THE AGRONOMIC CHALLENGES OF NITROGEN MANAGEMENT IN WISCONSIN

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Wisconsin Nitrate TAC Webconference 4-23-2020

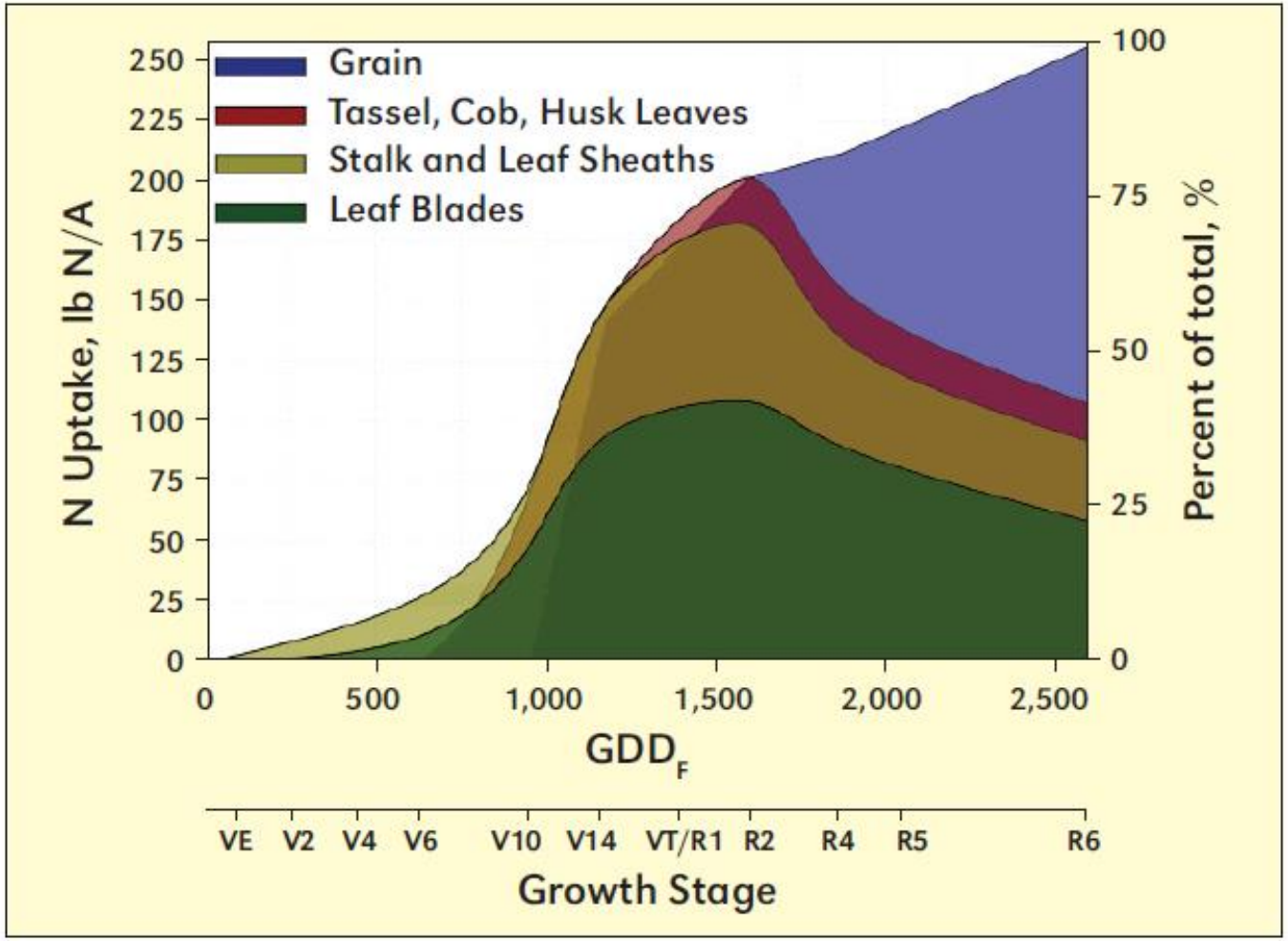
NITROGEN DYNAMICS ARE MUCH DIFFERENT THAN OTHER CROP NUTRIENTS

- MOST NUTRIENTS INTERACT WITH SOIL TO CREATE A RESERVOIR THAT CAN PROVIDE A CONTINUOUS SUPPLY OF THOSE NUTRIENTS TO GROWING PLANTS FROM SEASON TO SEASON.
- SOIL SAMPLE ANALYSIS AND FERTILIZER ADDITIONS EVERY FEW YEARS IS ADEQUATE TO SUSTAIN CROP GROWTH FOR THESE OTHER NUTRIENTS.
