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PRODUCTION OF HAIRY VETCH AND ITS UTILIZATION FOR COTTON PRODUCTION

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The use of winter legumes for soil improvement has greatly increased in Mississippi during comparatively recent years.

Of the several kinds of winter legumes adapted to Mississippi conditions, vetch is by far the most popular. Of the total acreage seeded in 1945, more than half was seeded to vetch.

Although sometimes utilized for hay, or seed, or grazing, winter legumes are mainly grown in Mississippi for soil improvement; and for this purpose are turned or plowed under in early spring and in time for planting the succeeding crop, usually cotton or corn.

No information is available as to the number of acres of cotton and corn, respectively, which follow vetch plowed under. Personal observation and esimates gathered at random from unofficial sources seem to indicate that approximately three-fourths of the vetch plowed under in Mississippi is followed by cotton, and approximately one-fourth by corn.

Problems in Vetch Production and Utilization

Many years ago when farmers in large numbers first began to plant winter legumes for soil improvement, the problems of production and utilization appeared to be quite simple of solution. From early writings it appeared that all one had to do to secure bumper yields was to sow winter legumes in the fall and turn them in the spring. Disappointments were quite common during the early days of vetch history, due perhaps most largely to lack of knowledge of plant food nutrients required for the optimum production of vetch, as well as the closely related plant food requirements for the optimum production of cotton following vetch.

The Mississippi Agricultural Experiment Station has done much work with vetch, especially during the past 12 years. Publications reporting this work have shown that in the hill sections of Mississippi, annual applications of phosphate are required for best vetch production. In common with other legumes, vetch has the capacity under favored growing conditions, to draw its requirements in nitrogen from the air. Cotton requires a complete fertilizer including nitrogen, phosphate, and potash; and cotton following vetch turned under utilizes the vetch plant residue, including nitrogen, so that most or all of the nitrogen is thus secured, leaving only potash and phosphate required for optimum cotton production.

Experiments have shown that an excellent crop of vetch plowed under supplies nitrogen available to the succeeding plant equivalent to about 32 pounds of actual nitrogen from commercial materials (200 pounds nitrate of soda, 100 pounds ammonium nitrate, or other equivalent material in nitrogen content). In addition to nitrogen (which vetch draws from the air and which the succeeding crop of cotton draws from the decomposed vetch material) both cotton and vetch require phosphate, potash, and probably lime.

That the relationship of vetch production and utlilization is a complex one is apparent when two important factors are kept in mind: (1) Used for soil improvement, vetch is valued exactly to the extent that yields of the following crops are increased; and (2) the needs and requirements for optimum production of both vetch and cotton must be consider-

ed, and that in relation to the soil and its cropping history.

Numerous farmers who produce vetch for soil improvement have been confronted with numerous problems incident to the two crops.

For example, since phosphate and potash are required by both vetch and cotton in the hill sections of Mississippi, many farmers are asking questions such as these:

May the needed amounts of phosphate and potash be applied either to vetch or cotton with equal results and with equal benefits in increased cotton yields?

Should the fertilizer application be made to the vetch or to the cotton, or should the required amounts be used in split applications, one-half applied to vetch and one-half to cotton?

Another question in which farmers are interested: Since relatively large yields of vetch are often produced, and since hay is produced in insufficient quantities on most Mississippi farms, would it be a profitable practice to use the vetch as hay and to apply required amounts of commercial nitrogen to the following crop of cotton?

In a vetch-cotton rotation, how necessary is potash, and what quantities should be used for maximum profit?

What is the place of lime in the vetch-cotton production program?

Fertilizer Experiments Conducted

To more nearly determine the effect of crop removal on the plant food supply of soils, to study the relationship existing between vetch production and cotton production, and to secure answers to many of the problems confronting farmers who utilize vetch for soil improvement, the Mississippi Experiment Station, in cooperation with the Tennessee Valley Authority, is conducting experiments at two locations in Mississippi.

On the farm of W. M. and R. C. Stinson, Lowndes County, Columbus, Mississippi, crop responses on Savannah fine sandy loam, a yellowish, sandy clay soil, have been studied.

The topography of the plot land is level to gently rolling, and the soil is fairly productive when properly fertilized.

In the main, this soil is usually low in its native supply of phosphorus and potash, and before maximum cotton production can be obtained, liberal amounts of these plant food nutrients must be supplied. This is especially true if winter legumes are used to furnish the nitrogen for the following crop of cotton.

At the Holly Springs Branch Station, Holly Springs, Mississippi, crop response on Grenada silt loam soil has been studied. The soil is largely silt and is fairly well drained. The topography is almost level and the soil is fairly productive even without fertilizer. Many crops, however, respond to fertilizers when applied and good yields are obtained in most cases.

Experiments on Savannah Fine Sandy Loam Soils

In the experiment conducted on the Stinson farm near Columbus, Mississippi, the following problems were studied:

1. The effect on the production of vetch of 500 pounds 0-8-4 fertilizer per acre, applied to vetch rather than to the succeeding cotton, whether the vetch is cut for hay or turned under.

2. The effect on the production of vetch of 500 pounds of 0-8-4 fertilizer per acre applied to cotton, rather than to the vetch, whether the vetch is cut for hay or turned under.

3. The effect of fertilized vetch (removed for hay) on the production of the following crop of unfertilized cotton.

4. The effect of fertilized vetch

Table 1. The effect of fertilized and unfertilized vetch, removed for hay and turned under, on the production of the following crops of fertilized and unfertilized cotton.
Soil type: Savannah fine sandy loam.

