



Forage Management

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February 1996

Forage Fertilization Based on Yield and Management Goals

Fertilizer recommendations returned from a soil testing laboratory are based on the analysis of a soil sample and an expected yield for the crop listed on the soil test form. Sometimes it is desirable to know the fertilizer needs of a crop if the yield is different from that used by the computer. Also the economics of fertilizer use changes as the cost of fertilizers change relative to the value of the crop. The work sheet provided with this fact sheet, outlines the calculations needed to determine the fertilization requirement of a forage crop at a specific yield level.

Expected Yield

Before a site specific fertilizer recommendation can be made, it is necessary to know the yield which can be achieved from the field. The crop yield will depend on the soil type, the crop management, and the weather during the growing season. An estimate of a soil's potential yield is provided in the county soil survey manual. Average yields under two management levels are published. Use the yield level for good management. Table 1 shows the yield estimate for selected soils in West Virginia. Yield levels such as these are based on experience in the area and are a reliable first estimate. However, with improved plant varieties and management it is possible to exceed these published levels by 25% or more. Where improved management is used, crop yield records for the farm give more accurate information than general area-wide yield estimates.

Yield and Cost/Ton of Hay

In today's economy relatively high yields are required to keep machinery and overhead cost at reasonable levels. Increased hay yields reduce the total cost per ton of hay produced when machinery, fertilizer, and labor charges are considered (Fig 1). The way to

minimize the cost of hay production is to manage for reasonably high yields, relative to the yield potential of the soil, and reduce machinery costs by harvesting as few cuttings as needed to achieve the potential yield, without reducing forage quality below an acceptable level. The forage quality required depends on how the forage is to be used. If forage is sold on a quality basis or used for dairy cattle, having high quality is more important than if the forage to be fed to dry beef cattle.

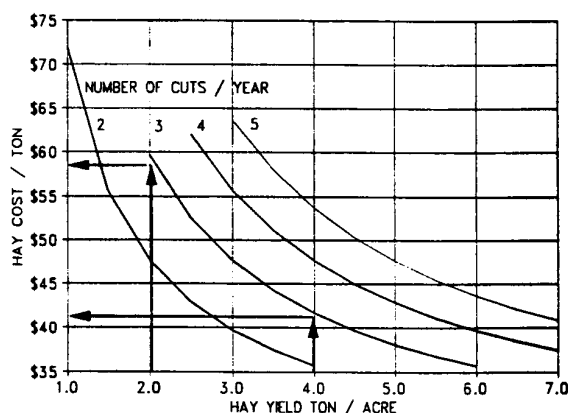


Figure 1. Harvest and fertilizer cost per ton of hay relative to the number of cuts per year and yield per acre.

Crop Response to Soil Test

To determine a crop's fertilizer requirement, we need to know the crop's response to soil fertility and to added fertilizer. Forage crop response to soil test phosphorus (P) or potassium (K) is shown in Figure 2 and Figure 3. These response curves are based on research in Ohio and New York with the soil test

values calibrated to the WVU soil test system (Sperow and Rayburn respectively, unpublished data). These response curves show forage crop yields over a range of soil tests when no fertilizer is applied. Yields are expressed as a fraction of the maximum crop yield obtained with fertilization. This is called relative yield. As can be seen, if the soil test P is greater than 50 (Fig. 2) or the soil test K is greater than 100 (Fig. 3), the crop yield is not greatly influenced by fertilization. However, these are short term experiments and do not account for removal of plant nutrients by the crop.

Table 1. Estimated yield, under good management, for selected soils in West Virginia for clover-grass and alfalfa-grass hay and grass-legume pasture.