- PERIODICALLY CHECKING THE OIL LEVEL OF AN ENGINE CRANKCASE IS A USEFUL ANALOGY FOR PHOSPHORUS, POTASSIUM, AND THE MICRONUTRIENTS.

NITROGEN IS MANAGED MUCH DIFFERENTLY

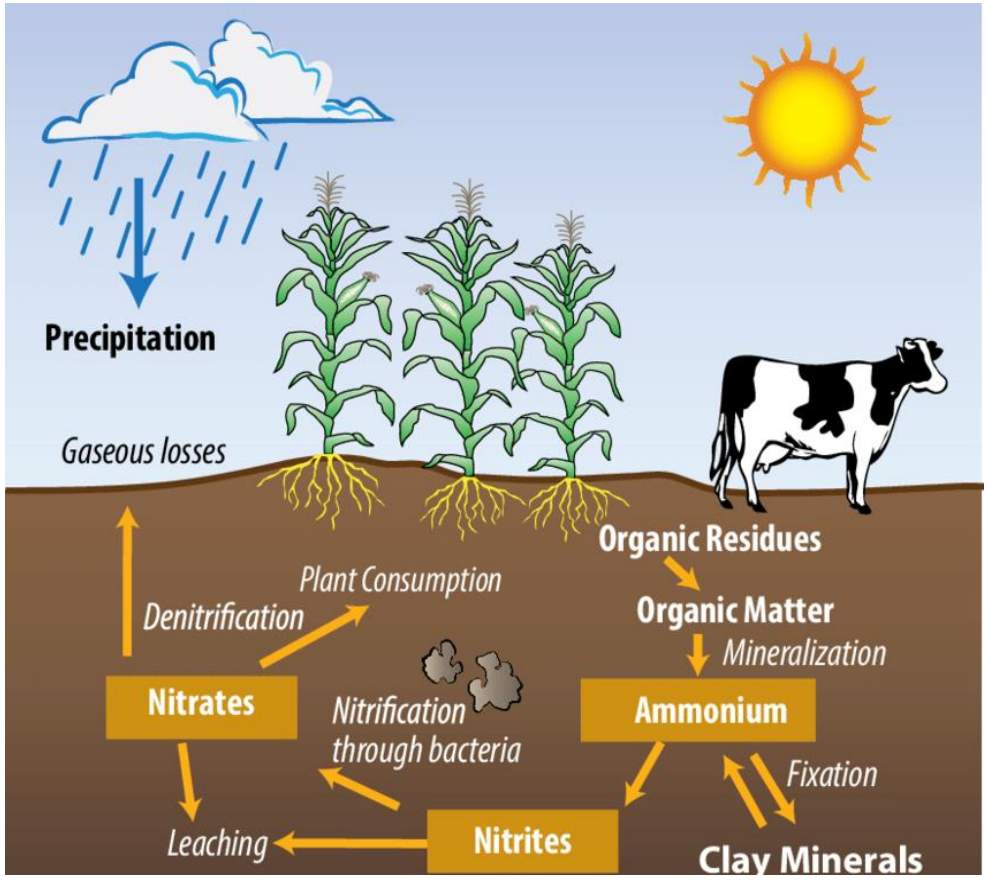
- ALTHOUGH THERE IS A SOIL RESERVOIR OF NITROGEN, IT IS NOT SUFFICIENT TO SUPPLY THE NEEDS FOR AGRONOMIC CROPS.
- THE YEARLY ADDITION OF FERTILIZER OR MANURE NITROGEN IS REQUIRED FOR NON-LEGUMINOUS CROPS.
- EXCESS NITROGEN WILL EXIST AS NITRATE AT THE END OF THE GROWING SEASON.
- NITRATE MOVES READILY WITH SOIL WATER AND IS PRONE TO MOVING INTO GROUNDWATER OR INTO SURFACE WATER AS THE SOIL DRAINS.

