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ESTABLISHMENT *and* MAINTENANCE *of* WHITE CLOVER-GRASS PASTURES *in* Alabama

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CONTENTS

Cover – Beef cattle on improved white clover-grass pasture.

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Establishment *and* Maintenance *of* White Clover-Grass Pastures *in* *Alabama*

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ALABAMA HAS ABOUT 2½ million acres of improved white clover-grass permanent pastures. In addition, there are at least 2 million acres of unimproved pasture land in the State.

Many of the so-called improved pastures are not highly productive because of lack of adequate lime and fertilizer and/or other poor management. Thus, the carrying capacity of Alabama pastures could be greatly increased by better management of improved pastures, as well as by development of unimproved pasture land.

Most soils in Alabama are inherently low in available potassium and even lower in available phosphorus. With the exception of some Black Belt land, soils of the State are moderately to strongly acid.

Fertility problems involved in establishment of pastures were recognized early. The Agricultural Experiment Station began a pasture fertility research program in 1939 that has been expanded gradually. This bulletin summarizes pertinent results of this research showing response of permanent pastures to lime and fertilizer and gives recommended production practices.

EXPERIMENTAL PROCEDURES

Many of the pasture fertility experiments were conducted on farmers' fields. Therefore, a wide variety of conditions was covered. The main objective of early phases of the fertility work was to determine if lime and fertilizers were needed to establish and maintain productive clover-grass pastures. Later phases have been more concerned with lime and fertilizer rates needed for most economical production of herbage. These phases have also been concerned with nutrient balances and interactions.

In most cases herbage yield was the only measure of lime and fertilizer effects. In more recent experiments, nutrient uptake and soil analysis were used along with yields to measure treatment effects. Soil analysis data are being correlated with yield response.

In evaluating data given in this report, the authors recognize that clipping yields do not represent total yields for a season. Often only one clipping was made during the peak growth period for clover and perhaps another during the peak growth period for the grass. More frequent clipping would probably have shown greater treatment effects.

RESULTS of EXPERIMENTS

Lime

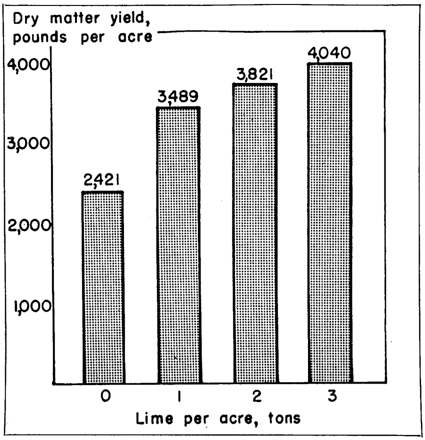

FIG. 1. Effect of lime on yield of clover-grass pastures is shown by the graph. Yields are averages of 21 experiments.

White clover is often grown with grasses in permanent pastures. This combination produces a high-quality feed and gives better seasonal distribution of forage than from grass alone. The clover also furnishes some nitrogen for grass following the main flush of clover growth. Many soils of the State are well adapted to white clover if properly limed and fertilized.

The response of clover-grass mixtures to lime has been determined at several locations. Data for individual locations are given in Appendix Tables 1, 2, and 3. A weighted average for all locations is given in Figure 1. Lime increased forage about 70 per cent, with most of the increase coming from the first ton of lime. The herbage yields given include both grass and clover. If only clover yields had been determined, the relative yield increase would have been much larger. Many of the locations produced no clover without lime.

Although 1 ton of lime per acre will usually be adequate for establishment of clover-grass pastures on moderately acid soils, yields may not be maintained for long without additional lime. Applying lime according to soil test prior to seeding gives best results. After establishment it is recommended that lime needs be determined at regular intervals and the soil maintained at pH 6.0 or above.

Nitrogen

Vigorous white clover stands are capable of fixing large amounts of atmospheric nitrogen in forms usable by plants. With moderate grazing, enough nitrogen remains after the spring flush of clover growth to produce a satisfactory growth of summer grass. Under such conditions only slight benefit may be expected from application of commercial nitrogen.

In situations where stand and growth of clover are not satisfactory and additional summer grass is needed, application of nitrogen fertilizer may be desirable. Data obtained under such conditions from a grazing experiment at the Black Belt Substation during 1952-57 are given below *(5)*:

Nitrogen treatment, lb./acre	*Forage, lb./acre, 4-yr. average*	*Beef, lb./acre, 5-yr. average*
0	3,536	168
40	5,106	261
80	5,594	291
160	6,529	312

Nitrogen applications at rates up to 80 pounds per acre were of definite benefit for forage production and beef gains. This practice does not adequately substitute for good clover growth, since the earlier growth of clover usually extends the grazing season 30 to 60 days.

