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RESPONSE *of* FIELD CROPS *to* FERTILIZER *and* RETURNS *per* DOLLAR INVESTED

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Response of Field Crops to Fertilizer and Returns per Dollar Invested

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FERTILIZER AND LIME requirements for a particular field can best be determined by analyzing a soil sample from that field. However, farmers, agricultural workers, and members of the fertilizer industry are frequently interested in the general crop response from nitrogen, phosphorus, and potassium fertilizers. Yield responses of cotton, corn, oats, Coastal Bermudagrass, and Dallisgrass-white clover are summarized in Figures 1 to 11. These show the average responses from various fertilizer elements. The black portion of the yield bar represents the yield required to pay for the additional increment of the fertilizer element above the cost of the previous increment. Total cost of application assumed for the elements were: nitrogen 12 cents per pound of N and phosphorus and potassium each 6 cents per pound of P_2O_5 and K_2O.

The data in these charts are from a number of locations, including a range of soil fertility conditions. However, experiments on soils low or medium in phosphorus and/or potassium outnumbered those on other soils unless otherwise explained. Where the response to one element is shown, the soil pH and rate of application of the other elements were at desirable levels.

As an indication of value from fertilizer, the dollars returned per dollar invested in fertilizer at the optimum rate of each element are given in the table. In calculating these data, no additional harvesting costs were included, and, since the cost assigned to fertilizer and value of crops are approximate, the figures should not be considered as complete economic evaluations of fertilizer use.

RETURNS PER DOLLAR INVESTED IN FERTILIZER USING RESPONSE DATA IN FIGURES 1-10.[1]

Crop	Fertilizer			Returns per dollar invested
	N	P_2O_5	K_2O	
	Lb.	*Lb.*	*Lb.*	*Dollars*
Cotton				
Limestone Valley	60	60	40	4.70
Sand Mountain	80	60	60	10.80
Coastal Plain	70	60	60	13.20
Corn				
Average	90	20	20	4.50
Highest yielding	120	20	20	4.40
Oats				
Grain	60	40	20	3.30
Grain and forage	120	40	20	4.30
Coastal Bermuda	80	[2]	[2]	3.30
	160			3.30
	320			2.40
	640			1.80

[1] Fertilizer cost was calculated on basis of 12 cents per pound of N and 6 cents each per pound of P_2O_5 and K_2O; crop value calculated on basis of 12 cents per pound for seed cotton, $1.20 per bushel for corn, 60 cents per bushel of oat grain, 2½ cents per pound dry matter of oat forage, and $20 a ton of Coastal hay.

[2] P_2O_5 and K_2O are not given for Coastal Bermudagrass, since there are insufficient longtime data at various rates of N to justify inclusion. The phosphorus and potassium required would increase with increasing rates of nitrogen; therefore, the cost and return per dollar would be less at each rate of N than shown.

COTTON

In Figures 1, 2, and 3, seed cotton was valued at 12 cents per pound. In studying these data, it should be noted that the values are averages of various soil fertility levels. Thus, they represent the probable response for many fields but not for a particular field.

The Limestone Valley soils include data from a total of 53 test years at locations in the Tennessee and Coosa River valleys. In these experiments 40 to 60 pounds each of N and P_2O_5 and 20 to 40 pounds of K_2O per acre are all that could be justified. When the higher rates, 60 pounds each of N and P_2O_5 and 40 pounds of K_2O, were used $4.70 was returned for each dollar invested in fertilizer.

Data from the Sand Mountain area locations for 40 test years show responses above the cost of fertilizer for nitrogen rates up to 80 pounds and for phosphorus and potassium rates up to 60 pounds per acre. At these rates of application, $10.80 was returned per dollar invested in fertilizer.

