Sorghum crop and soil management

Sorghum Management Days, 2013

Charles Wortmann
cwortmann2@unl.edu

University of Nebraska Lincoln

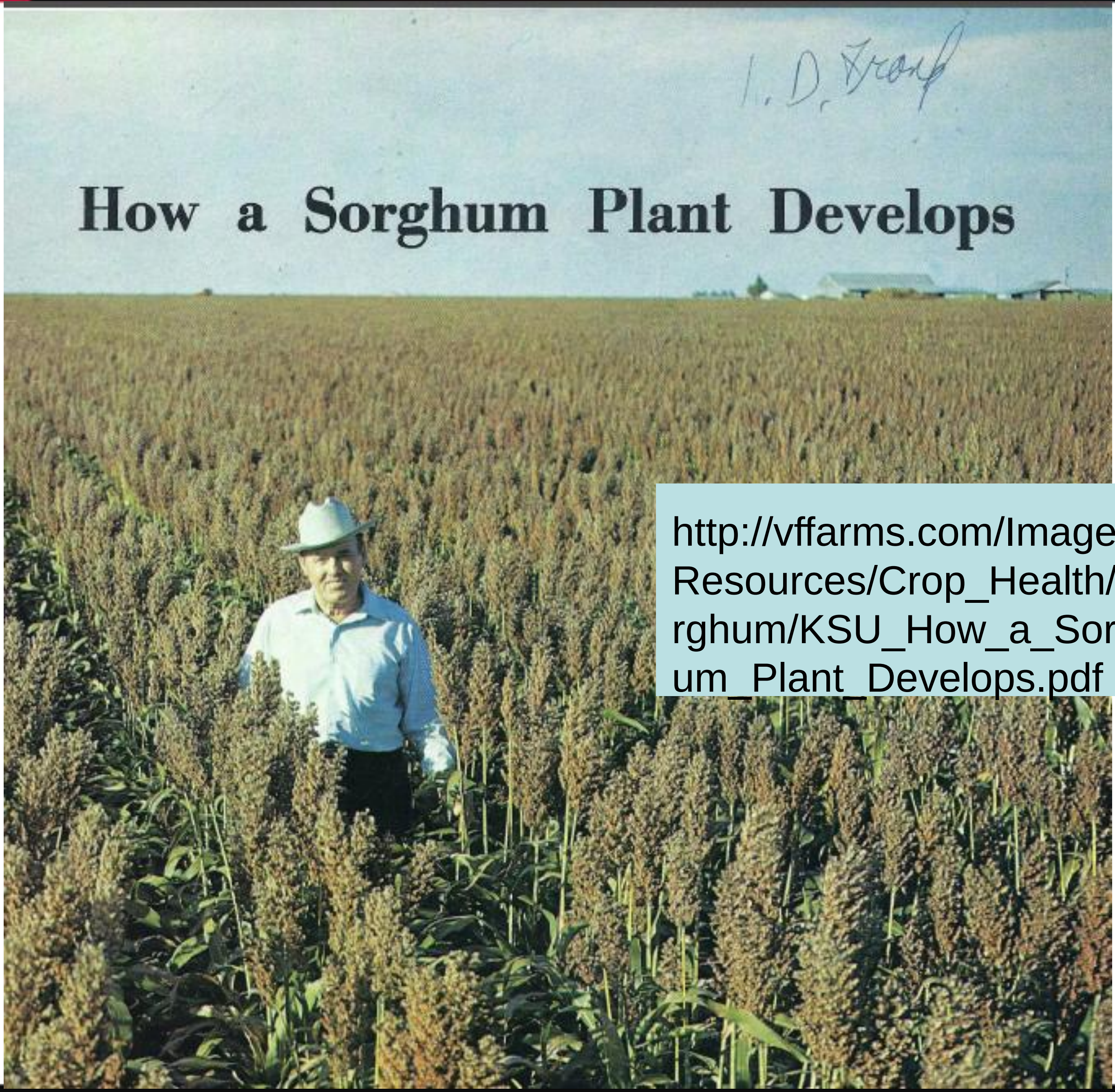
IANR

Sorghum crop and soil management

- Yield and yield components
- Fertilizer use of sorghum
    - N
    - P, K, S, Zn
    - Starter fertilizer
    - Nutrient management for 2013
- Other information
- Websites

University of Nebraska Lincoln

IANR



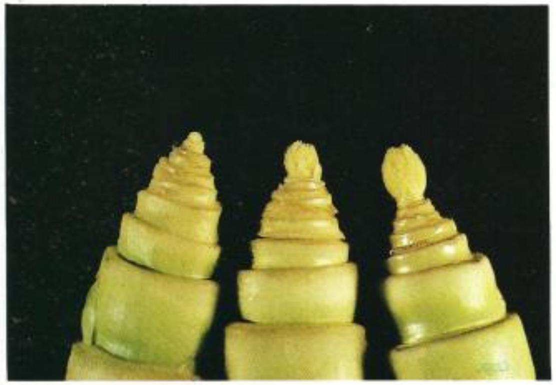
http://vffarms.com/Images/Resources/Crop_Health/Sorghum/KSU_How_a_Sorghum_Plant_Develops.pdf

Nebraska UNIVERSITY OF Lincoln

IANR

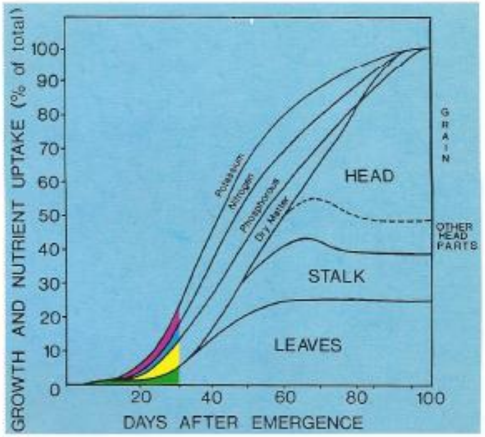
Stage 3

Growing point differentiation—About 30 days after sorghum emerges, its growing point changes from vegetative (leaf producing) to reproductive (head producing). The total number of leaves has been determined and potential head size will soon be determined. About one-third of the total leaf area has fully developed—7 to 10 leaves depending on maturity class—and the lower 1 to 3 leaves may have been lost. Culm or stalk growth increases rapidly following growing point differentiation. Nutrient uptake is rapid. Time from planting to growing point differentiation generally is about one-third of the time from planting to physiological maturity (maximum dry weight).