ONE OF THE GOALS OF A NITROGEN RECOMMENDATION IS TO MINIMIZE THE AMOUNT OF NITRATE IN THE SOIL RESERVOIR AT THE END OF THE GROWING SEASON.



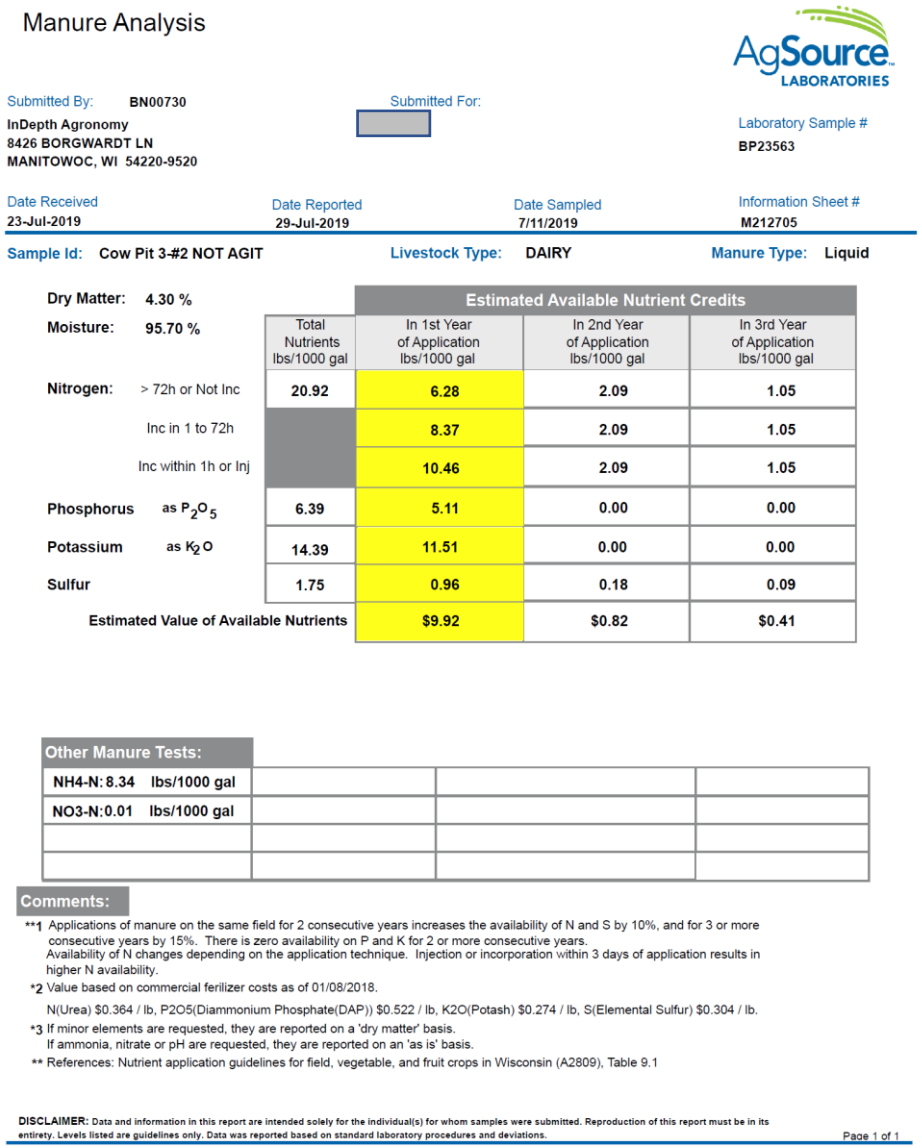
NITROGEN DYNAMICS ARE COMPLICATED AND DIFFICULT TO PREDICT

- NITROGEN EXISTS IN SEVERAL FORMS IN THE SOIL.
- TWO OF THE FORMS ARE AVAILABLE TO PLANTS.
- LARGE LOSSES OF AVAILABLE NITROGEN COMMONLY OCCUR WHEN EXCESSIVE RAIN CAUSES SOIL SATURATION.
- TEMPERATURE AND RAINFALL HAVE A LARGE EFFECT ON THE AVAILABILITY OF SOIL NITROGEN.
- WE ARE NOT CAPABLE OF PREDICTING WEATHER 3 MONTHS INTO THE FUTURE.



