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To the Graduate Council:

I am submitting herewith a thesis written by Joseph L. Elmore entitled "Response of Alfalfa to Fertilization and Management in Putnam County, Tennessee." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

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RESPONSE OF ALFALFA TO FERTILIZATION AND MANAGEMENT IN PUTNAM COUNTY, TENNESSEE

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Joseph L. Elmore

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CHAPTER I

INTRODUCTION

The principal reasons for this study were to determine the yields of alfalfa under the levels of management as practiced by farmers in Putnam County and to determine the potentials for increasing the yields by additional applications of fertilizer. No attempt was made to measure all management practices used by Putnam County farmers in alfalfa production. However, general observations were made during the growing season and certain variables were measured and related to yield. No attempt was made to determine the maximum production of alfalfa under optimum conditions and a high level of management on the soils studied.

Within a given environment the success or failure of alfalfa is dependent upon the managerial skills and abilities of the farmer. With few exceptions, the nutritive elements required for the production of alfalfa must either be supplied through reserves in the soil or additions to the soil. With these things in mind this study was designed to determine some of the effects of some soil properties, weather, and some managerial practices upon yields of alfalfa over a period of time.

CHAPTER II

LITERATURE REVIEW

A. SOIL REQUIREMENTS FOR ALFALFA

Scientists have shown that the nutrition of plants is very complex and affected by many factors besides the nutrients themselves. It is for this reason that a brief discussion of the soil requirements for alfalfa is necessary.

According to Parks (12), the choice of soil determines to a great extent the yield potential of alfalfa. Alfalfa is a deep-rooted legume and grows best in a deep, well-drained, well-aerated soil which usually has red to brown subsoil.

Blaser (3) states that alfalfa has a deep taproot system that requires more soil oxygen than many forage plants. These conditions can be found in well-aerated soils that do not have a high water table or poor drainage due to a restrictive layer. If conditions favor deep root penetration, alfalfa is more productive even during dry periods than shallow rooted crops. It is, therefore, best to select soils that are deep and well-drained for establishment of new alfalfa seedings.

B. ESTABLISHMENT OF ALFALFA STANDS

Davis (5) has said that the most important factor in successful alfalfa production is the establishment of a good stand. He gave ten rules to follow for successful establishment of an alfalfa stand.

Blaser (3) has said, "It is somewhat easier to establish stands of alfalfa than of other small-seeded forage crop legumes; however, alfalfa demands a rather specific root environment. He also gave some rules for successful establishment of alfalfa.

Pendergrass and Turner (14) and Bishop and Turner (2) gave eight rules to be followed for successful alfalfa production. They are:

1. Select land suitable for alfalfa.
2. Prepare a compact, weed-free seedbed.
3. Select a high-yielding, winter-hardy variety.
4. Apply lime in adequate quantity.
5. Use an adequate amount of the right kind of fertilizer.
6. Inoculate seed properly.
7. Do the seeding job right.
8. Manage the stand carefully.

C. ALFALFA FERTILIZATION AND LIMING

In field demonstrations conducted by Bishop and Turner (2), alfalfa yields were increased as much as 30% to 40% by annual fertilizer applications.

In experiments by Parks (12), there was little response from applying a topdressing of fertilizer in the first spring following a fall seeding. In most cases, spring topdressing on alfalfa should start after the first production year.

Wedin, Burger and Ahlgren (18) found increases in forage yield from high rates of fertilizer were most evident on soil types which had lower productivity ratings.

Stivers and Ohlrogge (15) of Indiana, found the longevity of an alfalfa stand depended more upon potassium fertilization than upon phosphorus fertilization, even though one of the soils used in their experiment was low in available phosphorus.

Christy (4) stated that regular annual applications of potash and phosphate are the key to a thick, vigorous stand of alfalfa. A yield of four tons per acre of alfalfa removes 48 pounds of P_2O_5 and 180 pounds of potash.

Davis (5) has said, "A ton of alfalfa hay removes about 10 pounds of phosphoric acid, 40 pounds of potash, 28 pounds of calcium and seven pounds of magnesium.

Gerwig (8) stated that after the first season nitrogen applications tended to discourage nitrogen fixation, to decrease yield and stand, and to increase weed competition. He also found a 50-pound application of P_2O_5 to be beneficial only after three years, in soils testing medium in phosphorus. Higher applications, on the other hand, proved to be of no value and actually decreased yields over a five-year period. The detrimental effects of high phosphorus treatments were believed to be the result of a deficiency of minor elements. In his experiment, Gerwig found that where no potash was applied, deficiency of potassium was responsible for loss of 98% of the stand over a five-year period. He further stated that an application of 200 pounds of K_2O per acre is needed to insure maximum yields.

MacGregor, Brownell, and Nelson (10) found topdressing with commercial nitrogen of little value in alfalfa production. Annual applications of phosphate and potash with a moderate amount placed on

the field at seeding time was of more value than a large initial application with no annual applications. There was little difference between applications of fertilizer in the spring and in the fall until the stand was about three years old. After three years the spring application seemed to be more favorable. They expressed the opinion that adequate fertilization resulted in more efficient utilization of soil moisture.

In experiments by Nelson and MacGregor (11), there was no significant difference in yield between fall and spring applications of fertilizer in eight fertilizer treatments studied over a three-year period. Highest total yield for the three-year period (13.52 tons) was obtained with 1,000 pounds of 0-20-20 fertilizer applied in the spring before seeding plus 200 pounds of 5-20-20 topdressing for the second and third crop years. With the same initial treatment but a topdressing of 200 pounds of 0-20-20 fertilizer annually, the yield for a three year period was 13.44 tons, indicating that the inclusion of the nitrogen had no significant effect. The yield of the unfertilized check plot was 9.69 tons per acre. Annual topdressings appeared to be most efficient, especially in the application of potassium.

Blaser (3) stated that eastern soils are too low in phosphorus, potassium, and boron to grow good alfalfa. However, he found when these were added the yields of alfalfa were greatly increased.

Parks and Chapman (13) found liming to a pH of 7.0 to 7.3 increased alfalfa yields. In their experiment comparisons were made on a Maury soil

with a pH of 6.5 and limed to 7.0-7.3. Phosphorus and potassium were applied at uniform rates. Over a five-year period the plots limed to the higher pH level showed a 3.5 ton-per-acre increase in yield over the unlimed plot. At the end of the five year period the stands on the plots with the higher pH were much better than those of the unlimed plots.

Davis (5) stated that lime should be applied to bring the soil within a pH range of 6.8 to 7.0.

D. PREVIOUS STUDY OF ALFALFA IN PUTNAM COUNTY, TENNESSEE

A study of alfalfa production in Putnam County, Tennessee was conducted in 1958. Most of the farmers in the county normally expect to get three to four cuttings per year with a total life-span of three to four years. Yields in 1958 were relatively low. This was probably the result of poor management. Most of the farmers used a low rate of fertilization at seeding and topdressings were at low rates and not always made annually. Most of the farmers, however, followed other recommended cultural practices.[1]

E. TIME OF CUTTING

Wakefield (17) found that alfalfa yields could be increased by removing the first cutting at the early bud stage and later cuttings

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1/ Joseph H. Vaden, "Relationships of Soils and Management to Establishment and Yield of Alfalfa in Putnam County, Tennessee" (Unpublished Master's thesis, the University of Tennessee, Knoxville, 1958) 91 pp.

at the one-half bloom stage. Cutting at these times alone increased the quality of hay.

In an experiment by Blaser (3) highest yields were obtained when the first cutting was removed in the bud stage and subsequent cuttings in the one-tenth bloom stage. Yields almost this high were obtained when alfalfa was cut in the full-bloom stage. However, the quality of hay was lower when cut in full-bloom. If orchardgrass is mixed with the alfalfa, making the first cutting early reduced the stand of orchardgrass.

CHAPTER III

METHODS AND PROCEDURES

A. LOCATION AND ESTABLISHMENT OF PLOTS

In this study, cooperation of the farmers was of paramount importance. Those concerned were contacted in the winter and early spring of 1959, and plans for the experiments were discussed in detail.

The original plan was to use only two soil series in the experiment. These were Mountview, a soil from a thin loess layer overlying old residual material, and Waynesboro, a terrace soil. Due to the limited number of stands of alfalfa on these soils, the plan was later altered to include other soil series. Twenty fields of alfalfa that were seeded in 1957, and 22 fields that were seeded in 1958, were selected for the fertilization study. On each field, two rates of fertilization were employed. A fertilizer of a 0-10-20 analysis containing 5% borax was selected because this ratio and analysis appeared to fit the soil conditions and plant requirements best. The rates of fertilizer applied depended upon the previous fertilization and the amount of fertilizer the farmer was willing to apply. One plot was fertilized at the rate chosen by the farmer for his commercial crop. The other plot was fertilized at a higher rate. All plots were topdressed in late February, March or early April 1959, before the first cutting was made. Yields from these plots were harvested separately on the same day.

Locations of the plots were recorded on aerial photos which have been retained as permanent records.

B. COLLECTION OF SELECTED MANAGEMENT DATA

Management data were collected by recording on mimeographed forms the information obtained from individual farmers. A copy of these forms may be found in Appendix A. Management as used throughout this thesis is defined as any practice that can be controlled by a farmer that would influence yield.

C. COLLECTION AND ANALYSIS OF SOIL SAMPLES

Soil samples were taken from the surface six inches of the fields in the winter of 1958, and laboratory tests for pH, available phosphorus and potassium were made by the research soils laboratory at the University of Tennessee. Tests were later made for calcium and magnesium on some fields. The methods of testing were the standard testing procedures used in the University of Tennessee soils laboratory.

D. ACREAGE MEASUREMENTS

The field boundaries were marked on aerial photos (scale one inch equals 660 feet) and total acreage was determined by a planimeter. Acreages of the experimental plots were calculated from measurements made with a 100-foot steel tape.

E. ESTIMATION OF STAND COUNT AND VIGOR

During the period of June 15-19, 1959, counts were made of stand density while percent full cover, and percent of cover that was alfalfa were estimated. The methods outlined by Vaden were used.[1] The determinations were made again during the period of September 9-11, 1959. A copy of the form used may be found in Appendix B.

F. COLLECTION OF YIELD DATA

Alfalfa yields were measured much the same way as Vaden did in 1958.[2] The number of bales from each plot was counted and a representative sample of bales (usually 10% of the total) was weighed to arrive at an average weight. On the few farms where baling was not done, hay was obtained from two 36 square-foot blocks in each acre. It was weighed when the hay was dry enough to be baled. The hay yields of cuttings that were lost due to rain were estimated by the farmer who used the weight of another cutting as a guide. Although this does not assure as much accuracy as the weighing of bales, it does give an estimate of the amount of forage lost.

G. MEASUREMENT OF WEATHER CONDITIONS

The weather data for Putnam County were obtained from the U. S.

1/ Joseph H. Vaden, "Relationships of Soils and Management to Establishment and Yield of Alfalfa in Putnam County, Tennessee" (Unpublished Master's Thesis, University of Tennessee, Knoxville, 1958) pp. 14-15.

2/ Ibid., pp. 13-14.

Weather Bureau Station located at Cookeville, Tennessee. Weather data for 1957 were recorded by Vaden.[3] The weather data collected for 1958, and 1959, may be found in Appendices C, D, and E. These data will be discussed in more detail later.

H. IDENTIFICATION OF SOIL MAPPING UNITS

Soil types of the fields used were identified by Jackson, Bacon, and Cox, Soil Conservation Service, of the cooperative soil survey party, located at Cookeville, Tennessee,[4] and Gass, Assistant in Agronomy, University of Tennessee.[5] Individual fields were acceptable which included less than 25% of other soil mapping units. Descriptions of the soils, with the exception of the Bewleyville and Cumberland series, have been given by Vaden.[6] A description of these series may be found in Appendices F and G.

3/ Ibid., pp. 23-24.

4/ George Jackson, Sam Bacon, and Buel Cox, "Identification of Soils and Description of Soil Profiles." U. S. Dept. of Agric. Soil Conservation Service, Private Communication, 1959.

5/ Charles R. Gass, "Identification of Soils and Description of Soil Profiles." Assistant in Agronomy, University of Tennessee, Private Communication, 1959.

6/ Joseph H. Vaden, op. cit., pp. 19-22.

I. MAINTENANCE OF STAND RECORDS OF STANDS STUDIED IN 1958 THAT WERE NOT USED IN THE 1959 FERTILIZATION STUDY IN PUTNAM COUNTY

A record of the 38 fields studied in 1958, that were not used in the 1959 fertilization study was also kept. The yields from these fields were measured in the manner previously outlined and the stands were evaluated in the same manner as the fields used in the fertilization study.

CHAPTER IV

FINDINGS AND DISCUSSION

A. SOME OBSERVED AND MEASURED FACTORS WHICH MAY CONTRIBUTE TO SUCCESS OR FAILURE OF ALFALFA

Many factors enter into the success or failure of an alfalfa stand. Some of the factors which contribute to the success or failure of alfalfa production in Putnam County are management practices, weather, and soils. These factors are discussed in detail in the following paragraphs.

Management Practices Followed by Farmers

Management practices followed by the farmers appeared to be the most important factors contributing to success or failure in production of high yields of alfalfa. Some of the practices are listed below.