Soil	slope	legume grass hay		pasture
		clover	alfalfa	
	%	---tons/a---		days/a
Albrights silt loam	8-15	3.0	3.5	200
Berks shaly silt loam	3-8	3.0	3.5	200
Berks shaly silt loam	15-25	2.0	3.0	170
Clarksburg channery silt	3-8	3.0	3.5	200
Clarksburg channery silt	8-15	3.0	3.5	200
Dekalb channery loam	5-12	2.8	3.2	120
Dekalb channery loam	12-25	2.6	3.0	105
Ernest silt loam	8-15	3.0	3.5	140
Franktown silt loam	3-10	3.5	4.5	165
Franktown silt loam	10-20	3.2	4.3	160
Frederick cherty silt loam	3-8	3.5	4.5	165
Frederick cherty silt loam	8-15	3.2	4.3	155
Frederick cherty silt loam	15-25	3.0	4.0	150
Gilpin silt loam	8-15	3.0	3.5	200
Gilpin silt loam	15-25	2.5	3.0	170
Laidig channery loam	8-15	3.0	4.0	130
Laidig channery loam	15-25	2.5	3.5	200
Lehew-Berks complex	8-15	2.0	2.5	140
Monongahela silt loam	3-8	3.0	3.5	200
Monongahela silt loam	8-15	2.5	3.0	170
Teas and Litz silt loams	3-8	3.0	3.5	130
Teas and Litz silt loams	8-15	2.8	3.2	120
Teas and Litz silt loams	15-25	2.4	3.0	100
Weikert-Berks complex	8-15	2.0	2.2	115
Westmoreland silt loam	3-10	3.0	4.0	145
Westmoreland silt loam	10-20	3.0	3.8	135
Westmoreland silt loam	20-30	2.8	3.5	125
Wharton silt loam	8-15	3.5	2.9	175

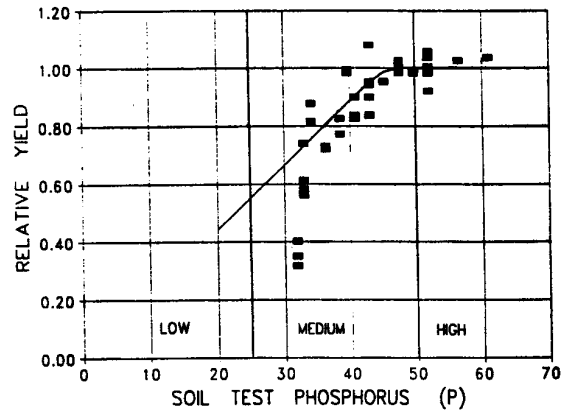


Figure 2. Effect of soil test P on forage crop yield without supplemental fertilizer as a fraction of the yield when adequate fertilizer applied.

If a crop is grown and no fertilizer is applied the crop will remove nutrients from the soil and the soil test will go down. Over a period of time crop yields will go down. The decrease in crop yields will depend on the initial soil test, nutrients removed in the harvested crop, the soil's reserve nutrients, the release rate of reserve nutrients, and the length of time that fertilizer is not applied. It is easy to measure the first two of these variables and control the last. First, take a good soil sample to obtain an index of the soil fertility. Second, fertilizer nutrients removed in each ton of crop dry matter can be measured by forage testing, or use average forage test values for the type of crop grown (worksheet Table 1).

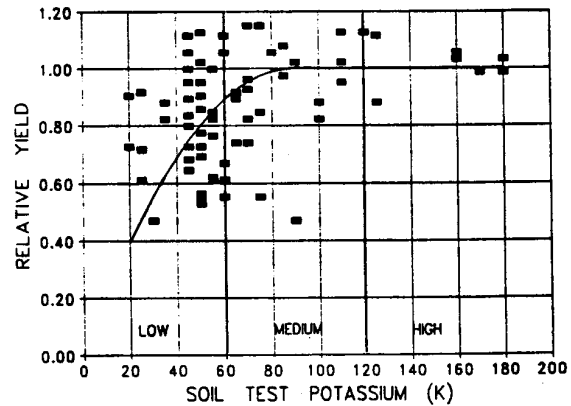


Figure 3. Effect of soil test K on forage crop yield without supplemental fertilizer as a fraction of the yield when adequate fertilizer applied.

Crop Response to Fertilizer

When looking at crop fertilizer response, it is helpful to express fertilizer rates as a multiple of the plant nutrients removed by the crop. If the soil test is medium or high and P is applied at 1 times the crop removal rate, crop yields are 90-100% of maximum

(Fig. 4). If no fertilizer is applied, crop yields will drop to between 50 and 80% of the potential yield. If cutting hay three times a year, a savings in fertilizer which reduces yields by half will increase the cost per ton of hay by 40% (Fig. 1, 3 cut system, 4 ton/a cost \$42, 2 ton/a cost \$59). On the other hand, applying more than the removal rate results in little yield increase. Soil test levels would increase but would return no value unless fertilizer inputs are reduced in the future to draw on this reserve fertility.