Phosphorus

Laboratory and field data show that phosphorus accumulates in soils as a result of past fertilization and this accumulation is of real value for crop production *(4)*. Because of variation in past fertilization, soils throughout the State now range from low to very high in available phosphorus.

Data showing response of clover-grass pastures to superphosphate are presented in Appendix Table 4. Weighted averages for all locations are given in Figure 2. A response to as much as 80 pounds of P_2O_5 is indicated by average yields. Many locations included in Figure 2 had received little or no past phosphate fertilization.

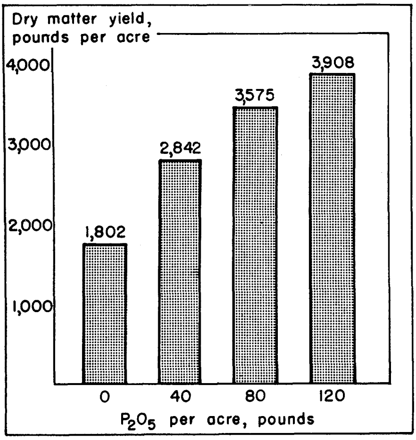

FIG. 2. Effect of phosphorus fertilization on yield of clover-grass pastures is shown by the graph. Yields are averages of 23 experiments.

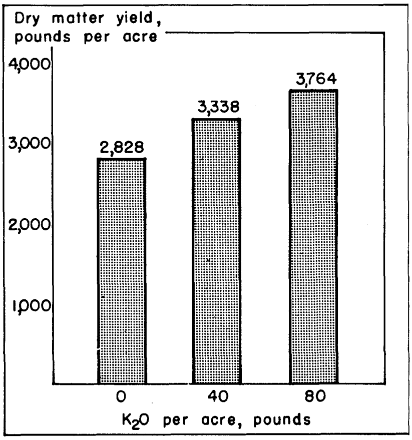

FIG. 3. Effect of potassium fertilization on yield of clover-grass pastures is shown by the graph. Yields are averages of 25 experiments.

Since the yield figures presented do not represent total herbage produced, a complete economic analysis cannot be made. However, based on the data presented, phosphate fertilization appears to be a paying practice in terms of increased forage production. Superphosphate applied at the rate of 80 pounds P_2O_5 per acre annually increased herbage production about 1,800 pounds.

Phosphorus is the mineral most likely to be deficient for grazing animals. The minimum phosphorus requirement in forage varies with the type of animal grazing. Setting a minimum figure is difficult, since borderline cases often pass as normal. Young animals and nursing cows require a higher level than older cattle and dry cows. Studies in Texas *(6)* indicate a minimum phosphorus content of 0.14 per cent for maintenance of grazing cattle.

Effect of phosphorus fertilization and lime on phosphorus content and yields of white clover is given in Table 1. The phosphorus content of clover from unphosphated plots and those receiving the raw phosphates was near the critical level for certain types of cattle; clover from the superphosphate-treated plots appeared adequate for all types of cattle. Leguminous crops are usually higher in phosphorus than non-legumes, but the content of either is determined to a large extent by available phosphorus in the soil. Lime increased the uptake of phosphorus where superphosphate had been applied. Rock and colloidal phosphates

TABLE 1. EFFECT OF LIME AND SOURCES OF PHOSPHORUS ON YIELD AND PHOSPHORUS CONTENT OF WHITE CLOVER GROWN ON VAIDEN CLAY

Source of phosphorus[1]	Yield per acre and phosphorus content, for liming rates							
	None		1 ton		2 tons		3 tons	
	Yield	P	Yield	P	Yield	P	Yield	P
	Lb.	*Pct.*	*Lb.*	*Pct.*	*Lb.*	*Pct.*	*Lb.*	*Pct.*
None	534	0.18	768	0.18	706	0.17	698	0.17
Superphosphate	5,220	0.28	5,926	0.32	5,620	0.31	6,243	0.31
Rock phosphate	2,000	0.22	840	0.22	660	0.16	793	0.15
Colloidal phosphate	2,103	0.20	988	0.17	1,072	0.17	978	0.17

[1] All phosphates applied at rate of 160 pounds of P_2O_5 per acre.

produced much less clover than superphosphate and their efficiency decreased with increasing amounts of lime.

There are several sources of phosphorus on the market at present. Results from research in Alabama on sources *(3)* show superphosphate to be satisfactory under a wide range of soil conditions. Most other processed phosphates are satisfactory sources for pastures. Raw phosphates (colloidal and rock) have not produced as much herbage as superphosphate when compared on the basis of equal P_2O_5 or equal cost.

Potassium

Grasses take up more potassium than do associated clovers *(2)*. Data reported by Alabama workers *(7)* show that yield of white clover decreases when the potassium content drops below 1.8 per cent, whereas yield of Dallisgrass is not affected until potassium content drops below about 0.5 per cent. This means that clovers are more likely to respond to potassium than grasses in a mixed pasture.