Seedbed preparation and rates of seeding. For the 22 stands that were seeded in 1958, and used in the 1959 study, the seeding practices indicated that the farmers in most cases were conforming to the recommended methods of seedbed preparation and rates of seeding. Of the 22 fields, 14 used the recommended practices, including summer fallow. The other eight used the recommended practices with the exception of summer fallow. The rate of seeding was from 20 to 25 pounds per acre for all the 22 fields seeded.

Fertilization and liming. In most instances the initial fertilization was below that recommended for establishment of alfalfa. In more than 70% of the stands studied in 1959, the initial rate was less than 500 pounds per acre of a 6-12-12 fertilizer. Table I is a summary of fertilization practices carried out on the 70 alfalfa stands studied in 1959.

Applications of maintenance fertilizer were greater in 1959 than in 1958. Fifty-four percent of the farmers applied no topdressing at all in 1958 and of the 22 farmers who did topdress, 64% of these applied less than 400 pounds of a 0-9-27 analysis. On the same stands in 1959 less than 32% applied no topdressing and 44% applied more than 450 pounds per acre. Of the 22 stands seeded in 1958, 23% applied no topdressing, 50% applied less than 400 pounds per acre, and 23% applied 500 pounds or more per acre of a 0-10-20 analysis. The increase in topdressing may be due to increased interest of the farmers created by the study. A summary of the fertilization practices may be seen in table 2. Fertilization on individual fields is included in Appendices H, I, and J.

In most cases sufficient lime was applied to raise the pH to 6.5 or above. In 1959, 70% of the 42 fields tested pH 6.5 or above. The number of fields testing in the pH range of 5.1 to 5.5 was 1; of 5.6 to 6.0, 3; of 6.1 to 6.5, 13; of 6.6 to 7.0, 13; and of 7.1 to 7.5, 12.

The rate and time of lime application, along with the seeding dates, are given in Appendix N. Farmers may not be applying lime far enough in advance of seeding for the lime to react with the soil before germination. Of the 71 stands listed in table 3, more than one-half

Table 1.--Number of selected stands of 1957 and 1958 seeded alfalfa receiving various initial fertilizations in Putnam County, Tennessee.

Year seeded	6-12-12			Other fertilizer		
	Less than 400 lbs./A	400-500 lbs./A	More than 500 lbs./A	Less than 400 lbs./A	400-500 lbs./A	More than 500 lbs./A
1957	2	32	2	7	3	2
1958	2	15	1	2	2	0

Table 2.--Summary of topdressing fertilization practices on selected alfalfa stands in Putnam County, Tennessee

Year seeded	Year top-dressed	Total No. stands	Fertilizer analysis	Topdressing application pounds per acre				
				0	150-250	300-400	400-500	More than 500
1957	1958	48	-----	26				
			0-60-0		1			
			0-9-27		5	9	2	1
			0-20-20		1			
			3-9-18			1		
			6-12-12			2		
1957	1959	48	-----	15				
			0-9-27		2	1	1	
			0-10-20		2	4	14	6
			0-20-20		2	1		
1958	1959	22	-----	5				
			0-10-20		7	4	4	1
			0-20-20				1	

Table 3.--Summary of time of seeding and time of lime application on selected 1957 and 1958 seeded alfalfa stands in Putnam County, Tennessee.

	Time lime applied before seeding			No lime applied within 10 years
	Less than 2 months	2 to 4 months	More than 4 months	
Number of stands	36	16	15	4

received lime less than two months before seeding.

Inoculation. Most of the farmers inoculated their seed with new inoculant and followed the recommendations on the inoculant packages. Of the 22 stands seeded in 1958, only two were not inoculated.

Cutting practices. It was observed in visits throughout the summer that many of the farmers were not cutting their hay at the recommended maturity stage, which is one-tenth to one-half bloom. More than half of the stands were allowed to overmature at least once. Farmers gave as their reasons for not harvesting at the proper time either unsuitable weather or competition for their time by other crops.

Weather

As stated by Vaden[1] the weather in the fall and winter of 1957 was cold with a low rainfall. A study of table 4 reveals that the total growing season of 1958 had an abundance of rainfall even though the yearly average was low. The month of April had 2.6 inches of rain more than the long-term mean of 4.4 inches for the County. The months of May and June, however, fell 2.2 inches short of the long-term means of 8.8 inches, with small rains distributed throughout these months. Extreme variability in rainfall conditions in the fall of 1958 may have had an influence on the high rate of stand failures for the fall seedings of 1958. Of 51 stands of 1958 seedings of alfalfa that were checked, 22 were failures.

1/Joseph H. Vaden, "Relationships of Soils and Management to Establishment and Yields of Alfalfa in Putnam County, Tennessee" (Unpublished Master's Thesis, University of Tennessee, Knoxville, 1958) pp. 23-24.

Table 4.--Comparison of long-term mean (L/M) rainfall for a 24-year period with rainfall for the years 1958 and 1959 in Putnam County, Tennessee.

Month	Precipitation		
	L/M	1958	1959
January	5.65	3.05	3.40
February	4.05	2.63	4.63
March	5.64	4.36	6.82
April	4.38	6.94	3.01
May	4.50	2.79	3.04
June	4.25	3.70	2.71
July	4.97	4.29	5.16
August	4.60	4.79	5.12
September	2.98	5.74	3.53
October	3.57	0.79	5.01
November	4.08	4.65	6.00
December	4.71	1.64	6.76
Annual	53.38	42.37	55.19

During the recommended seeding period rainfall was only 3.02 inches. Of this 2.88 inches fell on 24 and 25 August. This period was followed by an abundance of rainfall in the latter part of September. Following this was an extremely dry October with only 0.79 inch of rainfall during the entire month.

Rainfall for the growing season of 1959 was low. The total for the months of April, May and June 1959 was 4.75 inches less than the long-term mean of 13.13 inches. Even though the rainfall was low for these months there were frequent small showers during late May and early June. These caused loss of the first cutting of hay on 12 fields and delayed the first cutting on 17 others out of a total of 67 fields. On eight fields other cuttings were lost due to rain. Three farmers lost two cuttings of hay. Hay losses due to rain by individual fields and cuttings may be found in table 5.

The average percent of forage lost on the sampled fields was determined by dividing the average forage lost by the average yield of forage per acre for all plots studied. The average percent of forage lost on fields with a loss was 35% and for all fields studied 9%. In this instance as the yields increased there was less loss from rain damages. These yields are obtained from the farmer fertilization plots.

The maximum and minimum temperatures and rainfall for 1958 and 1959 are given in Appendices C, D and E.

Soils

For the most part alfalfa was seeded on soils that had a deep,

Table 5.--Forage loss because of rain in 1959 from 20 of 67 alfalfa fields in Putnam County, Tennessee.

Stand number	Estimated pounds per acre of forage lost					Total yield	Percent of forage lost
	1st. Cutting	2nd. cutting	3rd. cutting	4th. cutting	total lost		
2	1800				1800	5610	32
6			1200		1200	6310	19
7	1840	60			1900	3510	54
9	2100				2100	4340	48
10	2500				2500	9300	27
19	1000				1000	3960	25
29			1800		1800	5570	32
30	1800				1800	3290	55
31b			1000		1000	6010	17
32	1600				1600	5380	30
39				1500	1500	6170	24
52	2000				2000	6060	33
53			2000		2000	6550	31
56	1800		700		2500	3210	78
58		2100			2100	5190	40
61	1500		2000		3500	7160	49
63	1800				1800	5650	32
68			1500		1500	5030	30
72	2000				2000	3530	57
77			2000		2000	6800	29
Averages:							
All fields with loss					1880	5430	35
All fields without loss					0	6300	
All fields					560	6024	9

permeable, red or yellowish brown subsoil. In a few instances, however, portions of fields used for alfalfa had spots with poor drainage.

B. COMPARISON OF SOME OBSERVED AND MEASURED FACTORS OF 1958 WITH THOSE OF 1959

Soil Tests

A comparison of the soil tests of selected alfalfa fields in 1958 with tests of the same fields in 1959, may be made using the data in table 6. There was little change in pH in 75% of the fields. In 90% of the tests the available phosphorus and available potassium were higher in the 1958 tests than they were in the 1959 tests. It is believed in most of these instances the differences were due to variations in the samples themselves rather than a change in the field as a whole. Although the sampling procedures were the same in both years, small fertilizer particles could have been picked up in some of the samples, thus greatly influencing the tests. The samples in 1958 were taken approximately six to seven months after the initial fertilizer applications. The 1959 samples were taken approximately one year later. On approximately half of the fields a topdressing was applied in 1958, and the 1959 samples were taken approximately nine months after this topdressing application. This was not sufficient data on which to base any conclusions but it did indicate that soil samples taken before fertilizers have completely reacted with soil may not show an accurate estimate of the fertility.

Table 6.--Results of soil tests in 1958 and 1959 on selected alfalfa fields in Putnam County, Tennessee.

Stand number	Soil mapping unit	1958 pH	1958 P Lbs./A	1958 P rating	1958 K Lbs./A	1958 K rating	1959 pH	1959 P Lbs./A	1959 P rating	1959 K Lbs./A	1959 K rating
13	Baxter C-2	6.1	83	H	346	H	6.6	24	M	193	H
26	Bewleyville B-2	6.8	2	VL	138	M	6.1	27	H	92	L
33	Bewleyville C-2	6.0	16	L	245	H	6.1	8	L	100	L
2	Cumberland B-2	6.7	3	VL	201	H	7.2	2	VL	178	M
15	Cumberland C-2	6.9	6	VL	211	H	6.8	9	L	175	M
6	Mountview B-1	6.4	17	M	72	VL	6.5	8	L	160	M
9	Mountview B-1	6.3	9	L	104	L	7.3	6	L	72	VL
10	Mountview B-1	6.6	38	H	237	H	6.4	9	L	96	L
14	Mountview B-1	6.2	31	H	84	L	7.0	19	M	138	M
21	Mountview B-1	6.9	29	H	142	M	7.1	19	M	126	L
27	Mountview B-2	6.1	58	H	286	H	6.8	23	M	197	H
28	Mountview B-2	6.6	5	VL	130	L	6.6	4	VL	201	H
3b	Waynesboro B-2	6.5	9	L	306	H	6.9	4	VL	298	H
11	Waynesboro C-2	6.9	55	H	249	H	7.2	3	VL	142	M
16a	Waynesboro B-1	6.7	10	L	115	L	7.0	7	L	100	L
16b	Waynesboro B-2	6.8	112	H	272	H	6.7	14	L	100	L
20	Waynesboro C-3	7.1	29	H	230	H	7.4	17	M	182	M
29	Waynesboro B-2	6.5	7	L	134	L	6.3	2	VL	104	L
36	Waynesboro B-2	5.9	53	H	400	H	5.8	23	M	197	H
40	Waynesboro C-3	6.6	5	VL	219	H	6.8	3	VL	208	H

VL - very low
L - low
M - medium
H - high

Yields

A comparison of the yields on the 1957 seeded stands used in the 1959 fertilization study can be made from table 7. On the plots where the normal farmer fertilization was used, yields were slightly higher in 1958 than in 1959. This decrease in 1959 yield is slight, however, with an average decrease of only 100 pounds per acre. The plots with the higher rate of fertilization showed an increase of 1510 pounds per acre over the 1958 yields and an increase of 1620 pounds per acre over adjoining plots with the lower rate of fertilization.

Stand Evaluations

Stand evaluations were made on the alfalfa fields in 1959 in much the same way as in 1958. The stand evaluation data by plots and the soil type may be found in Appendix K. These data indicate that the number of plants per square foot had decreased by 38%, while the percent cover had increased slightly and the percent of cover that was alfalfa had decreased. Two stands have decreased to less than 1% alfalfa. This explains a large portion of the average decrease in plants per square foot and percent alfalfa.

C. STANDS USED IN THE 1958 STUDY THAT NO LONGER REMAIN AS PRODUCTIVE ALFALFA FIELDS

The study in 1958 consisted of 58 stands. Of these 58 stands, seven were dropped as failures before the end of the 1958 growing season. Records were kept of the remaining 51 productive stands during the growing season of 1959. At the end of the 1959 growing season all fields

Table 7.--Alfalfa yields in pounds hay per acre on selected fields in Putnam County in 1958 and 1959.

Stand number	Soil mapping unit	Pounds forage per acre				
		Farmer's fertilization			Higher fertilization	
		1958	1959	Increase or decrease over 1958	1959	Increase or decrease over 1958
13	Baxter C-2	16330	8620	-7710	10740	-5590
33	Bewleyville C-2	4850	5300	+ 450	6300	+1450
2	Cumberland B-2	5280	5610	+ 330	7250	+1970
15	Cumberland C-2	6290	6960	+ 670	10880	+4590
6	Mountview B-1	7470	6310	-1160	8550	+1080
9	Mountview B-1	6100	4340	-1760	5950	- 150
10	Mountview B-1	9090	9300	+ 210	10120	+1030
14	Mountview B-1	5140	2500	-2640	5370	+ 230
21	Mountview B-1	4270	9390	+5120	8910	+4640
28	Mountview B-2	2980	4510	+1530	12350	+9370
3b	Waynesboro B-2	5470	6130	+ 660	7220	+1750
11	Waynesboro C-2	2950	5760	+2810	4400	+1450
16a	Waynesboro B-1	8210	8760	+ 550	7530	- 680
16b	Waynesboro B-2	7550	7400	- 150	9210	+1660
20	Waynesboro C-3	9810	8870	- 940	8610	-1200
29	Waynesboro B-2	5280	5570	+ 290	7710	+2430
36	Waynesboro B-2	9350	6340	-3010	6500	-2850
40	Waynesboro C-3	5060	8010	+2950	11040	+5980
Average		6750	6650	- 100	8260	1510

were visited and it was decided to discontinue a field as a productive alfalfa stand when the percent alfalfa dropped below 50%. At the end of the 1959 growing season, 18 or 31% of the stands studied in 1958 had been dropped as productive alfalfa stands. The reasons for discontinuance were as follows: five stands were failures at seeding, two stands were turned under, two stands were placed in the soil bank, and nine stands decreased to less than 50% alfalfa. Of the stands with less than 50% alfalfa, five were turned to pasture.

