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CORN GUY INDIANA

Agronomic Practices for Irrigated Corn Production

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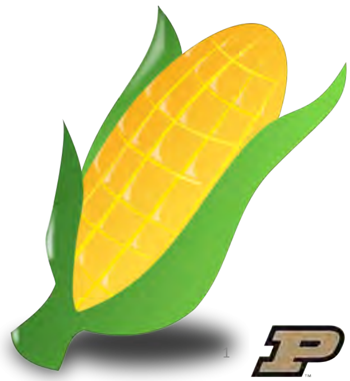

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Irrigation vs. Rainfall…

- 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.

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What is the greatest single obstacle to consistently achieving higher corn yields?

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"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

Image: http://www.keepbanderabeautiful.org/climate-change.jpg

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Consequently, our greatest agronomic challenge today is to stress-proof our crops against unpredictable, extreme weather events.

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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.

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The opportunity…

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

Image source: http://typesofpoetry99.blogspot.com/2010/01/mother-nature.html

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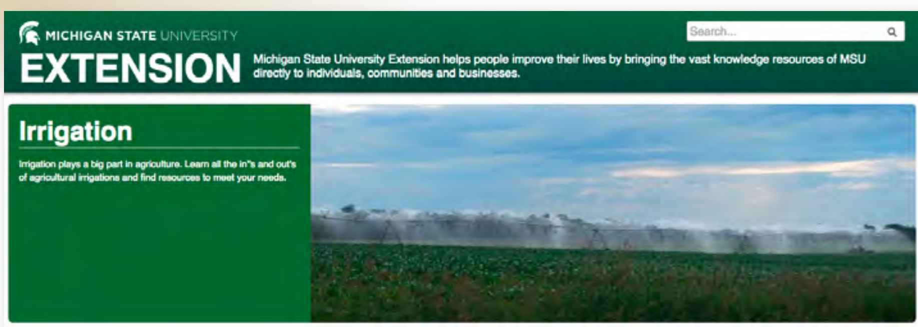

http://msue.anr.msu.edu/program/info/irrigation

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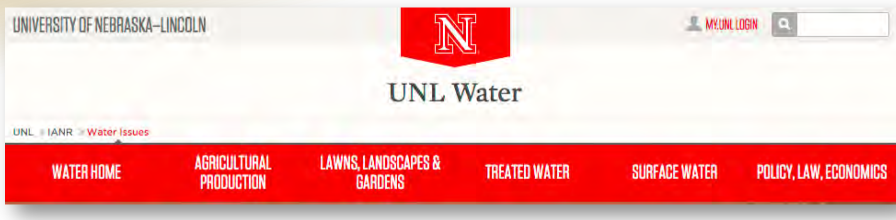

http://water.unl.edu/

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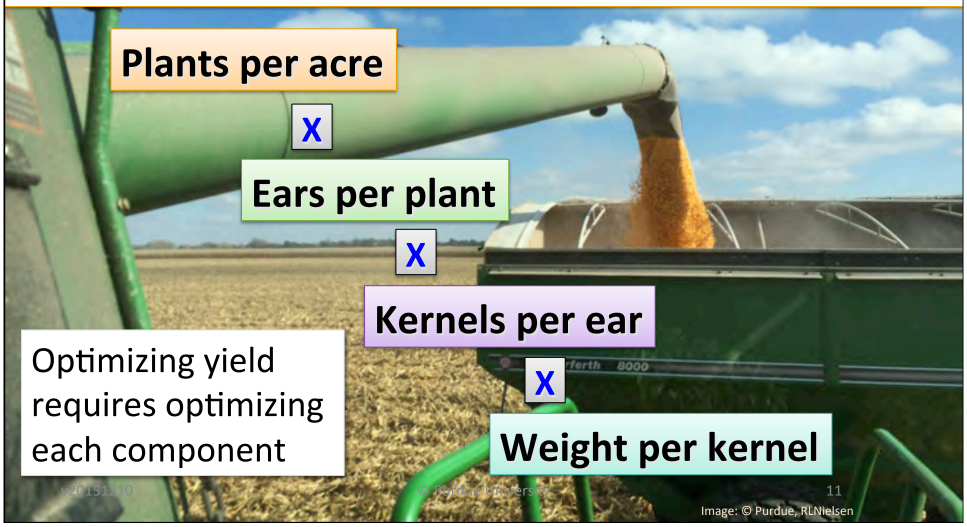
Grain yield is the product of the season-long development of the individual components of yield.