Continued use of phosphate without adequate potassium may cause a potassium deficiency, as shown by results of a grazing experiment at the Black Belt Substation *(1)*. During the first 7 years plots receiving 800 pounds of superphosphate per acre every 3 years produced more beef than plots getting 400 pounds. However, during the last 4 years the 400-pound rate of superphosphate out-yielded the 800-pound rate. After 7 years white clover growing on the plots receiving 800 pounds of superphosphate showed symptoms of potassium deficiency. The most characteristic symptom is development of small white spots near the edge of the leaflets. In severe cases marginal leafburn develops and the leaflet may die.

Results showing the response of pastures to potassium are given in Appendix Table 5. Average response values for all locations are given in Figure 3. The average response to 40 pounds of K_2O was 525 pounds of herbage. The response for the second 40-pound increment was only 314 pounds, which is little more than enough to pay for the additional K_2O.

Combined Effect of Lime, Phosphate, and Potash

The data presented thus far show the separate effects of lime, phosphorus, and potassium. In Table 2 are data showing the effect of no treatment versus lime plus phosphorus and potassium. Lime and minerals increased clipping yields 2 tons. The weighted averages for the seven locations show an increase of 2,933 pounds

TABLE 2. RESPONSE OF CLOVER-GRASS PASTURES TO LIME, PHOSPHATE AND POTASH

Fertilizer applied per acre				Dry matter yield per acre						
Initially		Annually		Susqehanna fsl 5-yr.av.	Lufkin c 4-yr.av.	Oktibbeha c 9-yr.av.	Ochlockonee cl 6-yr.av.	Wickham fsl 3-yr.av.	Huntington sil 4-yr.av.	Huntington sil 3-yr.av.
P_2O_5	K_2O	P_2O_5	K_2O							
Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Unlimed										
0	0	0	0	2,147	1,376	339	837	815	2,701	506
Limed										
60	30	60	30	----	----	4,255	3,937	----	5,216	3,439
80	40	80	40	3,779	----	----	----	3,926	----	----
80	60	80	60	----	3,704	----	----	----	----	----

FIG. 4. The plot at left received lime, phosphate, and potash; untreated plot is at right. Soil is Susquehanna fine sandy loam on Brabham Farm near Comer.

of forage. Since clipping yields do not reflect total yields for a season, the actual increases would be greater.

The combined effect of lime, phosphate, and potash on growth of white clover is illustrated by Figure 4.

Frequency of Fertilizer Application

Many experiments have been conducted to determine how frequency of phosphate and potash application affects herbage yields. Yields for the various locations are given in Appendix Table 6. Average yields for the eight locations are given below:

Frequency of application	*Average yields, lb./acre*
Annually	3,581
Every 2 years	3,692
Every 3 years	3,639

It is evident from these data that periodic applications of phosphate and potash are as efficient as annual applications for soils well adapted to white clover. An experiment was conducted at the Black Belt Substation from 1933 to 1942 to determine effect of frequency of superphosphate application on efficiency as measured by beef gains. The 3-year and annual applications (equivalent amounts) produced similar amounts of beef, Table 3. Observations indicate that this may not be true for soils very deficient in phosphorus and potassium or for very sandy soils susceptible to leaching of potassium.

TABLE 3. YIELDS OF BEEF AS INFLUENCED BY RATE AND FREQUENCY OF APPLICATION OF SUPERPHOSPHATE, BLACK BELT SUBSTATION, 1933-42

Superphosphate treatments		Beef produced per acre annually[1]	Increased beef production per acre
Rate per acre	Frequency		
Lb.		*Lb.*	*Lb.*
0	----	188	----
200	annually	241	53
400	annually	307	119
600	3 years	276	88
1,200	3 years	352	164

[1] Stocking rate was adjusted according to forage available for grazing.

DISCUSSIONS and RECOMMENDATIONS

Factors to be Considered

Although lime and fertilizer are important in establishment and maintenance of good pastures, other factors must be considered.

These include species-site combination, land preparation, quality of seed, time and method of planting, weed control, and grazing intensity.

Species-site combination. The productive capacity of a soil is determined largely by its moisture relationships—the ability to absorb, to hold against gravity, and to release water to growing plants. This, in turn, is influenced by soil texture, depth, and slope. The intermediate-textured or loamy soils have the best moisture relationships. Alluvial soil areas, such as creek bottoms and river terraces, usually have a large percentage of medium-textured soils.

Although an individual farm may have only a limited area of soil well suited to production of a certain grass-legume combination, there are climatically-adapted pasture species that can be successfully grown on most Alabama soils. Selection of crops best suited for the soil situation is one of the most important steps in developing pastures.