WE NEED TO UTILIZE DAIRY MANURE – OFTEN FALL APPLIED

- DAIRY MANURE HAS CHANGED THROUGH THE YEARS !!
- LESS ORGANIC BEDDING IS USED NOW. STRAW AND SAWDUST HAVE LARGELY BEEN REPLACED BY SAND.
- MANURE TENDS TO BE MORE “PROCESSED” NOW. MULTI-STAGE PITS, METHANE DIGESTORS, SOLIDS SEPARATORS.
- SIGNIFICANTLY LESS OF THE TOTAL NITROGEN IS IN THE ORGANIC FORM AND MORE EXISTS AS AMMONIUM NITROGEN



Manure Analysis

AgSource LABORATORIES

Submitted By: BN00730
InDepth Agronomy
8426 BORGWARDT LN
MANITOWOC, WI 54220-9520

Submitted For:

Laboratory Sample #
BP23563

Date Received	Date Reported	Date Sampled	Information Sheet #
23-Jul-2019	29-Jul-2019	7/11/2019	M212705

Sample Id: Cow Pit 3-#2 NOT AGIT Livestock Type: DAIRY Manure Type: Liquid

Dry Matter: 4.30 %
Moisture: 95.70 %

		Total Nutrients lbs/1000 gal	Estimated Available Nutrient Credits: In 1st Year of Application lbs/1000 gal	In 2nd Year of Application lbs/1000 gal	In 3rd Year of Application lbs/1000 gal
Nitrogen:	> 72h or Not Inc	20.92	6.28	2.09	1.05
	Inc in 1 to 72h		8.37	2.09	1.05
	Inc within 1h or Inj		10.46	2.09	1.05
Phosphorus	as P_2O_5	6.39	5.11	0.00	0.00
Potassium	as K_2O	14.39	11.51	0.00	0.00
Sulfur		1.75	0.96	0.18	0.09
Estimated Value of Available Nutrients			$9.92	$0.82	$0.41

Other Manure Tests:

NH4-N: 8.34 lbs/1000 gal			
NO3-N: 0.01 lbs/1000 gal			

Comments:

**1 Applications of manure on the same field for 2 consecutive years increases the availability of N and S by 10%, and for 3 or more consecutive years by 15%. There is zero availability on P and K for 2 or more consecutive years. Availability of N changes depending on the application technique. Injection or incorporation within 3 days of application results in higher N availability.

*2 Value based on commercial ferilizer costs as of 01/08/2018.
N(Urea) $0.364 / lb, P2O5(Diammonium Phosphate(DAP)) $0.522 / lb, K2O(Potash) $0.274 / lb, S(Elemental Sulfur) $0.304 / lb.

*3 If minor elements are requested, they are reported on a 'dry matter' basis.
If ammonia, nitrate or pH are requested, they are reported on an 'as is' basis.

** References: Nutrient application guidelines for field, vegetable, and fruit crops in Wisconsin (A2809), Table 9.1

DISCLAIMER: Data and information in this report are intended solely for the individual(s) for whom samples were submitted. Reproduction of this report must be in its entirety. Levels listed are guidelines only. Data was reported based on standard laboratory procedures and deviations.

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WE COULD IMPROVE THE MANAGEMENT OF NITROGEN IF WE HAD RELIABLE METHODS TO GAUGE ITS AVAILABILITY TO PLANTS THROUGHOUT THE GROWING SEASON.

- **THE FOLLOWING TOOLS HAVE SOME LIMITED UTILITY IN HELPING TO GAUGE N AVAILABILITY**
- SOIL NITRATE TESTS
- PLANT TISSUE TESTING
- NDVI IMAGERY FROM DRONES, AIRPLANES OR SATELLITES
- SENSORS MOUNTED ON AN APPLICATOR THAT MEASURE “GREENNESS” AND VARY THE RATE OF APPLIED NITROGEN
- CHLOROPHYLL METERS
- NITROGEN MODELS