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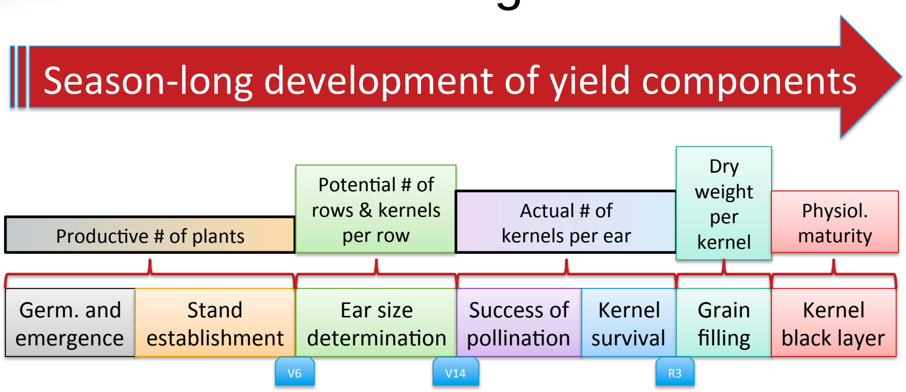
High yields require attention to detail all season long…



Source of graphic: Nielsen's imagination

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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**.
Image: RLNielsen


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If you fail to do so…
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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.

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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.

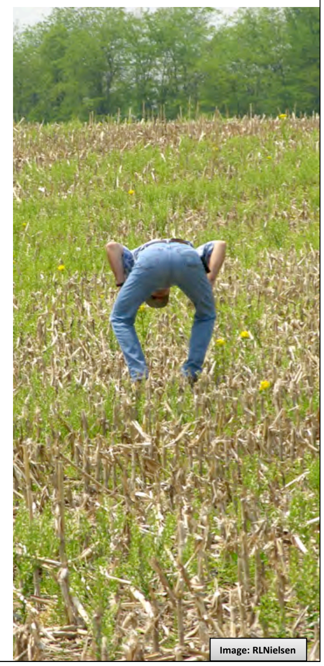
Image: RLNielsen

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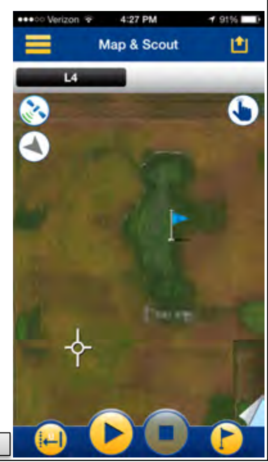
Take advantage of handheld GPS technologies…

- …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



Screen capture: RLNielsen

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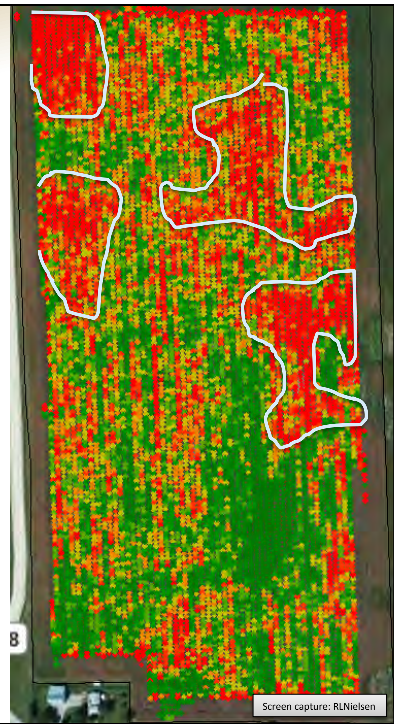
Use yield monitor data…

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


Screen capture: RLNielsen

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Remotely sensed imagery

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

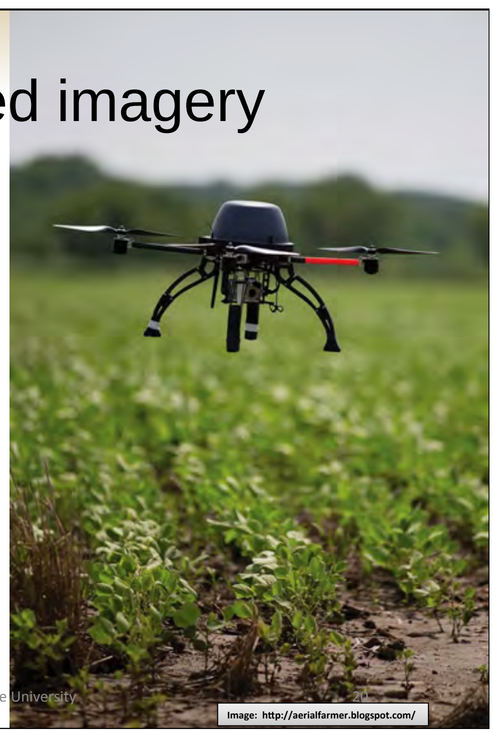
Image: http://aerialfarmer.blogspot.com/

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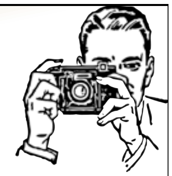
Remotely sensed imagery…



- …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.