Dallisgrass-white clover is a combination best adapted to moist, well-drained bottom lands of medium texture and to the heavy clay soils of the Black Belt. Seasonal distribution of beef gains and carrying capacity for this combination on such soils is shown

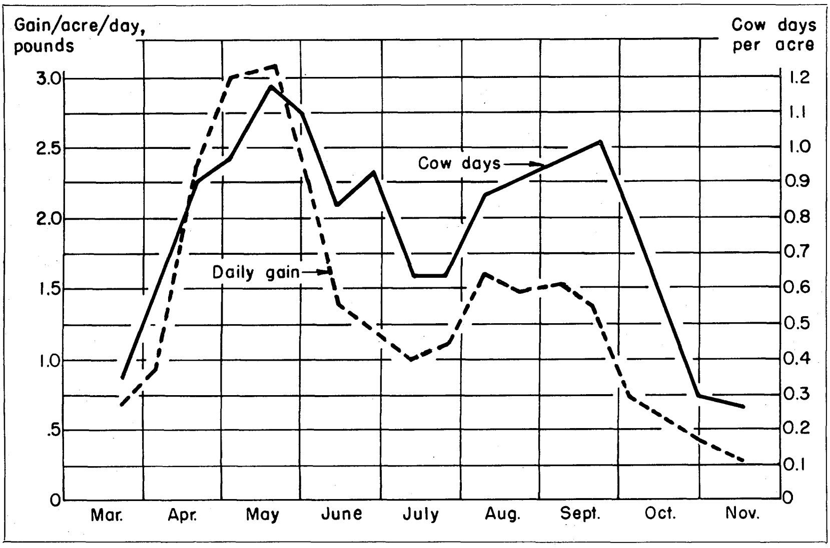

FIG. 5. This graph shows seasonal distribution of beef gains and carrying capacity of Dallisgrass-clover pastures on alkaline soils at Black Belt Substation. Pasture received 1,200 pounds superphosphate every 3 years (from Lit. Ref. 1).

in Figure 5. In northern Alabama orchardgrass should be included in the mixture.

Many Alabama soils are not well adapted to Dallisgrass. Other adapted grasses may be used to advantage on such soils.

Coastal Bermudagrass and crimson clover have been the most productive species for light-textured sandy or droughty uplands.

Pensacola Bahiagrass is best adapted to moist, sandy lands of central and southern Alabama. Although it persists on droughty sites, Bahia is not as productive as Coastal Bermudagrass on such soils. It competes successfully with carpetgrass if not overgrazed and if fertilized properly.

Tall fescue is well suited to relatively wet areas in central and northern Alabama. Ladino white clover has been the most successful legume grown with tall fescue.

Land preparation or renovation. The type of land preparation will depend on what is growing on the land. Where desirable plants are already growing, it may be desirable to only scarify the land so another species can be added. For new seedings the land must be prepared far enough ahead of seeding to be settled by rains.

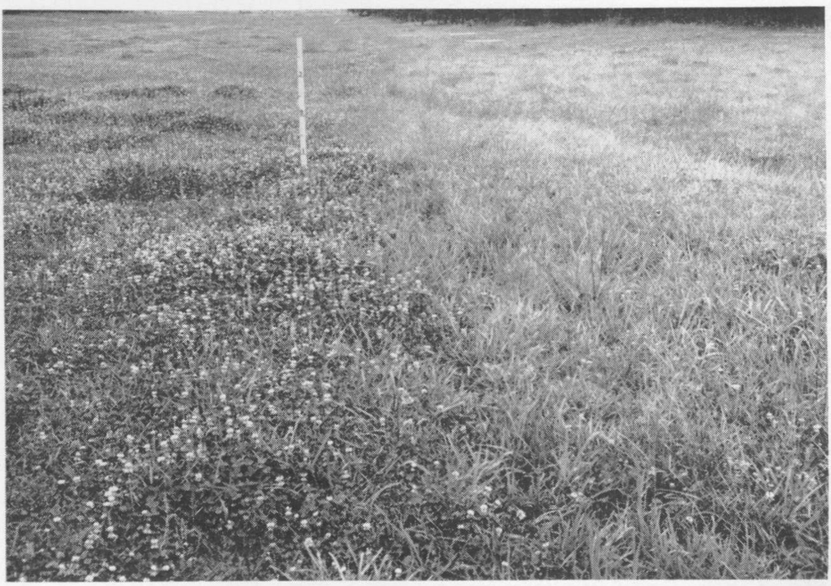

FIG. 6. Good stand at left is on area that was well prepared by plowing and disking. Area on right was not prepared. Fertilizing and seeding was the same.