Management Guide

Growth and nutrient uptake are rapid during Stage 3. Adequate supplies of nutrients and water are necessary to provide maximum growth. Sorghum plants are now quite competitive which helps maintain good weed control the remainder of the growing season.



Sorghum yield: yield components

- Yield/acre = panicle (head) number x kernels per panicle x kernel weight

- Each component is affected by growing conditions at different times

- Harvest index = grain wt. / total above-ground wt.

University of Nebraska Lincoln

IANR

Panicle (head) number

- Number of plants and tillers with a panicle
- More plants and panicles is not necessarily better
- Panicle forms 30 days before bloom
- Optimal plant population, adequate water, nutrients, light

University of Nebraska Lincoln

Kernels per panicle

- Determined from before bloom until after pollination
  - Panicle size, which is determined early
  - Successful embryo establishment determined during pollination
  - Embryo survival determined during 2 weeks following pollination
  - Important stresses may be: inadequate water, light, and nutrients; ergot; sorghum midge

Kernel weight

- Determined during grain fill
  - – Photosynthesis continues; need healthy green leaves
  - – Carbohydrates move from vegetative to grain
- Needs adequate water and nutrient supply; green bugs and sooty stripe can limit grain fill and kernel weight
- Harvest index determined: proportion of above ground plant that is in the grain

University of Nebraska Lincoln

IANR

Harvest index

- Sorghum HI of 45 to 50, that is with grain 45 to 50% of aboveground dry wt, is desired
- Often less with stress during pollination and grain fill
- For example, HI of <25 common in Ethiopia due to severe drought stress during grain fill
  - grain is small with low test weight
  - stover is used

University of Nebraska Lincoln

IANR

Yield component summary

- Yield components are informative of growing conditions and stresses that occurred during the season, e.g.
  - Few panicles due to poor stand and/or early stress
  - Small panicles indicate stress before boot stage
  - Few kernels per panicle, depending on panicle size, may indicate stress during   2 weeks of pollination
  - Small kernels and low grain wt. indicate stress during grain fill.

University of Nebraska Lincoln

IANR

NebGuide

University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources

Know how. Know now.

G1669
(Revised January 2013)

Nutrient Management Suggestions for Grain Sorghum

Charles S. Wortmann, Richard B. Ferguson, Gary W. Hergert, Charles A. Shapiro, and Tim M. Shaver
Extension Soil Specialists

University of Nebraska Lincoln

The Nitrogen Cycle

Volatilization: surface applied manure or fertilizer ammonium N may convert to ammonia gas and be lost to atmosphere

Runoff: causes N loss and water contamination

Denitrification: reduction of nitrate-N to N_2 or nitrous oxide under low O_2 conditions

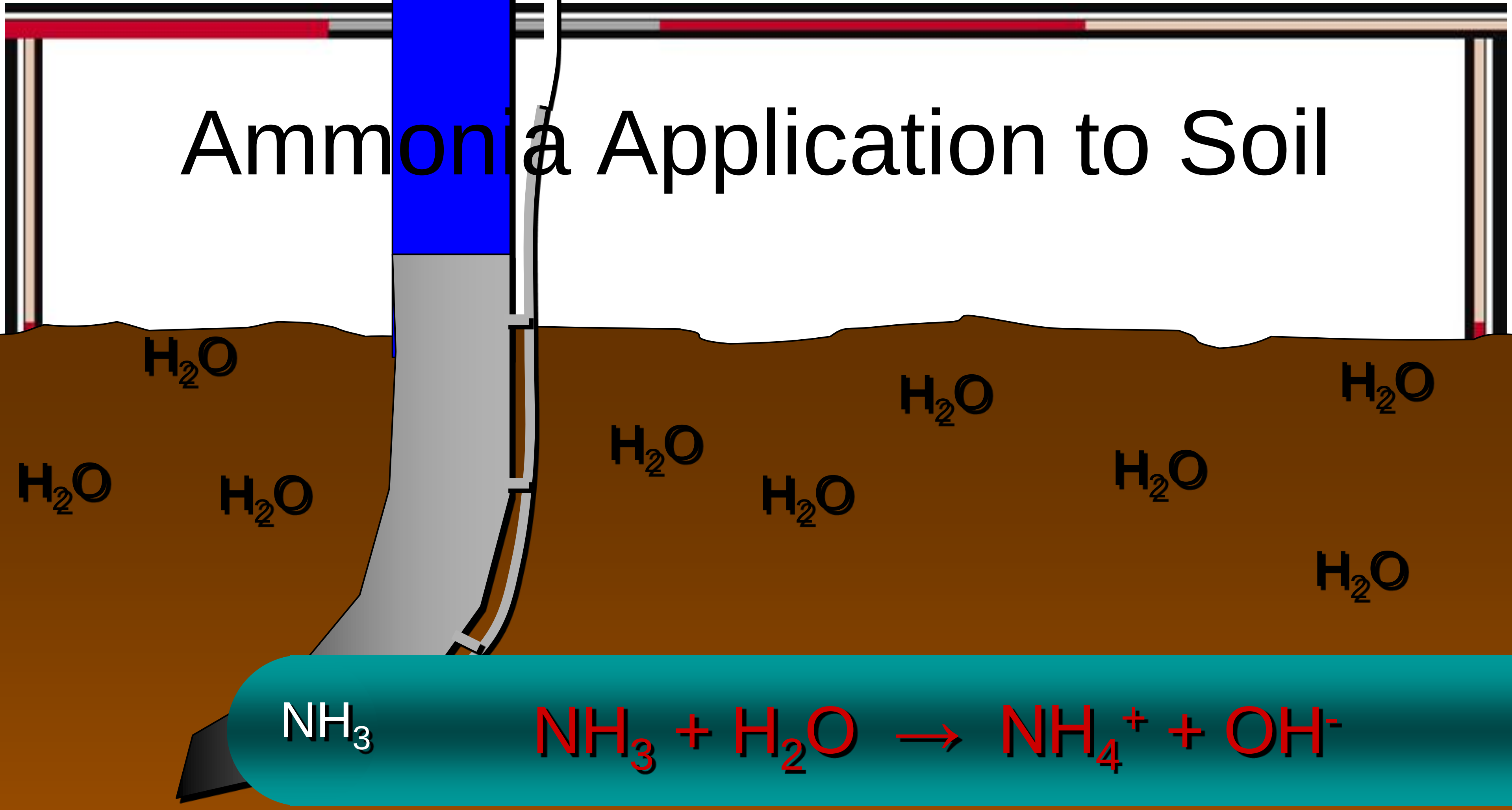
Leaching of nitrate-N below the rooting zone

University of Nebraska Lincoln

IANR

Was much N loss with anhydrous ammonia application on dry soil?

