Participatory Breeding and Testing Networks: A Maize Based Case Study for Organic Systems

Instagram: cornandsoilhealth
Website: eOrganic.info/CASH

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Winter Meeting February 2020

ASAP
Agroecology and Sustainable Agriculture Program
@ The University of Illinois at Urbana-Champaign

USDA
United States Department of Agriculture
National Institute of Food and Agriculture

Corn and Soil Health = CASH!

Participatory Network

Facilitate the exchange of needs/wants among producers, researchers, seed producers, and end users.

On-Farm Testing and Replicated trials

Screen materials for organic growing conditions.

Study weed and nutrient interactions with plant and soil health.

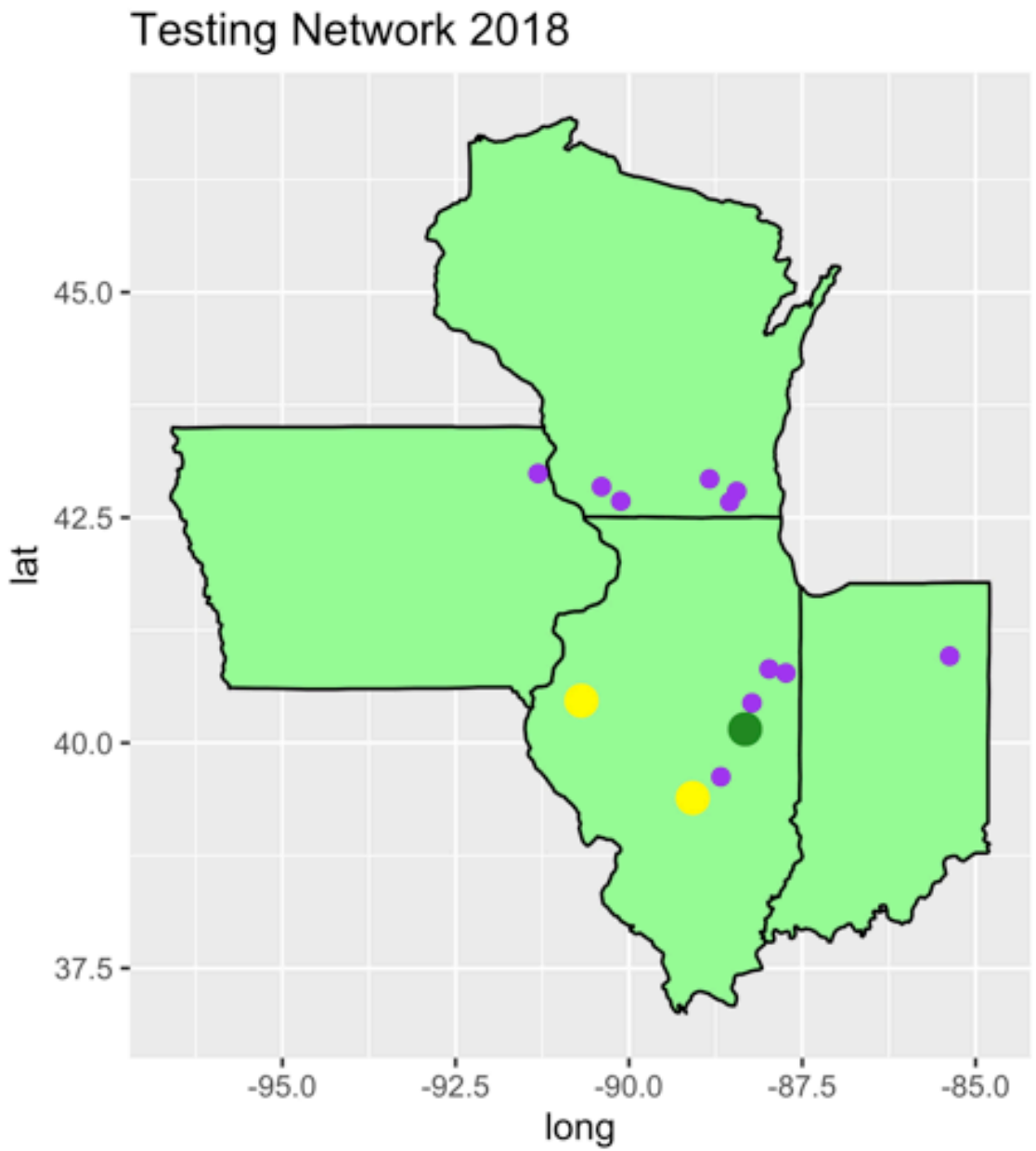
Business structure, sharing, and IP

Study business models, intellectual property, germplasm sharing structures that determine seed access.

Two Years of Strip Trials

Seed Sources	HYB 2018	HYB 2019
Mandaamin	10	7 (4 new)
Montgomery	4	0
UIUC	0	5
Checks	2	2 (1 new)

- Offered 16 cultivars in 2018 and 14 cultivars in 2019 selected from the U of I collection, 2 private breeding programs, and 2 commercially available cultivars as checks
  - Food grade quality
  - High protein (methionine)
  - N efficiency
  - Good agronomic characteristics