On land infested with undesirable perennial species, it is desirable to use a herbicide before seeding to Dallisgrass and clover. Even if the desired species can be established, it may be impossible to maintain them for any length of time in the presence of highly competitive undesirable plants. Use of Dalapon has proved to be as good, or better, than land preparation to renovate carpetgrass pasture for establishment of white clover. However, in some cases it is preferable to use both herbicide and land preparation.

Unless completely eradicated, undesirable species may again crowd out the clover, especially under unfavorable grazing management. The effect of renovation of carpetgrass sod by land preparation is shown in Figure 6. A good stand of clover was obtained, but carpetgrass was not completely eradicated.

Seed. Certified seed of either Ladino or an intermediate type white clover may be used with Dallisgrass. However, since white clover may not survive severe summer droughts, it is advisable to use a clover that will produce sufficient seed for natural reseeding. California Ladino usually produces enough seed for reseeding, whereas Oregon Ladino does not. A comparison of flowering of intermediate white clover and Oregon Ladino is shown in Figure 7.

The seeding rate of white clover is 3 to 5 pounds of inoculated

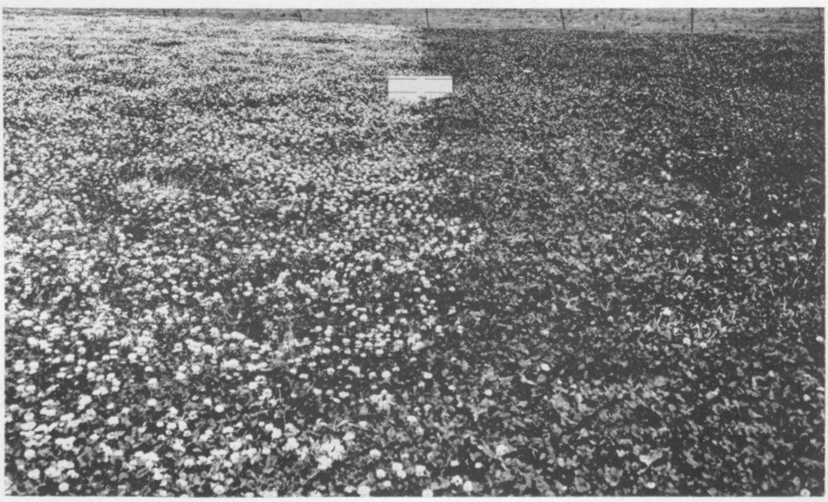

FIG. 7. Difference in flowering between intermediate white clover (left) and Oregon Ladino grown on Pittman Farm near Auburn. Fertilization was the same for both plots.

seed per acre. Under ideal conditions 1 pound will give a good stand.

Dallisgrass is difficult to establish even with the best seed available. Either domestic or imported seed may be used. Domestic seed is likely to be lower in germination than imported seed. Dallisgrass is seeded at the rate of 10 pounds of live seed per acre. It is important that seeding rate be adjusted to live seed basis, since germination of domestic seed is often as low as 60 per cent.

Time and method of planting. White clover is seeded in early fall. For best results the land must be well prepared and should be culti-packed after seeding. Later fall seedings are more subject to being lost by heaving. Dallisgrass is seeded in late February or March on top of fall-seeded white clover. It may be broadcast, but drilling is preferred in most cases.

On droughty land that is not well adapted to Dallisgrass, it may be better to seed Dallisgrass in the spring on well-prepared land and then overseed with clover in the fall. This gives the Dallisgrass a chance to become established without competition from clover.

Lime. Lime must be applied for production of white clover on soils below pH 6.0. The amount of lime needed depends on the soil and can best be determined by soil test. Most soils require 2 tons or less. This is not an expensive treatment since a lime application should last for 4 or 5 years. Liming is of first importance and lime needs must be met if fertilizer treatments are to be effective.

Fertilizers. Data presented in Figures 2 and 3 show that, on the average, pastures need 80 pounds of P_2O_5 and 40 pounds of K_2O per acre annually for maintenance. Areas that had not been fertilized to any extent previously responded to as much as 120 pounds of P_2O_5 per acre, Table 4. Soils known to be low in available phosphorus require about double the maintenance application for establishment. The extra phosphorus increases growth and improves seedling vigor. The amount of fertilizer needed for either establishment or maintenance is best determined by soil test.

For most soils maintenance applications may be applied either annually or a double amount every 2 years. Even though data presented show that 3-year applications are satisfactory, the chances of lowering efficiency are greater than with 2-year applications. Thus, application at 3-year intervals is not recommended.