Years	500 lbs. 0-8-4 fertilizer per acre Lbs. of green vetch per acre when		No fertilizer applied to cotton Pounds of seed cotton per acre following vetch		No fertilizer applied to vetch Lbs. of green vetch per acre when		500 lbs. 0-8-4 fertilizer per acre Lbs. of seed cotton per acre following vetch	
	Cut for hay	Turned under	Cut for hay	Turned under	Cut for hay	Turned under	Cut for hay	Turned under
1940	1920	1920	276	272	1156	1064	354	332
1941	0000	0000	0000	0000	0000	0000	0000	0000
1942	7944	8348	1128	1290	3172	4880	1132	1328
1943	9600	10000	864	936	7680	9840	1048	1080
1944	5248	6016	944	1448	4128	4992	1306	1564
1945	3680	5024	1040	1771	3296	3120	1394	1856
1946	5312	7424	——	——	4992	5696	——	——
Average	4815	5533	709	953	3489	4227	872	1027
Average increase	——	718	——	244	——	738	——	155

(turned under) on the production of the following crop of unfertilized cotton.

5. The effect of fertilized cotton following unfertilized vetch (removed for hay) on the production of cotton.

6. The effect of fertilized cotton following unfertilized vetch (turned under) on the production of cotton.

7. The effect of 100 pounds of nitrate of soda per acre applied to cotton following fertilized vetch (removed for hay) on the production of cotton and vetch.

8. The effect of 500 pounds of 3-8-4 fertilizer per acre applied to cotton following unfertilized vetch (removed for hay) on the production of cotton and vetch.

9. The effect of 500 pounds of dolomitic limestone per acre applied to fertilized vetch (turned under) on the production of cotton and vetch.

10. The effect of 500 pounds 0-8-0 (basic slag) fertilizer per acre applied to vetch (turned under) on the production of vetch and the following crop of cotton.

11. The effect of 250 pounds 0-8-0 (basic slag) fertilizer per acre applied to vetch (turned under) and 250 pounds 0-8-0 (basic slag) fertilizer applied to unfertilized cotton, on the production of vetch and the following crop of cotton.

12. The effect of 500 pounds 6-8-4 fertilizer (no vetch) on the production of cotton.

13. The effect of no fertilizer and no vetch treatment on the production of cotton.

14. The effect of an additional 100 pounds of 50 percent muriate of potash per acre applied to cotton on the production of vetch and cotton, following the above treatments.

Fertilizer Applied to Vetch or Cotton

Since under the conditions of this test and according to numerous other experiments, both cotton and vetch require liberal amounts of phosphorus and perhaps of potash for optimum production, especially when the vetch is removed for hay, two questions naturally arise:

1. Should required amounts of fertilizer be applied to vetch or to cotton; and

2. What effect does removing a crop of vetch for hay have on the succeeding crop of cotton?

The results (table 1) indicate a slight

advantage in the direct application of the fertilizer to cotton rather than to vetch, and that cotton yields following vetch removed for hay were reduced considerably.

In the comparison in which vetch was removed for hay, where the fertilizer was applied to vetch and none to cotton, the succeeding crop of cotton yielded 709 pounds of seed cotton per acre; where the vetch was unfertilized and the succeeding crop of cotton was fertilized, the yield of seed cotton was 872 pounds.

In the comparison in which the vetch was turned under, cotton following the fertilized vetch crop yielded 953 pounds, whereas fertilized cotton following unfertilized vetch yielded 1072 pounds.

Vetch Cut for Hay or Turned

In this test the same comparisons are shown for vetch as for cotton, and similar results were obtained. The results (table 1) indicate slightly higher yields of vetch when the fertilizer was applied to vetch rather than to cotton, and that vetch yields following the removal of vetch for hay were less than yields of vetch after the preceding crops of vetch had been turned under.

In the comparison in which the vetch was removed for hay: where the vetch was fertilized and cotton unfertilized, the succeeding crop of vetch yielded 4,815 pounds of green vetch per acre; where the vetch was unfertilized and the succeeding crop of cotton was fertilized, the yield of green vetch was 3,489 pounds.

In the comparison in which the fertilized vetch was turned and followed by unfertilized cotton, the vetch yield was 5,533 pounds; whereas unfertilized vetch following fertilized cotton yielded 4,227 pounds.

It is clear from the foregoing that vetch produced for the purpose of increasing cotton production is more efficiently utilized when the entire crop is turned under than when the hay is removed and only the roots and stubble are turned under.

It will be noted that cotton following vetch removed for hay produced 244 pounds less seed cotton per acre than cotton following turned vetch. It appears that the removal of vetch for hay had less effect on the production of vetch than on cotton, since an increase of less than 1000 pounds were obtained following turned vetch.

The discussion above relates only the average yield and increase yields, since annual yields do not show definite trends due largely to weather conditions. For instance, during the year of 1941, the vetch and cotton crops on the Stinson farm resulted in a complete failure, weather conditions being such that vetch yields were negligible. The following crop of cotton was planted in early May, but there was not enough moisture to germinate the seed, and stands were not secured until after July 1. Cotton made good growth and put on a good crop of fruit, but was entirely destroyed by the boll weevil.

Commercial Nitrogen Applied to Cotton Following Fertilized and Unfertilized Vetch Removed for Hay

Vetch grown for the purpose of increasing cotton production is more efficiently utilized when the entire crop is turned than when the hay is removed and only the roots and stubble are turned. However, economic factors may enter into the picture on many farms, and the value of vetch-hay must not be overlooked. It will be noted (table 1) that cotton following fertilized vetch removed for hay produced approximately 250 pounds of seed cotton per acre less than when the vetch was turned, and fertilized cotton following unfertilized vetch removed for hay produced approximately 150 pounds seed cotton per acre less

Table 2. The effect of 100 pounds of nitrate of soda per acre applied to cotton following fertilized vetch removed for hay and turned under, and fertilized cotton following unfertilized vetch removed for hay and turned under, on the production of cotton.

Soil type: Savannah fine sandy loam.

