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What to Consider When Fertilizing Nebraska Sandhills Subirrigated Meadows for Hay Production

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Market Report	Year Ago	4 Wks Ago	1/21/15
Livestock and Products, Weekly Average			
Nebraska Slaughter Steers, 35-65% Choice, Live Weight.	*	162.97	161.99
Nebraska Feeder Steers, Med. & Large Frame, 550-600 lb.	173.83	300.66	293.99
Nebraska Feeder Steers, Med. & Large Frame 750-800 lb.	151.36	242.09	219.44
Choice Boxed Beef, 600-750 lb. Carcass.	193.81	249.05	261.51
Western Corn Belt Base Hog Price Carcass, Negotiated.	82.30	83.03	71.31
Pork Carcass Cutout, 185 lb. Carcass 51-52% Lean.	83.42	91.96	83.38
Slaughter Lambs, Ch. & Pr., Heavy, Wooled, South Dakota, Direct.	107.75	147.00	*
National Carcass Lamb Cutout FOB.	299.16	375.96	375.09
Crops, Daily Spot Prices			
Wheat, No. 1, H.W. Imperial, bu.	7.42	5.81	5.19
Corn, No. 2, Yellow Nebraska City, bu.	7.22	3.73	3.59
Soybeans, No. 1, Yellow Nebraska City, bu.	13.78	9.92	9.32
Grain Sorghum, No.2, Yellow Dorchester, cwt.	11.96	7.46	7.09
Oats, No. 2, Heavy Minneapolis, Mn, bu.	3.81	3.45	3.21
Feed			
Alfalfa, Large Square Bales, Good to Premium, RFV 160-185 Northeast Nebraska, ton.	247.50	193.75	212.50
Alfalfa, Large Rounds, Good Platte Valley, ton.	230.00	85.00	75.00
Grass Hay, Large Rounds, Good Nebraska, ton.	212.50	75.00	82.50
Dried Distillers Grains, 10% Moisture Nebraska Average.	270.00	157.00	175.00
Wet Distillers Grains, 65-70% Moisture Nebraska Average.	103.50	49.00	56.50
* No Market			

With the ever changing value of hay and input costs, those producers who use their subirrigated meadows to produce hay may often wonder if they should apply fertilizer and, if so, how much and what type? The biological research needed to answer these queries has been completed decades ago, but because hay values and fertilizer prices are constantly changing, it becomes necessary to revisit the topic and answer these questions using current economic information. This analysis uses the classical approach where the value gained from increased production is at least as much as the cost of applying the additional fertilizer, marginal cost equals marginal revenue, and where profits, or in this case net returns, are maximized.

The starting point for this analysis is the four fertility response functions created by Nichols et. al. (1990) from research on various levels of nitrogen applied to a subirrigated meadow, located at the University of Nebraska Lincoln's Gudmundsen Sandhills Laboratory near Whitman, NE. These four functions were combined with baling costs from UNL's Custom Rate Survey and fertilizer prices courtesy of J R Simplot personnel located in Hershey NE. to form four net return (modified profit) functions. These equations are optimized using calculus and an Microsoft Excel spreadsheet using various hay price scenarios. The resulting simulations are evaluated using the Excel add-in SIMETAR.

It is expected that a modified version of this spreadsheet will be made available later this year at *www.agmanagerstools.com.* The spreadsheet can be used as a cattle decision-aid tool enabling interested readers to do a similar analysis using their own cost and price values.

In the original work, Nichols et al. compares the use of the four different fertilizer scenarios: 1) Application of nitrogen (N) only, 2) Application of N with a set quantity of phosphorus (P), 3) Application of N with a set quantity of sulfur (S), and 4) Application of N with set amounts of both P and S. These alternative scenarios are necessary given the high ph (>7) and relatively low phosphorus level of the Sandhills subirrigated meadows. The addition of S or P has a different action but similar effects. The S changes the ph and allows plant absorption of P, the limiting nutrient. It was expected but unknown at the time of their experiment about the exact effects of S or P or combination of the two on hay meadow productivity and/or quality.

These experiments were completed in 1985 and are available for your perusal (see the reference at the end of this article). The resulting response functions are illustrated in Figure 1. Please note the original work is published using metric measures but for ease of use and understanding is translated into US weights and measures, lbs of dry matter (DM), or lbs of N/acre (Ac) or dollars per acre ($/Ac). Yields of lbs DM/Ac in all scenarios where S and or P were used in addition to the N were higher than those with just N or no fertilizer.