NONE OF THESE TOOLS SHOULD BE CONSIDERED TO BE THE TOTAL SOLUTION TO MANAGING NITROGEN

- SOIL NITRATE IS A "SNAPSHOT" MEASUREMENT. IT IS DIFFICULT TO PULL FIELD SCALE NITRATE TESTS WHEN CORN IS TALLER THAN 24 INCHES.
- PLANT TISSUE ANALYSIS IS NOT ADEQUATELY CALIBRATED FOR THIS USE AT ALL STAGES FROM V4 TO R2. TISSUE TESTS ARE DIFFICULT TO PULL AT A FIELD SCALE WHEN CORN IS TALLER THAN 24 INCHES.
- NDVI IMAGERY RELIES ON A GOOD CROP CANOPY. IT SHOWS DIFFERENCES IN VEGETATIVE INDEX FROM ALL FACTORS – NOT JUST NITROGEN.
- "GREENNESS" SENSORS ALSO RELY ON A GOOD CROP CANOPY SO THAT REFLECTANCE IS MEASURED FROM THE CROP AND NOT THE SOIL. GREENNESS IS AFFECTED BY OTHER NUTRIENT DEFICIENCIES ALSO.
- CURRENT CHLOROPHYLL SENSORS REQUIRE HAND MEASUREMENTS.
- IF EACH OF THESE TOOLS WERE CALIBRATED FOR AN EXTENDED PORTION OF THE GROWING SEASON OF A CROP, WE WOULD HAVE USEFUL INFORMATION TO USE IN CONJUNCTION WITH A NITROGEN MODEL.

MODELS ATTEMPT TO ACCOUNT FOR CLIMATE, SOIL AND OTHER VARIABLES, BUT CANNOT BE EXPECTED TO ACCOUNT FOR ALL VARIABLES ACROSS THE LANDSCAPE.

- **VARIABILITY WITHIN A FARM**
- ROTATION AND PREVIOUS CROP
- SOIL SERIES
- EFFECTIVENESS OF TILE DRAINAGE
- MANURED?
- TILLAGE SYSTEM – TILLED OR NO-TILL?
- NITRIFICATION INHIBITORS USED?
- NITROGEN MANAGEMENT SYSTEM IS UNIFORM
- COVER CROPS

- **VARIABILITY BETWEEN FARMS**
- ROTATIONS AND PREVIOUS CROPS – MANY MORE CHOICES
- SOIL SERIES – IS THE MAP CORRECT?
- DRAINAGE IS MORE VARIABLE BETWEEN FARMS
- MANURED?
- CHARACTERISTICS OF THE MANURE
- TILLAGE SYSTEMS – MORE CHOICES
- NITROGEN MANAGEMENT SYSTEMS CAN BE VERY DIFFERENT
- NITRIFICATION INHIBITORS – MORE VARIABILITY
- SOIL HEALTH
- COVER CROPS – MUCH MORE VARIABILITY