Data for the Coastal Plain area locations totaling 243 test years show less increase from the 80-pound application of N over the

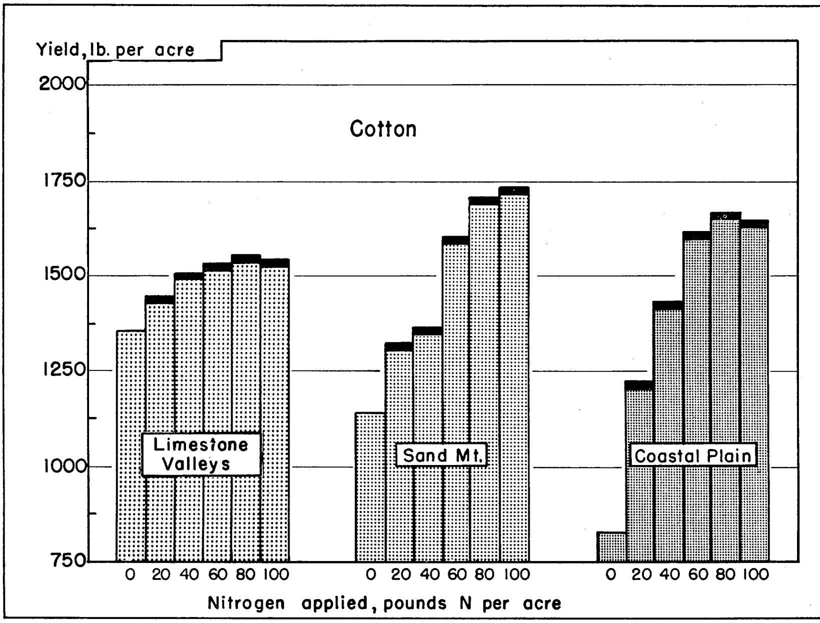

FIGURE 1. Seed cotton yields from different nitrogen rates (1949-59) are shown above. Blackened parts of bars show yields required to pay for 20 pounds of N.

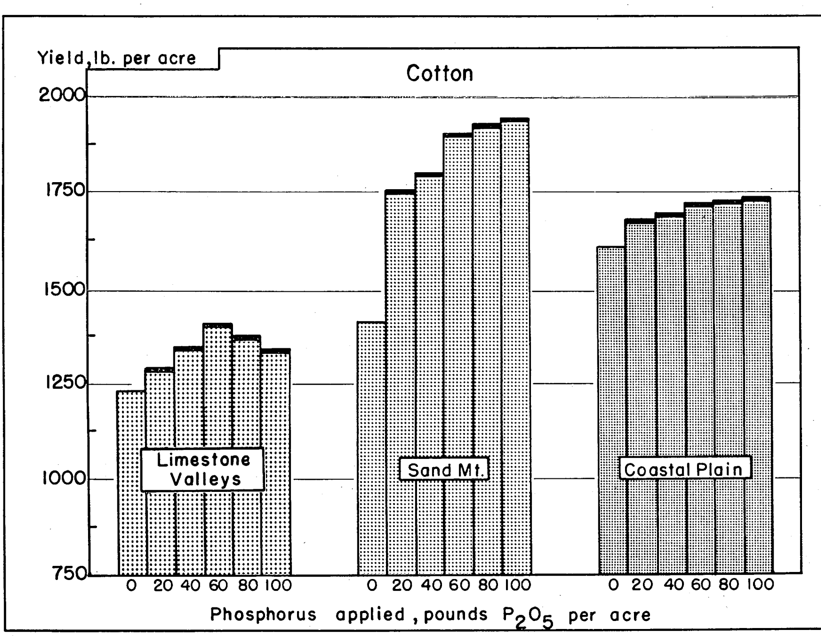

FIGURE 2. Seed cotton yields above are from six phosphorus rates (1949-59). Blackened portions of bars show yields required to pay for 20 pounds of P_2O_5.