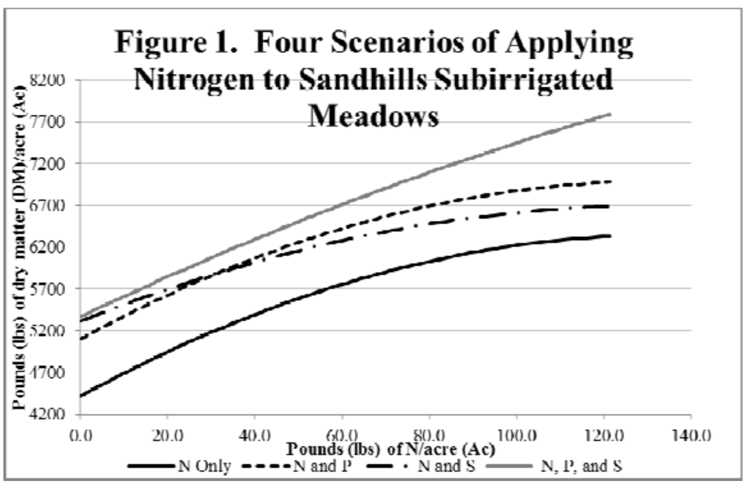

Figure 1. Four Scenarios of Applying Nitrogen to Sandhills Subirrigated Meadows

The following assumptions were used for the analysis: fertilizer costs are $0.43/lb of S, $0.61/lb of P, and $0.73/lb for N bought as Urea. In this case the P source had 11% N, which was accounted for in the model. Note that these measures are in $/lb of nutrient, not in $/lb material purchased. See Table 1 for the actual nutrient percentages of materials used. This price approximates that which a producer might currently pay given he/she expects the product to be delivered and spread on a meadow in the Sandhills. Baling costs were based on UNL's Farm Custom Rate Survey. We assume a DM content of 90% baled into large round bales weighing 1500 lbs and costing $15.00 each and do not include raking or mowing, which is based on a per-acre basis. These per-acre values would be directly subtracted from the net return per acre, as would any other costs not associated with haying. The per-bale charge translates to approximately $22.22 per ton of DM baled. Hay prices in the simulation varied from a low of $50.00/ton to a high of $120.00/ton.

Table 1. Cost per Pound (lb) of Nutrient for N, P and S

$/lb	Standard Fertilizer Label (N-P-K, Other Nutrient)	Type of Fertilizer
$ 0.43	0 - 0 - 0, 90S	Sulfur
$ 0.61	11 - 52 - 0	Phosphorus
$ 0.73	46 - 0 - 0	Urea

Results

Table 2 summarizes the outcome of the model simulations. The scenarios show maximized net returns consecutively increase in order from the first scenario (1) N to the last scenario (4) N, P and S as hay values increase. Scenario 1 was optimal only when hay value was $66/ton. No fertilizer was optimal when hay prices were below this value, indicating that the addition of fertilizer cost more than it would return.
Scenario 2 is found to maximize net returns when hay values are between $67 and $83/ton. In this case, as little as 2.52 lbs/Ac of N to as much as 35.53 lbs of N are applied in addition to the constant 18 lbs P/Ac. Using these fertilizer prices, for each $1.00 increase in hay value, an average 2.06 lbs/Ac N should be applied with the additional P. Remember, the average additional amount of fertilizer is decreasing with each additional lb applied. That is, each additional lb of fertilizer applied has a diminishing effect on production. The first $1 increase in hay value suggests an additional 2.71 lbs N/Ac with the last additional dollar suggesting only an increase of 1.57 lbs of N/Ac.

Scenario 3 maximizes net returns for hay prices from $84/ton to $87/ton, a very narrow range. Only 1.09 lbs of N/Ac is applied at the $84 hay value and 7.03 lbs of N/Ac at the $87 value. In this case the N is accompanied by a constant 20 lbs S/Ac. For each $1.00 increase in hay value an average 1.98 lbs/Ac N is recommended and additional lbs of N/Ac range from as much as 2.04 to as little as 1.5 lbs N/Ac.

Scenario 4 maximizes returns for more hay values than any other of the scenarios considered, with values ranging from $88 /ton to the maximum considered in this analysis, of $120/ton. Fertilizer rates are much higher in this scenario starting at 68.52 lbs of N/Ac applied at the $88/ton hay value to as much as 147.33 lbs of N/Ac at the $120/ton value. In this scenario, the N would be accompanied by a constant 20 lbs S/Ac and 18 lbs P/Ac. For each $1.00 increase in hay value, an average 2.46 lbs N/Ac would be applied. Optimal outcomes ranged from the addition of 3.57 to as little as 1.69 lbs N/Ac for each additional dollar of hay value.

It is apparent that at low hay prices or high production costs the addition of fertilizer of any type does not increase net returns. Adding a single type of fertilizer, in this case N, has a very narrow window where it might optimize net returns. Large amounts of N used alone or when only P or S is applied is not recommended. The range of hay prices where combinations of N with either S or P are effective but only in a relatively small window of hay values, making it more difficult to use these scenarios correctly when trying to maximize net returns.

The interesting point here is when hay making is fairly profitable, in our case hay values above $87/ton, putting on the triple combination fertilizer N, P and S is most likely to pay the best. It is also important to note that the hay value and costs do affect which quantity and type(s) of fertilizers result in the greatest profit and that the triple effect uses fairly substantial amounts of N at least 67 lbs/Ac. This final result is consistent with Figure 1, where it is illustrated that the yield of using a combination of N, P, and S climbs at a faster rate than for any of the other fertilizer combinations.

Table 2. Simulation Results by Fertilization Scenario

Scenario		Hay Value Range $/Ton		N Fertilizer lbs/Ac		Range of Additional lbs/Ac of N Applied		Avg # of lbs N for each $1.00 Hay Value
No.	Description	Low	High	Low	High	Low	High	lbs N/Ac
	No Fertilizer	50.00	65.00	-	-	-	-	-
1	N	66.00	66.00	0.63	0.63	0.063	0.63	0.63
2	N and P*	67.00	83.00	2.52	35.52	2.71	1.57	2.06
3	N and S**	84.00	87.00	1.09	7.03	2.04	1.92	1.98
4	N, P and S***	88.00	120.00	68.52	147.33	1.69	3.57	2.46

* In addition to N approximately 18 lbs of elemental P/Ac would be applied
** In addition to N approximately 20 lbs of elemental S/Ac would be applied
*** In addition to N approximately 18lbs and 20 lbs of elemental (P and S)/Ac would be applied

Reference:

Nichols, J.T., P. E. Reese, G.W. Hergert , and L. E. Moser. 1990. Yield and Quality Response of Subirrigated Meadow Vegetation to Nitrogen, Phosphorus and Sulfur Fertilizer. Agron. J.82:47-52.

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