TABLE 4. RESPONSE OF CLOVER-GRASS PASTURES TO SUPERPHOSPHATE FIRST YEAR AFTER APPLICATION ON LAND NOT PREVIOUSLY FERTILIZED

P_2O_5 per acre applied as superphosphate	Dry matter yield per acre		
	Kaufman clay Armstrong	Iuka silt loam Winfield	Norfolk sandy loam Fairhope
Lb.	*Lb.*	*Lb.*	*Lb.*
0	1,799	296	2,063
200	2,722	1,087	----
300	----	----	2,906
400	2,814	2,372	----
600	3,851	4,085	4,144

Weed control. Good management is essential in establishment and maintenance of permanent pastures. Management practices include control of weeds and brush, and grazing intensity.

Any space occupied by brush and weeds will decrease production of herbage. Proper grazing intensity and fertilization may lessen this problem, but will not eliminate it. Mowing will control many of the most objectionable weeds. However, the use of herbicides is more effective and economical than mowing in many

FIG. 8. This is an ideal balance of grass and clover growing on Izagora fine sandy loam on Warren Farm near Batesville.

cases. One half to 1 pound per acre of 2,4-D (2,4-dichlorophenoxyacetic acid) will control most broadleaf plants. The amine formulation of 2,4-D is less toxic to white clover than is the ester.

Clover-grass balance. Grazing intensity is important in maintaining the proper clover-grass balance of permanent pastures, Figure 8. If clover stands become weak or fail, it may be advisable to apply commercial nitrogen to the grass *(5)* until clover is reestablished.

With adequate summer moisture white clover may act as a perennial, but it may not survive during dry summers. If grass is either clipped or grazed close in early fall, the clover will have a better chance to volunteer.

SUMMARY

Field tests have been conducted during the past 20 years to determine the response of clover-grass pastures to lime, nitrogen, phosphorus, and potassium. In some experiments, frequency of application was also studied. The results are summarized as follows:

1. Lime is necessary for establishment and maintenance of clovers.

2. Nitrogen applications increased forage yields and beef gains from Dallisgrass pastures that did not have satisfactory stands of clover.

3. Soils not previously well fertilized are very deficient in phosphorus. Heavy applications are needed for establishment of clover-grass mixtures. Phosphorus status of soils depends on past fertilization.

4. Most soils require potassium for establishment and maintenance of clover-grass pastures. Removal of large amounts of hay or silage will soon result in a potassium deficiency, especially on sandy soils.

5. Frequency of applying phosphorus and potassium fertilizers to pastures on medium- to heavy-textured soils was not a critical factor. On such soils, applications at 2- to 3-year intervals produced as much forage as did annual applications when total amounts of fertilizer were equal for the period.

6. Phosphorus content of clover grown on well-fertilized land is usually above the critical level for all types of cattle.

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ACKNOWLEDGMENT

This report covers data obtained by workers of the Agricultural Experiment Station of Auburn University over a period of 20 years.

Summarized are results of cooperative field tests conducted on farmers' fields by J. D. Burns[3], E. M. Evans, E. L. Mayton, R. M. Patterson, Howard T. Rogers, J. M. Scholl[3], and E. L. Stewart[3]. County agents in the counties concerned were helpful in selecting suitable cooperators for the tests.

Tests on the Substations were conducted by K. G. Baker[1], Otto Brown[2], Lavern Brown, W. W. Cotney, W. B. Kelly[1], E. L. Mayton, and Harold Yates.

Work on the Experiment Fields was conducted by J. F. Segrest[3] and J. T. Williamson[1].

[1] Deceased
[2] Retired
[3] Resigned

APPENDIX TABLE 1. RESPONSE OF CLOVER-GRASS PASTURES TO LIME ON COASTAL PLAIN SOILS

Lime applied per acre	Dry matter yield per acre								
	Susquehanna fsl Tuskegee 1943-46	Iuka sil Winfield 1948-52	Norfolk sl Fairhope 1944, 1946	Norfolk sl Geneva 1942-46	Wickham fsl Camden 1950-51	Izagora fsl Comer 1952-54	Susquehanna fsl Comer 1952-54	Norfolk sl Auburn 1943-44	Wickham fsl Miller's Ferry 1945-50
Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	6,468	2,045	1,151	706	2,689	1,740	3,894	238	2,783
2,000	7,696	----	3,125	----	3,332	1,870	----	----	4,052
3,000	----	2,028	----	1,174	----	----	----	1,458	----
4,000	8,624	----	3,364	----	3,478	----	5,428	1,402	3,883
5,000	----	----	----	----	----	----	----	----	----
6,000	----	2,236	----	1,827	----	----	----	----	----
7,000	----	----	----	----	----	----	----	----	----
8,000	8,449	----	----	----	----	----	----	----	----
pH of unlimed soil	5.4	----	----	----	6.2	5.7	5.4	5.4	6.5