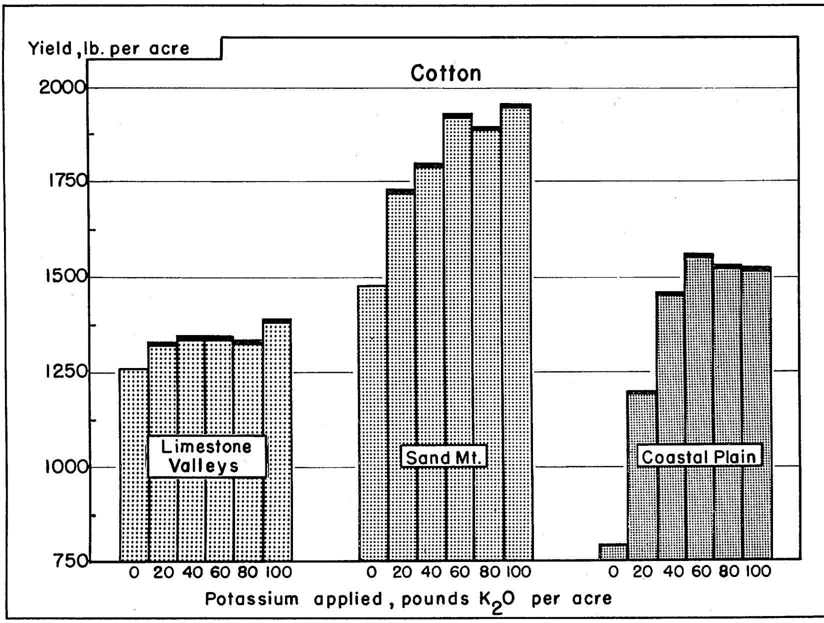

FIGURE 3. Yields of seed cotton given above are from different rates of potassium in experiments conducted on Limestone Valley, Sand Mountain and Coastal Plain soils (1949-59). Blackened portions of yield bars represent yields required to pay for 20 pounds of K_2O.

60-pound rate than for the same increment in the Sand Mountain tests. Although some Coastal Plain farmers will benefit from more than 70 pounds, the returns above cost will usually be small for higher rates. A response was obtained from 60 pounds of both phosphorus and potassium. The relatively small increase in yield from phosphorus reflects the buildup in soil phosphorus in many fields. Soils were medium or high in phosphorus at the majority of locations where tests were conducted. At these rates of application, $13.20 was returned per dollar invested in fertilizer.

Returns per dollar invested in fertilizer for cotton show considerable range. A part of the low returns on Limestone Valley soils can be explained on the basis that these soils produce higher yields without nitrogen application than soils in the other regions.

CORN

The pattern of response of corn to fertilization in the different soil regions was similar. Therefore, all corn data were grouped together. Since corn yields are markedly influenced by drought, data from the highest yielding locations are shown separately. In Figures 4, 5, and 6, corn was valued at $1.20 per bushel. Averages from all locations show that 90 pounds of N and 20 pounds each of P_2O_5 and K_2O are the most profitable rates to apply. At these rates of application, each dollar invested in fertilizer returned $4.50.

When only highest yielding locations are considered, nitrogen can be profitably increased up to 120 pounds, but there is no advantage to increasing phosphorus and potassium above 20 pounds. On these locations the return per dollar invested in fertilizer, using 120 pounds N and 20 pounds each of P_2O_5 and K_2O was $4.40.