Testing Network 2018
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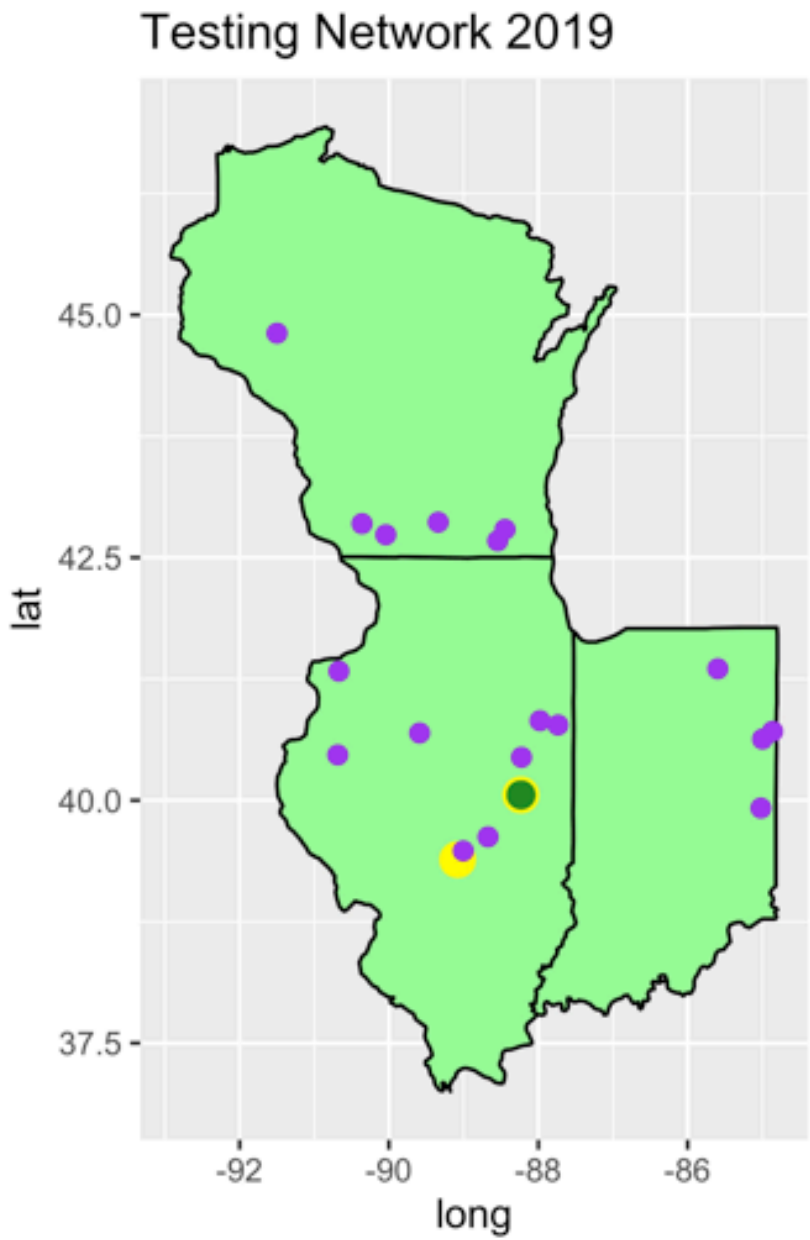
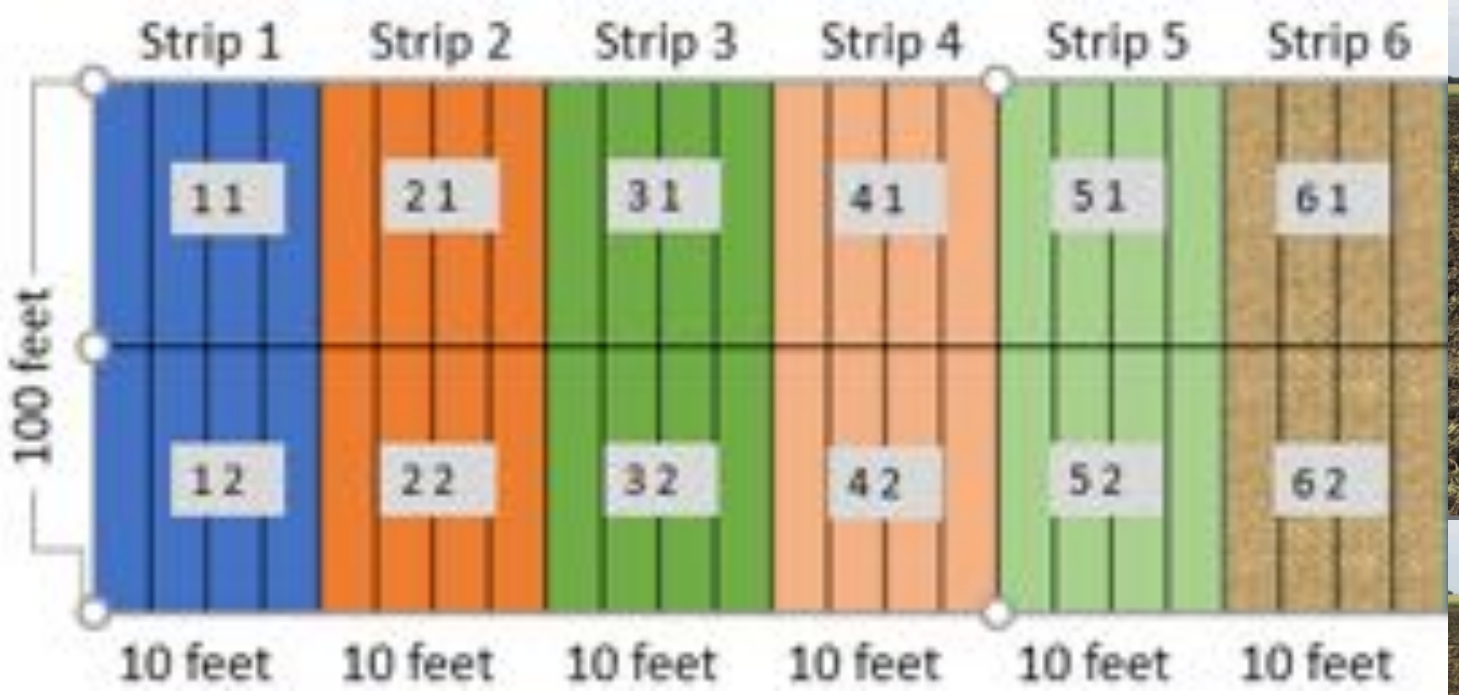
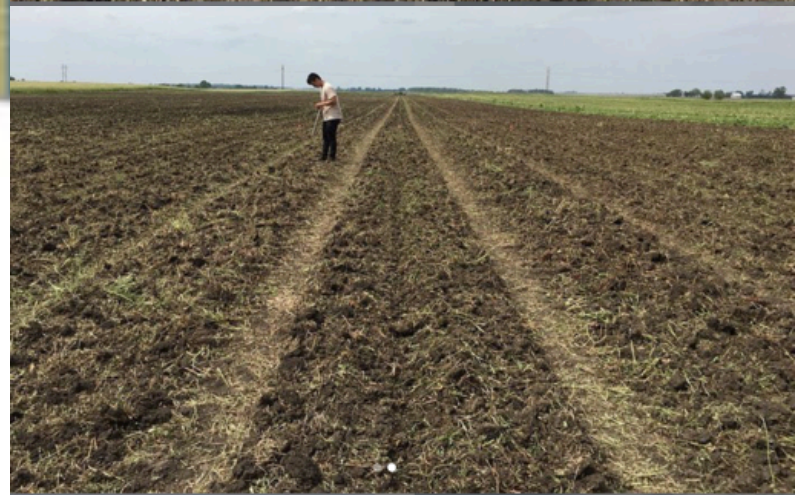
42.5
40.0
37.5
lat
-95.0
-92.5
-90.0
-87.5
-85.0
long