Ammonia Application to Soil

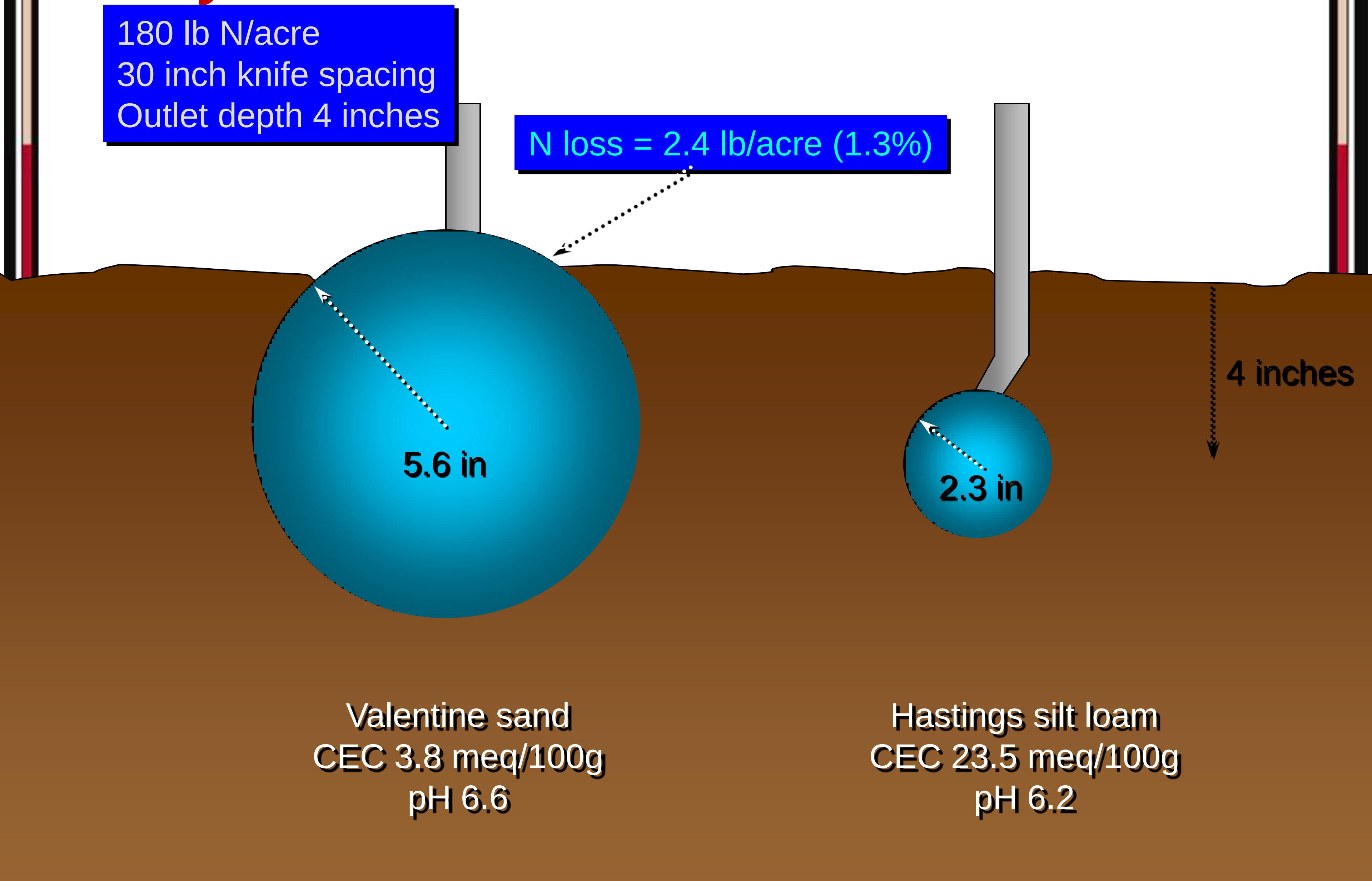


$$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$$

Ammonium (NH_4^+) binds rapidly to cation exchange sites on soil clay particles and soil organic matter.

Hydroxyl anions effectively increase soil pH.