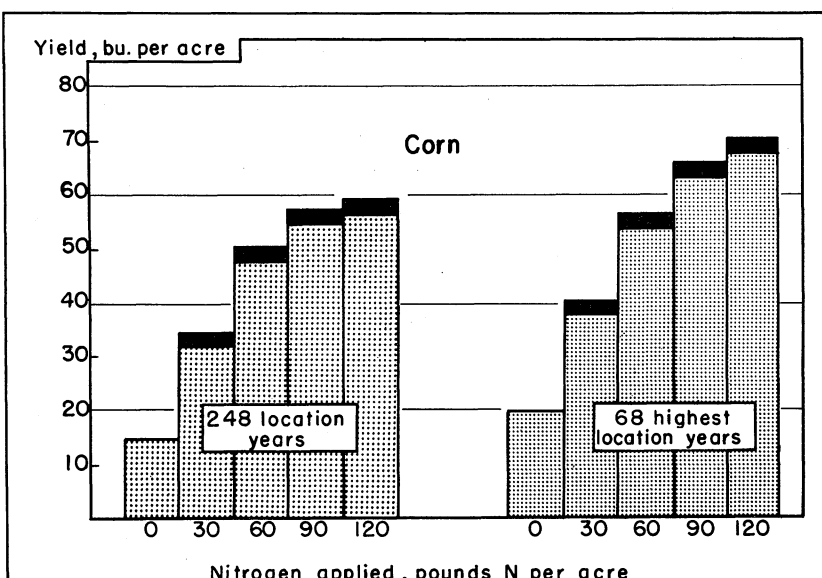

FIGURE 4. Yields of corn from different rates of nitrogen applied at various locations in the State are given above. Bars on right represent response of highest yielding tests out of total conducted (1946-58). Blackened parts of yield bars represent yields necessary to pay for 30 pounds of N.

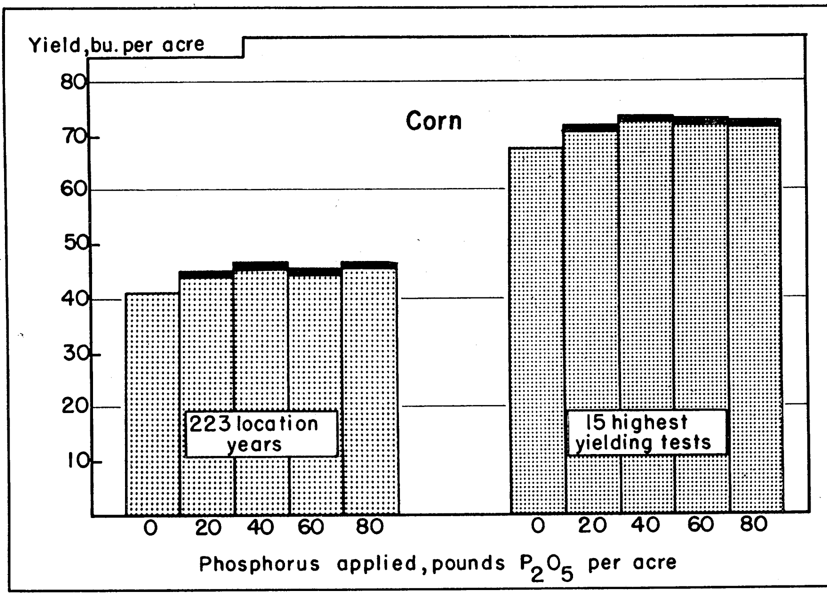

FIGURE 5. Yields of corn from different rates of phosphorus applied at various locations in the State are given above. Bars on the right represent response of highest yielding tests out of total conducted (1946-58). Blackened portions of yield bars represent yields required to pay for 20 pounds of P_2O_5.