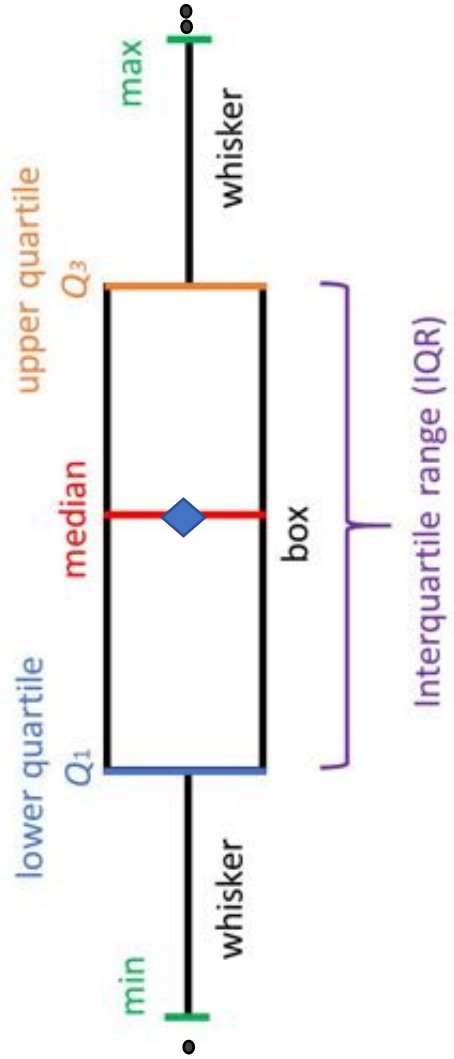

Testing Network 2019
45.0
42.5
40.0
37.5
lat
-92
-90
-88
-86
long

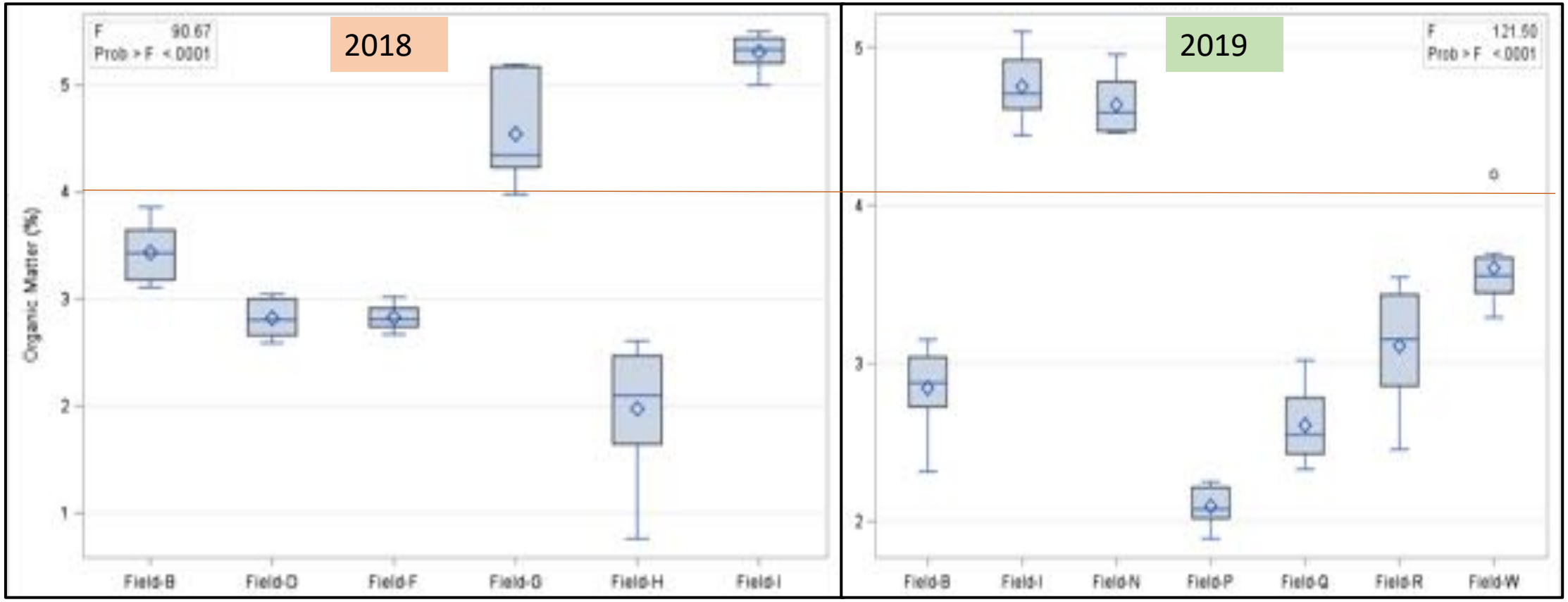
Spring Soil Sampling





Box Plots to Visualize Data

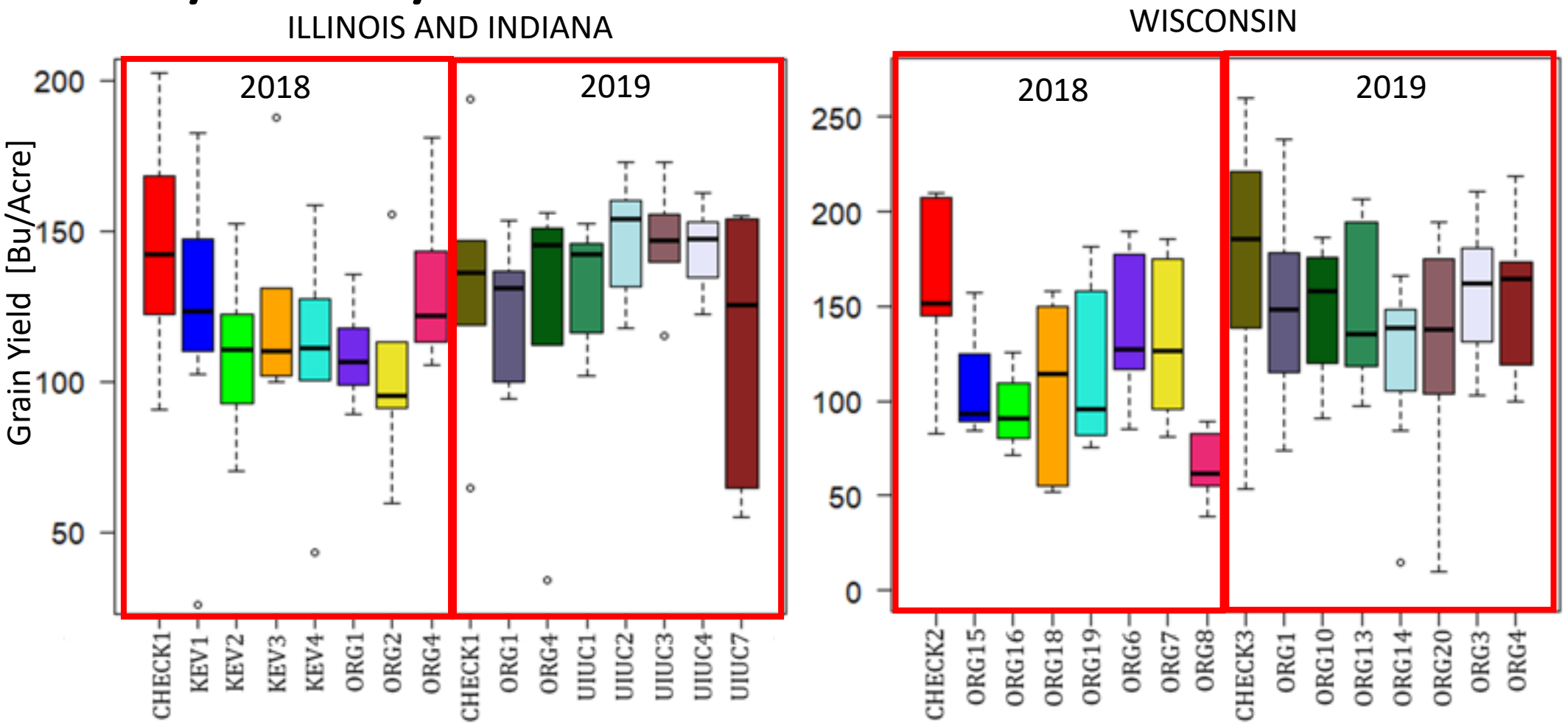




Organic matter (%) in strip trials in IL and IN in 2018 and 2019

Average standard soil fertility in strip trials in Illinois and Indiana in 2018								
Collaborator	pH	Organic matter (%)	Inorganic nitrogen (mg/kg)	Phosphorous (mg/kg)	Potassium (mg/kg)	Calcium (mg/kg)	Magnesium (mg/kg)	Sulphur (mg/kg)
Field-D	6.7	2.8	36.3	132.1	327.4	2016.8	252.5	18.1
Field-F	6.3	2.8	22.0	6.5	78.6	2225.0	209.9	10.5
Field-G	6.6	**4.5**	15.7	12.0	179.8	4069.7	705.3	13.0
Field-H	5.8	2.0	14.8	57.4	126.0	1167.1	185.5	12.5
Field-I	6.4	**5.3**	16.2	19.8	94.4	4184.0	625.5	10.8
Field-B	6.2	3.4	15.5	38.3	184.5	1747.6	258.0	12.9
Average	**6.3**	**3.5**	**20.1**	**44.3**	**165.1**	**2568.4**	**372.8**	**13.0**
Standard deviation	**0.3**	**1.2**	**8.4**	**46.9**	**90.5**	**1258.8**	**229.7**	**2.8**
Average standard soil fertility in strip trials in Illinois and Indiana in 2019								
Field-Q	7.1	2.6	26.0	18.3	148.9	3267.2	522.1	8.6
Field-I	6.7	4.8	26.0	40.4	239.0	5103.0	685.3	10.4
Field-N	6.0	4.6	25.0	8.8	151.3	4434.4	567.4	10.4