D. 1958 SEEDED STANDS THAT WERE CHECKED

Many poor stands of alfalfa were obtained from the 1958 seedings. Fifty-one of the fields seeded to alfalfa in 1958 were checked at random. Of these 51 fields, 22 were stand failures. The exact reasons for these failures are not known. As previously stated, the weather may have played a great part. The farmers gave reasons such as: (1) late seeding on 12 fields, (2) followed soybeans with their alfalfa on three fields; (3) poor seedbed preparation on four fields; and (4) competition from companion crops on three fields.

E. COMPARISON OF YIELDS FROM FERTILIZATION STUDIES IN 1959

As previously stated there was a total of 42 stands used in the 1959 fertilization study. Of these 42 stands it was felt that accurate records were not kept on three of the stands, the owners having pastured the field for a portion of the year. Therefore, these

three stands were not used in comparing the results of the study.

Of the 39 stands used in the comparison there were increases in yields from the higher fertilization rate on 32 of the fields. The reason for a reduction in yield on the higher fertilization plots in seven of the stands is not known.

A summary of the average yields and number of plots from each soil type may be found in table 8. A review of this table shows an average increase in yield from the higher fertilization on all soils. The increases in yields from higher fertilization were obtained on the soils in the following order: Baxter, Cumberland, Mountview, Bewleyville, Hermitage and Waynesboro. The highest increases in yields from increased fertilization were obtained on the Baxter soil with a 40% increase in yield from approximately an 800 pound per acre increase of fertilizer. The Baxter soils were also leading in the average yield of forage with an average yield of 9950 pounds per acre on the higher fertilized plots. The number of observations on this soil, however, were too few to predict this as being average for all Baxter soils. It does indicate a need for further study with alfalfa on this soil.

There were good stands of alfalfa on all soils studied. From general observation by the author, management of the stands during seeding and after seemed to play a major role in alfalfa production.

F. EFFECT OF AGE OF STAND ON ALFALFA PRODUCTION

The Waynesboro was the only soil used in the test with sufficient samples to test the effects of the years since seeding on yield. The

Table 8.--Average yields of alfalfa at two levels of fertilization on selected soils in Putnam County, 1959.

Soil series	Number plots	Low fertilization plots				Higher fertilization plots				Average increase or decrease over low fertilization
		Fertilizer lbs./A	Average yield lbs./A			Fertilizer lbs./A	Average yield lbs./A			pounds forage per acre
			Forage	Weeds and grasses	Alfalfa		Forage	Weeds and grasses	Alfalfa	
Waynesboro	16	410	6040	450	5580	920	7420	540	6890	1380
Mountview	8	470	5600	630	4970	1060	8100	920	7180	2500
Bewleyville	7	270	5720	880	4840	660	7330	1180	6150	1610
Hermitage	4	200	6990	520	6460	740	8470	660	7810	1480
Baxter	2	750	7000	1770	5230	1560	9950	2080	7870	2950
Cumberland	2	250	6280	310	5980	800	9060	450	8620	2780

older stands had a higher yield on both the high and low fertilizer treatments. When age of the stand alone is considered, on the plots with the low fertilization treatment, the increase in yield due to one years'age was greater than increases on the higher treatments. The low fertilization stands in their second year of production averaged 1500 pounds of forage per acre more than the stands in their first year of production. This difference was not as great, however, on the stands receiving a double rate of fertilizer. On these stands the increase in yield for the second year of production was only 400 pounds of forage per acre. The average increase in yield of forage per acre from the higher fertilization plots was twice as much on the stands in their first year of production as was the increase in their second year of production. The plots in their first year of production had an average increase of 2200 pounds of forage per acre from the higher fertilization while those in their second year of production had an increase of 1100 pounds per acre. The reason for this increase from fertilization in the younger stands was probably due to better utilization of soil fertility by the older stands. The young stands had a less well developed root system and therefore was more dependent on the fertilizer added.

G. MULTIPLE CORRELATION ANALYSIS

Multiple correlation analysis was chosen as a means to analyze these data. Reasons for choosing the multiple correlation were: 1) to isolate the relationships of inputs occurring in varying rather than discrete amounts, 2) because of a small number of observations, and 3)

to study the effects of all inputs simultaneously.

The general equation used to analyze the data is:

$$X_1 = a + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + b_8 X_8$$

The following is the legend for the components of the equation:

X_1 = Yield of forage per acre in 100 pounds.

X_2 = Pounds of weeds and grasses per acre in 100 pounds.

X_3 = L_n Phosphorus soil test (pounds per acre)

X_4 = L_n P_2O_5 added (pounds per acre)

X_5 = L_n Potassium soil test and potassium added (expressed as pounds of K per acre).

X_6 = L_n Soil pH

X_7 = Year since seeding

X_8 = Calcium-magnesium ratio in soil.

a = Point at which the curve line crosses the Y axis.

b_i = Representative partial regression coefficients

L_n = Natural logarithm

Partial Regression Coefficients "b"

The partial regression coefficients measures the slope of the regression line. This shows the units increase or decrease in the dependent variable with each unit increase in the independent variable. The partial regression coefficients for this equation are shown in table 9. An example of a partial regression coefficient from table 9 is X_6 on the Mountview soil. For each unit increase in pH there was a reduction of 307 pounds of forage.

Table 9.--Partial regression coefficients "b's", for seven independent variables measured on three soil series.

Soil series	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Waynesboro	.77	3.19	4.69	13.69	10.34	8.10	1.02
Mountview	.34	-.77	-3.81	42.91	-307.44	19.90	.39
Bewleyville	3.06	-.39	14.14	25.16	-24.99	17.30	-2.88

X_2 Weeds and grasses (100 pounds per acre)

X_3 L_n soil test phosphorus (lbs./A)

X_4 L_n P_2O_5 added (lbs./A)

X_5 L_n Potassium added plus potassium in soil test (expressed as 100 pounds K/A)

X_6 L_n soil test pH

X_7 Years since seeding

X_8 Ca/Mg ratio

The variables used in the equation are discussed later in the chapter.

Standard Errors for Partial Regression Coefficients (S_b)

The standard error of estimate shows how nearly the estimated values agree with values actually observed for the variable being estimated. This coefficient is stated in the same units as the original dependent variable, and its size can be compared directly with those values. In this equation the standard errors were large compared with the partial regression coefficients. This was largely due to a small number of observations. The numbers of observations on the Bewleyville were 14, Mountview 16, and Waynesboro 36. These standard errors are at the confidence limits of 66-2/3% probability. The standard errors are shown in table 10.

Coefficients of Partial Determination (r^2) and Coefficients of Multiple Determination (R^2)

The coefficient of partial determination shows what proportion of the variance in the values of the dependent variable can be explained by, or estimated from, the comparable variation in the values of the independent variable. In this equation the largest coefficients of partial determination were obtained on the Bewleyville soil. Of the seven independent variables measured potassium, pH, and age of stand had the largest explanation on all soils.

The coefficients of multiple determination show the influence expressed by the independent variables upon the dependent variable. In

Table 10.--Standard errors for partial regression coefficients "S_b" for seven independent variables measured on three soil series.

Soil series	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Waynesboro	1.203	5.297	5.226	13.045	72.290	8.825	.772
Mountview	2.32	15.23	9.45	34.53	340.33	20.03	2.18
Bewleyville	.42	16.15	1.96	14.38	39.55	6.93	.89

X_2 Weeds and grasses (100 pounds per acre)

X_3 L_n soil test phosphorus (lbs./A)

X_4 L_n P_2O_5 added (lbs./A)

X_5 L_n potassium added plus potassium in soil test (expressed as 100 pounds K/A)

X_6 L_n soil test pH

X_7 Years since seeding

X_8 Ca/Mg ratio

this equation the largest coefficient of multiple determination was on the Bewleyville soil. The seven variables measured explained 94% of the total yield. These same variables only explained 30% of the yield on the Waynesboro soil and 43% on the Mountview soil. The coefficients of partial and multiple determination for each soil are shown in table 11.

These coefficients are discussed later in the thesis.

Three soils were used in the multiple correlation. The soils used were the Waynesboro, Bewleyville and Mountview series. These three soils were chosen because of their more abundant use for alfalfa in Putnam County and because they are considered to be suited for alfalfa production.

The equations obtained from analyzing the data are as follows:

Waynesboro Series '1'

Yield = -13.633 + .767 (pound weeds and grasses) + 3.193 (L_nP test) + 4.690 (L_n P_2O_5 added) + 13.686 (L_n K added + test) + 10.343 (L_n pH) + 8.102 (years since seeding) + 1.016 (Ca/Mg ratio)

Mountview Series '2'

Yield = 606.41 + .34 (pounds weeds and grasses) - .77(L_n P test) -3.81 (L_n P_2O_5 added) + 42.91 (L_n K added + test) - 307.44 (L_n pH) + 19.90 (years since seeding) + .39 (Ca/Mg ratio)

Bewleyville Series '3'

Yield = 59.8 + 3.06 (pounds weeds and grasses) + 14.14 (L_n P_2O_5 added) - .390 (L_n P test) + 25.16 (L_n K added + test) - 24.99 (L_n pH) + 17.30 (years since seeding) - 2.88 (Ca/Mg ratio)

Table 11.--Coefficients of determination of seven independent variables measured on three soil series.

Soil series	Partial (r^2)							Multiple (R^2)
	X_2	X_3	X_4	X_5	X_6	X_7	X_8	
Waynesboro	.014	.013	.028	.038	.001	.029	.058	.302
Mountview	.003	.000	.020	.162	.092	.111	.004	.432
Bewleyville	.987	.007	.113	.338	.623	.509	.639	.943

X_2 Weeds and grasses (100 pounds per acre)

X_3 L_n soil test phosphorus (lbs./A)

X_4 L_n P_2O_5 added (lbs./A)

X_5 L_n potassium added plus potassium in soil test (expressed as 100 pounds K/A)

X_6 L_n soil test pH

X_7 Years since seeding

X_8 Ca/Mg ratio

Pounds of Weeds and Grasses - Yield Relationship

On the three soils used in the study there was a positive correlation between the total pounds of forage per acre and the pounds of weeds and grasses. The highest correlation was on the Bewleyville soil. For each one hundred pounds increase in weeds and grasses there was an increase of 300 pounds of total forage. This large percentage of weeds and grasses on the Bewleyville soil is probably due to most stands on this soil being in their first year of production whereas on the other two soils most were in their second year of production. It should be noted, however, that for 1000 pounds of weeds and grasses on the Bewleyville soil, the yield of alfalfa was approximately 4000 pounds. On the Waynesboro and Mountview soils for 1000 pounds of weeds and grasses there was an alfalfa yield of approximately 5500 pounds. The response curves for this variable are shown in figure 1.

Soil Test Phosphorus - Yield Relationship

The response to soil phosphorus was too small on all soils used in the correlation to draw any conclusions. The coefficients of partial determination (r^2) were .013 for the Waynesboro, .000 for the Mountview, and .007 for the Bewleyville soils. This relationship may be seen in figure 2.

