development and stand establishment of the crop

Tillage & soil compaction

- Reduce the # of tillage trips
  - Fewer opportunities to create soil compaction.
  - Reduces soil moisture evaporation.
  - Increases snow capture and rainfall infiltration while lowering risk of surface run-off.

- Minimize soil compaction opportunities due to tillage tools, planters, combines, spreaders & applicators, grain carts, etc.
Yeah, but all this corn stover…

High yielding corn fields leave behind a lot of corn stover that causes all sorts of headaches for the succeeding crop.

Options to manage the stover…

- Stalk chopping, rolling, mashing with the combine header during harvest
- Fall stalk mowing or shredding
- Baling and removing some of it
- Vertical tillage that “sizes” stover into smaller pieces and buries some of it
- Strip tillage (planter performance)
- Row cleaners (trash whippers) on planter
- Aggressive fall / spring tillage
Irrigation management…

- Irrigation efficiency relies partly on optimum maintenance & proper operation of the irrigation system (Lyndon Kelley).
  - The results of over 400 system evaluations in Delaware showed over 50% applied 20% less water than the timer setting charts predicted.

  Source: James Adkins, Univ of Delaware

Also relies on deciding when to irrigate and how much water to apply.

- Capacity of irrigation water supply
  - Well, reservoir, river, drainage ditch
  - Pump capacity (gal/min)
- Efficiency (accuracy) of irrigation system
- Soil water holding capacity & current status
- Actual and anticipated rainfall
- Water needs (ET) of the crop
Evapo-transpiration (ET) by corn

- Early in the season, ET is primarily driven by soil moisture evaporation.
- As plants develop, ET is driven primarily by transpiration by the plants, but declines as plants mature during grain fill.
- Thus, seasonal ET for a corn crop looks like a typical “bell” curve...

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**Daily Water Use by Corn at Two Temperature Ranges**

- Daily ET influenced by growth stage, temperature, relative humidity, sunlight intensity

Data: Univ of Minnesota
Watering rules of thumb

- Soil moisture near field capacity at planting favors rapid germination & seedling growth.
- Avoidance of excessive soil moisture during the first 30 to 45 days after planting favors deeper rooting of the crop.
- Avoid “getting behind” on soil moisture as the crop moves through the pollination and early kernel set phases.
- Maintain adequate soil moisture to meet crop ET all the way to kernel black layer.

Cold water + Hot days = Injury?

- Anecdotal evidence that cold irrigation water on a hot day can scorch or scald upper leaves and otherwise damage the crop, but is not well documented.
- More likely due to a combination of inadequate root system & inadequate soil moisture availability that results in inadequate transpiration rates and excessive leaf tissue temperatures.
PLANT POPULATIONS

Reported Plant Populations – Indiana vs. Nebraska
USDA-NASS, 2015

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<th>Plant population per acre</th>
<th>Indiana</th>
<th>Nebraska</th>
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<td>29250</td>
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<tr>
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© Purdue Univ
Since 2008, we’ve conducted nearly 80 trials around the state.

- All field-scale, majority are on-farm research.
- Trials range in size from 30 to 100 acres.
- Various hybrids, but 27 trials were split-planter hybrid comparisons, purposefully chosen.
- Most at farmer’s normal N rate, but 8 trials w/ normal and higher than normal N rates.

**FEW IRRIGATED TRIALS**
Consider on-farm seeding rate trials

- Help you identify your overall “ballpark” optimum plant populations.
- Help you “tease out” specific yield responses to plant population for hybrids, N rates, spatial “zones” in fields.
- Help you maximize $ return to you from your seed input investment.

The layout could be similar to what we’ve done with our N trials; 4 reps of 5 seeding rates in a field with and without irrigation.
Irrigated Corn Management Practices

**Yield Response to Population**

- 55 trials, AO pop = 32,000
  - "Normal" range of growing conditions

- 12 trials, AO pop = 24,400
  - Primarily severe drought stress

"AO" = Agronomically Optimum

**Agronomic Optimum Population vs. Yield Level**

- 57 trials (excluding severe stress sites)

- No clear relationship between AGRONOMIC optimum population & yield level from about 140 bu/ac to about 240 bu/ac

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While the agronomic optimum plant population is technically 32k plants per acre, the yield response curve is so flat that final stands anywhere between ~ 29k and ~35k will yield close to optimum.

Consequently, the economics change significantly with any combination of expected grain price or seed cost.
Bottom line on plant population

- Our research: Two agronomic “sweet spots” for plant population for corn in Indiana.
  - Productive soils: Low 30’s FINAL stand
  - Droughty soils: Mid 20’s FINAL stand
  - Economic populations are at least several thousand less than these agronomic optimums.

- Our research: Few meaningful differences among hybrids or “management zones” for agronomic optimum populations.

Online summary...

Hybrid selection…

- More $$ to be gained or lost with this agronomic decision than almost any other!
  - Yields among “good” hybrids can easily vary 20 to 40 bu/ac in same field!
- Identifying good hybrids is NOT easy!
- Farmers ought not to relegate this decision solely to their seed dealer.
Not simply about yield potential

- But, also the ability of hybrids to perform consistently well across a wide range of growing conditions… because you don’t know what next year will bring.
- The evidence lies in the results of variety trials conducted across a wide range of locations, because those represent a “sampling” of possible growing conditions.

Crop traits in addition to yield

- Emergence & seedling vigor
  - Early season soils often wetter & cooler
- Resistance to important diseases
  - Seedling, foliar, stalk/ear rots
- Stalk & root health
- Overall stalk strength
- Drought tolerance
- Overall stress tolerance
- Transgenic insect resistance (Bt)
  - Rootworm & corn borer
Hybrid trial data online...

In addition to asking for seed company results, look at university & other independent variety trial results online...

Email: rnielsen@purdue.edu

Twitter: @PurdueCornGuy

Web: www.kingcorn.org/caffe