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Use Precision Ag technologies to supplement, not replace, old-fashioned "boots on the ground" technology

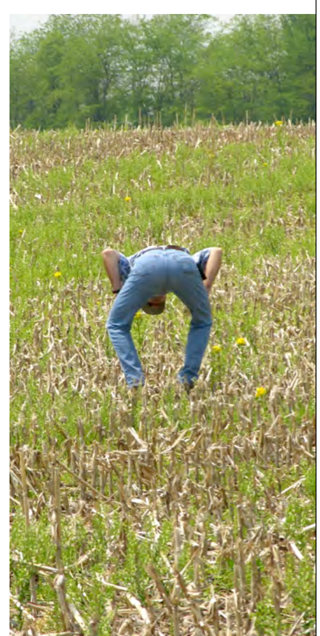

Image © Purdue Univ, RLNielsen

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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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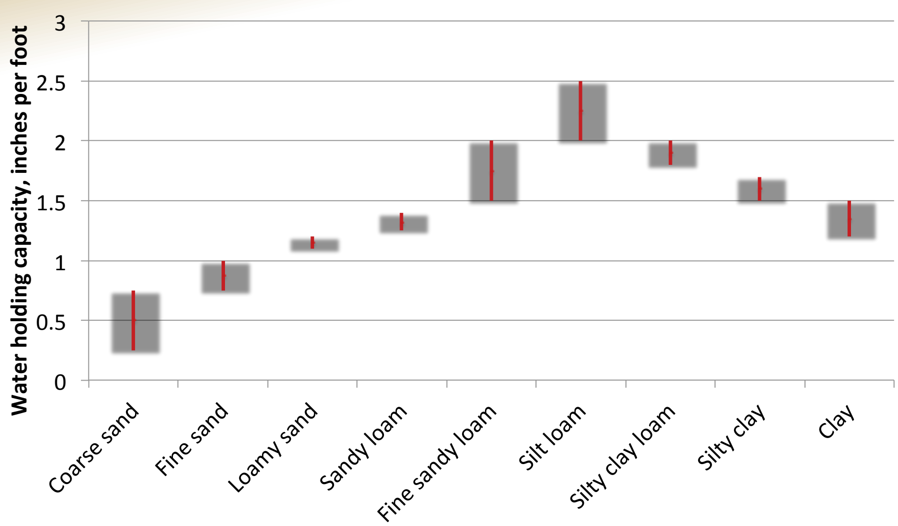
Range of Water Holding Capacities Among Soil Textures



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

24

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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.

Weaver, 1926 Fig. 85.—Mature root system of corn.

Image: Weaver, 1926, Root Development of Field Crops, McGraw-Hill Book Co.

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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.

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Weaver, 1926 Fig. 85.—Mature root system of corn.

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**

Image © Purdue Univ; RLNielsen

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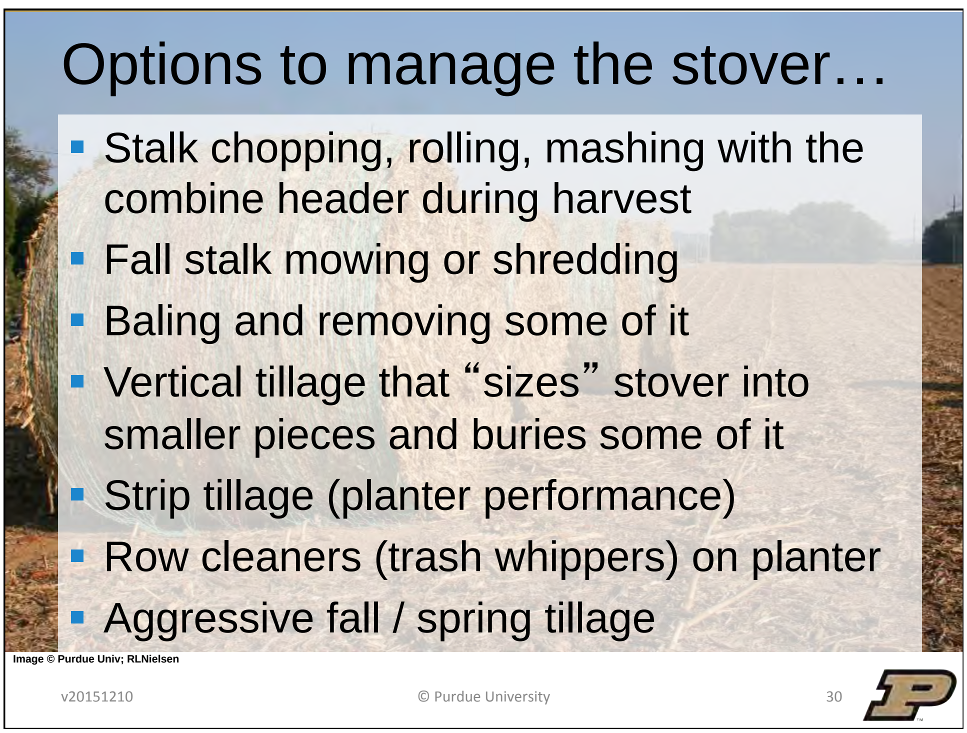
Tillage & soil compaction