Years	500 lbs. 0-8-4 fertilizer per acre applied to vetch when		100 lbs. soda to cotton following fertilized vetch	No nitrogen to cotton following fertilized vetch	Unfertilized vetch following fertilized cotton		500 lbs. 3-8-4 to cotton following unfertilized vetch	500 lbs. 0-8-4 to cotton following unfertilized vetch
	Yields of green vetch		Yields of seed cotton		Yields of green vetch		Yields of seed cotton	
	Cut for hay	Turned under	Cut for hay	Turned under	Cut for hay	Cut for hay	Cut for hay	Cut for hay
1940	1992	1920	328	276	980	1156	452	354
1941	0000	0000	0000	0000	0000	0000	0000	0000
1942	6588	7944	1120	1128	4820	3172	1272	1132
1943	9120	9600	856	864	6800	7680	1052	1048
1944	5824	5248	972	944	5056	4128	1376	1306
1945	3776	3680	1328	1040	3184	3296	1664	1394
1946	5792	5312	——	——	4800	4992	——	——
Average	4727	4815	767	709	3663	3489	969	872
Average increase	——	88	58	——	174	——	97	——

than when the vetch was turned. The question then arises: Can the vetch tops be removed as hay without loss in yield if the required amount of commercial nitrogen is applied to the cotton crop?

The use of 100 pounds of nitrate of soda per acre applied to cotton following fertilized and unfertilized vetch removed for hay increased cotton yields 58 pounds and 97 pounds of seed cotton per acre, respectively, over yields where the vetch was turned and no additional nitrogen was supplied.

Vetch yields were not affected by the commercial nitrogen applied to cotton. When the vetch was fertilized with 500 pounds of 0-8-4 fertilizer per acre, the yield of green vetch was approximately 5000 pounds, which is in the neighborhood of one ton of hay. Removal of approximately a ton of hay necessitates the application of 100 pounds of soda (or equivalent) per acre to maintain and slightly increase cotton yields.

Whether it is preferable to turn under the vetch crop, or to harvest it for hay and add nitrogen fertilizer, is a matter for the individual farmer to determine.

The Application of Lime in Addition to Phosphorus and Potash

In one of the comparisons made in the test, 500 pounds of lime was applied in addition to the 500 pounds 0-8-4 fertilizer applied under vetch. This treatment yielded 5,660 pounds of green vetch per acre, and was slightly more than when the same fertilizer was applied without lime.

The cotton which followed the fertilized and lime-treated vetch received no additional fertilizer and yielded 1,042 pounds of seed cotton. This is the highest yield of cotton in the vetch series, and was 89 pounds superior to the no-lime treatment. The data are shown in table 3.

The Value of Basic Slag for Vetch and Cotton

The application of 500 pounds per acre of 0-8-0 (basic slag) under vetch resulted in the production of 4,203 pounds of green vetch. The following crop of cotton, unfertilized, yielded 648 pounds of seed cotton.

Table 3. The effect of a 500 pound annual application of dolomitic limestone per acre applied to fertilized vetch (vetch turned under) on the production of cotton and vetch.
Soil type: Savannah fine sandy loam.

Years	500 pounds 0-8-4 per acre		Unfertilized cotton following vetch fertilized with 500 pounds 0-8-4 and 500 lbs. lime per acre	Unfertilized cotton following vetch fertilized with 500 pounds 0-8-4 per acre. No lime
	Yields in pounds of green vetch per acre		Yields in pounds of seed cotton per acre	
	500 lbs. lime	No lime		
	Vetch turned under	Vetch turned under	Vetch turned under	Vetch turned under
1940	2228	1920	316	272
1941	0000	0000	0000	0000
1942	8996	8348	1424	1290
1943	10080	10000	1192	936
1944	6624	6016	1440	1448
1945	4048	5024	1880	1771
1946	7648	7424	——	——
Average	5660	5533	1042	953
Average increase	127	——	89	——

The split application of basic slag (applied at the rate of 250 pounds 0-8-0 under vetch and 250 pounds under cotton) produced approximately the same amounts of vetch and cotton as did the single application of 500 pounds applied to vetch.

Yields under these basic slag treatments were the lowest in the test with the exception of the crop receiving no vetch and no fertilizer, and compare with 1,042 pounds of seed cotton per acre produced on the plots on which fertilizer and lime were applied to the vetch and no fertilizer was applied to the following crop of cotton.

Basic slag contains approximately 10 percent of P_2O_5 and approximately 50 percent lime. It contains no potash. That potash may be essential to optimum production on this soil is indicated by a test made in 1945 in which additional quantities of potash were used and which is discussed in a following section.

Complete Fertilizer Applied to Cotton

The highest 6-year average yield of seed cotton in the test was made when 500 pounds of 6-8-4 complete fertilizer per acre was applied to cotton and no vetch was employed (table 5). This treatment yielded 1,087 pounds seed cotton per acre, compared with 1,027 pounds when 500 pounds of 0-8-4 fertilizer was applied to cotton following unfertilized vetch, to 1,042 pounds following vetch fertilized with 500 pounds 0-8-4 and 500 pounds of dolomitic limestone, and to 455 pounds when no vetch and no fertilizer were used.

Since the same amounts of phosphate and potash were used on the vetch and no-vetch plots, there is a direct comparison of vetch nitrogen and commercial nitrogen. The results agree with numerous other results of tests in the hill section, in indicating that a good crop of vetch is equal in cotton yield to 24 to 32 pounds of nitrogen (obtained from 75 to 100 pounds of nitrate of soda or 37 to 50 pounds of ammonium nitrate).

It is evident that for best cotton production on this soil, adequate fertilization is necessary, for yields were approximately doubled by both treatments. It is evident, too, that it makes little or no difference whether the nitrogen is secured from commercial sources or from vetch grown and turned under to supply the nitrogen.