Anhydrous Ammonia Retention Zone



Anhydrous application with dry soil

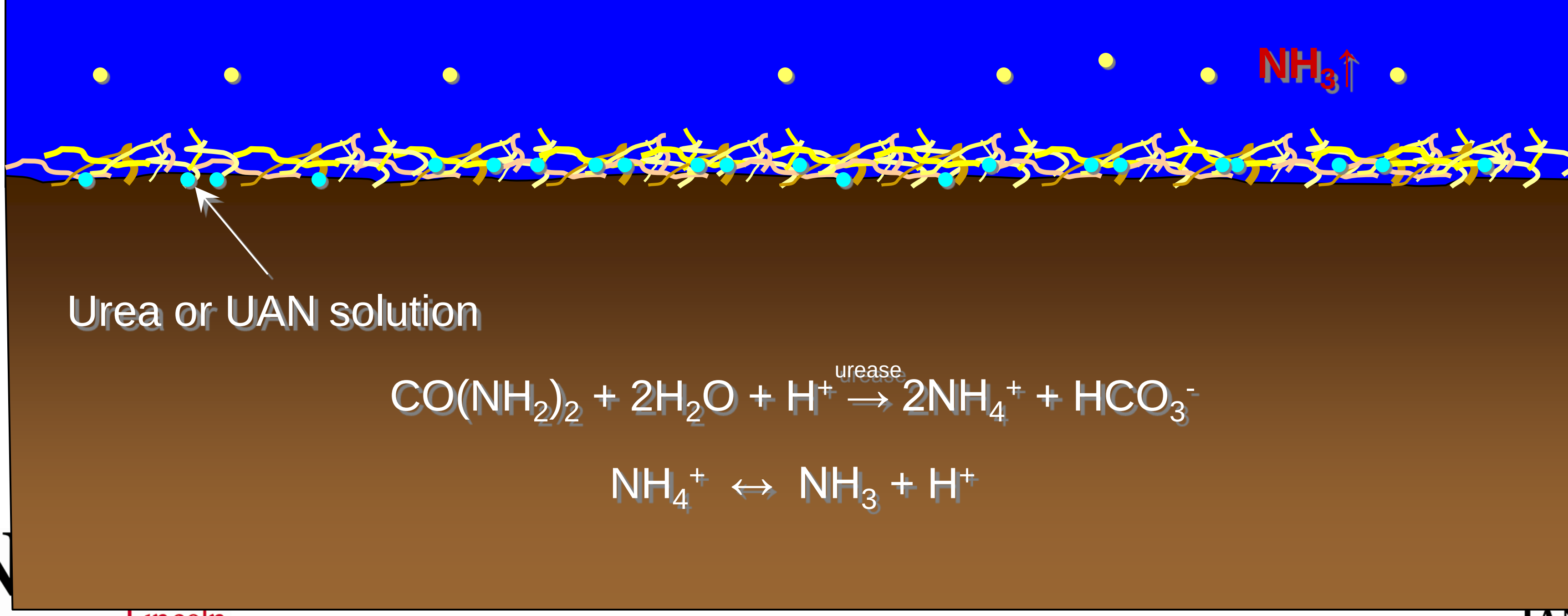
- Even with dry soil, soil water is generally enough to react with and hold the N
  - Maybe 1 or 2” deeper with very dry soil
- Most important is good furrow closure
- Detecting loss: the white gas and smell indicate loss but difficult to quantify amount

University of Nebraska Lincoln

IANR

Ammonia Volatilization with Urea & UAN

- Loss can be >50%, but typically <10%
    - More loss with heavy residue cover and high soil pH
    - Mostly temperature independent
- Urease inhibitors can protect against volatilization for up to 2 weeks
- Rainfall or irrigation of ¾ inch eliminates potential for volatilization



N products and inhibitors: SE NE, 4 sorghum trials, 2009-10, 70 lb N

	Yield, bu ac
Control, 0N	50
Ammonium nitrate (AmN)	92
Urea	79
Urea, Nutrisphere	79
Urea, Agrotain	83
AmN plus foliar SRN28	81
AmN plus foliar Coron	74

University of Nebraska Lincoln

IANR

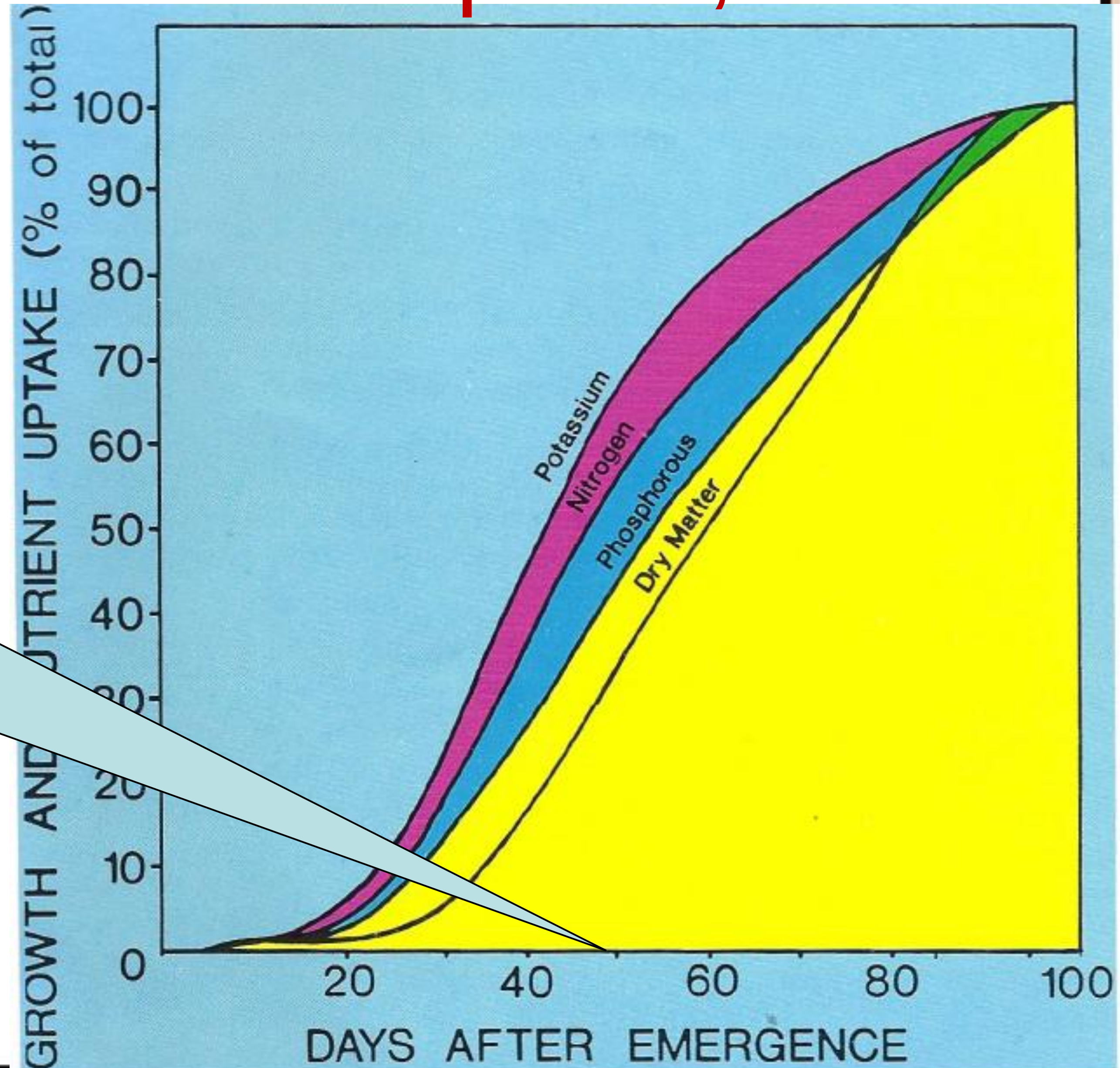
N products and inhibitors: SE NE, more treatments in 2 trials, 2010, 70 lb N

	Yield, bu ac
Control, 0N	60
Ammonium nitrate (AmN)	98
Urea	81
UAN	82
Urea, SuperU	83
Urea, polymer coated	89

University of Nebraska Lincoln

IANR

Timing of nutrient uptake; side-dress N



In-season sidedress application; will there be rainfall to take it into the soil?? Use a urease inhibitor?