P_2O_5 Added - Yield Relationship

A positive response was obtained from phosphorus added on the Bewleyville and Waynesboro soils. The larger portion of this response was below the 75 pound rate of P_2O_5 added with the response curve

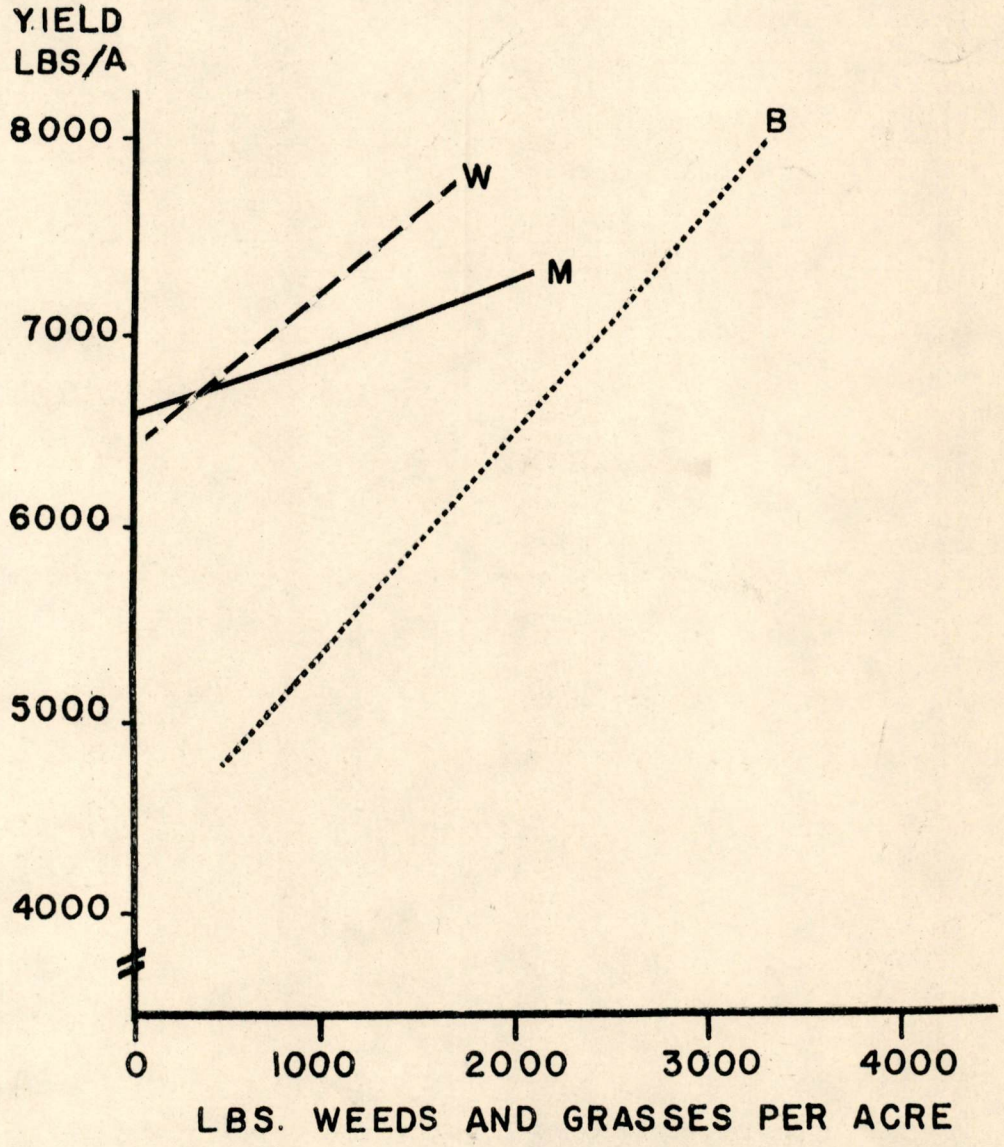


Figure 1.--Relationship of pounds of weeds and grasses to yield of forage on Bewleyville (B), Mountview (M), and Waynesboro (W) soils.

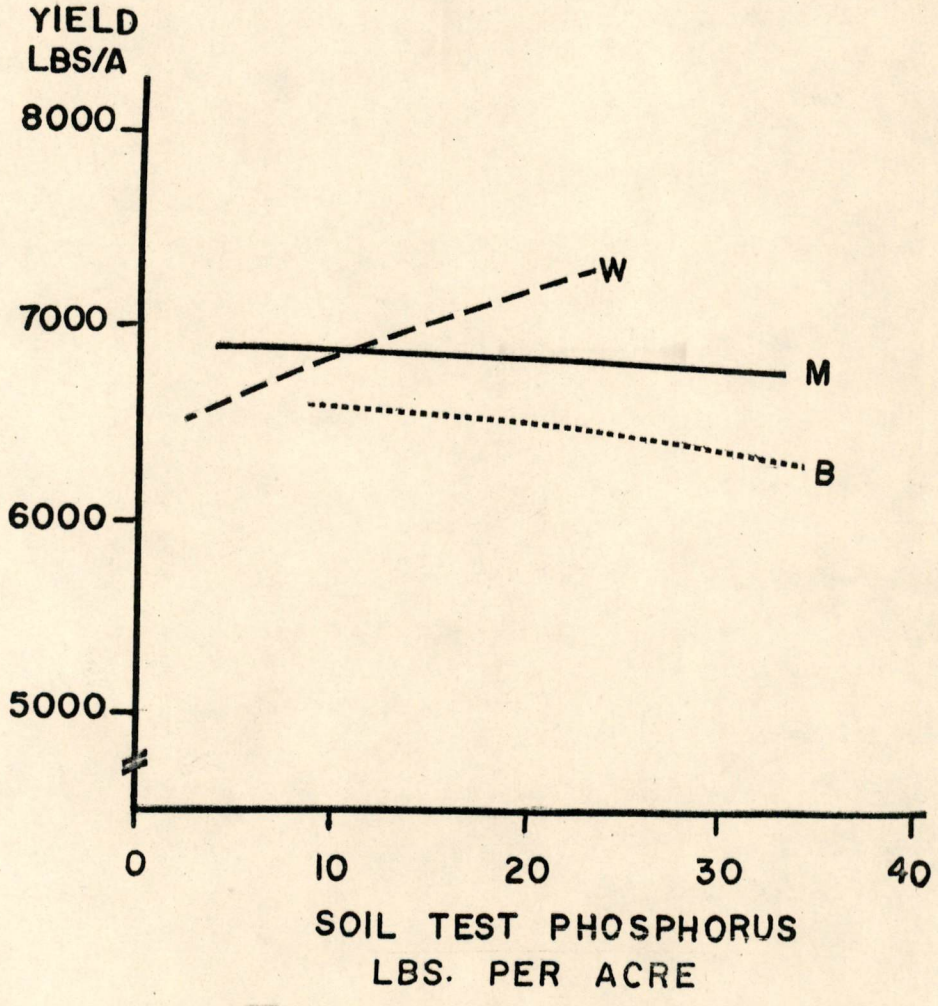


Figure 2.--Relationship of soil phosphorus to yield of forage on Bewleyville (B), Mountview (M), and Waynesboro (W) soils.

approaching the horizontal for rates added in excess of 75 pounds. This is similar to the response found by Gerwig (8) who found no response to P_2O_5 added in excess of 50 pounds. There was a negative response to P_2O_5 on the Mountview soils. Also there was a reduction in yield with an increasing pH. According to Hoagland (9) an increase in calcium concentrations may reduce the uptake of phosphorus in some plants. An interrelation of these two elements could have been the reason for no response to P_2O_5 on the Mountview soils.

The response curves for P_2O_5 added to each soil are shown in figure 3.

Potassium - Yield Relationship

The potassium determined by the soil test and potassium added to the soil as fertilizer were combined for computation. The K_2O added was converted to pounds of K per acre. These two forms were considered the available K for plants.

There was a positive response to potassium on all three soils. The greatest response was obtained on the Mountview soil.

A possible reason for the greater response on the Mountview soil may have been due to the low level of potassium in this soil. It should be noted that with increases in P_2O_5 and pH on this soil there was a decrease in yield. These decreases could have been caused by a potassium deficiency limiting the response. Then when higher levels of potassium were added a large response was obtained.

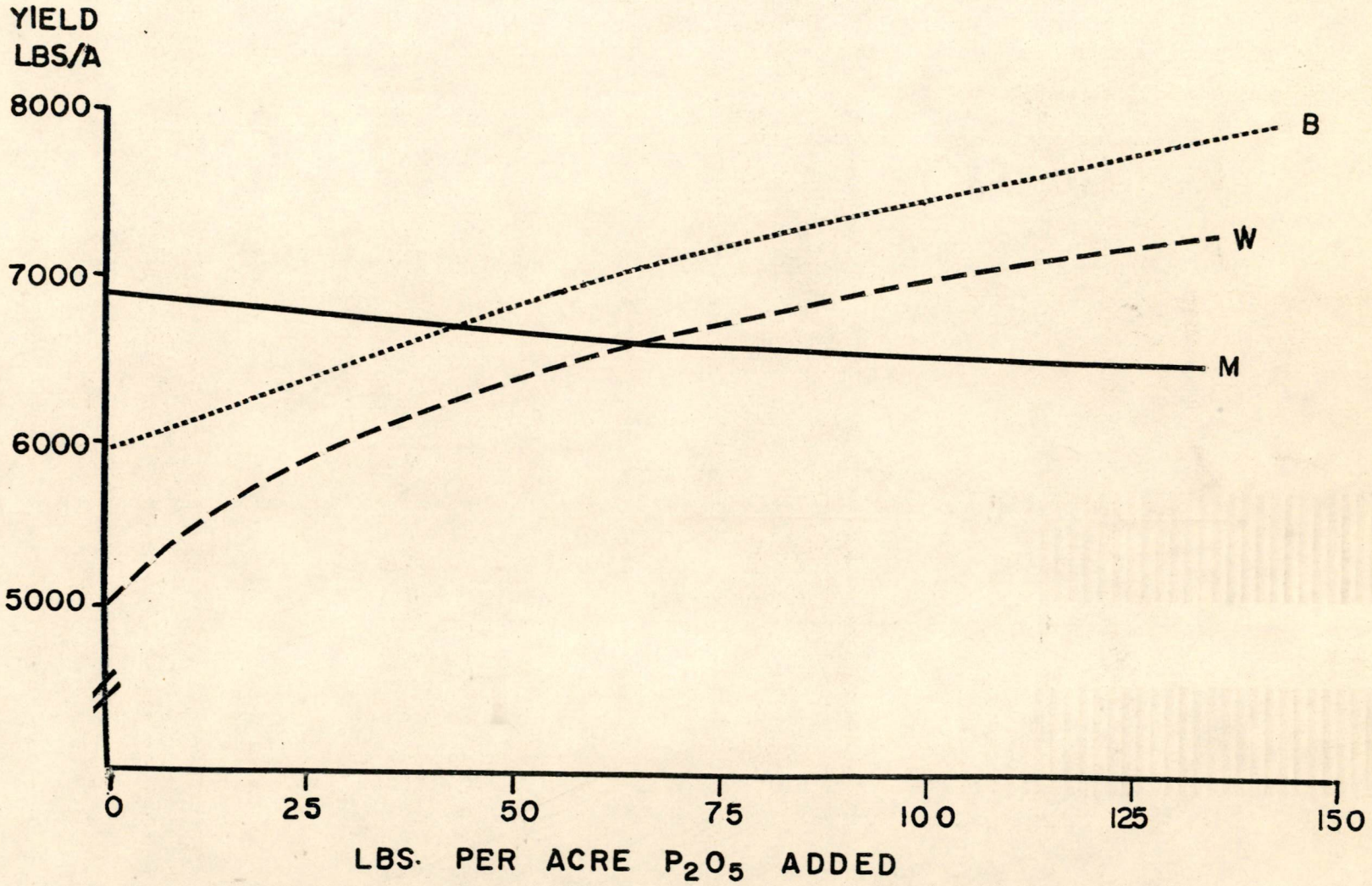


Figure 3.--Relationship of P_2O_5 added to yield of forage on Bewleyville (B), Mountview (M), and Waynesboro (W) soils.

A higher potassium supplying capacity of the Bewleyville and Waynesboro soils may have been partially responsible for a less response to potassium than was obtained on the Mountview soils.

Response curves for potassium yield relationship are shown in figure 4.

Soil pH - Yield Relationship

An increase in yield with increasing pH was found only on the Waynesboro soil. The Bewleyville and Mountview soils had decreasing yields with increases in pH. This may have been caused by low levels of potassium or other elements on the soils with higher pH values. The Mountview soils showed the greatest response to potassium. It also had the greatest yield decrease with an increased pH. This may have been due to the large supply of calcium creating a decrease in uptake of the already low level of potassium.

Response curves for pH-yield relationship are shown in figure 5.

Years Since Seeding - Yield Relationship

The alfalfa stands used in this correlation were either in their first or second year of production. On the three soils there was a positive increase in yield with the increased time since seeding. This was possibly due to a better developed root system which penetrated deeper into the soil mass and also had more lateral roots for soil contact.

The yields for the two years are shown graphically in figure 6.

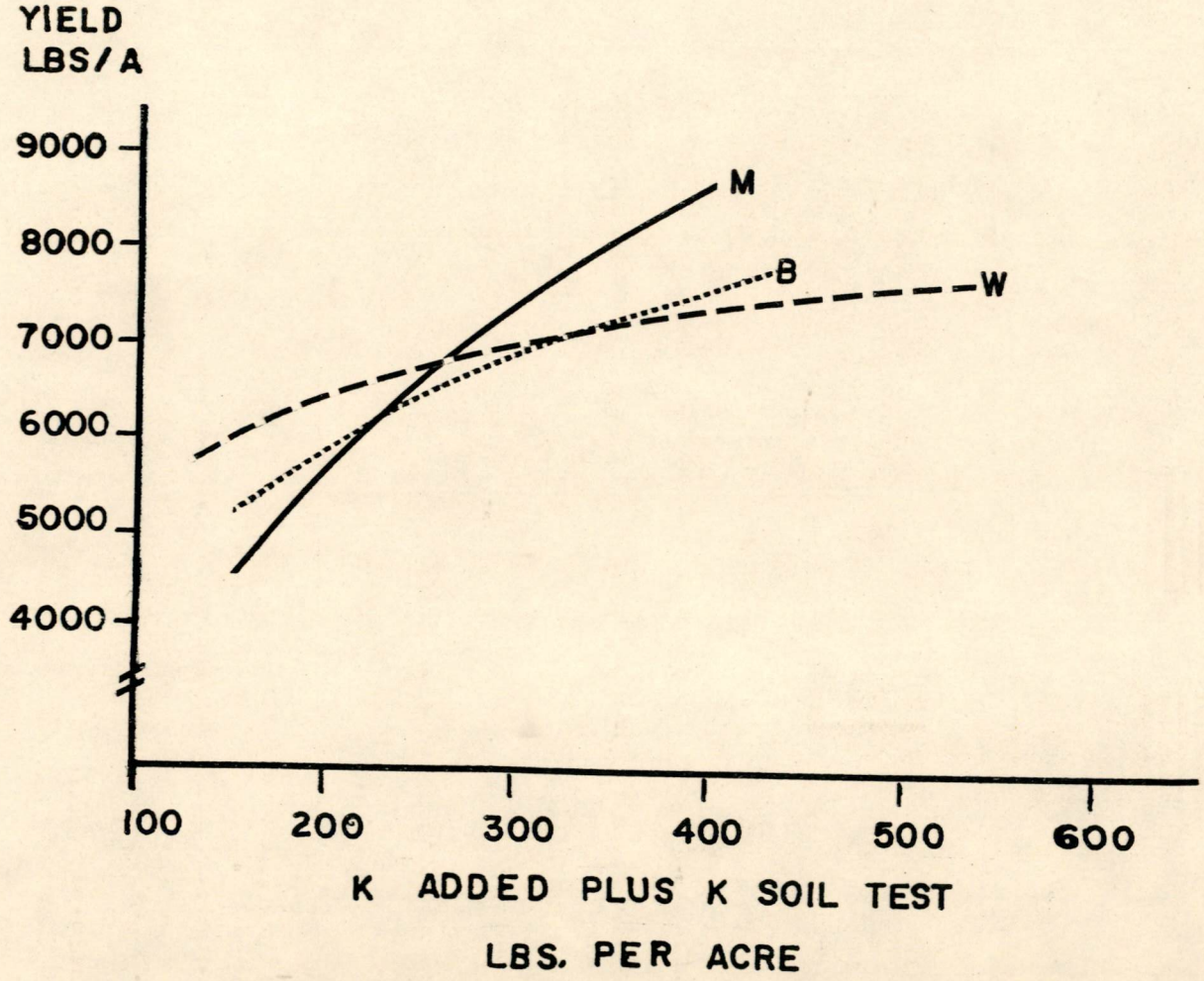


Figure 4.--Relationship of soil potassium plus potassium added to yield of forage on Bewleyville (B), Mountview (M), and Waynesboro (W) soils.