Additional Potash Applied During 1945

To determine whether additional potash may profitably be used for cotton

Table 4: The effect of split applications of basic slag on the production of cotton and vetch. Soil type: Savannah fine sandy loam.

Years	500 pounds 0-8-0 basic slag per acre	250 pounds 0-8-0 basic slag per acre	Unfertilized cotton following vetch fertilized with 500 pounds 0-8-0 basic slag per acre	250 lbs. 0-8-0 basic slag applied to cotton following vetch fertilized with 250 pounds 0-8-0 basic slag per acre
	Yields in pounds of green vetch per acre		Yields in pounds of seed cotton per acre	
	Turned under	Turned under		
1940	2036	1976	272	312
1941	0000	0000	0000	0000
1942	6648	6792	1000	1064
1943	7920	7500	916	892
1944	5024	5056	772	712
1945	3568	3152	928	928
1946	4224	4960	——	——
Average	4203	4205	648	651
Average increase	——	2	——	3

production, 100 pounds of 50 percent muriate of potash per acre in addition to the specified annual applications was applied to cotton on one-half of all plots in the spring of 1945. The results are shown in table 6.

With minor exceptions, the several comparisons clearly indicate that on this soil an abundant supply of potash is required for optimum cotton production. In two of the comparisons the addition of 100 pounds of potash resulted in a loss in cotton production. It appears that when the 0-8-4 fertilizer was applied directly to cotton following unfertilized turned vetch, there was sufficient potash for optimum production, and that when cotton was fertilized with a complete fertilizer (500 pounds 6-8-4, no vetch) there was also no need for additional potash. These results are for 1945 only. hence are to be accepted only as a lead.

The outstanding response to additional potash was shown by the two basic slag treatments. These plots, of coure, received no potash, whereas all other fertilized plots in the test received 40 pounds of muriate of potash per acre annually for the 6-year period.

Without potash, the basic slag plots produced 648 and 657 pounds of seed cotton per acre, respectively, during the 6-year period, and each produced 928 pounds during the single year 1945. These yields were the lowest in the test, except the untreated plot which received neither fertilizer nor vetch.

With the application of 100 pounds of potash during 1945, the plot on which 500 pounds of 0-8-0 (basic slag) per acre was applied under vetch gave a yield of 1,979 pounds, an increase of 1,051 pounds seed cotton per acre. The crop on which 250 pounds 0-8-0 (basic slag) was applied to the vetch plus 250 pounds applied to the cotton, was increased to 2,056, an increase due to potash of 1,127 pounds per acre.

It is worthy of note that without potash the two basic slag plots were lowest in yield among the treated plots, but that with the additional potash the basic slag plots were second and third highest in the 1945 test.

Unfertilized cotton following turned vetch fertilized with 500 pounds of 0-8-4 and 500 pounds of lime per acre, produced the highest yields of seed cotton in the vetch series for the 6-year period. The 6-year average was 1,042 pounds seed cotton. The production for the one year 1945 was 1,880 pounds without additional potash, and 2,232 pounds with additional potash, an increase of 352

Table 5. A comparison of vetch nitrogen with commercial nitrogen on the yield of seed cotton, in relation to yields of cotton receiving neither vetch nor fertilizer.
Soil type: Savannah fine sandy loam.

Years	Unfertilized vetch following cotton fertilized with 500 lbs. 0-8-4 per acre	500 lbs. 0-8-4 per acre applied to cotton following unfertilized vetch	500 pounds 6-8-4 fertilizer per acre	No fertilizer
	Yields in pounds of green vetch per acre		Yields in pounds of seed cotton per acre	
	Turned under	Turned under	No vetch	No vetch
1940	1064	332	524	276
1941	0000	0000	0000	0000
1942	4880	1328	1300	584
1943	4992	1080	1084	536
1944	3120	1564	1728	700
1945	5696	1856	1888	632
1946	4227	——	——	——
Average	——	1027	1087	455
Average increase	——	——	60	——

pounds of seed cotton per acre due to additional potash.

Plots that received the same fertilizer treatment as above but having no lime, produced a 6-year average yield of 953 pounds of seed cotton per acre. The 1945 yield without additional potash was 1,771 pounds, whereas the plots receiving additional potash yielded 1,931 pounds, an increase of 160 pounds due to additional potash.

The yields of cotton following vetch removed for hay were less than those following turned vetch in every case. However, when the fertilizer was applied directly to the cotton, the cotton yields were reduced less than when the fertilizer was applied to the vetch and followed by unfertilized cotton.

Additional potash applied to the 1945 cotton crop, following fertilized vetch removed for hay, produced 1,416 pounds seed cotton per acre as compared to 1,040 pounds without additional potash, an increase of 376 pounds due to additional potash. Additional potash applied to the cotton crop in 1945 following fertilized turned vetch produced 1,931 pounds of seed cotton per acre, whereas without additional potash the yield was 1,771 pounds, an increase of 160 pounds.

Fertilized cotton following unfertilized vetch removed for hay produced 1,394 pounds of seed cotton for the one year 1945; but when 100 pounds of additional potash was applied to fertilized cotton following unfertilized vetch removed for hay, the cotton yield was 1,552 pounds, an increase of 158 pounds.

It is interesting to note that cotton yields were slightly depressed when additional potash was applied to cotton fertilized annually with 500 pounds 0-8-4 and following unfertilized turned vetch. Plots receiving the additional potash yielded 1,752 pounds seed cotton per acre, whereas the plot that had not been fertilized with additional potash yielded 1,856 pounds, a loss of 104 pounds seed cotton per acre.