University of Nebraska Lincoln

N for sorghum after sorghum

EONR (lb/acre) = [70 + (1.1 x EY) – (20 x OM) – (14 x NO_3-N ppm) – other credits] x (P_GP_N x 0.11)

where EY = expected yield (bu/ac) estimated as 1.05 x average sorghum grain yield over the past five years or more,

OM = percent soil organic matter to a maximum of 3 percent,

NO_3-N ppm = average nitrate-nitrogen concentration for the 2-3 foot depth in parts per million, and

P_GP_N = the price of grain ($/bu) divided by the price of fertilizer N ($/lb).

Other credits include nitrogen from manure or other applied organic material, and from irrigation water.

Nel

Lincoln

IANR

Nitrogen for sorghum-soybean

- Revised based on results from 39 trials conducted between 1995-2004
- Residual soil nitrate and soil organic matter did not account for differences in EONR

University of Nebraska Lincoln

IANR

Table I. Economically optimum nitrogen rate (EONR) for grain sorghum following soybean in rotation.

Expected yield (EY, bu/ac)	*Grain price to nitrogen price ratio (P_G/P_N), (\$/bu grain) / (\$/lb N)*				
	4	**6**	**8**	**10**	**12**
70	0	10	20	35	50
90	5	20	30	45	60
110	15	30	40	55	70
130	25	40	50	65	80
150	35	50	60	75	90
170	45	60	70	85	100
190	55	70	80	95	110

Grain price to nitrogen price ratio ($P_G P_N$), (\$/bu grain) / (\$/lb N).

$EONR = -68 + 0.49\ EY + 6.9\ P_G P_N$.

Table III. Phosphorus fertilizer suggestions.

Phosphorus Soil Test, ppm P		*Amount to Apply Annually (P_2O_5), lbs/ac*	
Bray-1 P or Mehlich-3[1]	*Olsen P*[2]	*Broadcast*	*Band*
0-5	0-3	80	40
6-15	4-10	40	20
>15	>10	0	0

[1]Bray P-1 for acid and neutral soils, Mehlich-3 for all soils.

[2]Olsen P for calcareous soils.

University of Nebraska Lincoln

IANR

Table IV. Potassium fertilizer suggestions.

Potassium Soil Test, ppm K	*Relative Level*	*Amount to Apply Annually (K_2O), lbs/ac*	
		Broadcast	Row[1]
0 to 40	Very Low (VL)	120	20
41 to 75	Low (L)	80	10
75 to 125	Medium (M)	40	10
>125	High (H)	0	0

[1]Banded beside seed row but not with the seed.

University of Nebraska Lincoln

IANR

Table V. Sulfur fertilizer suggestions (sandy soils only).

Sulfur Soil Test, ppm SO_4-S	*Amount to Apply Annually, lb/ac*		
	Soil Organic Matter <1%		*Soil Organic Matter > 1%*
	Irrigation water with less than 6 ppm SO_4-S		
	Broadcast	Row[1]	Row[1]
<6	20	10	5
6-8	10	5	0
>8	0	0	0
	Irrigation water with 6 or greater ppm SO_4-S		
<6	10	5	0
6-8	10	5	0
>8	0	0	0

Sulfur Test - $Ca(H_2PO_4)_2$ Extraction

[1]Applied in a band next to row but not with seed.

Table VI. Zinc fertilizer recommendations.

Zinc Soil Test Level		*Amount to Apply (Zn), lbs/ac*[1]			
DTPA Extraction	*Relative Level*	*Calcareous Soils*[2]		*Noncalcareous Soils*	
ppm Zn		Broadcast	Band	Broadcast	Band
0 to 0.4	Low (L)	10	2	5	2
0.41 to 0.8	Medium (M)	5	1	3	1
> 0.8	High (H)	0	0	0	0

[1]Rates are for inorganic forms of zinc such as zinc sulfate.

[2]Calcareous soils defined as soils with moderate to excess lime.

