Sudangrass forage biomass and hay quality in response to fertilizer and irrigation water levels.

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Background

- Sudangrass is a C4 grass that thrives well under low deserts.
- Acreage of sudangrass in IV ranged from 42,000 (*1990*) to 49,164 (*2022*) & generated over $63M in revenue in 2022
- Having extensive root systems, sudangrass responds very well to supplemental fertilizer meaning can luxuriously uptake and store excessive nitrogen in its tissue).

Common grower fertilization practices

- In anticipation of maximizing hay production, growers of the low desert commonly apply large quantities of N fertilizers in the production of sudangrass hay at rates varying from 150 to over 800 lbs N/acre during the growing cycle.

Potential effects of excessive N fertilizer

- Coupled with over-irrigation, it could move out of the crop root zone through either erosion or leaching (into drainage) & cause environmental pollution & damage to ecological & aquatic life.

- High levels of supplemental fertilizer could also result in higher sudangrass tissue nitrate & /or prussic acid concentration, making the hay toxic to livestock.

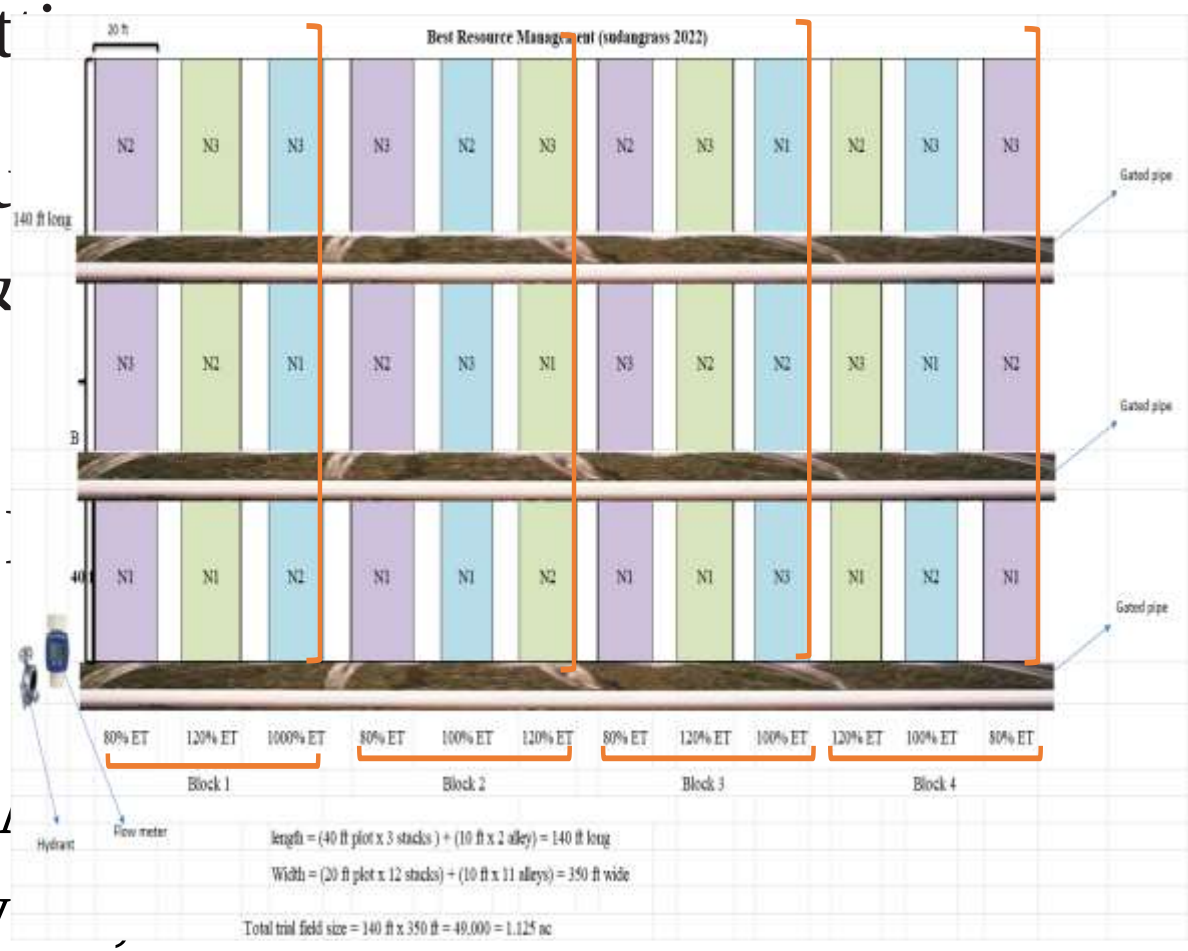
Objective (s) of our research project

- Assess the effects of supplemental fertilization and irrigation water on biomass and hay quality of Sudangrass.