Field-B	6.3	2.8	23.6	64.7	169.7	2047.2	213.1	15.3
Field-P	6.7	2.1	25.0	49.6	161.8	1719.1	321.6	11.5
Field-W	7.4	3.6	24.8	39.4	238.3	3613.4	709.6	16.1
Field-R	7.2	3.1	24.5	**432.1**	326.4	2919.8	569.8	21.6
Average	**6.8**	**3.4**	**25.0**	**93.3**	**205.0**	**3300.6**	**512.7**	**13.4**
Standard deviation	**0.5**	**1.0**	**0.8**	**150.5**	**66.0**	**1214.5**	**183.1**	**4.5**

Two-year Hybrid Performance



- Strip trial hybrids tested in 2019 generally performed better than hybrids in 2018 relative to the check across the two regions.
- Given the harsh weather conditions in 2019, these hybrids can potentially yield higher under more favorable environmental conditions.
- Some hybrids from U of I performed better and with less variability across locations when compared to hybrids from the Mandaamin Institute and the checks

Two-year Hybrid Performance

	2018 GRAIN YIELD PER FARMER [BU/ACRE]								
HYBRIDS	B	D	F	G	H	I	K	MEANS	SE
CHECK1	142.25	202.39	175.84	124.55	91	160.15	120.33	145.22	± 14.16
KEV1	167.06	182.29	123.46	102.55	26.05	117.53	127.85	120.97	± 19.09
KEV2	123.46	152.33	110.63	86.53	99.45	120.8	70.57	109.11	± 10.12
KEV3	131.22	187.44	131.09	102.84	100.9	110.32	100.1	123.42	± 11.82