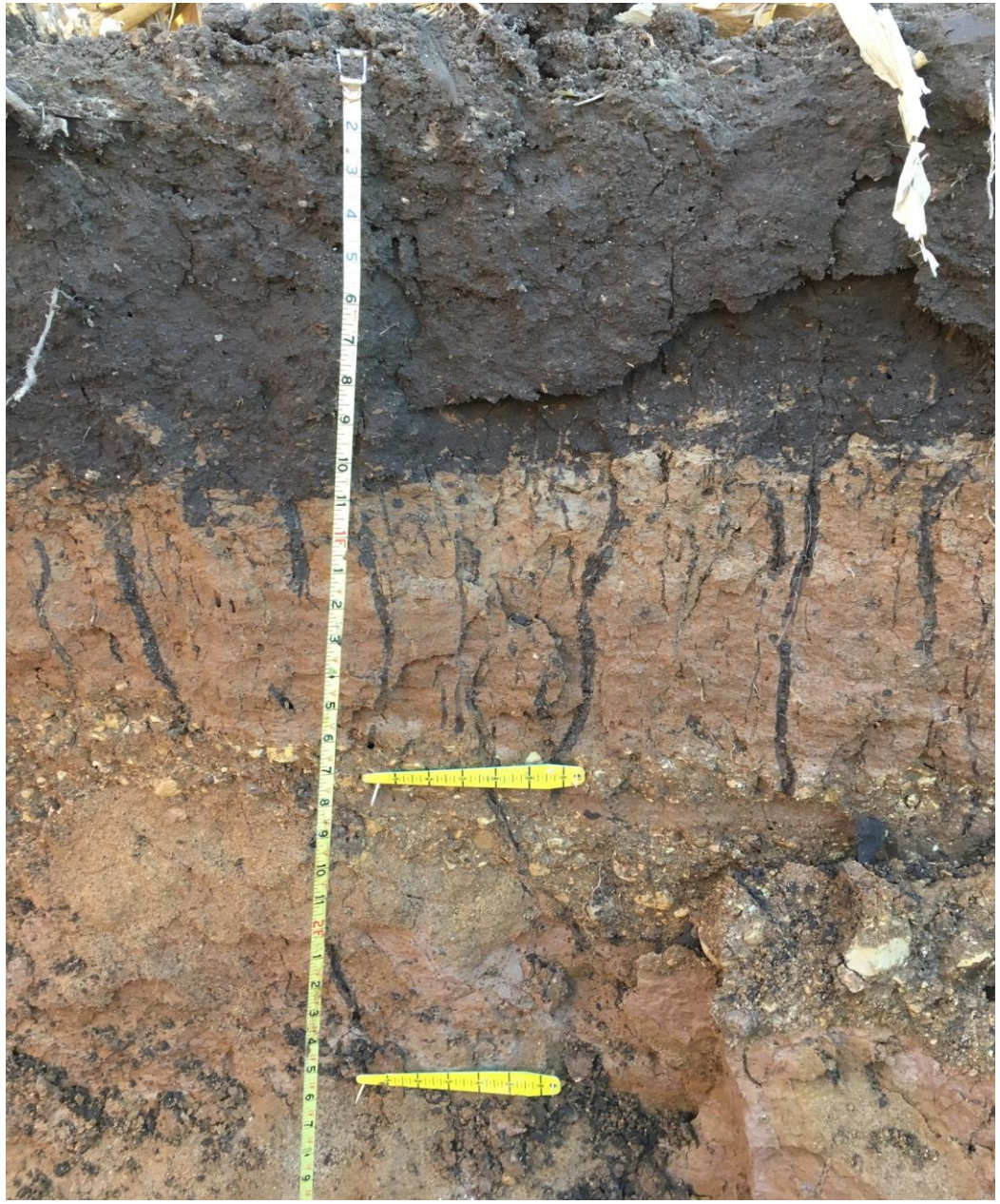
OPINION WARNING
THIS IS WHAT WILL NEED TO HAPPEN TO REALIZE THE FULL POTENTIAL OF NITROGEN MODELS

- THE MODEL MUST BE USED WITH OTHER MANAGEMENT TOOLS TO VERIFY AND "RECALIBRATE" THE CURRENT VS PREDICTED NITROGEN STATUS AT LEAST ONCE DURING THE GROWING SEASON.
- THIS WILL REQUIRE CALIBRATION OF **CRITICAL VALUES** FOR SOIL NITRATE, PLANT TISSUE, NDVI, AND SENSOR READINGS FOR MOST STAGES OF CROP GROWTH.
- THERE ARE TIMES WHEN A CERTAIN MANAGEMENT TOOL WILL BE MORE CONVENIENT TO USE THAN OTHER TOOLS. IT IS NOT POSSIBLE TO PULL A SOIL CORE IN MUD. NITROGEN MODELS NEED TO BE "PLUG-IN READY" FOR THE VARIOUS NITROGEN STATUS MEASUREMENTS.