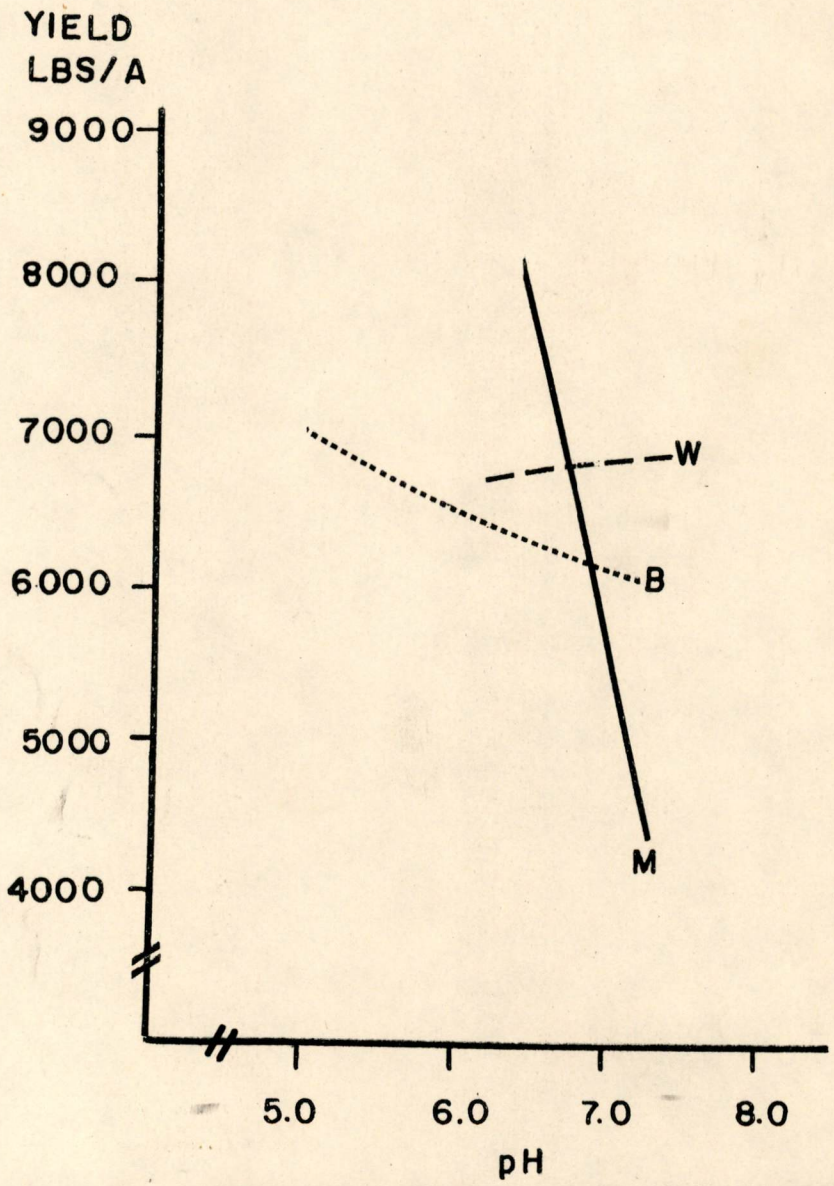


Figure 5.--Relationship of pH to yield of forage on Bewleyville (B), Mountview (M), and Waynesboro (W) soils.

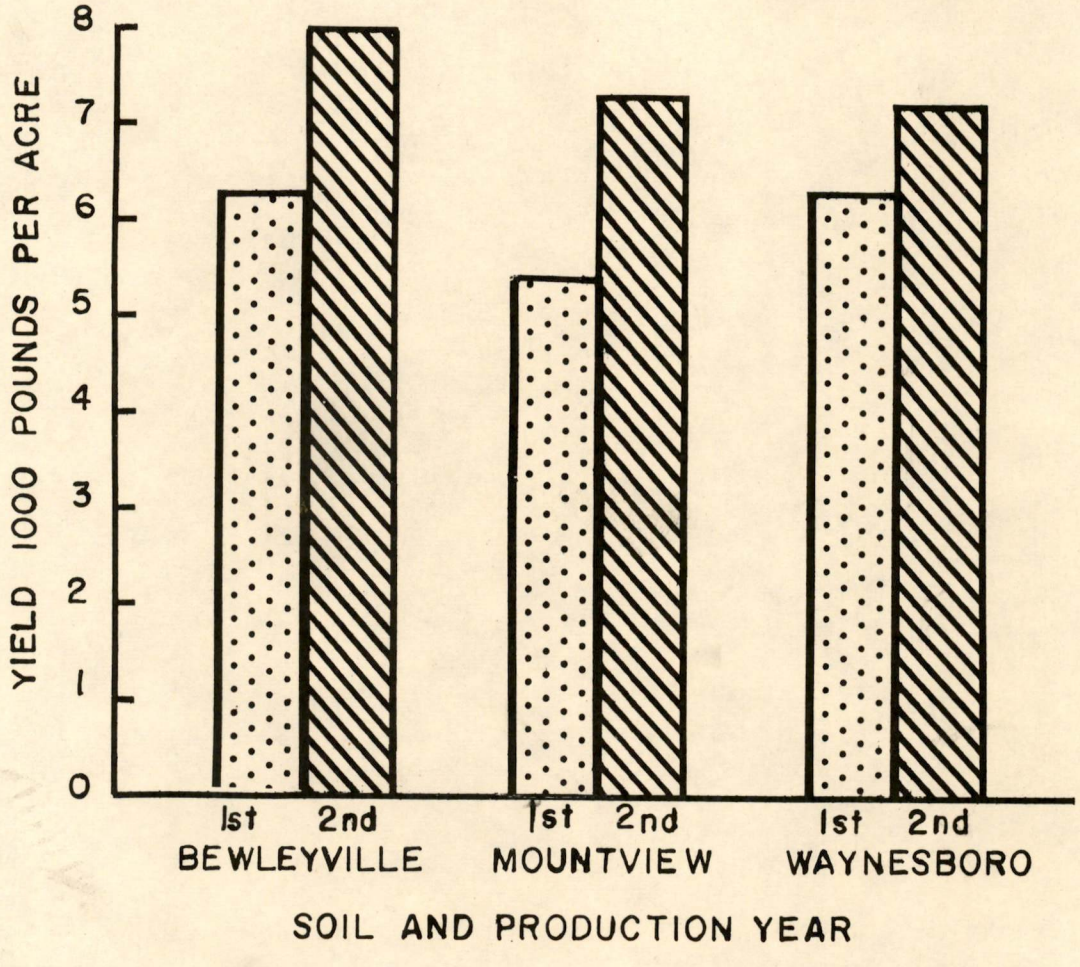


Figure 6.--Relationship of years since seeding to yield of forage on Bewleyville (B), Mountview (M), and Waynesboro (W) soils.

Calcium-Magnesium Ratio - Yield Relationship

The Bewleyville was the only soil tested that had a negative response to the calcium-magnesium ratio. On the Bewleyville soil for each unit increase in the calcium-magnesium ratio there was a decrease of 288 pounds of forage $\pm$ 89 pounds. The Waynesboro and Mountview soils, on the other hand, had an increase in yield with an increase in the calcium-magnesium ratio. This may have been due to an inter-relationship with potassium or to subsoil magnesium. According to Hoagland (9) an increase in absorption of potassium will in general tend to decrease the absorption of calcium and magnesium.

The calcium-magnesium ratio - yield relationship curves are presented in figure 7.

Correlations on Waynesboro Series

Of the seven variables measured on Waynesboro series, none had a large influence on the total yield. The calcium-magnesium ratio had the greatest influence on total yield. However, the influence was in the opposite direction from that which one would expect. The total yield increased as the calcium-magnesium ratio increased. Of the seven variables measured on this soil the coefficient of multiple determination (R^2) was only .302. This indicates that an unmeasured variable or variables had much more influence on yield than these seven measured variables. For the highest and lowest levels of inputs and yields with other measured variables held at the average on this soil see table 12.

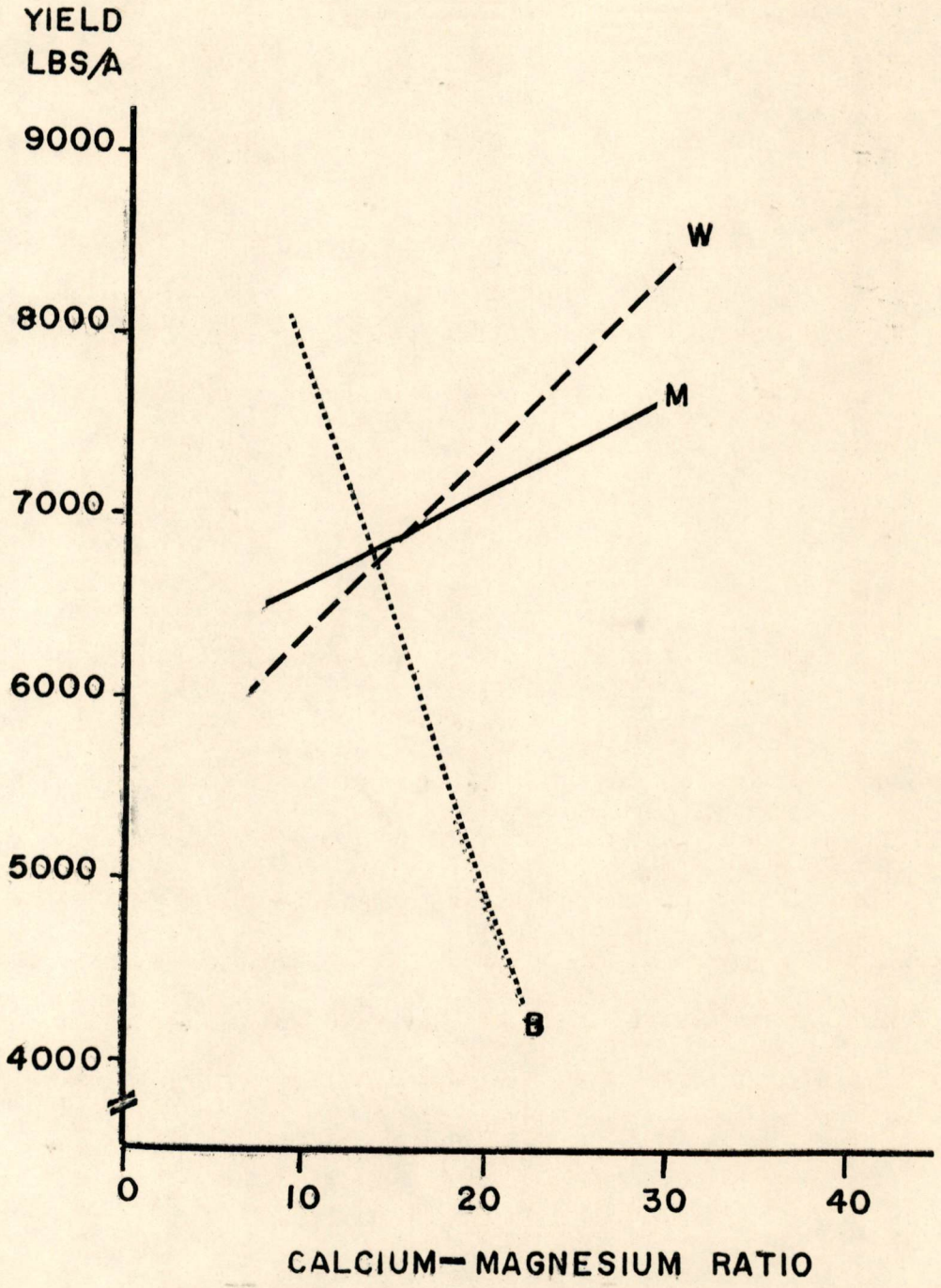


Figure 7.--Relationship of calcium-magnesium ratio to yield of forage per acre on Bewleyville (B), Mountview (M), and Waynesboro (W) soils.