For potassium the effect is almost the same (Fig. 5). When the soil test is medium or high an application rate of 1 times removal, maintains crop productivity at maximum level. Even at a K fertilizer rate of 75% the removal rate, yield is near maximum. However, soil fertility will decrease. Again with no added K, the crop yield drops to 30 to 90% of potential over a 3 to 7 year period. The drop in yield without K fertilizer is determined by soil type, crop yield, and forage species.

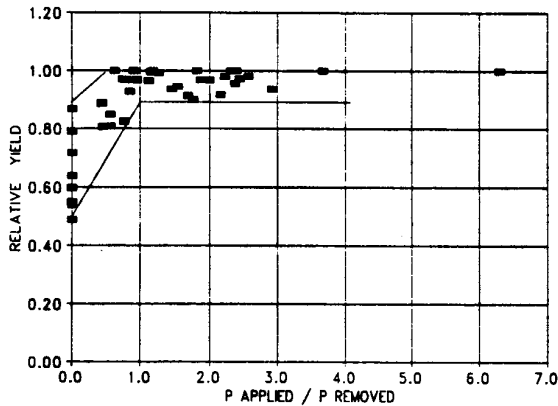


Figure 4. Forage crop response to fertilizer phosphorus (P) on soils having a medium or high P soil tests.

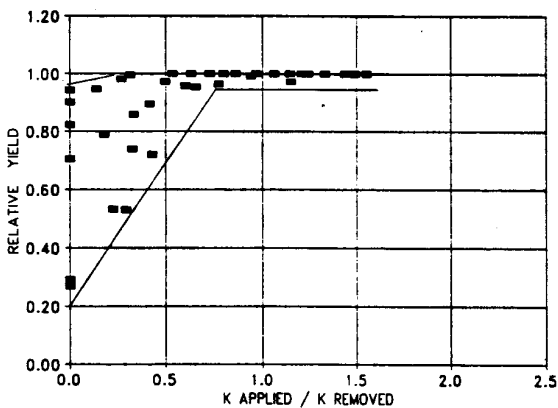


Figure 5. Forage crop response to fertilizer potassium (K) on soils having a medium or high K soil test.

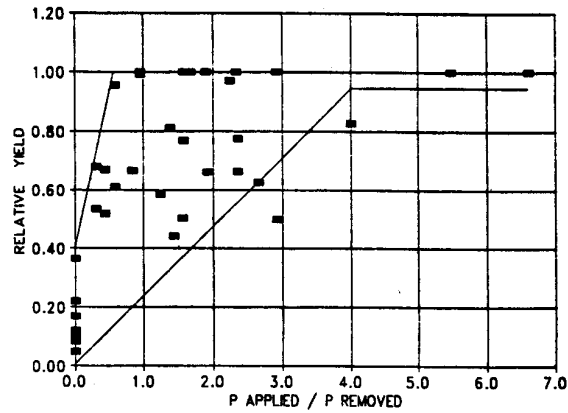


Figure 6. Forage crop response to fertilizer phosphorus (P) on soils having a low P soil test.

When soil test levels are low, crop yields will be greatly reduced if fertilizers are not used. For soils testing low in P and K, when no fertilizer is applied crop yields drop to 10 to 40% of potential for P (Fig. 6) and to 30 to 70% of potential for K (Fig. 7). For low testing soils, the cost to get near potential yield increases since the fertilizer rate needed is 1.5 to 4.0 times the removal rate rather than the 1 times removal rate needed on medium and high testing soils. On low testing soils, fertilizing at the removal rate gives a yield between 40 to 100% for P and between 80 to 100% for K. The actual yield response depends on the soil's ability to fix these minerals and how low the test is at the start.