KEV4	127.39	158.34	100.64	.	43.43	106.46	115.83	108.68	± 14.34
ORG1	135.54	117.76	104.46	.	98.99	108.31	89.31	109.06	± 6.07
ORG2	97.44	155.5	112.98	.	91.48	93.19	59.7	101.72	± 11.93
ORG4	143.39	180.81	113.57	.	105.49	112.96	129.84	131.01	± 10.58

	2019 GRAIN YIELD PER FARMER [BU/ACRE]							
HYBRIDS	B	N	P	Q	R	I	MEANS	SE
CHECK1	143.7	64.7	146.6	118.7	128.6	193.5	132.63	± 17.17
ORG1	153.3	99.7	94.5	129.4	136.7	132.9	124.42	± 9.29
ORG4	112.2	34.3	144.5	150.7	145.7	156.1	123.92	± 18.99
UIUC1	144.9	101.9	139.5	116.1	152.6	145.7	133.45	± 8.13
UIUC2	117.7	131.4	151.3	172.8	160.1	156.5	148.30	± 8.24
UIUC3	142.9	139.5	151	115.3	155.4	172.7	146.13	± 7.79
UIUC4	152.8	134.5	151	122.3	162.4	143.2	144.37	± 5.85
UIUC7	141.6	55.2	109.6	65	155.1	153.9	113.40	± 18.18

- High variability across farm
- We need farm management data to estimate G×E×M

Grain Quality

Sensorial Attributes
(Taste, color, size, shape, texture)

Compositional Quality
(Macro and micro nutrients : protein, starch, fat, vitamins, minerals, etc)

Functional Quality
(Elasticity, plasticity, viscosity, water absorption)

"The totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs."

ISO 8402:1987

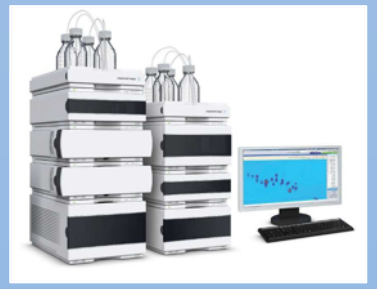
Inframatic 9500 NIR

Integrated Bioprocessing Research Laboratory (IBRL)