- Develop the best nitrogen fertilization and irrigation management strategies for optimum Sudangrass yield and quality production in the low desert

Approaches / methods

- 3 fertilizer rates (sub plots), @ every cut
  - ✓ (1) lower rate (50lbs N / ac) at each cu
  - ✓ (2) conventional rate (80lbs N / ac), &
  - ✓ (3) high fertilizer rate (100lbs N / ac)
- 3 irrigation levels (main plots): (1) 80% (2) 100% ET, & (3) 120%ET.
- The study is being conducted at the UC and Extension Center (DREC), in Holtv



- Initial fertilizers were applied as pre-plant.
- Used sprinkler irrigation during initial crop establishment & then farrow irrigation controlled by gated pipes for each irrigation treatment.

- The soil is predominantly silty loam, with variations in texture with depth.

  - ✓ Generally low in organic matter, nitrogen & phosphorus but high in Potassium.

  - ✓ Soil pH was alkaline.

Major soil components for pre-fertilizer & pre-plant soil samples at four soil depths, 0-1, 1-2, 2-3, and 3-4 ft, respectively

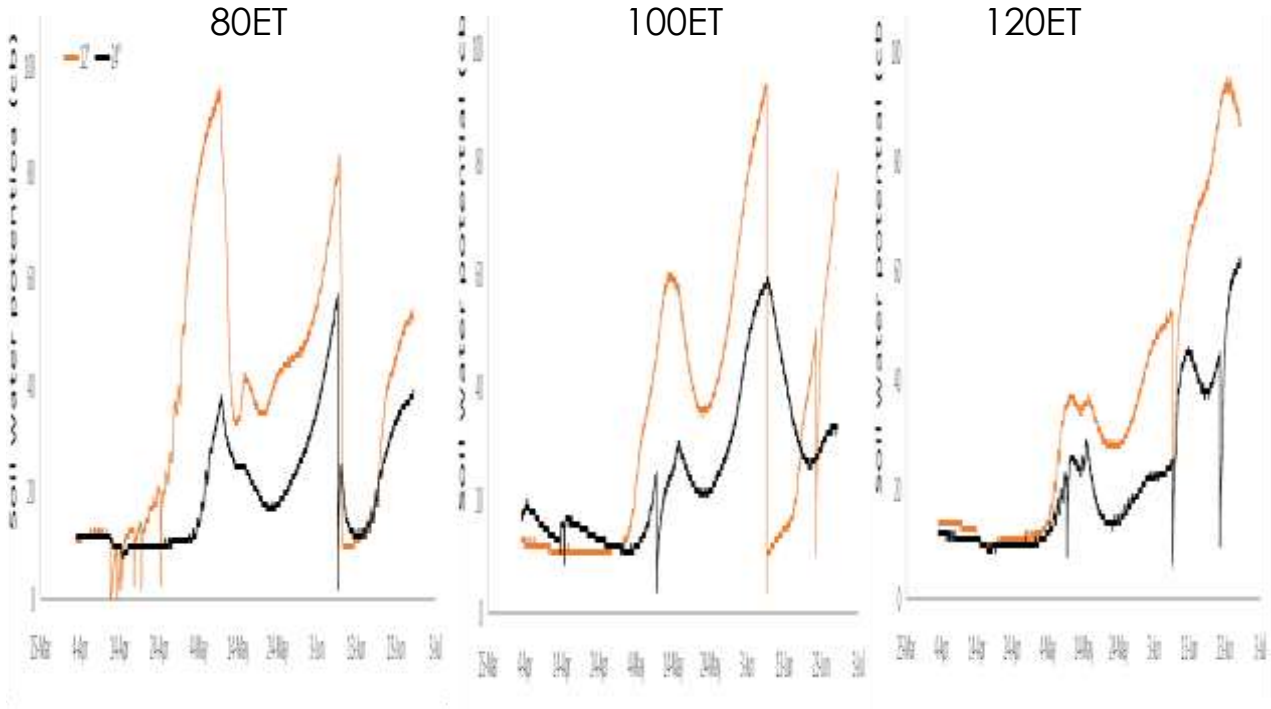
Type	Soil Depth				Optimum Levels	
	0 - 12"	12 - 24"	24 - 36"	36 - 48"	Low	High
Total N,*Combustion/%*	0.02	0.01	0.01	0.01	-	-
Org. Matter, *Combustion/%*	0.30	0.18	0.23	0.20	-	-
NO3-N, *OLSEN/PPM*	53.1	12.4	6.3	12.7	25.0	50.0
PO4-P, *OLSEN/PPM*	16.3	7.1	2.0	2.2	10.0	20.0
K, *OLSEN/PPM*	262	157	114	86	80	160
Soil Texture / estimate	Loam; Sl. Lloam	Loam; Sl. Lloam	Loam; Sl. Lloam	Sandy Loam	-	-
pH, *Saturation Paste / Units*	7.98	8.11	8.14	8.04	6.50	7.50