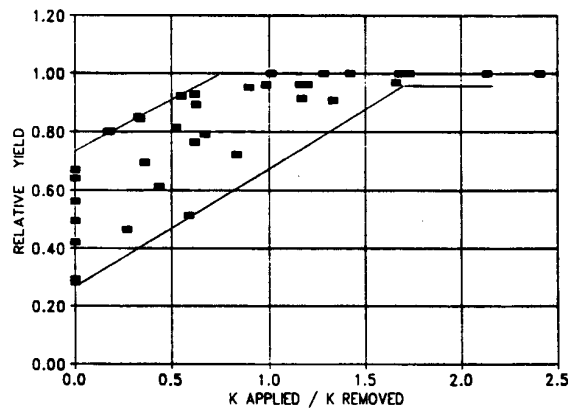


Figure 7. Forage crop response to fertilizer potassium (K) on soils having low K soil test.

Site Specific Fertilizer Requirements

Use the attached worksheet to determine the fertilizer rates needed on your farm based on your soil's

expected yield, soil test, and management goals. Identify the farm, field, crop, and soil type at the top of the worksheet.

1. Soil test each field and enter the soil test level (low, medium, high, very high) for (P₂O₅) and K (K₂O) in the appropriate column.
2. On line 2 enter the expected crop yield in tons per acre.
3. On line 3 enter the plant nutrient removal rate/ton of forage (worksheet Table 1).
4. Multiply yield by removal rate (line 2 x line 3) and enter the result on line 4.
5. The application rate factor (line 5) is the fertilizer rate as a multiple of crop removal. This varies under different management conditions based on soil test, harvest management, and management philosophy related to economics and risk. Two application rate factors are given for each soil test level (worksheet Table 2). The lower application rate will result in the soil test moving towards the medium range. Using the higher value will move the soil test into the high range. Maintaining a high soil test will allow some insurance for improved crop growth under adverse environmental conditions such as drought, cold soils, and when diseases are present. A high soil test also allows skipping fertilization for one or two years if economic or supply conditions prevent purchase of fertilizer. Once the soil test is in either range, the cost to maintain fertility at that level is the same. Pastures require less fertilizer than harvest crops, since most of the nutrients are returned directly to the soil by the animal. Under rotational grazing the distribution of manure and urine is more uniform, so the efficiency of recycling is greater.
6. Multiply removal rate/acre by the application rate factor (line 4 x line 5) and enter the result in line 6. This is pounds of fertilizer P and K (expressed as P₂O₅ and K₂O) needed to meet the crop management goals.

Nitrogen Fertilizer

Legumes should be used with grasses on pastures and hayfields to provide economical nitrogen (N) fixation and improved forage quality. Where N is used in place of legumes to grow grass hay or pasture, apply

150-180 pound/acre of N from chemical fertilizer or available N from poultry litter or livestock manure. If using chemical fertilizer, N should be split applied at 50-60 pounds per acre, 3 times during the growing season.

Lime Rates

The lime requirement from the WVU soil test report is for raising the soil pH to 6.6. For grass and clover a pH of 6.0 to 6.2 is adequate. Figure 8 provides the adjustment factor for the required liming rate when a pH less than 6.6 is desired. Look up on the lower axis the soil test pH reported on the WVU soil test report (example 5.6). Move up to the line representing the soil pH you desire (example 6.2). Go over to the left axis and read the liming rate adjustment factor (example 0.6). Multiply this factor by the WVU soil test report lime requirement to obtain the lime requirement which should raise the soil pH to 6.2. If the soil test called for a lime requirement of 4 tons per acre, multiply 4 x 0.6 and the rate would be 2.4 tons per acre.

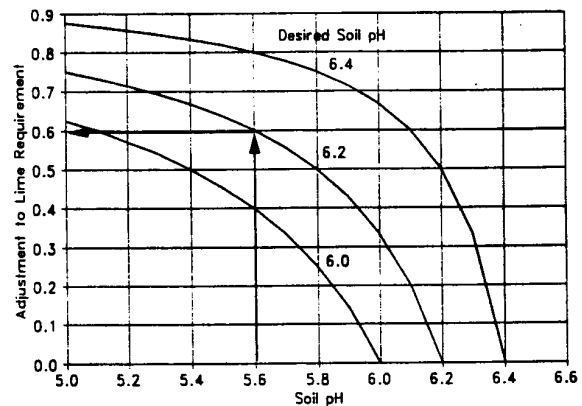


Figure 8. Adjustment to a lime requirement to raise the soil pH to 6.6, based on current soil pH and desired adjusted soil pH.