The cotton plot that had been fertilized annually with 500 pounds 6-8-4 per acre (no vetch) yielded 1,888 pounds seed cotton in 1945 without additional potash and 1,819 pounds with additional potash, which also resulted in a loss of 69 pounds seed cotton. It is entirely possible that the decline in cotton yields in both cases was due to soil variations rather than to the potash treatment. However, it is evident when applied directly to cotton that the 20 pounds of actual potash carried in 500 pounds of 0-8-4 and 6-8-4 is enough to supply the

Table 6. The effect of crop removal, and continuous cropping of cotton and vetch on the potash supply of Savannah fine sandy loam soil.
Soil type: Savannah fine sandy loam.

A. Fertilizer applied to vetch, none to cotton.

Vetch fertilized with 500 pounds per acre of	Disposition of vetch	7 years average vetch yields 1940-1946	1946 vetch yields following	
			No additional potash	Potash applied to cotton in 1945
		Yields in pounds of green vetch per acre.		
0-8-4 superphosphate	Cut for hay	4815	5312	6528
0-8-4 superphosphate	Turned under	5533	7424	7264
No fertilizer	Cut for hay	3489	4992	5568
No fertilizer	Turned under	4227	5696	5536
0-8-4 superphosphate	Cut for hay	4727	5792	6560
No fertilizer	Cut for hay	3663	4800	5728
No fertilizer	No vetch	——	——	——
No fertilizer	No vetch	——	——	——
0-8-4 superphosphate plus lime	Turned under	5660	7648	8288
500 lbs. 0-8-0 basic slag	Turned under	4203	4224	6752
250 lbs. 0-8-0 basic slag	Turned under	4205	4960	7744

B. Fertilizer applied to cotton, none to vetch.

Cotton fertilizer with 500 lbs. per acre of	6 year average cotton yields	1945 cotton yields following		
		No additional potash	100 lbs. of additional potash per acre	Increase over additional potash
	Yields in pounds of seed cotton per acre			
No fertilizer	709	1040	1416	376
No fertilizer	953	1771	1931	160
0-8-4	872	1394	1552	158
0-8-4	1027	1856	1752	—104
3-0-0	767	1328	1672	344
3-8-4	969	1664	1947	283
6-8-4	1087	1888	1819	—69
No fertilizer	455	632	675	13
No fertilizer	1042	1880	2232	352
No fertilizer	648	928	1979	1051
250 lbs. 0-8-0 basic slag	657	928	2055	1127

potash needed for good cotton production on this soil, even with turned-under vetch in the picture.

In one comparison cotton fertilized annually with 500 pounds of 3-8-4 per acre and following unfertilized vetch removed for hay, yielded 1,664 pounds of seed cotton per acre for the year 1945; cotton receiving the same fertilizer treatment plus 100 pounds of muriate of potash per acre yielded 1,947 pounds, an increase of 283 pounds of seed cotton per acre.

The no-vetch, no-fertilizer plot yielded 632 pounds of seed cotton per acre, as compared to 675 pounds when the additional 100 pounds of muriate of potash was applied, an increase of only 13 pounds of seed cotton. This perhaps indicates that adequate quantities of all three plant food nutrients are required, nitrogen and phosphorus as well as potash.

Summary of Experiments Conducted on Savannah Fine Sandy Loam Soil

Cotton and vetch production studies were made on the farm of W. M. and R. C. Stinson near Columbus, Mississippi. The soil was Savannah fine sandy loam, a fairly productive soil when adequate quantities of plant food nutrients are supplied.

These studies during the 6-year and 7-year period seem to indicate the following:

1. In order to produce cotton at profitable levels on soils that are not naturally fertile, annual applications of phosphate nutrients are required whether in a soil improvement program making use of legumes, or whether by the application of sufficient amounts of complete fertilizers.

2. Vetch produced for soil improvement is best utilized when turned back to the soil; however, by using 100 pounds of nitrate of soda per acre applied to cotton following vetch removed for hay, the cotton yields are slightly better than yields obtained from cotton following turned vetch.

3. Annual applications of lime applied to vetch at the rate of 500 pounds per acre for the 7-year period, did not increase vetch yields; however, cotton yields were significantly increased when lime was applied to the vetch and followed by cotton.

4. Basic slag alone applied to vetch at the rate of 500 pounds 0-8-0 per acre yielded less green vetch and less seed cotton than any of the 0-8-4 fertilizer treatments where the vetch was turned under.

5. The 500 pounds of 6-8-4 fertilizer treatment (no vetch) produced a 6-year average yield of 1,087 pounds of seed cotton per acre, whereas the 0-8-4 fertilizer plus vetch nitrogen yielded 1,027 pounds, and the no-vetch and no-fertilizer plot yielded only 455 pounds. A slight advantage was shown for commercial nitrogen over vetch nitrogen.

6. Potash applied at the rate of 100 pounds per acre under cotton in 1945 and following vetch fertilized with basic slag at the rate of 500 pounds 0-8-0 per acre, and the split application of 250 pounds of 0-8-0 basic slag applied to cotton—increased yields of seed cotton 1,051 pounds and 1,127 pounds, respectively. Yields of vetch following the 1945 treatment of potash applied to cotton were increased 2,528 pounds and 2,784 pounds of green vetch per acre, respectively.

Additional potash increased cotton yields 160 pounds and 376 pounds of seed cotton per acre, respectively, following turned and removed vetch fertilized with 500 pounds 0-8-4 fertilizer per acre, and 352 pounds following turned vetch fertilized with 500 pounds of 0-8-4 fertilizer plus 500 pounds of lime per acre.

Additional potash applied to unfertilized cotton following fertilized vetch was by far more valuable than when applied to fertilized cotton following unfertilized vetch.

Experiments on Grenada Silt Loam Soil

In the experiment conducted on the Holly Springs Branch Station, at Holly Springs, Mississippi, the same problems were studied as on the Stinson farm near Columbus, with one exception. Field observations and results obtained at this location indicated that this soil is fairly well supplied with potash, therefore the use of additional potash was not tested.