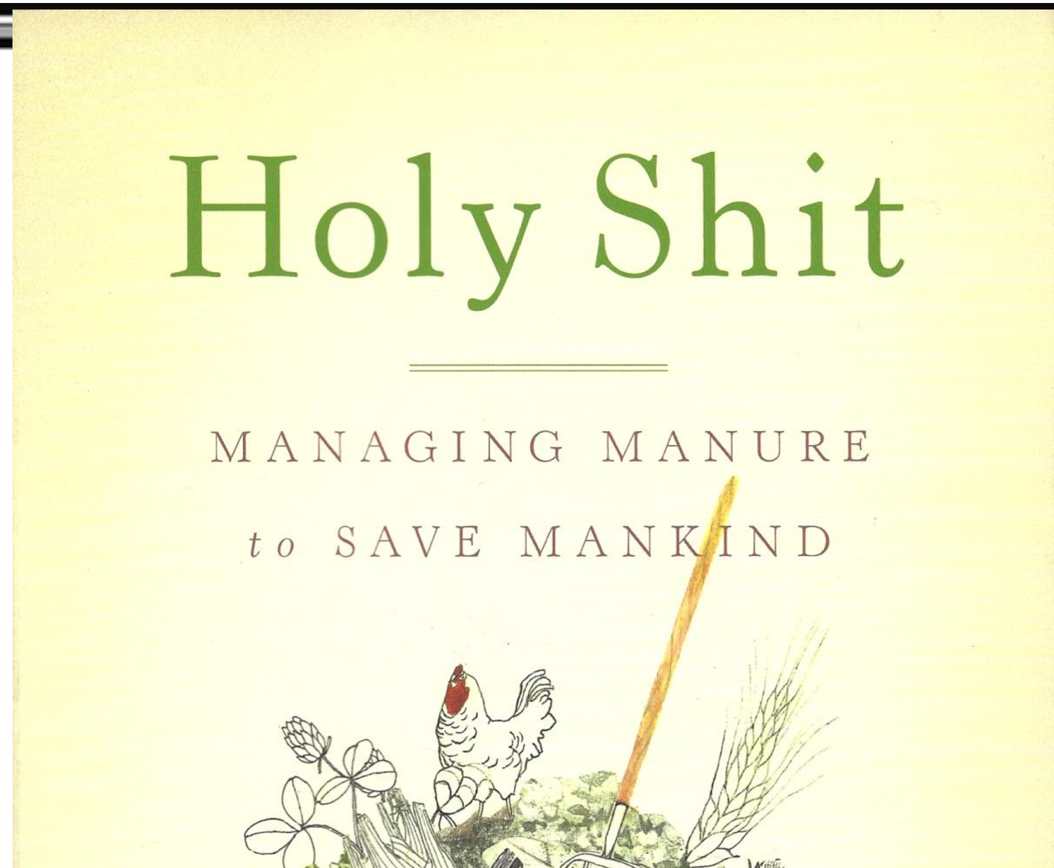
P, K, S, Zn

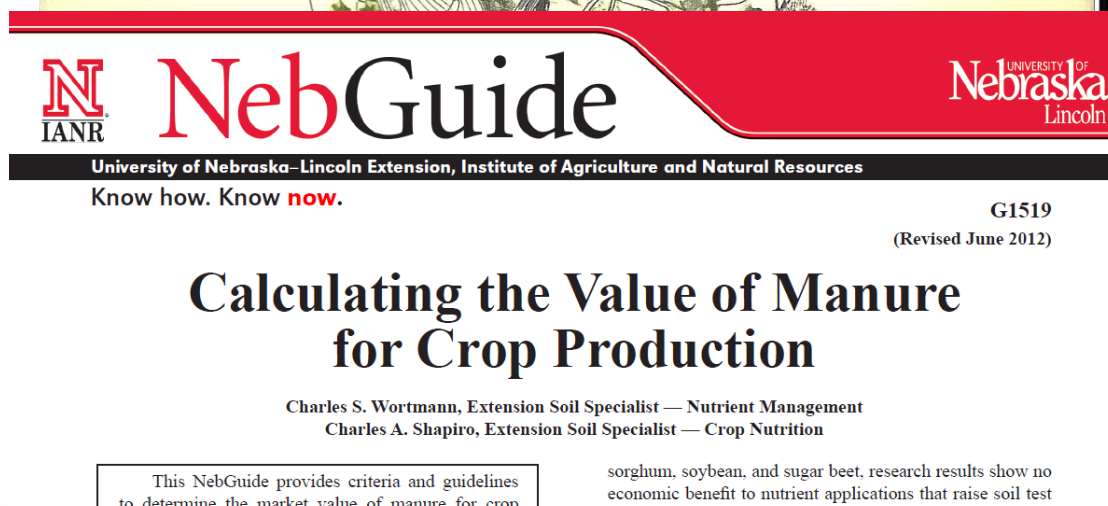
- P, K, Zn: apply according to soil tests
  - P is often needed
  - K is seldom needed and application is more likely to reduce than increase yield
  - Zn is sometimes needed
- Sulfur: profitable response is highly unlikely except on sandy soil

"….belongs in every bathroom of every home" – Joseph Jenkins, author of the "*Humanure Handbook*".

"….This is the book to read if you give a crap about crap" – Sim van Der Ryn, author of the "*The Toilet Papers*".

"….in his naughty and inimical style, ………….. Read and heed." – Joel Salatin, author of the "*The Sheer Ectasy of Being a Lunatic Farmer*".





NebGuide

University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources

Know how. Know now.

G1519
(Revised June 2012)

Calculating the Value of Manure for Crop Production

Charles S. Wortmann, Extension Soil Specialist — Nutrient Management
Charles A. Shapiro, Extension Soil Specialist — Crop Nutrition

This NebGuide provides criteria and guidelines to determine the market value of manure for crop

sorghum, soybean, and sugar beet, research results show no economic benefit to nutrient applications that raise soil test

University of Nebraska Lincoln

Drought and nutrient management

Much residual nitrate-N: take stock and give credit/reduce N rate

- Little loss in 2012 to leaching and denitrification; less nutrient uptake; early maturity and warm fall
- Deep sampling, at least to 24”
  - Sample before N application, but
  - Sample near to planting for greatest confidence
- Give credit to 50-60% of nitrate-N found, but give more credit if
  - used with in-season diagnosis
    - pre-sidedress nitrate test
    - reading the crop canopy reflectance

Yield variability and variable residual nitrate-N??

- More residual N expected with low yield unless these areas have high potential for loss
- Use yield maps and other within field yield information to target soil sampling

Will soybean N credit be affected?

- Many drought-associated factors can affect the credit with a mix of increases and decreases
- Give 45 lb/ac N credit, even if 2012 soybean crop was poor or failed

Phosphorus (P), Potassium (K), Zinc (Zn)

- Where are the applied 2012 nutrients for rainfed fields? How will low 2012 uptake affect 2013 availability?
- Immobile nutrients; unused 2012 nutrients are still there and mostly available

P, K, Zn-rainfed fields

- Increased soil test values expected
  - Soil tests of fall 2012 and spring 2013 are useful for 2013 management but mis-leading for future years
- Generally less or no fertilizer P, K, Zn needed in 2013

Dry soil effect on soil test values

- Soil test K and pH may be less than normal because of dry soil effect

Grid sampling

- Good practice when results are properly interpreted
- However, many unusual soil test results expected in 2013
- Delay grid sampling to a more typical year

NebGuide
University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources
Know how. Know now.

G361
(Revised October 2012)

Using Starter Fertilizers for Corn, Grain Sorghum, and Soybeans

Gary W. Hergert, Charles S. Wortmann, Richard B. Ferguson, Charles A. Shapiro, and Tim M. Shaver
Extension Soils Specialists

in-furrow), and depends on the fertilizer used and soil

Starter fertilizer, 2002-5, SE NE

- 18 trials
  - 2-3 bu/ac gain with N-P starter fertilizer
  - 1.0 bu/ac gain by including S in starter
  - No statistically significant effects
  - Yield with 2x2 and in-furrow placement was 2 and 1 bu/ac more compared with over the row

Removing crop residue from over the row, 2004-5, 6 trials, SE NE

	Bu/ac
Control	136
Row cleaning 10 DBP	136
Row cleaning during planting	135
Row cleaning plus starter N,P	138

No yield advantage with row cleaning.