Atomic Emission Spectrometer

Colorimeter

UV/Vis Spectrometer



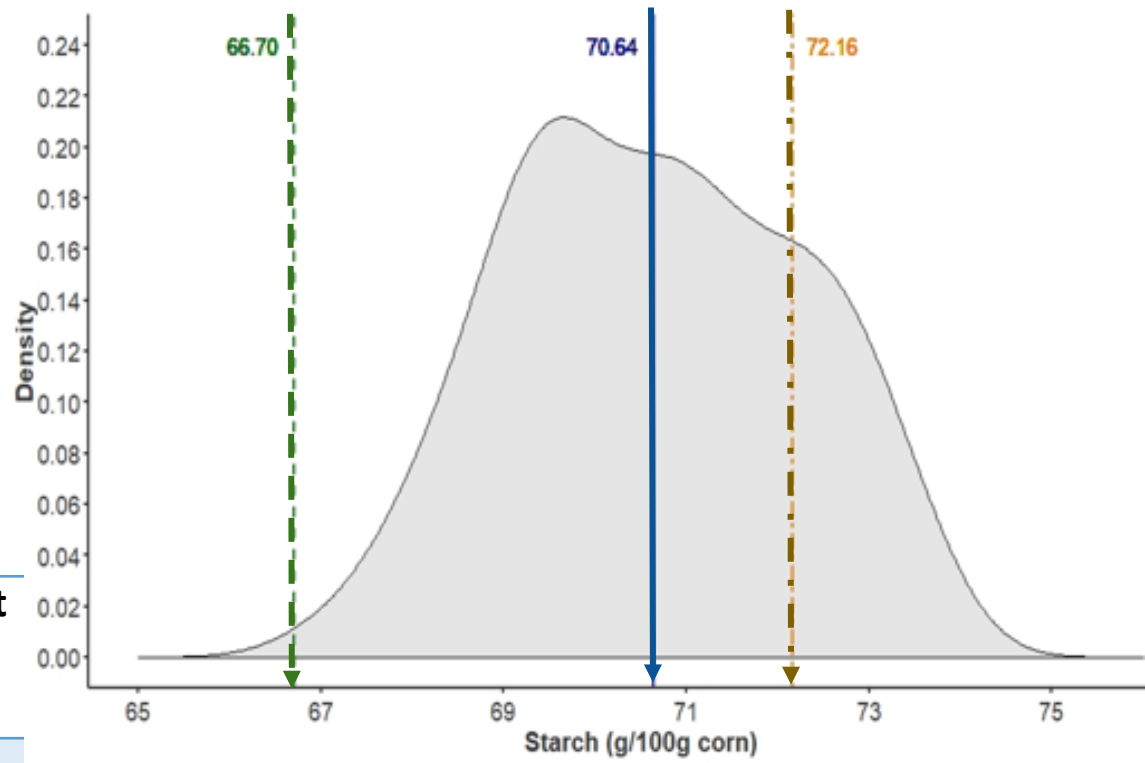
UHPLC

Reading Grain Quality Data

Moisture (g/100 g)	Lysine (g/100g protein)	N P K Mg S (g/100g)
Protein (g/100 g)	Methionine (g/100g protein)	
Oil (g/100 g)		B Mn Fe Zn
Starch (g/100 g)	Cysteine (g/100g protein)	Cu Al (mg/kg)
Color (L a b)		

Example for Corn Starch Content from NIR Analysis

Strips (Cultivar)			Starch (g/100g corn)	Average starch content of each IL&IN cultivar (g/100g corn)
Your Name	Strip 1	ORG1	70.70	69.78±1.0
Your Name	Strip 2	KEV3	73.00	71.64±0.9
Your Name	Strip 3	KEV4	72.25	71.01±1.0
Your Name	Strip 4	KEV2	72.60	70.97±1.1
Your Name	Strip 5	ORG4	71.90	70.19±1.1
Your Name	Strip 6	KEV1	72.35	71.9±0.8
Your Name	Strip 7	ORG2	70.70	69.23±0.9
Your Name	Strip 8	CHECK1	73.75	73.3±0.3
Your cultivars average			**72.16***	
Average in all IL & IN cultivar			**71.09±1.5**	



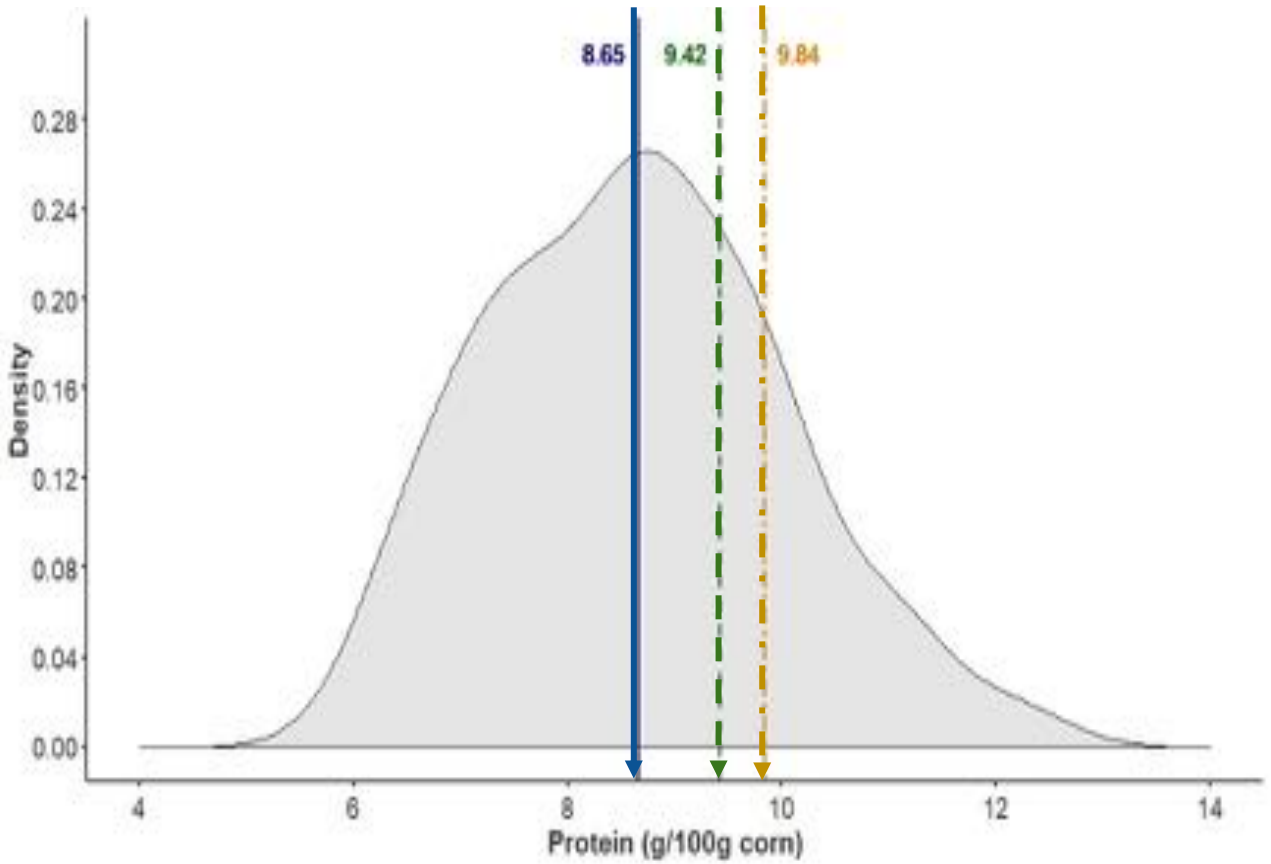
Average value of all farmers

Reference value

Average value of your cultivars

Reading Grain Quality Data—Protein (Wisconsin)