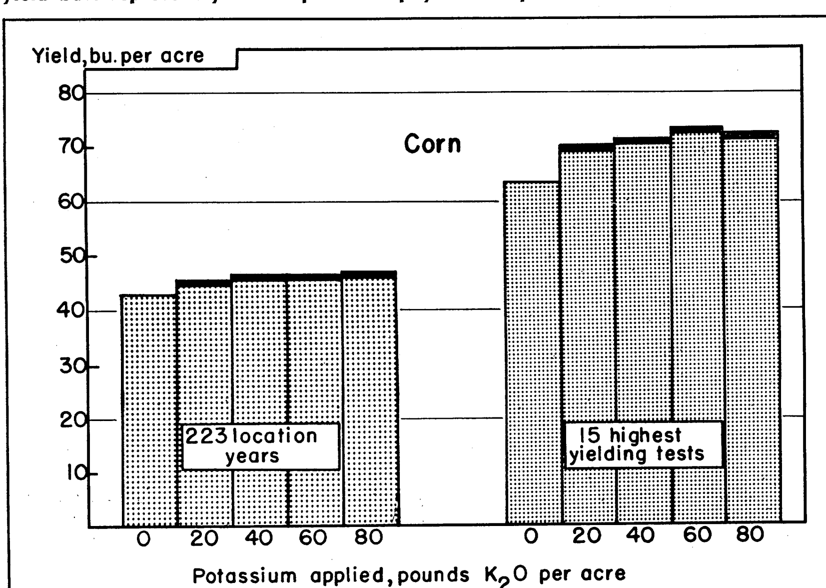

FIGURE 6. Yields of corn from different rates of potassium; bars on right represent response of highest yielding tests out of total conducted (1946-58). Blackened parts of yield bars represent yields required to pay for 20 pounds of K_2O.

OATS

The data for oats are shown for both forage and grain in Figures 7, 8, and 9. Nitrogen applied in the fall was for forage and the same rate was repeated again in the spring for grain.

The forage was valued at 2½ cents per pound of dry matter and the grain at 60 cents per bushel. The value of small grain forage depends on its use. When used only as a supplement to stimulate milk flow, Main Station animal nutritionists at Auburn report that it may have a value as high as 12 cents per pound of dry matter. On the other hand, the value may be only 3 cents when grazed throughout the day. A comparable figure as a feed for beef cattle would be 2 cents. Therefore, as a supplement for milking dairy cows, 80 pounds of N may be justified. For beef animals no more than 40 pounds of N is advisable. About 60 pounds of N can be applied in the spring for grain with oats at

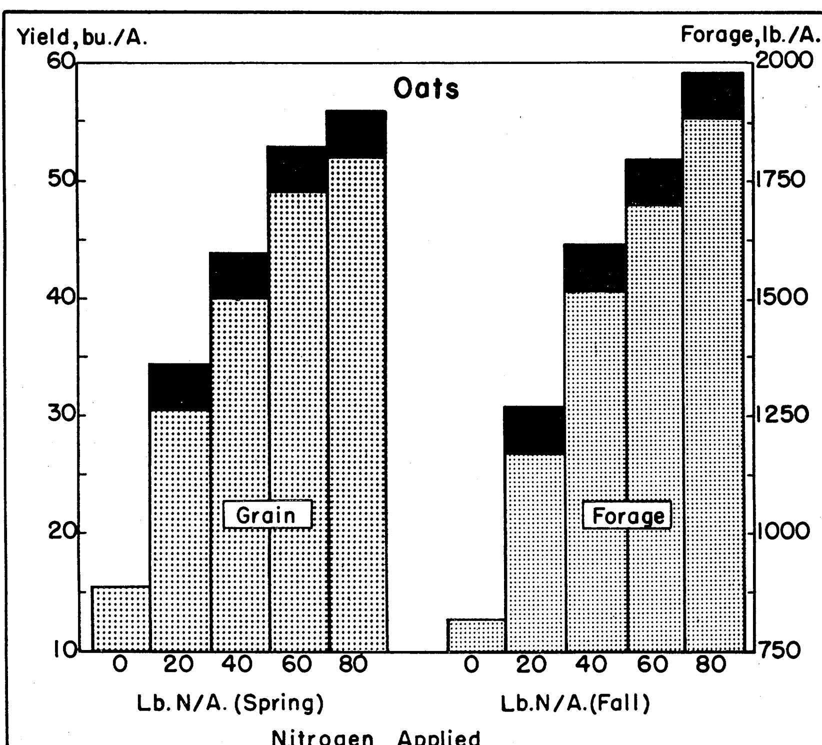

FIGURE 7. Oat yields of grain and forage above are from different rates of nitrogen applied at various locations in the State. Blackened parts of yield bars represent yield required to pay for 20 pounds of N.