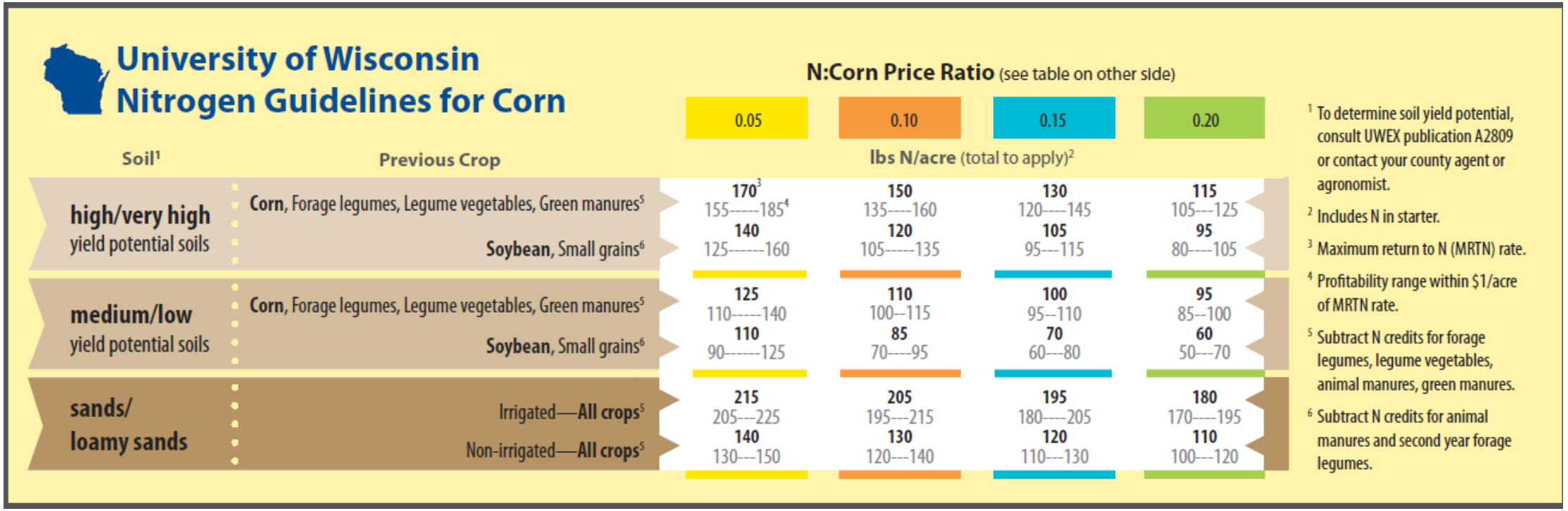
WE MAKE BIG ASSUMPTIONS ABOUT OUR SOILS

REGULATORS USE DATA FROM THE NRCS SOIL SURVEY TO VARY NITROGEN RECOMMENDATIONS FOR DIFFERENT SOIL SERIES. THE AVAILABLE DATA DOES NOT HAVE THE SPATIAL RESOLUTION REQUIRED TO MANAGE NITROGEN.

WE ARE ONLY BEGINNING TO UNDERSTAND HOW TO QUANTIFY SOIL HEALTH AND NUTRIENT CYCLING THAT OCCURS IN COVER CROP SYSTEMS.



WHEN "GUIDELINES" BECOME LAW, IT IS CRITICAL THAT THE GUIDELINES ARE CORRECT 100% OF THE TIME



University of Wisconsin Nitrogen Guidelines for Corn

N:Corn Price Ratio (see table on other side)

Soil[1]	Previous Crop	0.05	0.10	0.15	0.20
		lbs N/acre (total to apply)[2]			
high/very high yield potential soils	**Corn**, Forage legumes, Legume vegetables, Green manures[5]	**170**[3] 155–185[4]	**150** 135–160	**130** 120–145	**115** 105–125
	Soybean, Small grains[6]	**140** 125–160	**120** 105–135	**105** 95–115	**95** 80–105
medium/low yield potential soils	**Corn**, Forage legumes, Legume vegetables, Green manures[5]	**125** 110–140	**110** 100–115	**100** 95–110	**95** 85–100
	Soybean, Small grains[6]	**110** 90–125	**85** 70–95	**70** 60–80	**60** 50–70
sands/ loamy sands	Irrigated—**All crops**[5]	**215** 205–225	**205** 195–215	**195** 180–205	**180** 170–195
	Non-irrigated—**All crops**[5]	**140** 130–150	**130** 120–140	**120** 110–130	**110** 100–120

[1] To determine soil yield potential, consult UWEX publication A2809 or contact your county agent or agronomist.

[2] Includes N in starter.