Vetch Removed for Hay or Turned Under

In two of the treatments, direct comparisons may be had of the vetch yields when removed for hay and when turned under, and the yields of the following crops of cotton when the vetch was removed for hay or turned. In both cases it is clear that for optimum cotton production vetch should be turned rather than removed for hay. In point of the weight of green vetch produced per acre, it appears to make little or no difference whether the vetch is removed for hay or turned under, since vetch yields were

Table 7. The effect of fertilized and unfertilized vetch removed for hay and turned under, on the production of the following crops of fertilized and unfertilized cotton.
Soil type: Grenada silt loam.

Years	Vetch fertilized with 500 lbs. 0-8-4 per acre		No fertilizer applied to cotton		No fertilizer applied to vetch		Cotton fertilized with 500 lbs. 0-8-4 per acre	
	Pounds of green vetch per acre		Pounds of seed cotton per acre following vetch		Pounds of green vetch per acre		Pounds of seed cotton per acre following vetch	
	Cut for hay	Turned under	Cut for hay	Turned under	Cut for hay	Turned under	Cut for hay	Turned under
1940	3221	3205	768	728	1381	1328	808	896
1941	7280	6666	962	940	4459	4953	864	1046
1942	3380	3956	1060	1436	2568	3064	1012	1356
1943	8880	9120	672	740	6640	7520	636	768
1944	6336	6448	1180	1364	5408	6080	1212	1436
1945	2144	2424	1080	1200	1096	1504	960	1148
1946	1728	1856	——	——	704	1152	——	——
Average	4710	4811	953	1068	3178	3657	915	1108
Average increase	——	101	——	115	——	479	——	193

practically the same under both conditions.

When 500 pounds of 0-8-4 fertilizer was applied under vetch and no fertilizer was applied to the following crop of cotton, the 7-year average green-weight yield of vetch from the plot cut for hay was 4,710 pounds, while the yield of the vetch turned was 4,811 pounds. The yield of cotton following vetch removed for hay was 953 pounds of seed cotton, whereas the yield of cotton following the crop of vetch turned under was 1,068 pounds. The yields of unfertilized cotton following fertilized vetch removed for hay resulted in a loss of 115 pounds of seed cotton per acre. Results are shown in table 7.

It is clear from the foregoing that on this soil, vetch produced for the purpose of increasing cotton production is more efficiently utilized when the entire crop is turned under than when the hay is removed and only the roots and stubble are turned under. However, the value of vetch used for hay can not be overlooked, and in some instances it may be of equal or greater value as feed. A fuller discussion of economic factors involved is included in the discussion of the similar test on sandy loam soil.

Fertilizer Applied to Vetch or to Cotton

Since under the conditions of this test, the fertilization of both cotton and vetch is to be considered, the question naturally arises: Should required amounts of fertilizers be applied to vetch or to cotton? The results indicate a slight advantage in the application of the fertilizer directly to the vetch for best vetch production, whether turned or removed for hay; but whether the fertilizers were applied to vetch or to cotton had but little effect on the production of cotton following vetch removed for hay or turned.

In the comparison in which vetch was removed for hay, where the vetch was fertilized and the cotton unfertilized, the succeeding crop of cotton yielded 953 pounds of seed cotton per acre. Where the vetch was unfertilized and the succeeding crop of cotton was fertilized, the yield of cotton was 915 pounds, an increase of 38 pounds. It is doubtful that the slight increase is significant.

In the comparison in which the vetch was turned, cotton following the ferti-

Table 8. The effect of 100 pounds of nitrate of soda per acre applied to cotton following fertilized vetch removed for hay and turned under, and fertilized cotton following unfertilized vetch removed for hay and turned under on the production of cotton.

Soil type: Grenada silt loam

Years	500 lbs. 0-8-4 fertilizer per acre applied to vetch, when		100 lbs. of nitrate of soda per acre applied to cotton following fertilized vetch when,	No commercial nitrogen applied to cotton following fertilized vetch when,	Unfertilized vetch		500 lbs. of 3-8-4 fertilizer per acre applied to cotton following unfertilized vetch when,	500 lbs. of 0-8-4 fertilizer per acre applied to cotton following unfertilized vetch when,
	Yield of green vetch per acre		Yield of seed cotton per acre		Yield of green vetch per acre		Yield of seed cotton per acre	
	Cut for hay	Turned under	Cut for hay	Turned under	Cut for hay	Cut for hay	Cut for hay	Cut for hay
1940	3504	3205	920	728	1045	1381	1080	808
1941	6869	6666	982	940	4192	4459	982	864
1942	4496	3956	1284	1436	2828	2568	1456	1012
1943	9440	9120	684	740	6960	6640	660	636
1944	5360	6448	1484	1364	3808	5408	1312	1212
1945	2264	2424	1120	1200	1416	1096	1296	960
1946	1792	1856	——	——	1344	704	——	——
Average	4818	4811	1079	1068	3085	3178	1131	915
Average increase	7	——	11	——	——	93	216	——

lized vetch crop yielded 1,068 pounds of seed cotton per acre; whereas fertilized cotton following unfertilized vetch yielded 1,108 pounds. This slight advantage in favor of direct application of the fertilizer to the cotton following turned vetch is similarly of doubtful significance. Data shown in table 7.

Commercial Nitrogen Applied to Cotton Following Vetch Removed for Hay

When vetch is grown for the purpose of increasing cotton production, it is more efficiently utilized when the entire crop is turned than when the hay is removed and only the roots and stubble are turned under. However, economic factors may enter into the picture on many farms. The value of vetch hay can not be overlooked, and the farmer is justified in asking, Can I afford to use the vetch tops as hay and keep cotton yields at high levels by applying required amounts of commercial nitrogen to the cotton crop?