APPENDIX TABLE 2. RESPONSE OF CLOVER-GRASS PASTURES TO LIME ON BLACK BELT ACID SOILS

Lime applied per acre	Dry matter yield per acre					
	Oktibbeha c Lamison 1943-52	Leaf sil Safford 1944-46	Vaiden c Marion Junction 1950	Vaiden c Marion Junction 1950	Vaiden c Marion Junction 1950	Susquehanna c Tuskegee 1950-52
Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	412	1,793	1,868	5,212	4,614	4,426
2,000	3,787	1,925	1,586	6,113	----	4,348
4,000	3,235	2,485	2,410	5,654	5,466	6,138
5,000	----	----	----	----	----	----
6,000	----	----	2,146	5,859	----	----
8,000	5,172	----	----	----	----	5,556
pH of unlimed soil	4.7		5.2	5.2	5.3	4.6

APPENDIX TABLE 3. RESPONSE OF CLOVER-GRASS PASTURES TO LIME ON LIMESTONE VALLEY AND PIEDMONT SOILS

Lime applied per acre	Dry matter yield per acre					
	Huntington sil Glencoe 1946-49	Huntington sil Alexandria 1946-48	Creek bottom Oxford 1947-49	Congaree sil 1944-46	Cecil sl Camp Hill 1953	Lloyd cl Gold Hill 1952-53
Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
0	4,048	3,193	1,748	967	7,464	3,665
2,000	----	----	----	1,392	8,822	4,047
3,000	4,845	3,572	3,051	----	----	----
4,000	----	----	----	1,728	7,291	----
6,000	5,517	3,226	2,822	----	----	----
pH of unlimed soil		----	----	----	5.9	5.7

APPENDIX TABLE 4. RESPONSE OF CLOVER-GRASS PASTURES TO SUPERPHOSPHATE AS MEASURED BY DRY MATTER YIELDS

Location	Soil type	Years yield obtained	Dry matter yield per acre, seven P_2O_5 treatments						
			None	36	54	72	108	144	162
		No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Henderson Bro's. Farm, Miller's Ferry	Lufkin clay	3	722	3,646	----	3,737	4,118	----	----
Black Belt Substation	Houston clay	3	2,541	4,256	----	6,958	----	5,289	----
Moss Farm, Lamison	Oktibbeha clay	10	2,308	----	4,255	----	4,229	----	----
Black Belt Substation	Vaiden clay	2	543	----	----	2,275	----	----	----
Black Belt Substation	Sumter clay	5	676	----	----	2,680	----	----	----
Black Belt Substation	Sumter clay	4	1,130	----	----	2,333	----	----	----
Ensminger Farm, Gold Hill	Lloyd clay loam	2	3,208	----	----	3,731	----	4,046	----
Piedmont Substation	Cecil sandy loam	4	3,995	4,978	----	----	5,358	----	----
Warren Farm, Comer	Izagora fine sandy loam	5	1,010	----	----	1,666	----	2,231	----
Brabham Farm, Comer	Susquehanna fine sandy loam	5	2,262	----	----	4,148	----	4,670	----
Lower Coastal Plain Substation	Wickham fine sandy loam	3	1,124	3,104	----	3,926	----	----	----
Upper Coastal Plain Substation	Iuka silt loam	2	385	2,189	----	2,788	3,585	----	----
Lower Coastal Plain Substation	Wickham fine sandy loam	2	3,529	----	4,991	----	5,166	----	5,249
Tuskegee Experiment Field	Boswell fine sandy loam	1	1,747	----	2,236	----	2,417	----	2,718
Tuskegee Experiment Field	Boswell fine sandy loam	4	3,745	----	----	7,696	7,973	----	----
Gulf Coast Substation	Norfolk sandy loam	2	1,193	----	2,001	----	3,124	----	----
Colley Farm, Stafford	Leaf silt loam	3	1,125	1,737	2,001	2,082	----	----	----
Baxley Farm, Enterprise	Norfolk sandy loam	2	169	----	1,828	----	1,060	1,294	1,294
Dees Farm, Ozark	Norfolk sandy loam	1	150	----	1,631	----	1,894	----	2,119
Dees Farm, Ozark	Norfolk sandy loam	2	1,603	----	2,309	----	2,531	----	2,627
Hixon Farm, Banks	Norfolk sandy loam	2	2,672	----	3,169	----	2,745	----	3,844
Womack Farm, Ashford	Norfolk sandy loam	1	825	----	581	----	769	----	2,156
Wood Farm, Headland	Norfolk sandy loam	2	640	----	1,965	----	1,837	----	2,453