Strips (Cultivar)				Protein (g/100g corn)	Average protein content of each IL&IN cultivar (g/100g corn)
Name	Strip	1	ORG19	10.10	8.96±1.0
Name	Strip	2	ORG7	9.55	9.53±0.2
Name	Strip	3	ORG6	8.60	9.71±0.5
Name	Strip	4	CHECK2	7.45	7.43±0.6
Name	Strip	5	ORG15	12.25	10.26±1.6
Name	Strip	6	ORG16	9.75	9.71±0.5
Name	Strip	7	ORG18	10.95	9.54±1.0
Name	Strip	8	ORG8	10.10	10.89±0.9
Your cultivars average				9.84*	
Average in all WIS cultivars					8.24±1.2

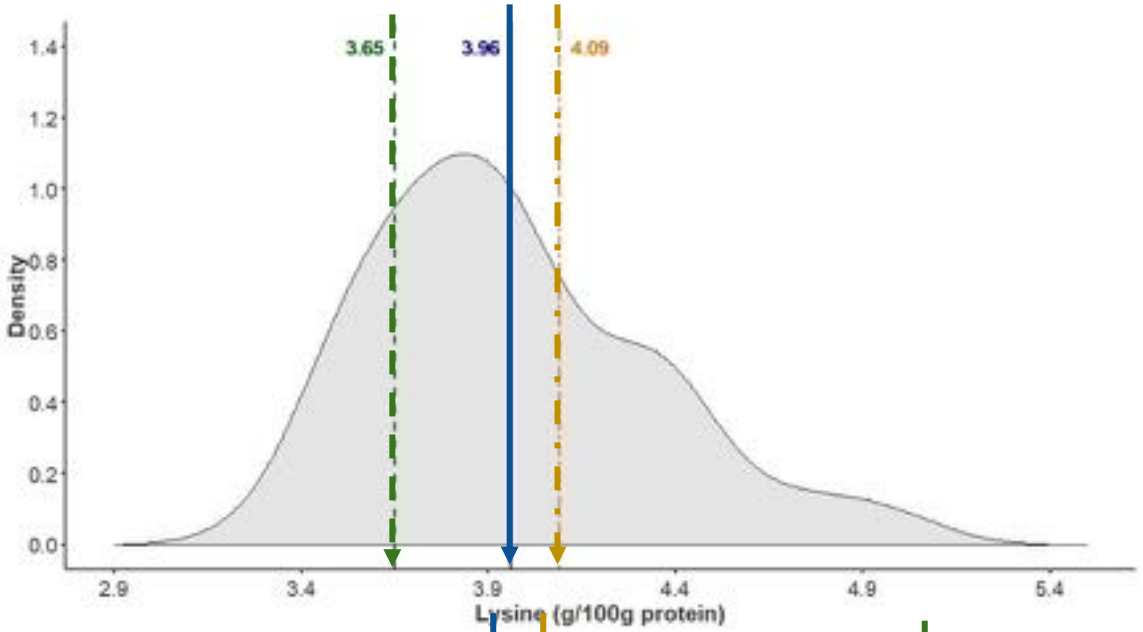


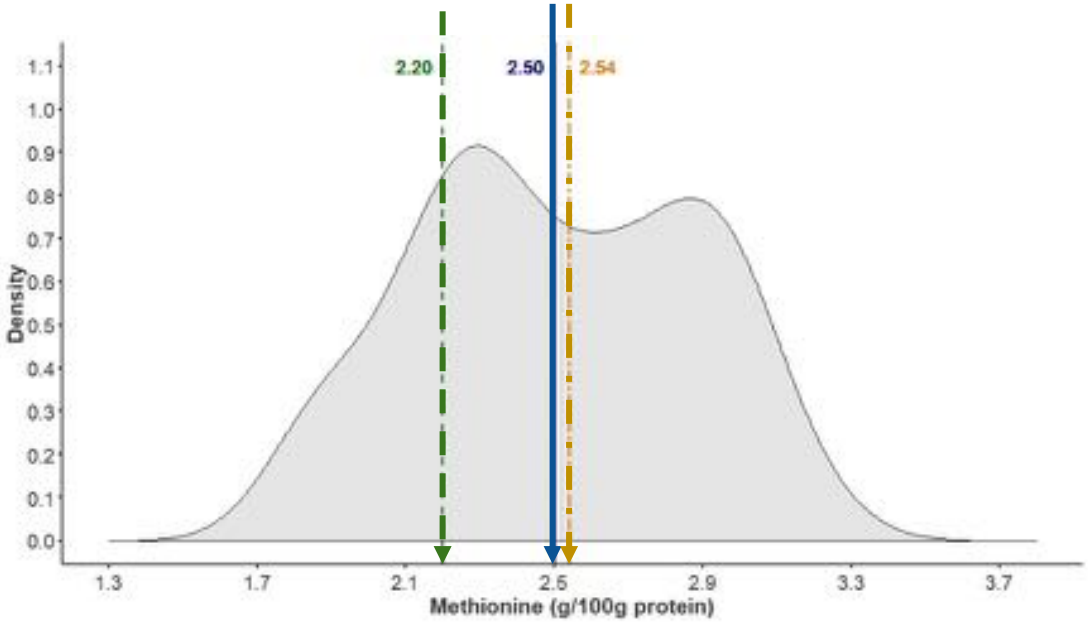
Reading Grain Quality Data—Amino Acids

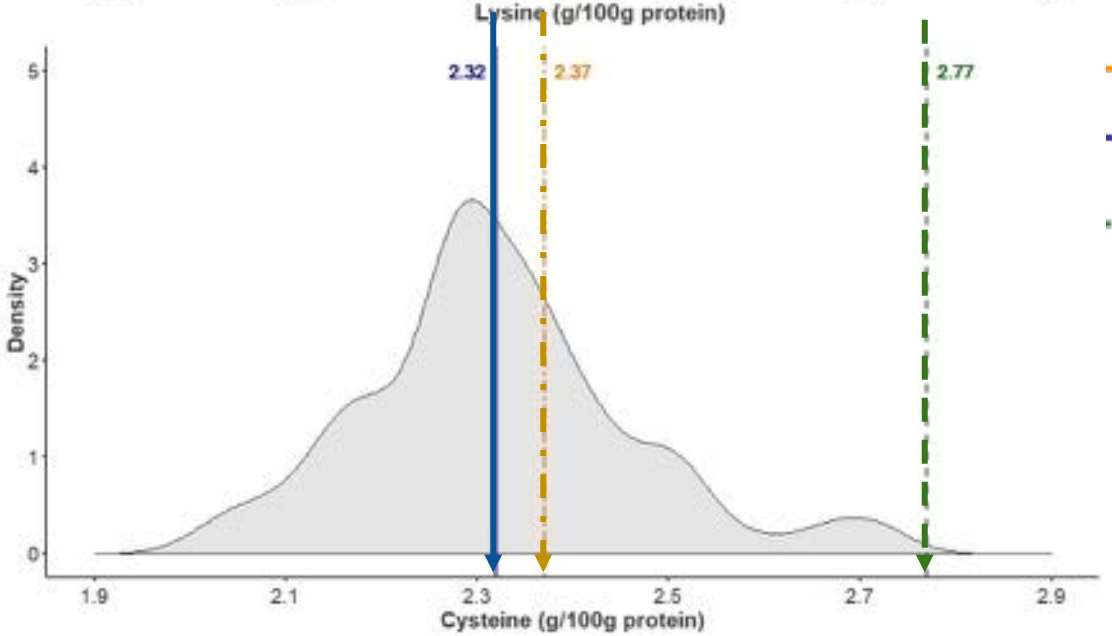
Strips (Cultivar)			Lysine (g/100g protein)	Average lysine content of each IL & IN cultivar (g/100g protein)	Methionine (g/100g protein)	Average methionine content of each IL & IN cultivar (g/100g protein)	Cysteine (g/100g protein)	Average cysteine content of each IL & IN cultivar (g/100g protein)
Name	Strip 1	KEV3	3.71	3.68 ± 0.2	2.32	2.23 ± 0.1	2.43	2.37 ± 0.1
Name	Strip 2	KEV2	3.78	3.23 ± 0.3	2.11	1.86 ± 0.2	2.28	1.98 ± 0.04
Name	Strip 3	ORG2	3.97	3.23 ± 0.3	2.83	2.33 ± 0.2	2.32	1.93 ± 0.1
Name	Strip 4	ORG4	4.44	4.34 ± 0.4	2.96	2.96 ± 0.1	2.48	2.46 ± 0.1
Name	Strip 5	ORG1	4.36	4.16 ± 0.5	3.08	2.86 ± 0.3	2.50	2.41 ± 0.2
Name	Strip 6	CHECK1	4.28	4.14 ± 0.3	2.21	2.06 ± 0.2	2.26	2.30 ± 0.1
Name	Strip 7	KEV4	4.41	2.78 ± 0.5	2.63	1.74 ± 0.2	2.36	1.58 ± 0.1
Name	Strip 8	KEV1	3.78	3.85 ± 0.3	2.15	2.09 ± 0.2	2.34	2.36 ± 0.1