- 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
Image © Purdue Univ; RLNielsen
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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

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Irrigation management…

- 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

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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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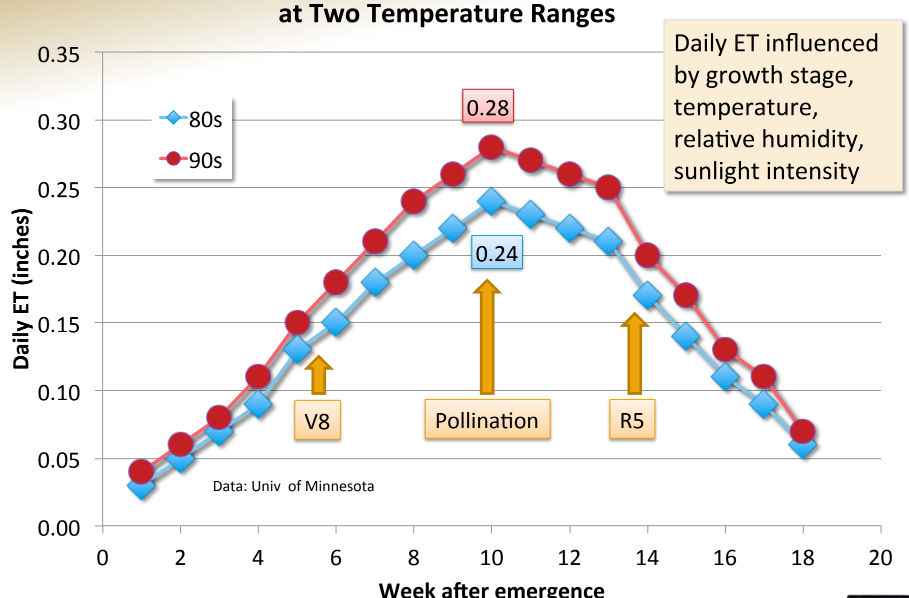
Daily Water Use by Corn at Two Temperature Ranges



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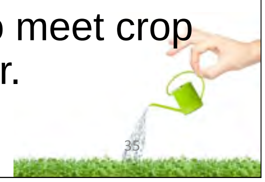
Watering rules of thumb

- 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.



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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.

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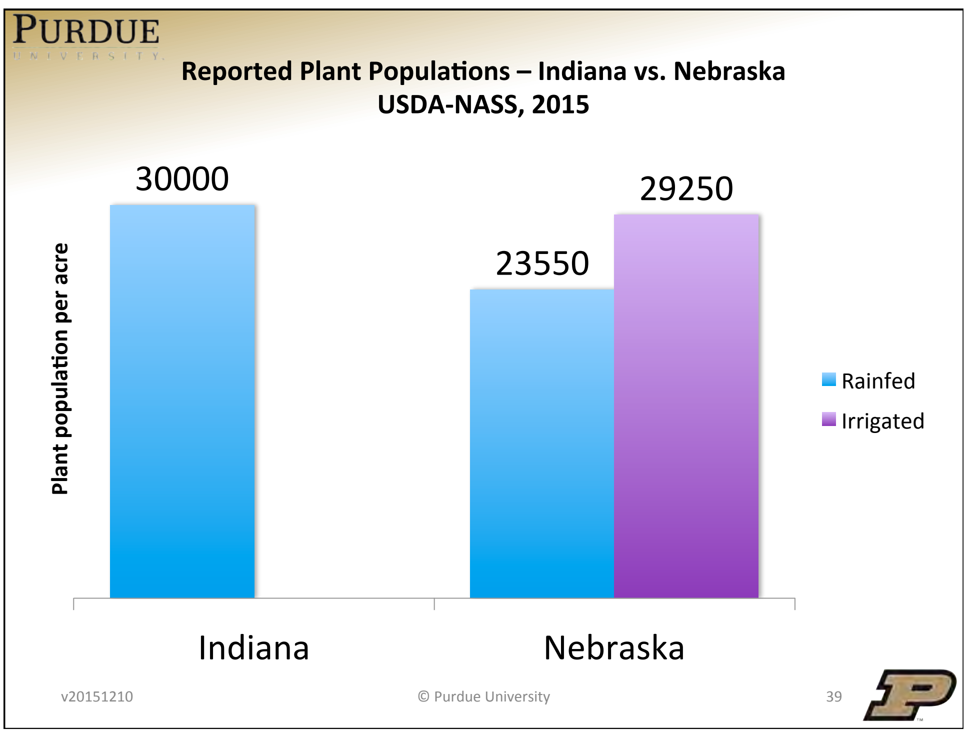
High Yield Corn Management:
PLANT POPULATIONS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Reported Plant Populations – Indiana vs. Nebraska
USDA-NASS, 2015
Plant population per acre
30000
23550
29250
Rainfed
Irrigated
Indiana
Nebraska
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Kansas State guidelines