The results (table 8) show little or no difference in cotton production following fertilized vetch removed for hay or turned under, when the cotton following removed vetch received commercial nitrogen. However, commercial nitrogen applied to cotton following unfertilized vetch removed for hay showed a substantial increase.

One hundred pounds of nitrate of soda per acre applied to cotton following fertilized vetch removed for hay, produced a 6-year average yield of 1,079 pounds of seed cotton per acre, whereas cotton following fertilized turned vetch (no commercial nitrogen) yielded 1,068 pounds. In these comparisons the same amount of vetch was removed for hay as that turned under, being approximately 4,800 pounds of green vetch per acre in each case.

Cotton fertilized with 500 pounds of 3-8-4 fertilizer per acre following the removal of approximately 3,000 pounds unfertilized green vetch for hay, yielded

Table 9. The effect of a 500 pound annual application of dolomitic limestone per acre applied to fertilized vetch (vetch turned under) on the production of cotton and vetch.
Soil type: Grenada silt loam.

Years	Vetch fertilized with 500 lbs. 0-8-4 fertilizer per acre		Unfertilized cotton following vetch fertilized with 500 pounds of 0-8-4 and 500 pounds lime per acre	Unfertilized cotton following vetch fertilized with 500 pounds 0-8-4 fertilizer per acre and no lime
	500 pounds of lime per acre	No lime		
	Yields in lbs. of green vetch per acre		Yields in pounds of seed cotton per acre	
	Vetch turned under	Vetch turned under	Vetch turned under	Vetch turned under
1940	5077	3205	1056	728
1941	11461	6666	1106	940
1942	5476	3956	1548	1436
1943	11280	9120	696	740
1944	8144	6448	1360	1364
1945	3368	2424	1580	1200
1946	3136	1856	——	——
Average	6849	4811	1221	1068
Average increase	2038	——	153	——

1,131 pounds of seed cotton per acre. Cotton fertilized with 500 pounds 0-8-4 per acre (no additional nitrogen) following the removal of approximately the same amount of green vetch, yielded 915 pounds. This is an increase of 216 pounds attributable to the application of nitrogen after the vetch tops had been removed for hay.

The Application of Lime in Addition to Phosphorus and Potash

In one of the comparisons made in the test, 500 pounds of lime was applied in addition to the application of 500 pounds 0-8-4 fertilizer under vetch. The 7-year average vetch yield following this treatment was 6,849 pounds of green vetch per acre, the highest yield of green vetch in the test. Unfertilized cotton following this 6,849 pounds of turned vetch, yield 1,221 pounds of seed cotton per acre, which was the highest cotton yield in the vetch series, except one treatment that produced 10 pounds more seed cotton per acre.

Vetch fertilized with 500 pounds of 0-8-4 fertilizer and no lime produced 4,811 pounds of green vetch per acre, and unfertilized cotton following this amount of turned vetch, yielded 1,068 pounds, an increase of 153 pounds of seed cotton per acre attributable to the 500-pound lime treatment. These results are shown in table 9.

The Value of Basic Slag

The application of 500 pounds per acre of basic slag under vetch resulted in the production of 5,842 pounds of green vetch. The following crops of unfertilized cotton yielded 1,172 pounds of seed cotton.

The split application of basic slag, in which 250 pounds of 0-8-0 (basic slag) was applied under vetch and 250 additional pounds applied under the succeeding crop of cotton, showed no appreciable benefits to vetch or cotton. The 7-year average yield of vetch was 5,779 pounds of green vetch when half the basic slag was applied to vetch and half to cotton, as compared to 5,842 pounds for the application of 500 pounds of 0-8-0 (basic slag) applied to vetch. Cotton fertilized with 250 pounds of 0-8-0 (basic slag) per acre and following turned vetch that had received 250 pounds of 0-8-0 (basic slag) per acre, yielded 1,231 pounds of seed cotton per acre; this was the highest cotton yield in the vetch series.

Table 10. The effect of 500 pounds 0-8-0 basic slag fertilizer and a split application of 0-8-0 basic slag (250 pounds applied to cotton and 250 pounds applied to vetch, vetch turned under) on the production of cotton and vetch.
Soil type: Grenada silt loam.

Years	500 lbs. 0-8-0 basic slag per acre	250 lbs. 0-8-0 basic slag per acre	Unfertilized cotton following vetch fertilized with 500 lbs. 0-8-0 basic slag per acre	250 lbs. 0-8-0 basic slag applied to cotton following vetch fertilized with 250 lbs. 0-8-0 basic slag per acre
	Yield in lbs. of green vetch per acre		Yield in lbs. of seed cotton per acre	
	Vetch turned under	Vetch turned under	Vetch turned under	Vetch turned under
1940	3984	3339	1144	1080
1941	8709	8592	1128	1160
1942	5300	4852	1424	1380
1943	10320	10320	708	740
1944	7424	7712	1272	1328
1945	2856	2888	1356	1596
1946	2304	2752	——	——
Average	5842	5779	1172	1231
Average increase	63	——	——	59

Basic slag contains approximately 10 percent of P_2O_5 and approximately 50 percent lime. It contains no potash. The results obtained from the use of basic slag are similar to those obtained from 0-8-4 fertilizer plus lime, in that the highest vetch and cotton yields were obtained following the phosphate-plus-lime treatments in the vetch series. Results are shown in table 10.

Other tests have shown that this soil is fairly well supplied with potash.

Complete Fertilizer Applied to Cotton

The highest 6-year average yield in the test was made when 500 pounds of 6-8-4 fertilizer per acre was applied to cotton and no vetch was employed.