Your cultivars average			**4.09***		**2.54***		**2.37***	
Average in all IL&IN cultivar				**3.97 ± 0.4**		**2.39 ± 0.4**		**2.35 ± 0.1**

*This value in the graph

Reading Grain Quality Data—Amino Acids







Average value of your cultivars

Average value of all farmers

Reference value

Reference Values

Lys	3.6	g/100 g protein
Met	2.20	g/100 g protein
Cys	2.77	g/100 g protein

(USDA, 2014; Thomson, P. et al., 2016)

ASTA Discussion

December 11, 2019

To identify future opportunities for organic corn and major obstacles to realizing these opportunities

Find that organic seed production is a major hurdle!

Participants

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Criteria for Seed Offerings in 2020

- Root characteristics—root plasticity
- Yield performance
- Grain quality
- Crop performance under low N availability
- Methionine content

How to Improve Strip Trials in 2020

- Quantity of seed and equipment size?
- Provide hand planting? Timing?
- Participatory evaluation of performance?
- Summer site visits?
- Preferred form of communication?
-
-

Testing Network Moving Forward

- Receive continuous feedback from educational network—we welcome input from all collaborators. We are available via phone, text, or email
- Meet one-on-one to collect field management data —we have print outs with information provided to Emily and would like to fill in some blanks or ask for clarification

CASH

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