APPENDIX TABLE 5. RESPONSE OF CLOVER-GRASS PASTURES TO POTASH AS MEASURED BY DRY MATTER YIELD

Location	Soil type	Years yield ob- tained	Dry matter yield per acre, seven K_2O treatments						
			0	30	40	60	80	90	120
		No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Moss Farm, Lamison	Oktibbeha clay	9	4,062	4,251	----	----	----	----	----
Colley Farm, Safford	Leaf silt loam	2	1,473	2,315	----	----	----	----	----
Bledsoe-Vail Farm, Armstrong	Vaiden clay	2	2,330	2,032	----	----	----	----	----
Cook Farm, Miller's Ferry	Lufkin clay	3	4,103	3,264	----	3,933	----	----	----
Bruce Farm, Catherine	Lufkin clay	4	3,004	----	----	3,704	----	----	3,612
Bledsoe-Vail Farm, Armstrong	Kaufman clay	2	3,404	2,993	----	3,055	----	----	----
Upper Coastal Plain Substation	Iuka silt loam	3	1,843	2,040	----	2,215	----	----	----
Black Belt Substation	Vaiden clay	3	2,182	2,325	----	2,103	----	2,325	----
Henderson Bro's. Farm, Miller's Ferry	Ochlockonee clay loam	2	2,168	2,156	----	2,053	----	----	----
Miller Farm, Glencoe	Huntington silt loam	4	4,198	5,517	----	5,671	----	----	----
Turner Farm, Oxford	Creek bottom	3	1,971	2,822	----	3,104	----	----	----
Green Farm, Abanda	Congaree silt loam	3	837	1,392	----	----	----	----	----
Loftin Farm, Auburn	Creek bottom	2	940	1,445	----	----	----	----	----
Henderson Bro's. Farm, Miller's Ferry	Wickham fine sandy loam	6	3,486	3,883	----	3,942	----	----	----
Passmore Farm, Montgomery	Cahaba fine sandy loam	3	3,577	4,589	----	----	----	----	----
Gulf Coast Substation	Norfolk sandy loam	2	1,408	2,881	----	----	----	----	----
Brabham Farm, Comer	Susquehanna fine sandy loam	5	3,404	----	3,779	----	4,036	----	----
Warren Farm, Batesville	Izagora fine sandy loam	5	1,345	----	1,380	----	1,660	----	----
Piedmont Substation	Appling gravelly sandy loam	4	4,094	----	4,656	----	4,631	----	----
Ensminger Farm, Gold Hill	Lloyd clay loam	2	3,535	----	3,519	----	4,046	----	----
Black Belt Substation	Sumter clay	5	1,787	2,244	----	2,680	----	2,494	----
Black Belt Substation	Sumter clay	1	553	1,170	----	1,263	----	1,030	1,420
Black Belt Substation	Sumter clay	1	2,165	1,820	----	2,809	----	2,865	2,725
Black Belt Substation	Vaiden clay	1	4,234	4,327	----	4,500	----	4,313	5,314
Black Belt Substation	Houston clay	1	1,982	2,145	----	2,379	----	2,656	2,782

APPENDIX TABLE 6. RESPONSE OF CLOVER-GRASS PASTURES TO RATE AND FREQUENCY OF APPLICATION OF PHOSPHATE AND POTASH

Location	Soil type	Years yield obtained	Fertilizer treatments per acre: Initial P_2O_5	Initial K_2O	Thereafter P_2O_5	Thereafter K_2O	Frequency	Average yields of dry matter per acre
		No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*		*Lb.*
Moss Farm, Lamison	Oktibbeha clay	9	162	90	162	90	3 years	5,235
		9	162	90	108	60	2 years	5,184
		9	162	90	54	30	annually	4,251
Henderson Brothers' Farm, Miller's Ferry	Lufkin clay	3	216	90	216	90	3 years	4,474
		3	144	60	144	60	2 years	3,737
		3	72	30	72	30	annually	4,968
Henderson Brothers' Farm, Miller's Ferry	Ochlockonee clay loam	2	216	90	216	90	3 years	1,805
		2	144	60	144	60	2 years	2,156
		2	72	30	72	30	annually	2,296
Henderson Brothers' Farm, Miller's Ferry	Wickham fine sandy loam	6	216	90	216	90	3 years	3,715
		6	144	60	144	60	2 years	4,052
		6	72	30	72	30	annually	3,937
Bledsoe-Vail Farm, Armstrong	Kaufman clay	2	216	90	216	90	3 years	3,209
		2	144	60	144	60	2 years	2,993
		2	72	30	72	30	annually	3,845
Upper Coastal Plain Substation	Iuka silt loam	3	216	30	216	30	3 years	1,205
		3	144	30	144	30	2 years	2,082
		3	72	30	72	30	annually	2,007
Turner Farm, Oxford	Creek bottom	3	216	90	216	90	3 years	3,306
		3	144	60	144	60	2 years	3,051
		3	72	30	72	30	annually	3,326
Loftin Farm, Auburn	Creek bottom	2	216	90	216	90	3 years	1,396
		2	144	60	144	60	2 years	1,445
		2	72	30	72	30	annually	1,183