This treatment yielded 1,321 pounds of seed cotton per acre, compared with 787 pounds seed cotton from the no-vetch, no-fertilizer plots; and to 1,108 pounds seed cotton when 500 pounds 0-8-4 was applied to cotton following unfertilized vetch. The results show an increase attributable to complete fertilizer of 534 pounds seed cotton per acre over the no-vetch, no-fertilizer plot, and of 213 pounds seed cotton per acre over the vetch nitrogen plot (table 11).

Relation of Cotton Yields to Vetch Yields

It has been generally accepted during recent years that a good crop of vetch is approximately 6,000 pounds of green material per acre, and that such a yield of vetch turned under would supply sufficient nitrogen to enable approximately the maximum production in the following crop of cotton. A comparison of vetch yields with yields of following crops of cotton, shown in tables 1 and 7, gives scant information on the relationship between the amount of vetch turned under and the amount of cotton produced in the following crop.

On Savannah fine sandy loam soil, vetch fertilized with 500 pounds of 0-8-4 fertilizer produced a 7-year average yield of 5,533 pounds of green vetch per acre, and was followed by unfertilized cotton that yielded 953 pounds seed cotton; whereas, fertilized cotton following 4,227 pounds of unfertilized green vetch per acre produced 1,027 pounds of seed cotton. This difference is perhaps due to the fertilizer being applied directly to the cotton rather than to the vetch and indicates that a direct application of the fertilizer to the cotton is of more value to the cotton crop than its application to vetch.

Table 11. A comparison of vetch nitrogen with commercial nitrogen on the yield of seed cotton in relation to yields of cotton receiving neither vetch nor fertilizer.
Soil type: Grenada silt loam.

Years	Unfertilized vetch following cotton fertilized with 500 lbs. 0-8-4 per acre	500 lbs. 0-8-4 per acre applied to cotton following unfertilized vetch	500 lbs. 6-8-4 fertilizer per acre	No fertilizer
	Yields in lbs. of green vetch per acre		Yields in lbs. of seed cotton per acre	
	Vetch turned under	Vetch turned under	No vetch	No vetch
1940	1328	896	1280	872
1941	4953	1045	1254	812
1942	3064	1356	1696	792
1943	7520	768	784	560
1944	6080	1436	1360	964
1945	1504	1148	1556	724
1946	1152	——	——	——
Average	3657	1108	1321	787
Average increase	——	——	213	—534

On Grenada silt loam soil a 7-year average yield of 4,811 pounds of fertilized vetch was turned under, and unfertilized cotton following this vetch yielded 1,068 pounds of seed cotton per acre; whereas, fertilized cotton following 3,657 pounds of green vetch per acre yielded 1,108 pounds of seed cotton. Here again, the lowest yields of vetch was followed by the highest yields of cotton, which is also perhaps due to the direct application of the fertilizer to the cotton crop rather than to the vetch crop.

Summary of Experiments Conducted on Grenada Silt Loam Soils

Grenada silt loam soil was used for the cotton and vetch production studies made at the Holly Springs Branch Experiment Station, Holly Springs, Mississippi. Grenada silt loam is of Brown loam origin, and is a fairly productive soil even without fertilizer. However, most crops respond to applied fertilizers and in most cases good yields are obtained.

From the above mentioned studies during the 6-year and 7-year period, the results seems to indicate the following:

1. In order to produce cotton more profitably on this soil, annual applications of phosphorus and lime are required, whether supplied in a legume soil improvement program or whether by the addition of sufficient amounts of complete fertilizers.

2. Fertilized cotton following unfertilized vetch turned under, yielded slightly more seed cotton per acre than did unfertilized cotton following fertilized vetch turned under.

3. The removal of fertilized vetch for hay depressed cotton yields 115 pounds of seed cotton per acre, whereas the removal of unfertilized vetch for hay depressed cotton yields 193 pounds.

4. When a 7-year average yield of 4,818 pounds of fertilized vetch per acre was removed for hay and followed by cotton that had been fertilized with 100 pounds of nitrate of soda per acre, cotton yields were slightly better than those obtained following approximately the amount of vetch turned under, but without the aid of commercial nitrogen.

When 7-year average yields of 3,085 pounds and 3,178 pounds of unfertilized vetch, respectively, were removed for hay, and followed by cotton fertilized with 500 pounds of 3-8-4 fertilizer and 500 pounds of 0-8-4 fertilizer per acre, the cotton yields were 1,131 pounds and 915 pounds, respectively. This is an increase

of 216 pounds seed cotton in favor of the added nitrogen.

5. The treatment using 500 pounds of 0-8-4 fertilizer plus 500 pounds of lime produced a 7-year average yield of 6,849 pounds of green vetch per acre, the highest yield in the test. Unfertilized cotton following this treatment and this amount of vetch turned under yielded 1,221 pounds of seed cotton per acre, as compared to 1,068 pounds for unfertilized cotton following turned vetch that had been fertilized with 500 pounds 0-8-4 fertilizer and no lime. An increase of 153 pounds of seed cotton per acre following the lime treatment.

6. The 500 pounds of 0-8-0 (basic slag) treatment applied to vetch produced a 7-year average yield of 5,842 pounds of green vetch per acre, the second highest yield in the experiment. Unfertilized cotton following this treatment and this amount of vetch turned under yielded 1,172 pounds of seed cotton per acre, as compared to 1,231 pounds that was produced following the split application of basic slag and with approximately the same amount of vetch turned under.

7. The treatment using 500 pounds of 6-8-4 fertilizer (no vetch) produced a 6-year average yield of 1,321 pounds of seed cotton per acre, whereas the 0-8-4 fertilizer plus vetch nitrogen yielded 1,108 pounds, and the no-vetch and no-fertilizer plat yielded 787 pounds. An increase of 213 pounds seed cotton for commercial nitrogen over vetch nitrogen and 534 pounds over no-vetch, no-fertilizer.