Preliminary Results

- Soil moisture sensors indicated variations in irrigation water availability (SWC) following irrigation treatments.

- The 80ET irrigation provided relatively less soil-available water over the growing period and exhibited some crop water stress.

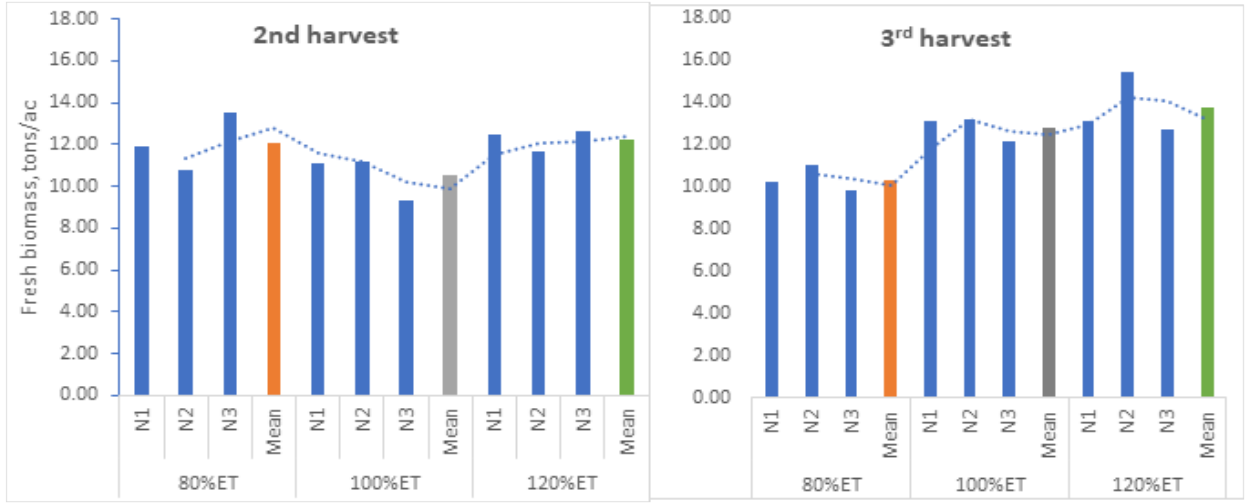
- Better water availability for the100ET & 120ET irrigation levels.