Table 6. Suggested final corn populations.

	Plants per acre
Northwest (dryland)	13,000 to 18,000
Northeast	18,000 to 24,000
East central and Southeast	
(normal planting dates)	16,000 to 20,000
Central	16,000 to 22,000
Early planting with early hybrids	
dryland	18,000 to 24,000
irrigated	28,000 to 36,000
Irrigated	24,000 to 34,000
Limited irrigation	18,000 to 26,000

v20151210 http://www.bookstore.ksre.ksu.edu/pubs/l818.pdf 40

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Purdue plant population trials…

- 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**

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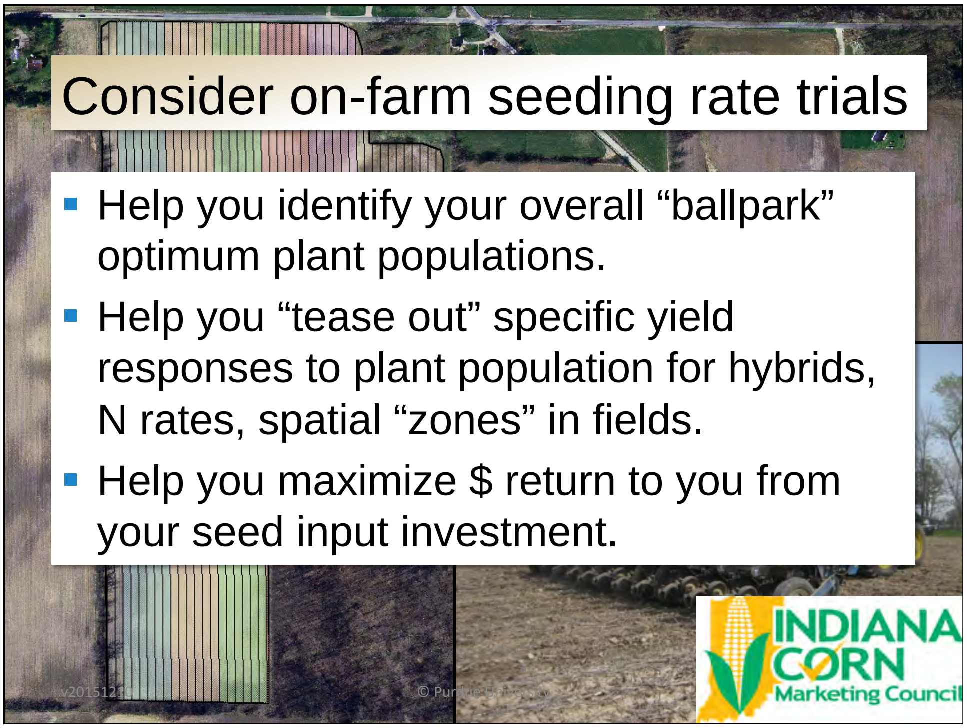
Consider on-farm seeding rate trials
Help you identify your overall "ballpark" optimum plant populations.
Help you "tease out" specific yield responses to plant population for hybrids, N rates, spatial "zones" in fields.
Help you maximize $ return to you from your seed input investment.
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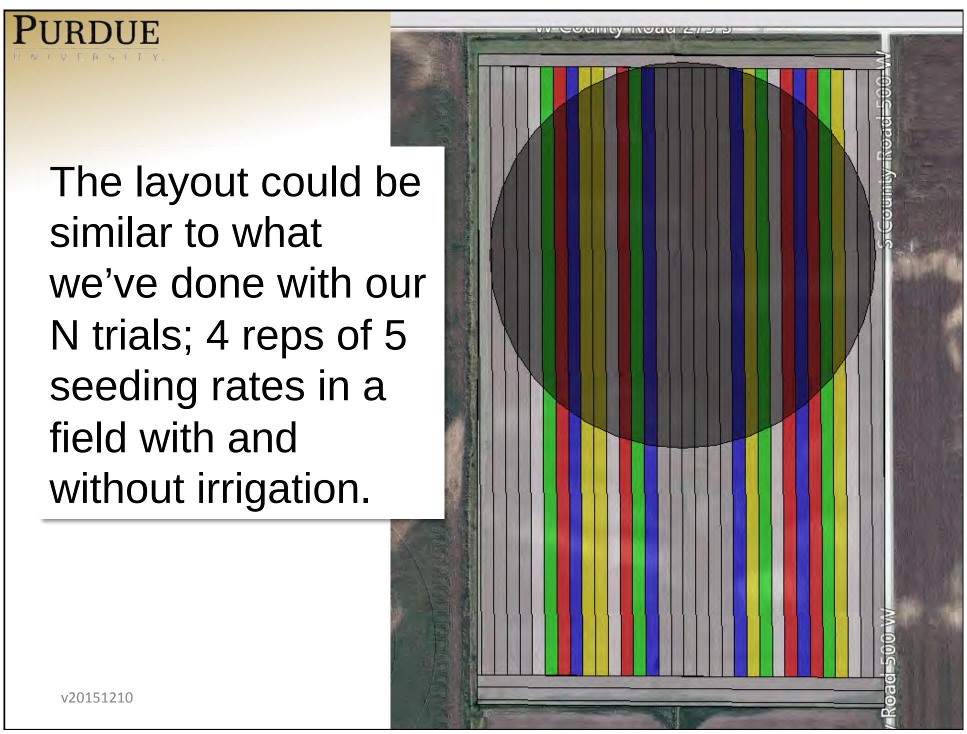
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The layout could be similar to what we've done with our N trials; 4 reps of 5 seeding rates in a field with and without irrigation.