Table 12.--Highest and lowest level of each variable measured on Waynesboro soils in 1959; influence of each variable at high and low levels upon yield in pounds per acre when other variables are held at an average.

Level of all variables	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Highest	1680	23	135	533	7.4	1	30.5:1
Lowest	60	2	0	126	6.1	0	6.5:1
Level of variable varying	OTHER VARIABLES HELD CONSTANT AT THE AVERAGE LEVEL YIELD OF FORAGE						
	Lbs./A	Lbs./A	Lbs./A	Lbs./A	Lbs./A	Lbs./A	Lbs./A
Highest	7800	7300	7300	7700	6900	7200	8400
Lowest	6500	6500	5000	5700	6700	6300	6000

X_2 Weeds and grasses (lbs./A)

X_3 Soils test phosphorus (lbs./A)

X_4 P_2O_5 added

X_5 Potassium added plus potassium soil test (expressed as lbs. K/A)

X_6 Soil test pH

X_7 Years since seeding

X_8 Ca/Mg ratio

Correlation on Mountview Series

Potassium, years since seeding, and pH had the greatest influence on yield of any of the variables measured on the Mountview soils. There was a negative response to pH on this soil. There was no significant response to soil phosphorus or to phosphorus added on this soil. The coefficient of multiple determination was also low on this soil. These seven variables measured accounted for only 43% of the total yield. This indicates a need for further study with more variables being measured. For the highest and lowest levels of inputs and yields with other measured variables held at the average on this soil, see table 13.

Correlation on Bewleyville Series

Responses to all variables measured were greater on this soil than on either of the other two soils. Coefficients of partial determination (r^2) were high on all variables checked with the exception of soil phosphorus which was only .007. The coefficient of multiple determination (R^2) was .943 on this soil. This means that variations in the seven variables measured accounted for 94% of the variation of total yield. For the highest and lowest levels of inputs and yields with other measured variables held at the average on this soil, see table 14.

Table 13.--Highest and lowest level of each variable measured on Mountview soils in 1959; influence each variable at high and low levels upon yield in pounds per acre when other variables are held at an average.

Level of all variables	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Highest	2060	33	134	402	7.3	1	34.1:1
Lowest	20	4	0	155	6.4	0	7.5:1
Level of variable varying	OTHER VARIABLES HELD CONSTANT AT THE AVERAGE LEVEL						
	Lbs./A	Lbs./A	Lbs./A	Lbs./A	Lbs./A	Lbs./A	Lbs./A
Highest	7300	6800	6500	8700	4400	7300	7600
Lowest	6600	6900	6900	4600	8400	5400	6500

X_2 Weeds and grasses (lbs./A)

X_3 Soils test phosphorus (lbs./A)

X_4 P_2O_5 added (lbs./A)

X_5 Potassium added plus potassium soil test (expressed as lbs. K/A)

X_6 Soils test pH

X_7 Years since seeding

X_8 Ca/Mg ratio

Table 14.--Highest and lowest level of each variable measured on Bewleyville soils in 1959; influence of each variable at high and low levels upon yield in pounds per acre when other variables are held at an average.

Level of all variables	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Highest	3260	145	35	430	7.2	1	22.0:1
Lowest	440	0	8	150	5.2	0	8.7:1
Level of variable varying	OTHER VARIABLES HELD CONSTANT AT THE AVERAGE LEVEL						
	Lbs./A	Lbs./A	Lbs./A	Lbs./A	Lbs./A	Lbs./A	Lbs./A
Highest	8000	8000	6300	7800	6100	8000	4300
Lowest	4800	5900	6700	5200	6900	6300	8100

X_2 Weeds and grasses (lbs./A)

X_3 P_2O_5 added (lbs./A)

X_4 Soil test phosphorus (lbs./A)

X_5 Potassium added plus potassium soil test (expressed as lbs. K/A)

X_6 Soil test pH

X_7 Years since seeding

X_8 Ca/Mg ratio

CHAPTER V

SUMMARY AND CONCLUSIONS

This study was designed to determine the yields of alfalfa under the levels of management on certain soils in Putnam County and to determine the potentials for increasing the yields by additional applications of commercial fertilizer.

Observed and measured inputs indicated that in most cases farmers were using a low level of management for alfalfa.

Variables measured were: (1) pounds of weeds and grasses, (2) soil phosphorus, (3) P_2O_5 added, (4) pH, (5) potassium added plus soil potassium, (6) years since seeding and, (7) calcium-magnesium ratio.

Weeds and grasses had an influence on yield on all the soils studied. The total yield was increased by weeds and grasses but the percent of alfalfa was reduced. Soil phosphorus had a positive influence on the Waynesboro soils only. This response was only slight and not significant. As the pH increased on the Bewleyville and Mountview series the total yield of forage decreased. This was probably due to a decrease in the uptake of potassium and/or minor elements. There was an increase in yield with increased potassium on all soils. The largest response to potassium was on the Mountview soils. Increases in yield were obtained on the Bewleyville and Waynesboro soils with an increase in the amount of P_2O_5 added. On all soils there was an increase in yield with the increased age of stand. On the Bewleyville soil the yield decreased as the calcium-magnesium ratio increased. The reverse of this was true on

the Mountview and Waynesboro soils.

Under the high fertilization rates used, the various soils were similar in productivity and gave yields ranging from 3 to 4 tons per acre. At the lower rates of fertilization, yields on Mountview, Bewleyville and Waynesboro were lower by 2,500, 1,600 and 1,400 pounds per acre, respectively.

Of the above mentioned variables the coefficients of multiple determination (R^2) of the soils are: (1) Waynesboro, .302; (2) Mountview, .432; and (3) Bewleyville, .943. This shows that variables do not have the same relative influence on all soils and demonstrates a need for each soil series to be studied separately. Different variables should be studied on different soil series rather than the same variables on all series. The cutting practices and weather conditions should be measured and given more consideration in future study.

Although this study included only a small portion of the factors of alfalfa production, it does give some indication of what yields may be expected on specific soils under the type of management given by farmers in Putnam County, the response associated with specified inputs, and the relative importance of the specified and unspecified variables.

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LITERATURE CITED

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APPENDICES

APPENDIX A

RECORD OF 1959 ALFALFA STUDIES IN PUTNAM COUNTY

OWNER:_____ OPERATOR:_____

ADDRESS:_____ ADDRESS:_____

PLANTING DATE:_____ VARIETY:_____

LAST CROP:_____ DATE OF REMOVAL:_____

SEEDBED PREP:_____

_____

_____

FERTILIZER APPLIED AT SEEDING: POUNDS/A_____ ANALYSIS:_____

LIME APPLIED: TONS/A_____ DATES APPLIED:_____

TOP-DRESSING 1958: POUNDS/A_____ ANALYSIS:_____

TOP-DRESSING 1959: DATE APPLIED:_____

FARMERS FERTILIZATION (Check plot): ACRES:_____ POUNDS/A_____

ANALYSIS:_____

EXPERIMENTAL PLOT: ACRES:_____ POUNDS/A_____ ANALYSIS:_____

SOIL TEST: pH_____ AVAILABLE P_____ AVAILABLE K_____ %O.M._____

PERCENT FULL COVER:_____ DATE_____

NUMBER OF PLANTS PER SQUARE FOOT_____ DATE_____

INNOCULATION:_____ NODULATION:_____ DATE CHECKED:_____

YIELD DATA:

FIRST CUTTING: CUTTING DATE:_____

EXPERIMENTAL PLOT: No. Bales:_____ Avg.Wt./Bale:_____ Yield/A_____

CHECK PLOT: No. Bales:_____ Avg.Wt./Bale:_____ Yield/A_____

SECOND CUTTING: CUTTING DATE:_____

EXPERIMENTAL PLOT: No. Bales_____Avg.Wt./Bale____Yield/A_____

CHECK PLOT: No. Bales_____Avg.Wt./Bale____Yield/A_____

THIRD CUTTING: CUTTING DATE:_____

EXPERIMENTAL PLOT: No. Bales_____Avg.Wt./Bale____Yield/A_____

CHECK PLOT: No. Bales _____Avg.Wt./Bale____Yield/A_____

FOURTH CUTTING: CUTTING DATE:_____

EXPERIMENTAL PLOT: No. Bales_____Avg.Wt./Bale____Yield/A_____

CHECK PLOT: No. Bales_____Avg.Wt./Bale____Yield/A_____

REMARKS:_____

APPENDIX B

ALFALFA STAND EVALUATION

Owner_____ Operator_____

Address_____ Address_____

Percent full cover_____ Date_____

Plants per square foot_____ Date_____

Percent of cover that is alfalfa_____

Percent of cover that is Tame Grass and legumes other than alfalfa_____

Kinds of Tame Grasses_____ Kind of legumes_____

Percent weeds and/or weedy grasses_____

REMARKS:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

APPENDIX C

PRECIPITATION IN PUTNAM COUNTY FROM AUGUST 1957 THROUGH SEPTEMBER 1959

Day of Month	1957						1958												1959					
	Aug.	Sept.	Oct.	Nov.	Dec.		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1			.03	T	T			.29	.65	T	.03		T			.54	.62		.23		.39		.06		T	1.22
2			T						.05		.08	.15					.26		.45			.46	.12	.15	.04		.60
3			.10	.43					.07							.03	.23	.25	.93		T	.09					.76
4	.02		.64	.03	.10						.08					.01	.10	T	.05		.70		.17					
5			.81						.05		.20						.02	T	.01		.12							
6			.03						.11		.86	.42	T						.86		.02			.25				
7									.64		.07	.45							.07									
8				.33	.79	T		.04		.61						.26		.16										
9				.08	.21	T			.46		.04	.26	.26			.18			.41		.27			.03				.02
10					1.00				.11	.83	.46						.10				.04	.01	.83					.35
11					.05					.26	.43						.03				.23	.02	.11		T	.01		.15
12				.08		T				T						.73												
13		T		1.93				.16		.34						.28					.49	T	.06	.48	.30			
14		T		.84				.56		.25						.66			.03									
15		.95		.58		.37		.07			.31				T		.09	T										
16		.71		.02		.51		.23			.02						.54											
17				.45		.37		.14									.97											
18		.05		.02		2.16		.03		.85						.02												
19		.10	T			1.81		.02									.02		.37									
20			.06						T							.74			.12									
21			.03					.10		.05		.23				2.06		.8C		1.51								
22									T			.07	.02			T		.16	T	.05								
23		.27	.43	.12	.25								.03					.47		.07								
24				1.00					.87								.32	1.77										
25		.09		.06	.81				.71								.03	1.11										
26																	.15		.33	1.97	T							
27				.10													.11			.09	.39	.36	.55					
28																				.02			.69					
29		.66			.41	.02																	.11					
30		.16		.08		.06																	.02					
31				.02																			.34					

Total	1.48	7.94	3.40	8.11	5.46	3.05	2.63	4.41	6.94	2.79	3.70	4.27	4.79	5.71	.79	4.65	1.64	3.40	4.63	6.82	3.01	3.04	2.71	5.16	5.12	3.53

APPENDIX D

MAXIMUM AND MINIMUM TEMPERATURES IN PUTNAM COUNTY
AUGUST THROUGH DECEMBER, 1958.

	August		September		October		November		December	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	87	72	86	46	64	46	61	38	41	20
2	86	68	86	50	61	40	51	45	56	34
3	87	68	89	66	55	46	50	35	47	37
4	83	62	80	65	63	46	55	35	49	40
5	88	61	74	60	70	42	56	43	58	40
6	89	63	85	60	75	47	69	43	43	18
7	89	65	87	60	78	54	59	26	34	16
8	89	68	85	52	75	52	57	30	35	17
9	82	69	81	48	77	59	60	34	42	22
10	91	66	86	68	79	63	67	33	34	18
11	90	68	80	65	70	35	63	28	34	16
12	88	65	88	58	65	37	67	33	40	18
13	88	67	81	57	65	39	61	37	38	18
14	87	70	80	57	77	44	61	38	28	13
15	87	67	84	64	79	52	68	59	30	8
16	88	66	89	70	75	48	70	62	29	13
17	86	70	85	55	76	54	77	62	44	16
18	84	56	78	52	78	51	80	68	51	19
19	86	53	70	45	75	46	69	34	46	21
20	85	57	77	54	71	49	51	29	61	32
21	89	65	70	61	74	43	63	39	37	13
22	86	67	74	63	78	48	59	32	43	16
23	85	65	83	59	77	54	58	33	57	28
24	79	66	85	67	70	39	62	36	49	32
25	76	62	84	66	70	34	70	44	34	21
26	79	52	85	63	60	39	78	46	39	16
27	79	51	88	64	52	37	49	24	49	17
28	83	53	70	45	53	40	39	25	48	35
29	84	54	70	46	61	30	36	16	52	32
30	87	59	75	50	63	34	41	16	61	33
31	87	64			67	32			40	33

APPENDIX E

MAXIMUM AND MINIMUM TEMPERATURES IN PUTNAM COUNTY
JANUARY THROUGH MAY, 1959.