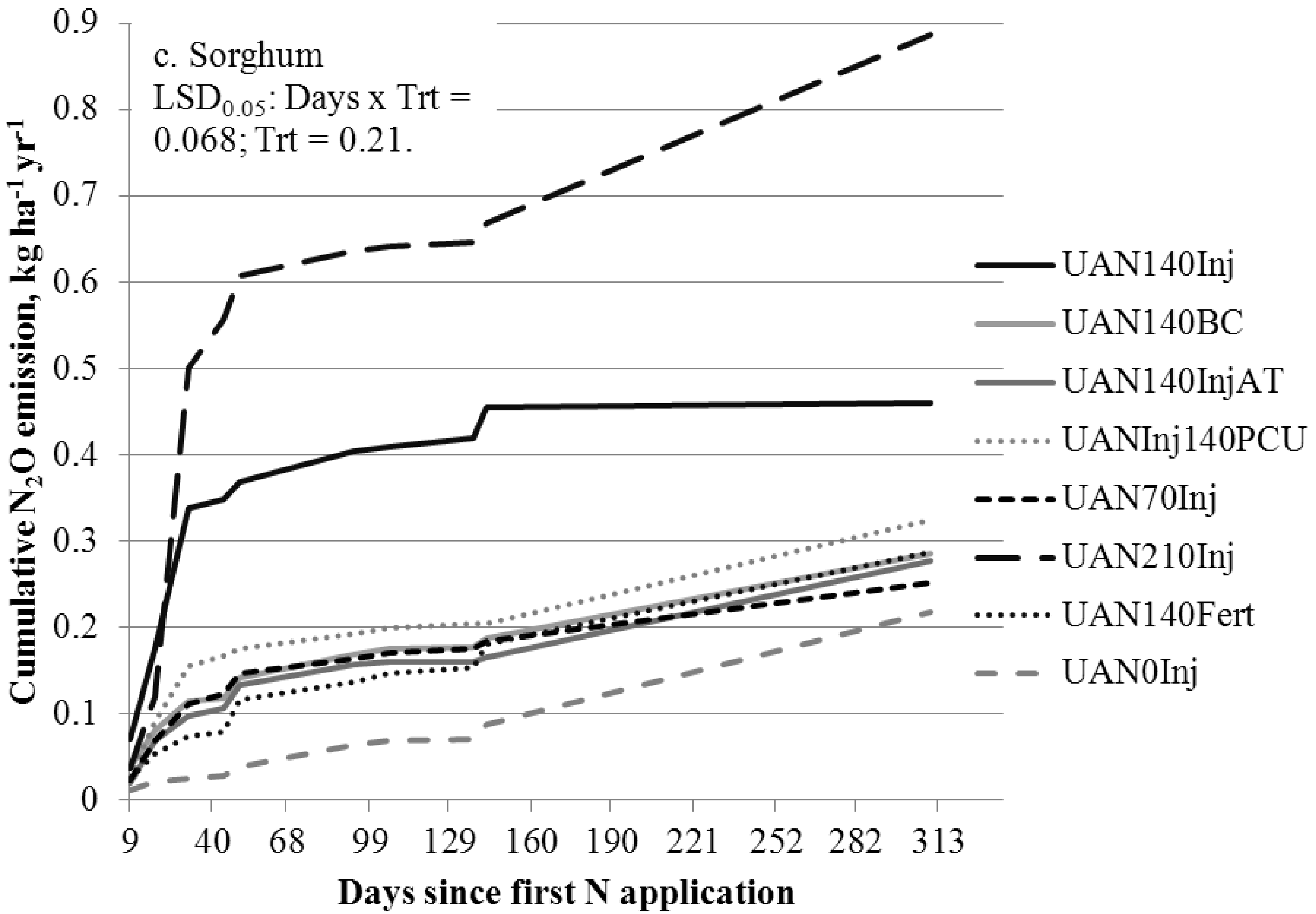
University of Nebraska Lincoln

IANR

Sweet Sorghum for Biofuel in Nebraska

- 7 site-yr in Nebraska in 2007-2008
  - Rainfed
  - Deep silt loam, loam, or silty clay loam soil
  - Previous crop: soybean or winter wheat
  - No-till
- Ethanol yield potential was greater with corn and grain sorghum than with sweet sorghum

N management and nitrous oxide emission



Plant Population Summary (results from KS and NE)

- ~ 30,000 plants/acre for semi-arid
- 30,000 to 50,000 plants/ac for better rainfall (SC&SE NE) or limited irrigation
- 75,000 plants/ac for ≥6” irrigation
- Fewer plants/ac needed with full season compared with early-medium maturity hybrids
- Do not replant fairly uniform stands of 20,000 or 30,000 for drier and wetter areas, respectively

What about narrow rows (<30")

- may be a detriment in dry, low yield environments
- may be more advantageous at later planting dates
- Not much hybrid maturity difference
- Select hybrids with resistance to stalk rots and excellent stand ability for narrow rows
- Probably no advantage with twin-rows
- **Generally not much if any advantage with <30"**

Rotation and Tillage Summary

(from NE and KS research)

- Sorghum yields commonly more in rotation
- Increased N rate may close the continuous compared with rotated yield gap
- Rotation is critical for no-till success.
- Greater no-till benefit in drier environments

University of Nebraska Lincoln

IANR

Topics

Improving Drought Tolerance in Grain Sorghum Through Skip-Row Planting

- Yield advantage if yield is less than
  - 55 bu/ac for Plant1:Skip1 and Plant2:Skip2
  - 70 bu/ac for Plant2:Skip1

Lincoln

NebGuide

University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources

Know how. Know now.

G1976

Skip-Row Planting of Grain Sorghum for Improved Drought Tolerance

Charles S. Wortmann and Richard B. Ferguson, Extension Soils Specialists
Robert N. Klein, Extension Cropping System Specialist
Drew J. Lyon, Extension Dryland Cropping Specialist
Steve R. Melvin, Extension Educator

This NebGuide advises on skip-row planting as a means to improve grain sorghum production under water-deficit conditions.