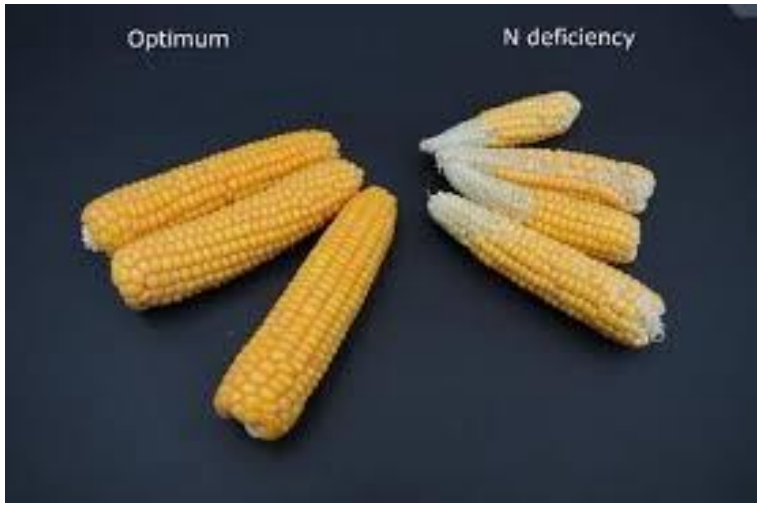
[3] Maximum return to N (MRTN) rate.

[4] Profitability range within $1/acre of MRTN rate.

[5] Subtract N credits for forage legumes, legume vegetables, animal manures, green manures.

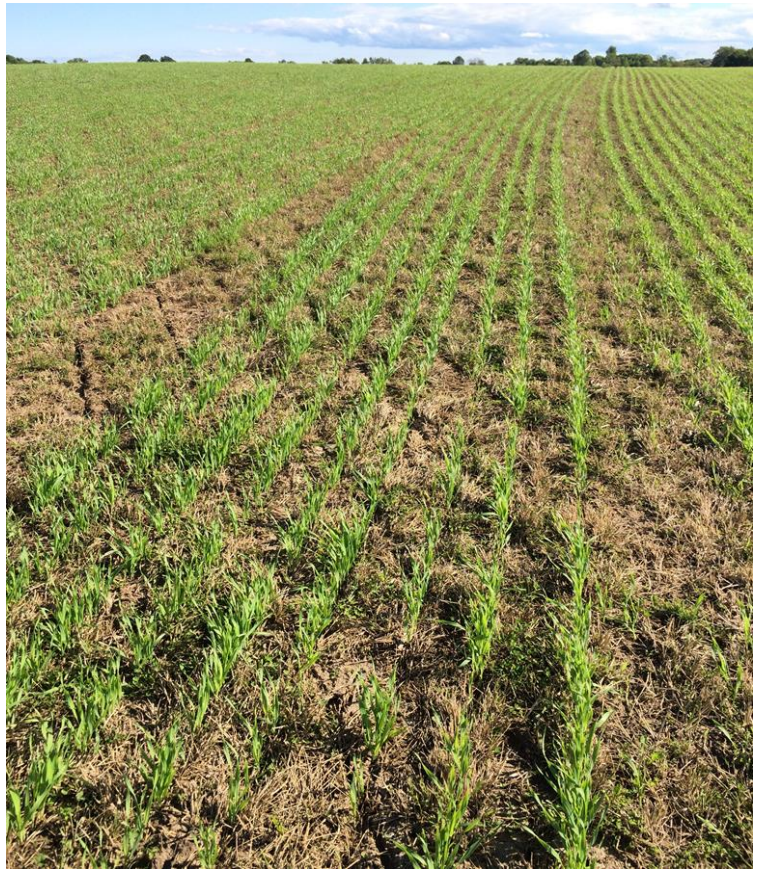
[6] Subtract N credits for animal manures and second year forage legumes.

N deficiency symptom



- FARMERS KNOW THE IMPLICATIONS OF RUNNING SHORT OF NITROGEN. THEY NEED TO TRUST THE AVAILABLE “GAUGES” AND RECOMMENDATIONS OR THEY WILL CHOOSE TO ERR ON THE SIDE OF ADDING EXTRA.

REASONS TO BE OPTIMISTIC!!



- FARMERS HAVE EMBRACED THE CONCEPTS OF SOIL HEALTH, COVER CROPS, WATERSHED IMPROVEMENT AND NITROGEN USE EFFICIENCY. WE ARE BEGINNING TO HAVE ACCESS TO TOOLS THAT CAN APPLY MANURE ON A GROWING CROP

THANK YOU

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