Soil water potential under the 3 irrigation schedules, 80ET (left), 100ET (middle), and 120ET (right) at 12" (orange line) and 24" (black) soil depth.

Sudangrass biomass production

- Biomass production for two subsequent cuttings was not significantly different between fertilizer rates (*Pr > 0.8577*) or irrigation levels (*Pr > 0.3411*) or for fertilizer * irrigation interactions (*Pr > 6689*).



Fresh biomass, tons /ac of crop under 3 fertilizer (N1, N2, and N3) and 3 irrigation rates for the second cutting (left) and third cutting (right) with no significant biomass differences between fertilizer (Pr > 0.8577) or irrigation (*Pr > 0.3411*) treatments, or fertilizer * irrigation interactions (*Pr > 6689*).

Sudangrass forage quality (a response to fertilizer & Irrigation

- Major nutrient components were consistent or linear for crude protein, ADF, NDF, Ash, and TDN, and are at a level desirable for sudangrass hay.
- Within each nutrient components there is no significant variation among fertilizer or irrigation levels.

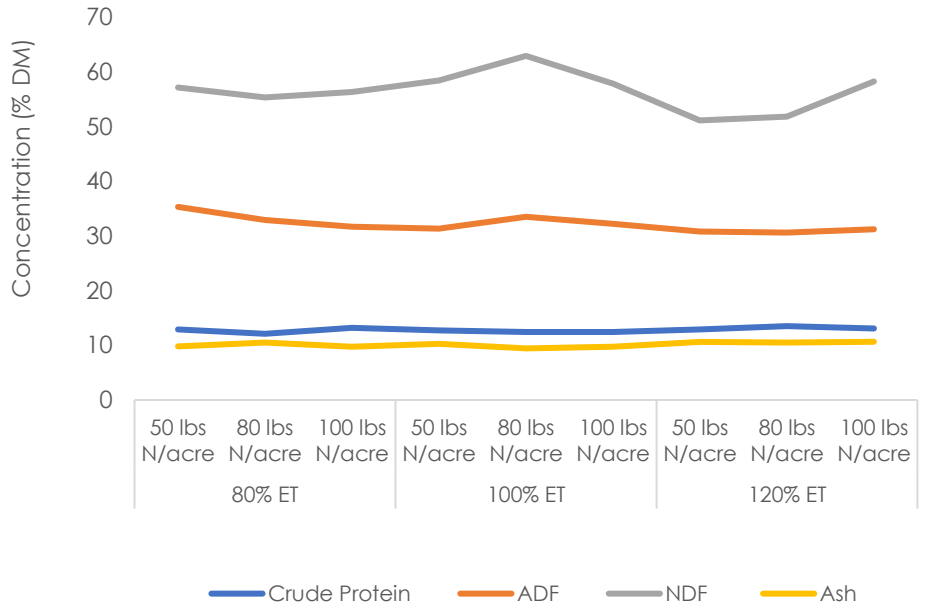


Figure 4: Sudangrass forage nutritional components.