Skip-row planting involves leaving some rows unplanted to save stored soil water under the unplanted row areas for use during reproductive stages of growth *(Figure 1)*. Roots do not reach this water until well into July. Common skip-row configurations are planting alternate rows (plant – skip1) or alternate pairs of rows (plant2 – skip2), or planting two rows and skipping one row (plant2 – skip1)

(Figure 2). In southeastern Nebraska, grain sorghum typically is produced on the relatively more drought-prone land. Research results from Nebraska and Kansas indicate that grain sorghum has a yield advantage relative to corn for average yields less than 100 bu/ac when the main constraint is inadequate water. Because grain sorghum has lower production costs than corn, due to lower seed costs and generally lower nitrogen needs, it may be more profitable than corn if average yields are less than 120 to 140 bu/ac, depending on land values. In the Nebraska Panhandle, the combination of less rainfall and a short growing season limits grain sorghum production at elevations above 4,000

Soil Test Nebraska

www.soiltest.unl.edu

Welcome to the University of Nebraska Department of Agronomy and Horticulture site for fertilizer recommendations. This site will allow you to calculate fertilizer recommendations for all crops produced in Nebraska, either by directly entering crop and soil test information, or by uploading files with test information from analytical laboratories. Please select a crop button to the left to begin.

Related Links
Soil Fertility

IANR

The Nebraska Environmental Trust

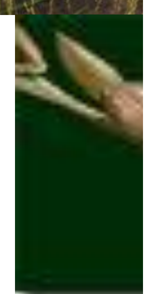
INTSORMIL focal crops

INTSORMIL

Sorghum, Pearl Millet and

- **Finger Millet (E. & S. Africa)**

- **Tef (Ethiopia)**



- **Fonio (West Africa)**

Supported the UNL research on

- N rate
- Starter fertilizer
- Row cleaning
- Plant population
- Skip-row planting
- Sweet sorghum
- Nitrogen products
- Nitrous oxide emission

University of Nebraska Lincoln

INTSORMIL

Charles Wortmann* and Martha Mamo, UNL

Christopher Mburu, Kenya

Elias Letayo, Tanzania

Girma Abebe, Ethiopia

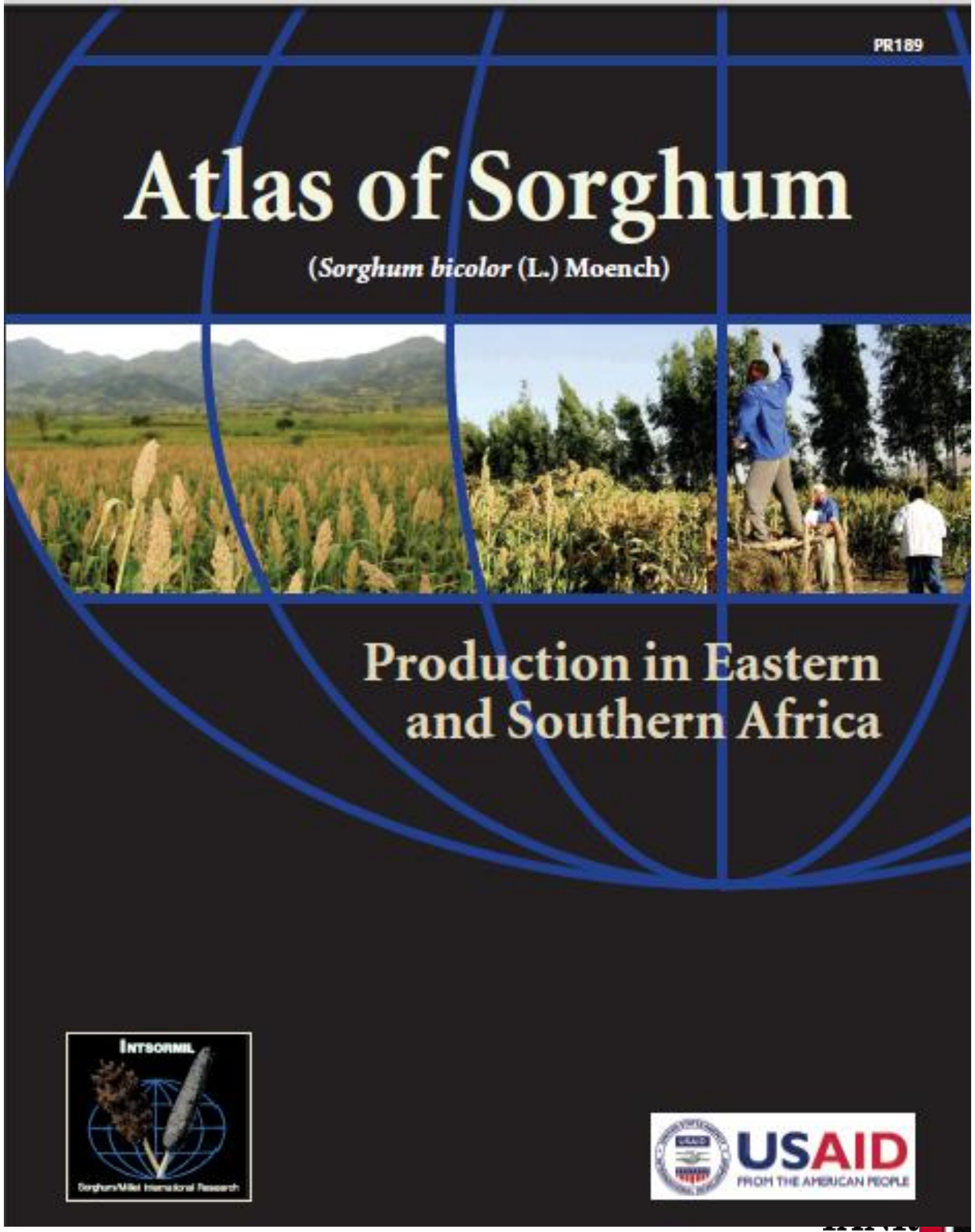
Kaizzi C. Kayuki, Uganda

Medson Chisi, Zambia

Munyaradzi Mativavarira, Zimbabwe

Soares Xerinda, Mozambique

Theophile Ndacyayisenga, Rwanda



Thank you!
Questions?

University of Nebraska Lincoln

IANR