	January		February		March		April		May	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	51	34	45	30	64	33	76	52	81	56
2	47	27	40	21	46	22	77	43	85	58
3	49	22	40	21	54	25	60	45	87	62
4	54	15	49	34	50	29	66	32	86	53
5	17	-2	36	29	61	31	63	49	86	57
6	18	-2	49	20	57	34	64	50	90	65
7	45	9	45	21	47	25	74	52	88	58
8	45	39	57	31	47	21	83	52	85	51
9	40	16	55	31	58	24	81	61	80	52
10	38	13	67	54	54	28	66	47	84	60
11	33	13	70	27	58	38	57	46	88	65
12	45	18	45	21	54	30	50	40	83	67
13	52	36	56	44	43	28	48	34	82	62
14	62	45	58	49	61	31	46	39	78	48
15	66	50	68	36	65	50	51	32	59	36
16	53	8	40	22	55	24	67	40	63	36
17	15	8	50	24	53	26	71	44	67	40
18	22	10	66	39	46	21	79	57	74	51
19	40	17	40	16	55	25	65	51	85	63
20	53	40	30	16	65	40	69	56	85	65
21	62	53	33	10	62	48	80	49	78	66
22	70	15	45	15	56	26	52	37	83	62
23	25	14	46	30	51	24	59	33	81	58
24	38	15	65	28	69	31	66	36	79	63
25	53	31	50	30	73	50	78	52	82	61
26	60	31	57	28	78	57	79	53	79	64
27	63	38	61	31	62	47	76	61	80	64
28	40	34	65	41	51	29	72	63	77	61
29	41	30			59	32	77	43	84	62
30	67	37			45	41	75	55	84	65
31	53	35			66	43			72	65

APPENDIX F

PROFILE DESCRIPTION OF BEWLEYVILLE SILT LOAM

Horizon description	Depth inches	Color		Consistence (moist)	Structure	Texture
		Name	Munsell notation			
A_1	0-1/2	Dark grayish brown	10 YR 4/2	friable	weak, fine granular	silt loam
A_2	0-5	Yellowish brown	10YR 5/4	friable	weak, medium granular	silt loam
B_1	5-9	Strong brown	7.5 YR 5/6	friable	moderate medium subangular blocky	silt loam
B_2	9-22	Yellowish red	5 YR 4/8	friable	moderate medium subangular blocky	silty clay loam
B_{3b} *	22-36	Yellowish red to red	5 YR 4/8-7.5 YR 4/8 variegated with 10 YR 6/6 (brownish yellow) and 10 YR 5/3 (brown)	slightly firm	moderate medium angular blocky	silty clay

* B_{3b} is shallower than model.

Sample taken 3/4 mile east of Cane Creek, 1.2 mile east of Boiling Springs Community.

APPENDIX G

PROFILE DESCRIPTION OF CUMBERLAND SILT LOAM

Horizon description	Depth inches	Na me	Munsell notation	Consistence (moist)	Structure	Texture
A_p	0-6	Dark brown	7.5 YR 3/2	friable	weak, fine granular	silt loam
B_1	6-8	Yellowish red	5 YR 4/6	friable	weak, medium subangular blocky	silty clay loam
B_{21}	8-14	Yellowish red	5 YR 4/6	friable	moderate medium subangular blocky	fine silty clay loam
B_{22}	14-40	Dark red	2.5 YR 3/6	friable to slightly firm	moderate medium angular blocky	silty clay
C	40 +	Dark red	2.5 YR 3/6 variegated with brownish yellow (10 YR 6/6) and brown (10 YR 5/3)	firm	moderate medium angular blocky	silty clay or clay

Sample taken from gently sloping sorghum field on a Scott farm 1 mile southeast of Ditty Community.

APPENDIX H

FERTILIZATION PRACTICES CARRIED OUT ON 1957 SEEDED ALFALFA STANDS USED AS FERTILIZATION PLOTS IN 1959.

Stand number	Initial fertilization Lbs. plant food per acre				Topdressing 1958 Lbs. plant food per acre				Farmers topdressing 1959 Lbs. plant food per acre			Topdressing experimental plots 1959 Lbs. plant food per acre		
	N	P_2O_5	K_2O	B	N	P_2O_5	K_2O	B	P_2O_5	K_2O	B	P_2O_5	K_2O	B
2	24	48	48	20	0	50	50	15	25	50	12	85	170	42
36	24	48	48	20	0	0	0	0	25	50	12	50	100	25
6	60	120	120	50	0	63	189	35	58	116	29	125	250	62
9	24	48	48	20	0	0	90	0	50	100	25	105	210	52
10	0	54	162	30	0	45	135	25	54	108	27	104	208	52
11	24	48	48	20	0	0	0	0	50	100	25	88	176	44
13	90	180	180	75	0	0	0	0	100	200	50	200	400	100
14	24	48	48	20	0	36	108	20	62	125	31	134	268	67
15	27	54	54	20	0	0	0	0	50	50	20	100	150	40
16a	0	22	67	12	0	27	81	15	57	114	28	107	214	53
16b	0	22	67	12	0	27	81	15	50	100	25	100	200	50
20	24	48	48	20	0	18	54	10	50	100	25	112	225	56
21	24	48	48	20	0	36	108	20	50	100	25	100	200	50
26	30	60	60	25	9	27	54	0	50	100	25	91	183	45
27	30	60	60	25	0	0	0	0	36	72	18	72	144	36
28	12	48	48	20	0	0	0	0	50	100	25	121	242	60
29	18	36	36	15	18	36	36	15	50	100	25	95	190	47
33	30	60	60	25	0	0	0	0	60	60	0	110	160	25
36	30	60	60	25	0	22	67	12	85	135	25	135	235	50
40	24	48	48	20	0	0	0	0	50	100	25	112	225	56

APPENDIX I

FERTILIZATION PRACTICES CARRIED OUT ON 1958 SEEDED ALFALFA STANDS USED IN THE 1959 FERTILIZATION TESTS.

Stand number	Initial fertilization Lbs. plant food per acre N	P_2O_5	K_2O	B	Farmer's topdressing 1959 Lbs. plant food per acre P_2O_5	K_2O	B	1959 Topdressing experimental plots Lbs. plant food per acre P_2O_5	K_2O	B
1	24	48	48	20	45	90	22	90	180	45
3a	24	48	48	20	25	50	12	50	100	20
4	24	48	48	20	100	100	25	145	190	47
5	24	48	48	20	35	70	17	90	180	45
7	36	72	72	30	25	50	12	75	150	38
8	24	48	48	20	25	50	12	75	150	38
12	24	48	48	0	25	50	12	60	120	30
17	27	54	54	22	40	80	20	80	160	40
18	24	48	48	20	30	60	15	101	202	50
19	24	48	48	20	54	109	27	104	209	52
22	0	36	108	20	0	0	0	52	105	26
23	24	48	48	20	0	0	0	100	200	50
24	15	60	60	25	0	0	0	62	125	31
25	18	36	36	15	25	50	12	80	160	40
30	18	36	36	15	30	60	15	80	160	40
31a	12	42	138	20	0	0	0	38	77	19
31b	18	36	156	15	0	0	0	38	77	19
32	30	60	60	20	50	100	25	112	225	56
34	24	48	48	20	25	50	12	80	161	40
35	24	48	48	20	20	40	10	70	140	35
38	24	48	48	0	50	100	25	100	200	50
39	24	48	48	20	45	91	22	91	182	45

APPENDIX J

FERTILIZATION PRACTICES CARRIED OUT BY FARMERS ON 1957 SEEDED ALFALFA STANDS THAT WERE NOT USED IN FERTILIZATION TESTS IN 1959 BUT STAND RECORDS WERE KEPT IN 1959.

Stand number	Initial fertilization Pounds plant food per acre				Topdressing 1958 Pounds plant food per acre				Topdressing 1959 Lbs. plant food per acre			
	N	P_2O_5	K_2O	B	N	P_2O_5	K_2O	B	N	P_2O_5	K_2O	B
50	24	48	48	20	0	0	0	0	0	0	0	0
51	24	48	48	20	0	0	0	0	0	0	0	0
52	24	48	48	20	0	22	67	0	0	50	50	0
53	21	42	42	0	0	0	0	0	0	0	0	0
54	0	18	54	10	0	0	0	0	0	0	0	0
55	24	48	48	20	0	36	108	0	0	40	80	20
56	12	48	48	20	0	0	0	0	0	50	100	25
57	24	48	48	20	0	0	0	0	0	0	0	0
58	30	60	60	25	0	0	0	0	0	0	0	0
59	24	48	48	20	0	0	0	0	0	20	60	0
60	30	60	60	25	0	0	0	0	0	0	0	0
61	15	0	90	20	0	18	54	0	0	27	81	15
62	24	48	48	20	0	0	0	0	0	0	0	0
63	12	72	72	30	0	0	0	0	0	0	0	0
64	0	18	54	0	18	36	36	0	0	0	0	0
65	24	48	48	20	0	31	94	0	0	40	80	20
66	24	48	48	20	0	31	94	0	0	40	80	20
67	24	48	48	20	0	27	81	0	0	24	75	17
68	24	48	48	20	0	0	0	0	0	50	100	25
69	24	48	48	20	0	0	0	0	0	0	0	0
70	24	48	48	20	0	0	0	0	0	50	100	25
71	24	48	48	20	0	0	0	0	0	50	100	25
72	0	27	81	15	0	31	94	0	0	0	0	0
73	24	48	48	20	0	18	54	0	0	0	0	0
74	30	60	60	0	0	0	0	0	0	0	0	0
75	30	60	60	25	0	0	0	0	0	50	100	25
76	33	132	132	55	0	45	135	0	0	45	135	25
77	0	60	0	0	0	0	0	0	0	0	0	0

APPENDIX K

COMPARISON OF STAND EVALUATIONS MADE IN SEPTEMBER 1958 AND SEPTEMBER 1959 INCLUDING SOIL TYPE AND ANNUAL TOPDRESSING

	Plants per square foot		Percent full cover and percent of cover that is alfalfa				Farmers Topdressing Lbs./Acre 1958				Farmers Topdressing Lbs./Acre 1959				
Number	1958	Sept. 1959	Percent cover 1958	Percent alfalfa 1958	Percent cover 1959	Percent alfalfa 1959	N	P	K	B	N	P	K	B	Soil mapping unit
2	25	12	95	90	90	95	0	50	50	15	0	25	50	12	Cumberland B-1
36		10			95	100	0	0	0	0	0	25	50	12	Waynesboro B-2
6	35	15	95	92	100	90	0	63	189	35	0	58	116	29	Mt. View B-1
9	12	5	90	75	90	55	0	0	90	0	0	50	100	25	Mt. View B-1
10	12	8	90	80	95	90	0	45	135	25	0	54	108	27	Mt. ViewB-1
11	15	10	60	50	90	85	0	0	0	0	0	50	100	25	Waynesboro C-2
13	20	5	100	90	65	70	0	0	0	0	0	100	200	50	Baxter C-2
14	16	5	75	60	65	70	0	36	108	20	0	62	125	31	Mt. View B-1
15	20	12	95	90	82	95	0	0	0	0	0	50	50	20	Cumberland C-2
16a	35	8	100	95	95	100	0	27	81	15	0	57	114	28	Waynesboro B-1
16b	18	7	90	90	90	95	0	27	81	15	0	50	100	25	Waynesboro B-2
20	20	15	90	85	100	95	0	18	54	10	0	50	100	25	Waynesboro C-3
21	15	12	85	75	95	85	0	36	108	20	0	50	100	25	Mt. View B-1
26	16	8	85	70	70	70	9	27	54	0	0	50	100	25	Bewleyville B-2
27	14	5	85	80	85	75	0	0	0	0	0	36	72	18	Mt. View B-2
28	20	3	90	85	90	55	0	0	0	0	0	50	100	25	Mt. View B-2
29	17	8	90	80	85	75	18	36	36	15	0	50	100	25	Waynesboro B-2
33	16	9	85	75	90	85	0	0	0	0	0	60	60	0	Bewleyville C-2
36	25	8	95	90	80	88	0	22	67	12	0	85	135	25	Waynesboro B-2
40	28	10	90	85	95	99	0	0	0	0	0	50	100	25	Waynesboro C-3
50	14	5	85	95	85	95	0	0	0	0	0	0	0	0	Baxter C-2
51	14	7	85	90	90	72	0	0	0	0	0	0	0	0	Waynesboro B-2
52	25	3	95	95	70	50	0	22	67	0	0	50	50	0	Emory A-1
53	15	9	65	90	85	95	0	0	0	0	0	0	0	0	Waynesboro B-2
54	18	4	85	70	85	47	0	0	0	0	0	0	0	0	Sequatchie
55	16	7	80	80	65	55	0	36	108	0	0	40	80	20	Hermitage C-1
56	12	1	90	85	80	1	0	0	0	0	0	50	100	25	Mt. View C-1
57	14	5	70	50	85	58	0	0	0	0	0	0	0	0	Mixed Collivum B-1
58	17	4	74	90	75	53	0	0	0	0	0	0	0	0	Waynesboro C-3
59	30	1	95	92	95	1	0	0	0	0	0	20	60	0	Huntington A-1
60	22	6	95	95	85	88	0	0	0	0	0	0	0	0	Cumberland B-1
61	14	6	85	85	85	82	0	18	54	0	0	27	81	15	Waynesboro B-1
62	22	7	85	80	90	90	0	0	0	0	0	0	0	0	Waynesboro C-2
63	18	8	90	60	85	88	0	0	0	0	0	0	0	0	Cumberland B-3
64	10	3	85	85	75	55	18	36	36	0	0	0	0	0	Waynesboro C-2
65	12	4	60	40	85	55	0	31	94	0	0	40	80	20	Mt. View B-1
66	16	4	70	40	80	55	0	31	94	0	0	40	80	20	Mt. View B-1
67	20	10	90	98	85	95	0	27	81	0	0	24	75	17	Cumberland C-3
68	14	9	90	85	85	95	0	0	0	0	0	50	100	25	Waynesboro C-2
69	17	8	80	65	90	80	0	0	0	0	0	0	0	0	Cumberland B-1
70	18	12	75	80	85	90	0	0	0	0	0	50	100	25	Waynesboro C-3