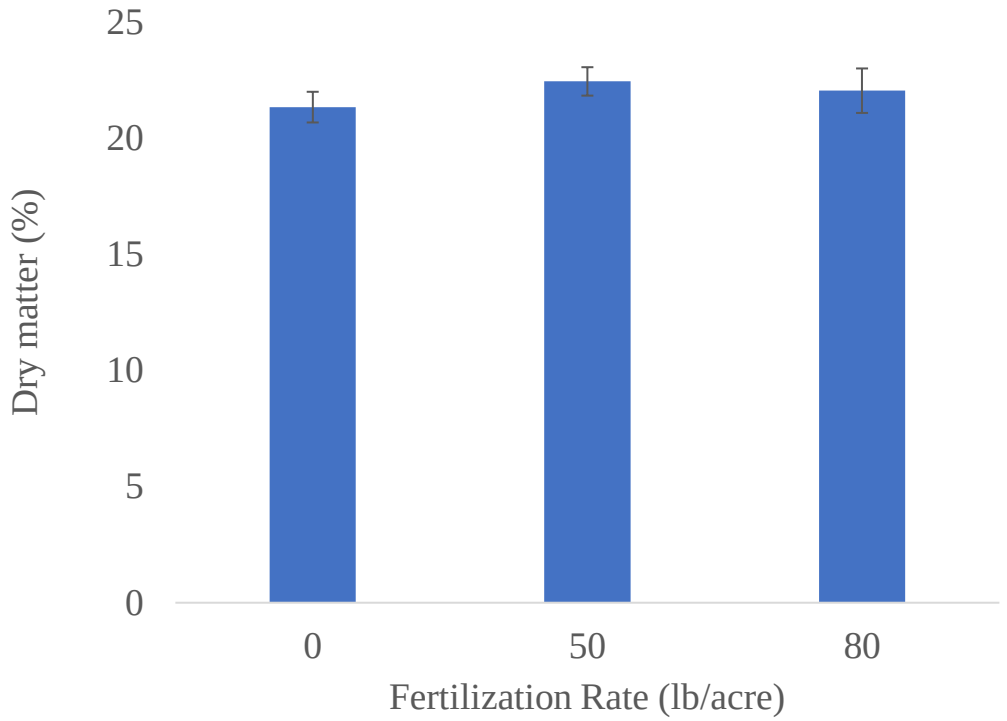
- However, all treatments & treatment combinations resulted in very high (highly elevated) sudangrass tissue nitrate-N conc.
  - ✓ Elevated above 2000 ppm, possible acute toxicity level for LS.
  - ✓ Hay with less than 1,000 PPM nitrate is generally safe, less than 2,000 PPM is mostly safe to LS

FSudangrass tissue nitrate-N composition.

Second-year project results

Dry Matter (%)

- Similar to the first-year trial, send year sudangrass biomass was not significantly different between fertilizer or irrigation treatments