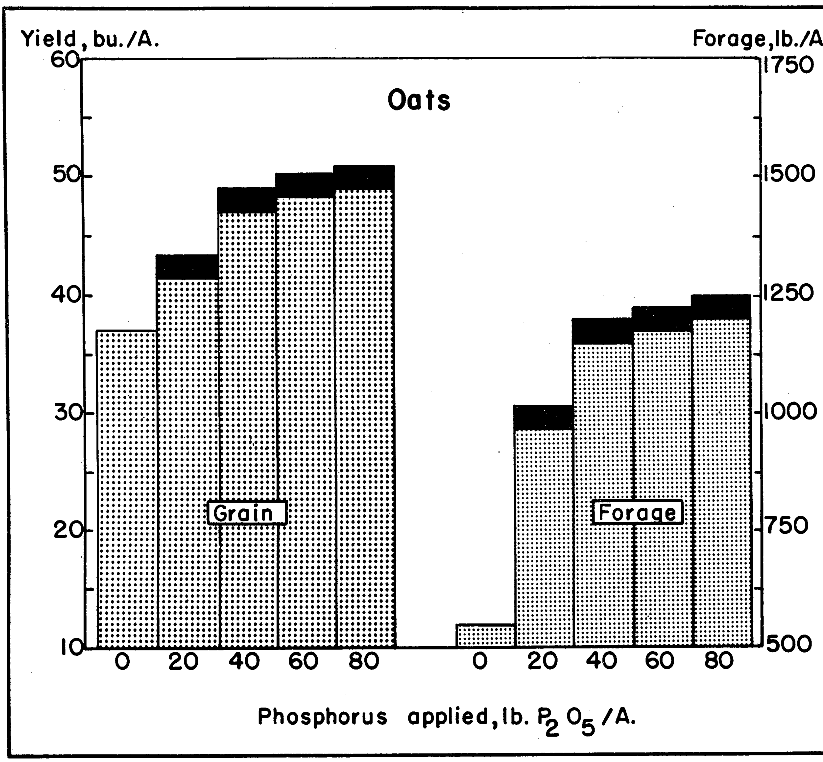

FIGURE 8. Oat yields of grain and forage above are from different rates of phosphorus applied at various locations in the State. Blackened parts of yield bars represent yields required to pay for 20 pounds of P_2O_5.

60 cents a bushel. Forty pounds of P_2O_5 and 20 pounds of K_2O applied in the fall were adequate for both forage and grain.

The return per dollar invested in fertilizer for oats using the average value for forage was $4.30 when 60 pounds of N, 40 pounds of P_2O_5 and 20 pounds of K_2O per acre were applied in the fall for grazing and 60 pounds N in the spring for grain. If grown for grain only and the fall application of nitrogen omitted, the return was $3.30.