Number	Plants per square foot 1958	Plants per square foot Sept. 1959	Percent full cover and percent of cover that is alfalfa: Percent cover 1958	Percent alfalfa 1958	Percent cover 1959	Percent alfalfa 1959	Farmers Topdressing Lbs./Acre 1958: N	P	K	B	Farmers Topdressing Lbs./Acre 1959: N	P	K	B	Soil mapping unit
71	15	9	80	60	85	95	0	0	0	0	0	50	100	25	Mt. View B-1
72	14	1	60	65	80	30	0	31	94	0	0	0	0	0	Waynesboro C-3
73	14	3	80	75	90	30	0	18	54	0	0	0	0	0	Holston B-1
74	12	2	60	65	65	40	0	0	0	0	0	0	0	0	Cookeville C-3
75	18	9	85	50	85	97	0	0	0	0	0	50	100	25	Waynesboro B-1
76	35	8	100	95	80	95	0	45	135	0	0	45	135	25	Baxter C-2
77	16	4	80	70	95	55	0	0	0	0	0	0	0	0	Mt. View B-1

APPENDIX L

FERTILIZER APPLIED AND YIELDS OF FORAGE ON ALFALFA FIELDS STUDIED IN 1959 IN PUTNAM COUNTY

	Lower fertilization rate					Higher fertilization rate						
Plot number	Pounds fertilizer per acre	Analysis	Pounds forage per acre	Pounds weeds & grasses	Pounds alfalfa per acre	Pounds fertilizer per acre	Analysis	Pounds forage per acre	Pounds weeds & grasses	Pounds alfalfa per acre	Increase or decrease lbs. forage per acre	Soil mapping unit
1	450	0-10-20	2760	140	2620	900	0-10-20	4390	230	4160	+1630	Waynesboro B-2
2	250	0-10-20	5610	130	5480	850	0-10-20	7250	180	7070	+1640	Cumberland B-1
3a	250	0-10-20	10,020	1000	9020	500	0-10-20	10,300	1020	9280	+ 280	Hermitage B-1
3b	250	0-10-20	6130	60	6070	500	0-10-20	7220	80	7140	+1090	Waynesboro B-2
4	500	0-20-20	6540	850	5690	500	0-20-20	9350	1500	7850	+2810	Bewleyville B-2
						450	0-10-20					
5	350	0-10-20	7610	440	7170	900	0-10-20	8700	490	8210	+1090	Waynesboro B-2
6	580	0-10-20	6310	340	5970	1250	0-10-20	8550	490	8060	+2240	Mountview B-1
7	250	0-10-20	3510	1070	2440	750	0-10-20	11,160	3260	7900	+7650	Bewleyville B-3
8	250	0-10-20	6510	1650	4860	750	0-10-20	6290	1130	5160	- 220	Bewleyville C-2
9	500	0-10-20	4340	670	3670	1050	0-10-20	5950	1040	4910	+1610	Mountview B-1
10	535	0-10-20	9300	840	8460	1035	0-10-20	10,120	920	9200	+ 820	Mountview B-1
11	500	0-10-20	5760	760	5000	885	0-10-20	4400	600	3800	-1360	Waynesboro C-2
12	250	0-10-20	6300	570	5730	600	0-10-20	7690	740	6950	+1390	Bewleyville B-2
13	1000	0-10-20	8620	2840	5780	2000	0-10-20	10,740	3480	7260	+2120	Baxter C-2
14	625	0-10-20	2500	1020	1480	1335	0-10-20	5370	2060	3310	+2870	Mountview B-1
15	250	0-20-20	6960	490	6470	500	0-10-20	10,880	720	10,160	+3920	Cumberland C-2
						250	0-20-20					
16a	570	0-10-20	8760	130	8630	1070	0-10-20	7530	170	7360	-1230	Waynesboro B-1
16b	500	0-10-20	7400	250	7150	1000	0-10-20	9210	310	8900	+1810	Waynesboro B-2
17	400	0-10-20	5210	910	4300	800	0-10-20	9860	1680	8180	+4650	Waynesboro C-2
18	300	0-10-20	6680	320	6360	1015	0-10-20	7600	400	7200	+ 920	Hermitage C-2
19	545	0-10-20	3960	550	3410	1045	0-10-20	5210	760	4450	+1250	
20	500	0-10-20	8870	540	8330	1125	0-10-20	8610	440	8170	- 260	Waynesboro C-3
21	500	0-10-20	5520	1280	8110	1000	0-10-20	8910	1180	7730	+3390	Mountview B-1
22	0		8380	350	8030	525	0-10-20	8300	340	7960	- 80	Mountview B-2
23	0		6940	920	6020	1000	0-10-20	10,910	880	10,030	+3970	Waynesboro B-2
24	0		9260	550	8710	625	0-10-20	10,360	600	9760	+1100	Hermitage C-2
25	250	0-10-20	4220	220	4000	800	0-10-20	6360	330	6030	+2140	Waynesboro B-2
26	500	0-10-20	3630	650	2980	915	0-10-20	6180	1150	5030	+2550	
27	360	0-10-20	7540	1460	6080	720	0-10-20	8840	960	7880	+1300	
28	500	0-10-20	4510	20	4490	1215	0-10-20	12,350	540	11,810	+7840	Mountview B-2
29	500	0-10-20	5570	430	5140	950	0-10-20	7710	580	7130	+2140	Waynesboro B-2
30	300	0-10-20	3290	340	2950	800	0-10-20	4950	450	4500	+1660	Waynesboro B-2

APPENDIX L (continued)

Plot number	Pounds fertilizer per acre	Analysis	Pounds forage per acre	Pounds weeds & grasses	Pounds alfalfa per acre	Pounds fertilizer per acre	Analysis	Pounds forage per acre	Pounds weeds & grasses	Pounds alfalfa per acre	Increase or decrease lbs. forage per acre	Soil mapping unit
31a	0		5850	740	5110	385	0-10-20	5520	680	4840	- 330	Bewleyville C-2
31b	0		6010	830	5180	385	0-10-20	4970	440	4530	-1040	Bewleyville B-2
32	500	0-10-20	5380	700	4680	1125	0-10-20	9160	690	8470	+3780	Baxter C-2
33	300	0-20-20	5300	460	4840	300	0-20-20	6300	500	5800	+1000	Bewleyville C-2
34	250	0-10-20	2000	230	1770	8000	0-10-20	5610	610	5000	+3610	Hermitage C-2
35	200	0-10-20	3360	150	3210	700	0-10-20	4070	210	3860	+ 710	
36	500	0-10-20	6340	550	5790	1000	0-10-20	6500	540	5960	+ 160	Waynesboro B-2
38	500	0-10-20	3540	400	3140	1000	0-10-20	5040	610	4430	+1500	Waynesboro C-3
39	455	0-10-20	6170	1030	5140	910	0-10-20	6350	1060	5290	+ 180	Waynesboro B-2
40	400	0-10-20	8010	110	7900	1125	0-10-20	11,040	150	10,890	+3030	Waynesboro C-3

APPENDIX M

EXCHANGEABLE Ca AND Mg AND Ca/Mg RATIOS FROM TOPDRESSED ALFALFA FIELDS IN PUTNAM COUNTY, TENNESSEE, 1959.*

Sample No.	Ca P.P.M.	Ca M.E.	Mg P.P.M.	Mg M.E.	Ca/Mg Ratio
		Waynesboro Soil			
1	1120	5.6	105	.861	6.5
2	1500	7.5	70	.574	13.1
3	1120	5.6	50	.410	13.7
4	1320	6.6	95	.779	8.5
5	1520	7.6	70	.574	13.2
6	960	4.8	35	.287	16.7
7	880	4.4	50	.410	10.7
8	1200	6.0	50	.410	14.6
9	2610	13.05	55	.457	28.9
10	3000	15.0	60	.492	30.5
11	780	3.9	35	.287	13.6
12	780	3.9	40	.328	11.9
13	1240	6.2	60	.492	12.6
14	620	3.1	35	.287	10.8
15	1360	6.8	45	.369	18.4
16	740	3.7	50	.410	9.0
17	1240	6.2	75	.615	10.1
18	1920	9.6	55	.451	21.3
		Bewleyville Soil			
19	100	3.5	35	.287	12.2
20	1440	7.2	40	.328	22.0
21	620	3.1	30	.246	12.6
22	640	3.2	45	.369	8.7
23	1040	5.2	55	.451	11.5
24	1500	7.5	45	.369	20.3
25	640	3.2	35	.287	11.1
		Mountview Soil			
26	580	2.9	35	.287	10.1
27	2520	12.6	45	.369	34.1
28	800	4.0	35	.287	13.9
29	940	4.7	25	.205	22.9
30	900	4.5	40	.328	13.7
31	920	4.6	30	.246	18.7
32	680	3.4	50	.410	8.3
33	680	3.4	55	.451	7.5

* m.e. of Ca was obtained by multiplying P.P.M. of Ca by .005. m.e. of Mg was obtained by multiplying P.P.M. by .0082. Ca/Mg ratio was determined by dividing m.e. of exchangeable Mg into m.e. of exchangeable Ca.

APPENDIX N

TIME OF SEEDING AND RATES AND TIME OF LIME APPLICATION ON SELECTED 1957 AND 1958 SEEDED ALFALFA STANDS IN PUTNAM COUNTY, TENNESSEE.

Stand number	Seeding Date		Lime applied	Date of lime application	
	Month	Year	Tons per acre	Month	Year
1	Sept.	1958	2	Aug.	1958
2	Sept.	1957	3	Aug.	1957
3a	Sept.	1958	2	June	1958
3b	Sept.	1957	2.5	March	1957
4	Sept.	1958	3.5	Sept.	1958
5	Sept.	1958	3	Aug.	1958
6	Aug.	1957	3	Aug.	1956
7	Sept.	1958	3	Aug.	1958
8	Sept.	1958	2	Sept.	1958
9	Aug.	1957	3	July	1957
10	Sept.	1957	2.5	July	1956
11	Sept.	1957	2.5		1954
12	Sept.	1958	2		1955
13	Aug.	1957	3	May	1957
14	Aug.	1957	3	Aug.	1957
15	Sept.	1957	3.5	June	1957
16a	Aug.	1957	2	June	1957
16b	Aug.	1957	2	June	1957
17	Sept.	1958	2	July	1958
18	Sept.	1958	2	Sept.	1958
19	Sept.	1958	3	July	1958
20	Sept.	1957	3	July	1957
21	Oct.	1957	2.5	Oct.	1957
22	Aug.	1958	2	May	1958
23	Aug.	1958	3	July	1958
24	Sept.	1958	4	Aug.	1958
25	Aug.	1958	3	Aug.	1957
26	Oct.	1957	2.5	Oct.	1957
27	Aug.	1957	0		
28	Aug.	1957	3	Aug.	1957
29	Oct.	1957	3	Sept.	1959
30	Aug.	1958	2	Aug.	1955
31a	Sept.	1958	2	June	1958
31b	Sept.	1958	2	June	1958
32	Apr.	1958	5	Feb.	1958
33	Sept.	1957	3	Sept.	1957
34	Aug.	1958	4	Sept.	1955
35	Aug.	1958	2	Aug.	1958
36	Sept.	1957	4	May	1957

APPENDIX N (continued)

Stand number	Seeding Date Month	Year	Tons per acre	Date of lime application Month	Year
37	Oct.	1958	3	Sept.	1958
38	Aug.	1958	2.5		1957
39	Aug.	1958	2.1	Apr.	1958
40	Oct.	1957	3	Aug.	1957
50	Aug.	1957	0		
51	Aug.	1957	0		
52	Sept.	1957	3	Aug.	1957
53	Sept.	1957	2		1955
54	Sept.	1957	3		1956
55	Oct.	1957	3	May	1957
56	Aug.	1957	3	July	1957
57	Aug.	1957	2	Aug.	1957
58	Oct.	1957	2	Sept.	1957
59	Aug.	1957	2	Aug.	1957
60	Sept.	1957	3	Sept.	1957
61	Aug.	1957	6	Aug.	1957
62	Sept.	1957	2.5		1954
63	Aug.	1957	3.5	June	1957
64	Aug.	1957	2.5	Aug.	1957
65	Aug.	1957	3	Aug.	1959
66	Aug.	1957	3	Aug.	1957
67	Oct.	1957	3	Oct.	1957
68	Aug.	1957	3	Aug.	1957
69	Oct.	1957	3	Nov.	1956
70	Sept.	1957	3	July	1957
71	Oct.	1957	3	Sept.	1957
72	Sept.	1957	2	Sept.	1957
73	Sept.	1957	2	Sept.	1957
74	Aug.	1957	0		
75	Sept.	1957	4	Apr.	1957
76	Sept.	1957	4		1956
77	Sept.	1957	2		1956