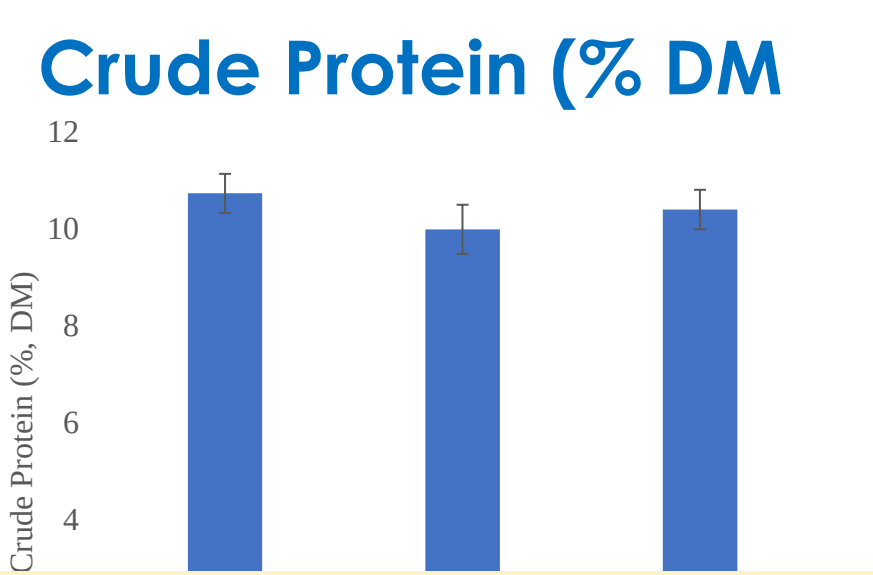


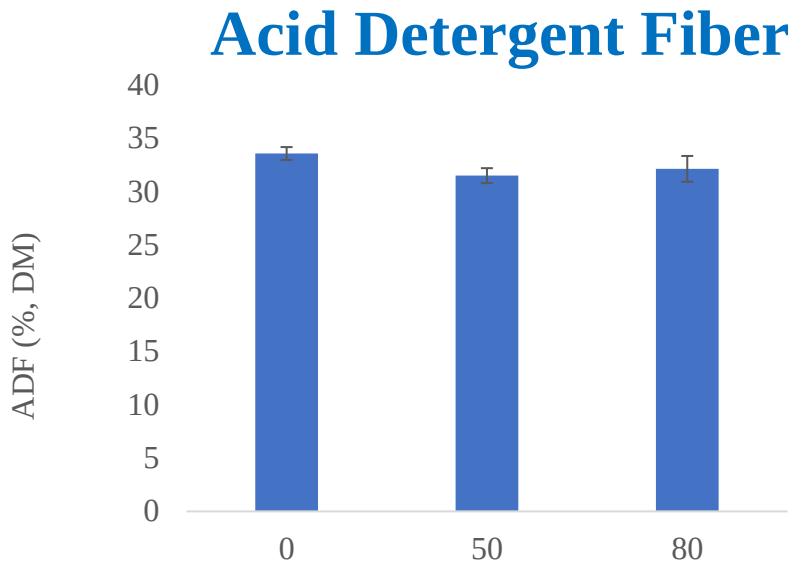
- ✓ Within the expected range
- ✓ Fertilizer rate = *NS*
- ✓ Irrigation rate = *NS*

ANOVA

Variable	p-value
N	0.31
ET	0.24
Interaction	0.83

- Greater crude protein is typically associated with higher quality.



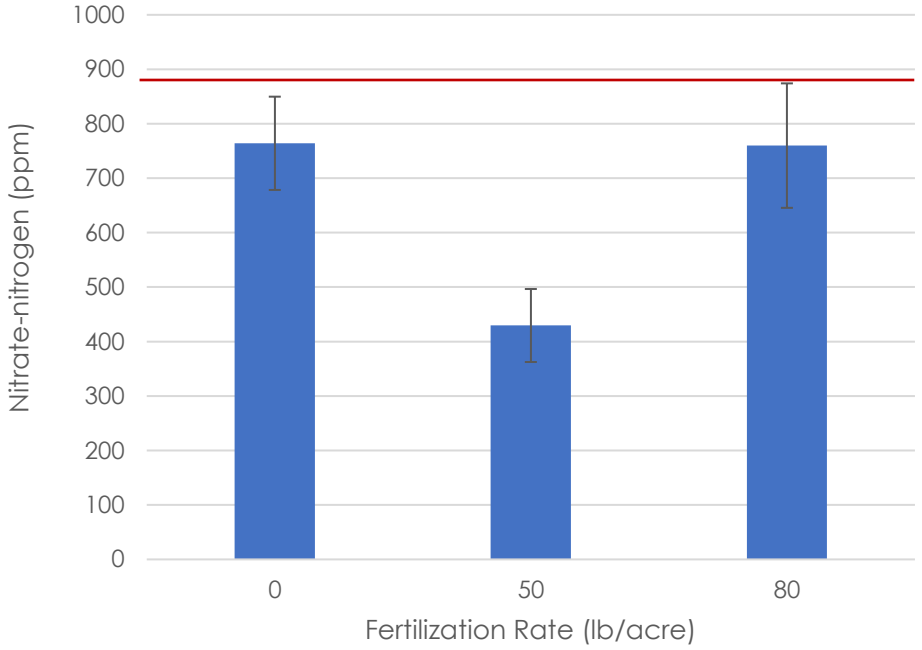


Similarly, other forage nutrient compositions (Neutral Detergent fiber, Calcium, Phosphorus, Magnesium, Potassium, Iron, Manganese, and copper were not significantly different for either fertilizer or Irrigation treatment.

Nitrate-Nitrogen (ppm)

- When too much is consumed, nitrite builds up and causes toxicity.

  - ✓ Fertilization rate = 50 lb/acre lower than zero & 80 lb N/acre
  - ✓ Irrigation rate = *NS*



ANOVA

Variable	*p-value*
N	*0.01*
ET	*0.12*
Interaction	*0.61*

- Zero fertilizer is 100 lbN/ac (pre-plant), 50 lbN /ac (1st cutting, & skip fertilizing at 2nd cutting

Summary

- Increased fertilizer supply more than 50lbs/ ac per cutting and higher irrigation levels beyond 80ET do not necessarily increase forage biomass in sudangrass.