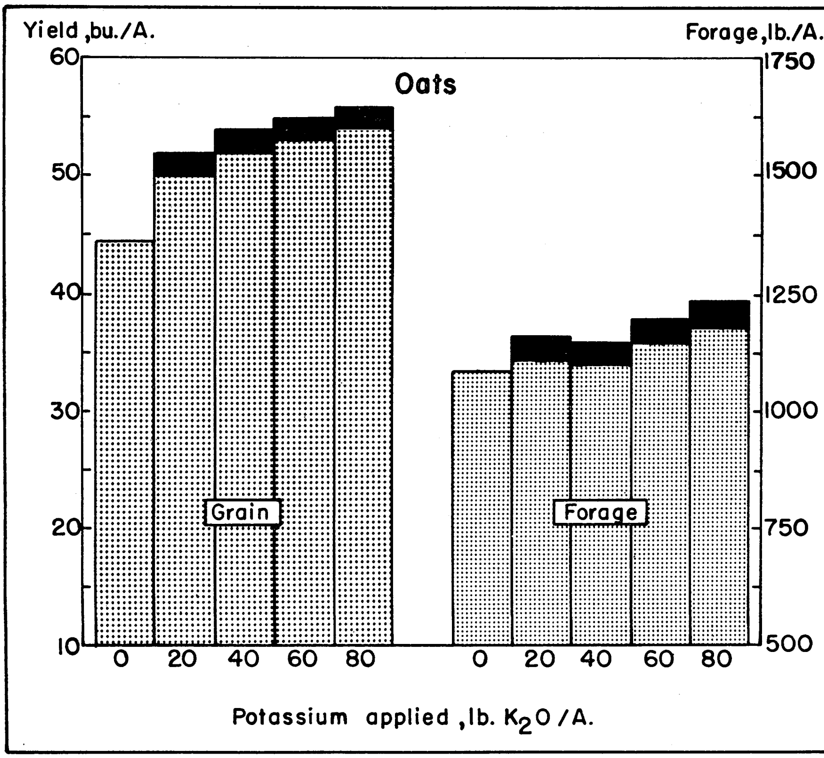

FIGURE 9. Yields of oat grain and forage given above are from different rates of potassium applied at various locations in the State. The blackened parts of yield bars represent yields required to pay for 20 pounds of K_2O.

COASTAL BERMUDAGRASS

Results of various experiments in Alabama and throughout the Southeastern States have shown that Coastal Bermudagrass will respond to high rates of nitrogen. Data collected in Alabama are presented in Figure 10. When a value of $20 a ton is assigned to Coastal hay, the increased yield obtained above 320 pounds of N per acre was only slightly more than enough to offset the cost of N. Considering possible losses in harvest and storage, it is doubtful that more than 200 pounds of N per acre will be profitable under usual farm operations.

The returns per dollar invested in nitrogen for Coastal Bermudagrass, see table, decreased when nitrogen rates were more than 160 pounds. A return of $3.20 per dollar invested in N was obtained at both the 80- and 160-pound rates of N. The returns per dollar invested in N decreased to $2.40 at the 320-pound rate and to $1.80 at 640-pounds per acre. These figures do not include the amounts of phosphorus and potassium that would be required. Including these in the cost would further decrease the return at each rate of N.