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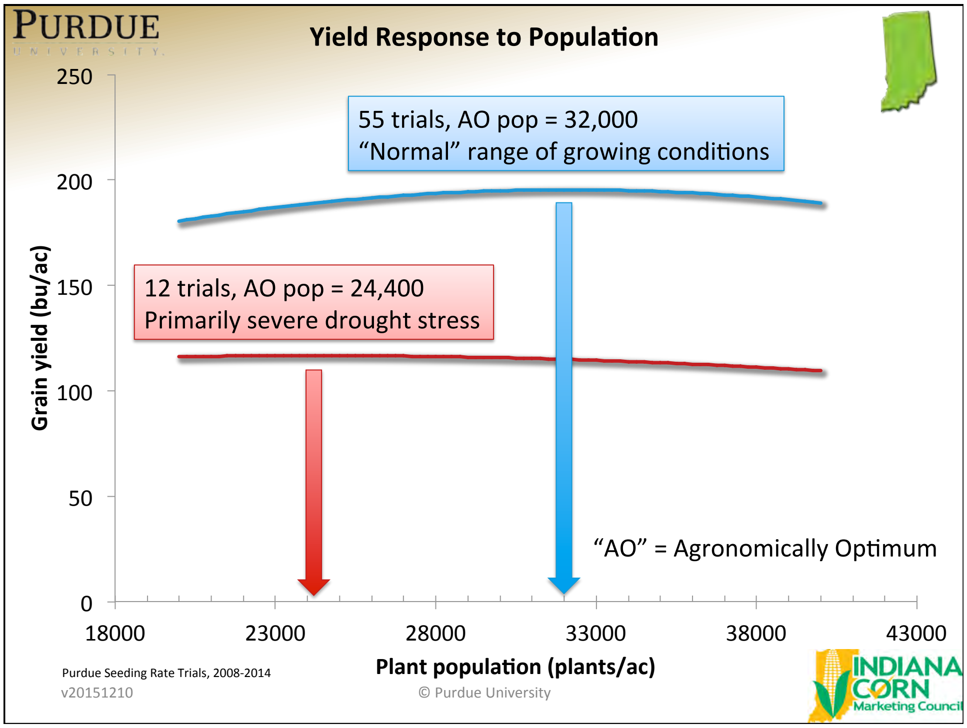
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Yield Response to Population
55 trials, AO pop = 32,000
"Normal" range of growing conditions
12 trials, AO pop = 24,400
Primarily severe drought stress
"AO" = Agronomically Optimum
Grain yield (bu/ac)
250
200
150
100
50
0
18000
23000
28000
33000
38000
43000
Plant population (plants/ac)
Purdue Seeding Rate Trials, 2008-2014
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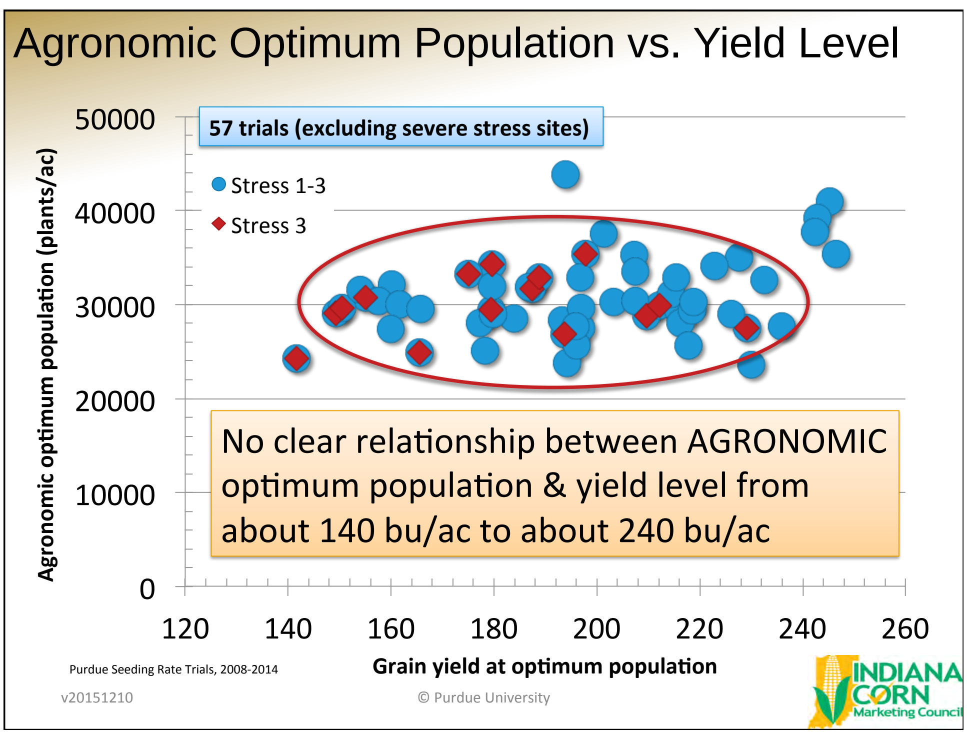
Agronomic Optimum Population vs. Yield Level
57 trials (excluding severe stress sites)
Stress 1-3
Stress 3
No clear relationship between AGRONOMIC optimum population & yield level from about 140 bu/ac to about 240 bu/ac
Agronomic optimum population (plants/ac)
50000
40000
30000
20000
10000
0
120
140
160
180
200
220
240
260
Grain yield at optimum population
Purdue Seeding Rate Trials, 2008-2014
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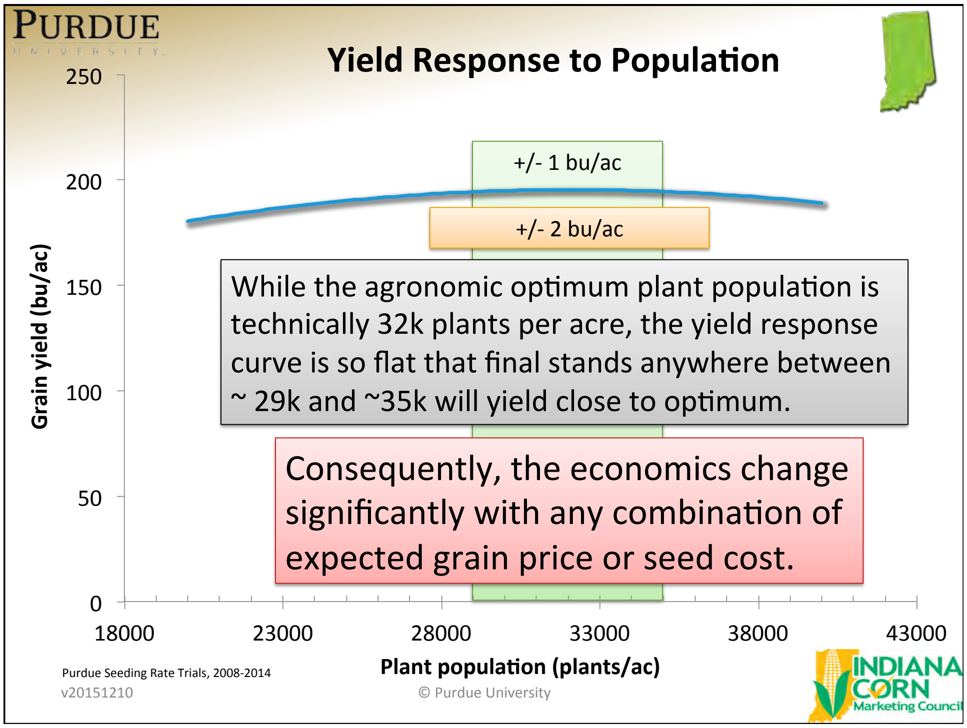
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Yield Response to Population
250
200
150
100
50
0
Grain yield (bu/ac)
+/- 1 bu/ac
+/- 2 bu/ac
While the agronomic optimum plant population is technically 32k plants per acre, the yield response curve is so flat that final stands anywhere between ~ 29k and ~35k will yield close to optimum.