- This preliminary finding also suggest that sudangrass can be safely stressed to 80%ET irrigation and produce desired biomass without significant reduction in yield

- High fertilizer rate can promote luxury N consumption & accumulate excess tissue nitrate concentration of sudangrass that can be toxic to livestock .

- Further research is in progress to confirm sudangrass forage tissue accumulation of nitrate –N and prussic acid under low or high fertilizer rates and irrigation levels

Thank you??

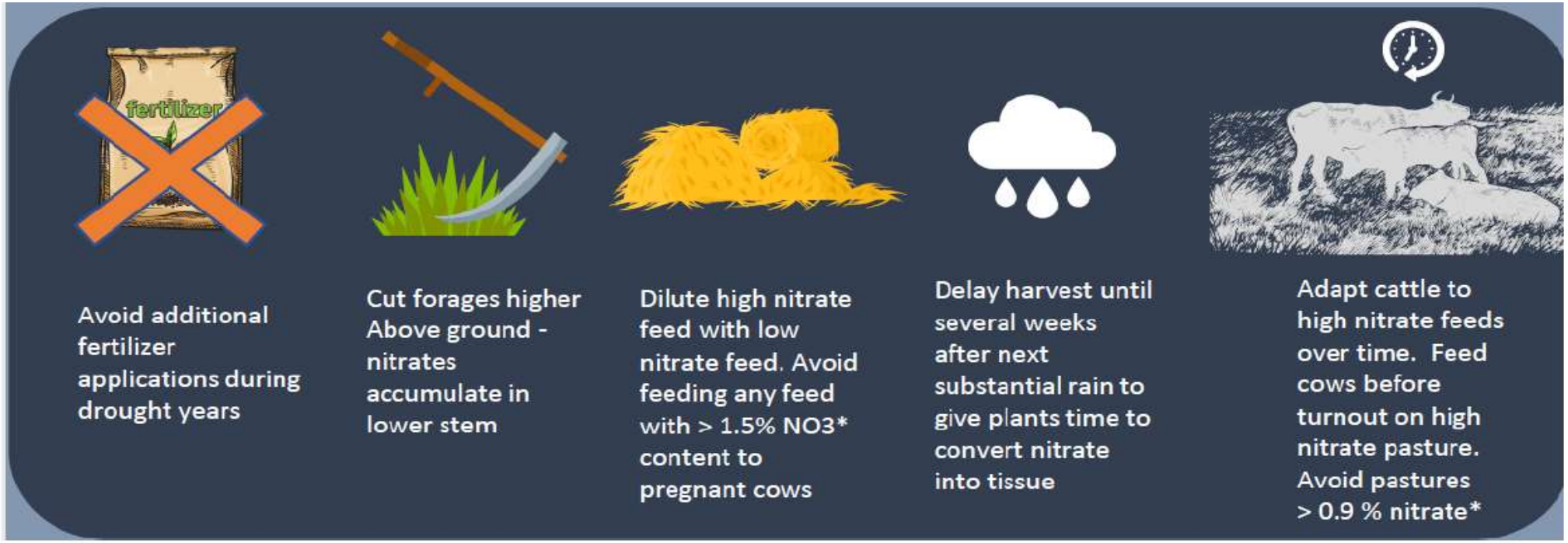
- Pushing for higher fertilizer level beyond 50lb/ac per cutting or irrigating above 80ET does not necessarily increase sudangrass forage biomass production. .

Which plants accumulate nitrates?

- Forages:
  - Johnson grass
  - Sweet clover
  - Tall fescue
  - Sorghum (Sudan grass)
- Crops
  - Oats
  - Barley
  - Wheat
  - Corn (silage will be lower risk)
- Weeds
  - Lambsquarters
  - Pigweed
    - Both can contaminate alfalfa hay

- Among the many suggested management practices to mitigate environmental N contamination are the use of enhanced-efficiency fertilizers (such as slow - and controlled-release), nitrification inhibitors, and urease inhibitor fertilizers

Mitigating for nitrate toxicity to LS



1 % = 10,000 ppm