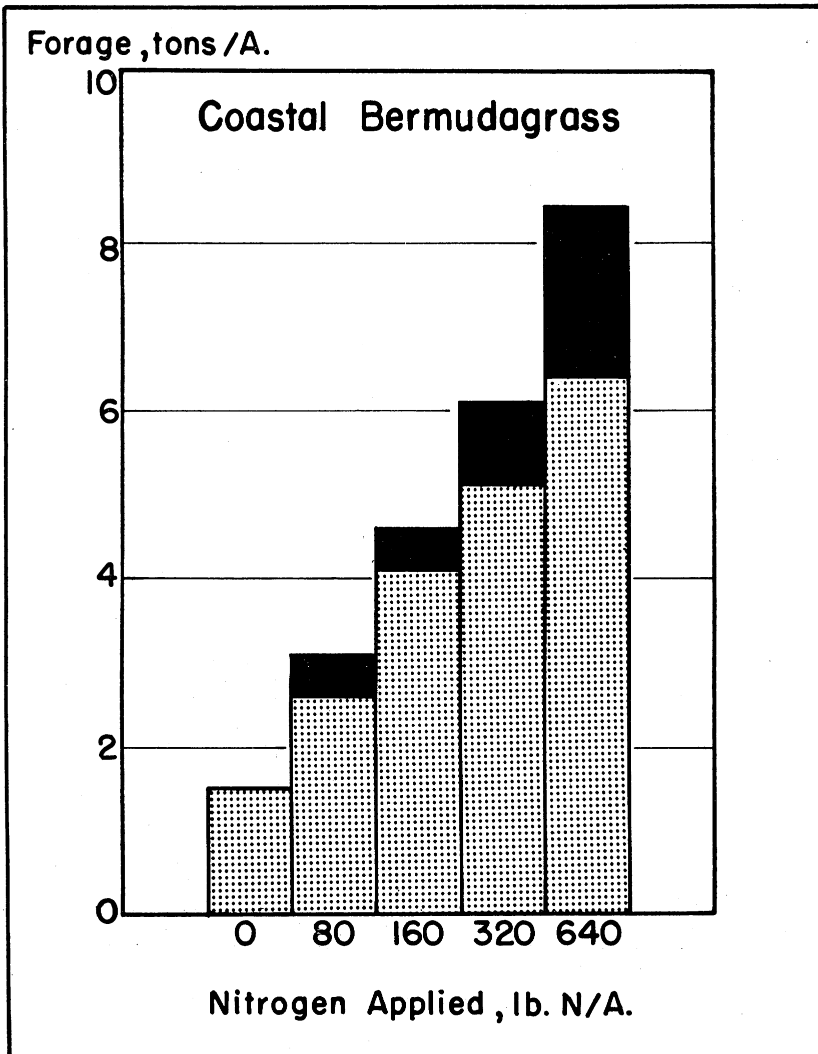

FIGURE 10. Coastal Bermudagrass yields from different rates of nitrogen applied at various locations in the State are given above. Blackened portions of yield bars represent yields required to pay for additional increment of N.

WHITE CLOVER-DALLISGRASS PASTURE

The responses from phosphorus and potassium applied to white clover-Dallisgrass pastures are shown in Figure 11. Most of the response was obtained by annual maintenance applications of 80 pounds of P_2O_5 and 40 pounds of K_2O. It is apparent that a much greater response was obtained from phosphorus than from potassium. Soils low in available phosphorus required about twice as much for establishment as for maintenance. The extra phosphorus increased early growth and improved seedling vigor.

No value was given forage produced for two reasons: (1) In most of the experiments summarized, total annual yields were not obtained, and (2) value realized depends on utilization and management.

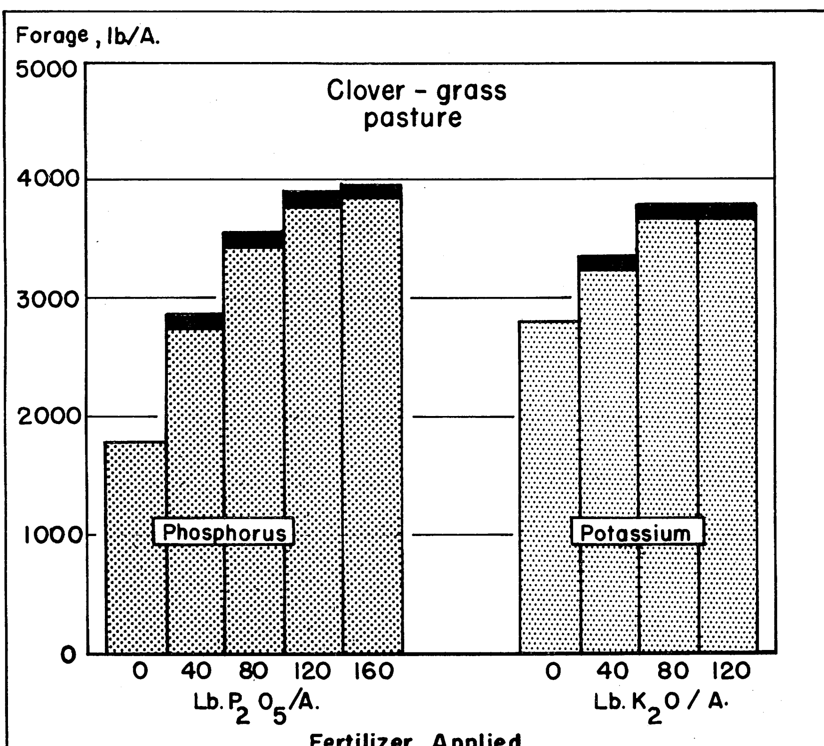

FIGURE 11. Dallisgrass-white clover pasture yields from different rates of phosphorus and potassium applied at various locations in the State are given above.

IRRIGATED COTTON AND CORN

Response from fertility studies where irrigation was used are not included in this report. Data obtained on cotton and corn indicate that where irrigation is used rates could be approximately double those without irrigation.

ACKNOWLEDGMENT

This report covers data obtained during the past 10 years by workers of the Agricultural Experiment Station, Auburn University. Experiments were conducted on most of the substations and experiment fields and on private farms.

These data were summarized and evaluated by the staff of the Department of Agronomy and Soils.