Consequently, the economics change significantly with any combination of expected grain price or seed cost.
18000
23000
28000
33000
38000
43000
Plant population (plants/ac)
Purdue Seeding Rate Trials, 2008-2014
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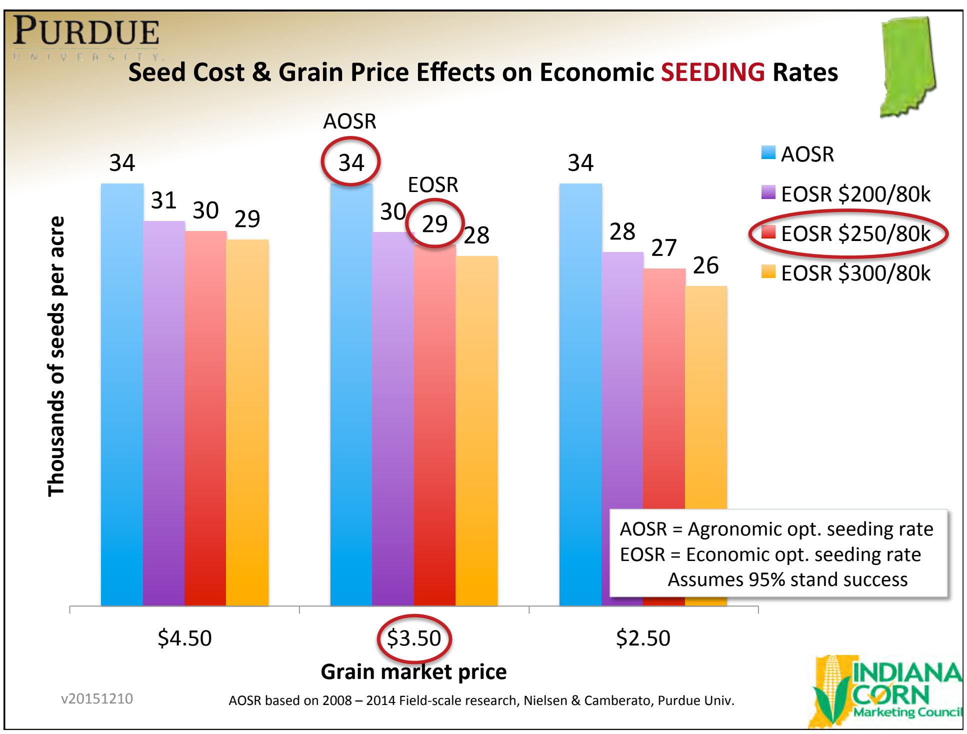
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Seed Cost & Grain Price Effects on Economic SEEDING Rates
Thousands of seeds per acre
34
31
30
29
AOSR
34
EOSR
30
29
28
34
28
27
26
AOSR
EOSR $200/80k
EOSR $250/80k
EOSR $300/80k
AOSR = Agronomic opt. seeding rate
EOSR = Economic opt. seeding rate
Assumes 95% stand success
$4.50
$3.50
$2.50
Grain market price
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AOSR based on 2008 – 2014 Field-scale research, Nielsen & Camberato, Purdue Univ.
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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.

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Online summary…

www.kingcorn.org/news/timeless/SeedingRateGuidelines.pdf

Purdue University Department of Agronomy
Applied Crop Production Research Update

Updated January 2015
URL: http://www.kingcorn.org/news/timeless/SeedingRateGuidelines.pdf

Yield Response of Corn to Plant Population in Indiana [1]

RL (Bob) Nielsen, Jason Lee, & Jim Camberato
Agronomy Department, Purdue University
West Lafayette, IN 47907
Nielsen's email: rnielsen@purdue.edu

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High Yield Corn Management

HYBRID SELECTION…

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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.

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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.

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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

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Photo: National Archives

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Hybrid trial data online…

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


Variety Trial Results

Univ. of Kentucky
Univ. of Illinois
Iowa State Univ.
Michigan State Univ.
Univ. of Minnesota
Univ. of Nebraska
Ohio State Univ.
Penn. State Univ. (Corn)
Penn. State Univ. (Soy)
Purdue Univ. (Indiana)
Univ. of Wisconsin (Corn)
Univ. of Wisconsin (Soy)

Other states' variety trials (corn)
Other states' variety trials (soy)

Integrated Ag Services
F.I.R.S.T.

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