THE EFFECT OF FORAGE MANAGEMENT UPON SUBSEQUENT YIELDS OF CORN AND OATS

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MARK RICHARD BERRETT ABSTRACT

A previous experiment was conducted in 1950-52 (1) on several forage species fertilized at various rates and managed in different ways to test the effects of such practices on sugar beet production the year following. The present experiment is a study of the possible carry-over effect of these forages and practices on corn and oats following the beets in the rotation.

Under the conditions of this experiment, there was a marked difference in the way forages affected subsequent corn yields. The response of corn to the original fertilizer application on the forages was not significant. The corn yields, from plots where the forage had been previously left on, were higher for every forage species and mixture than corn yields where the hay was removed. The increase in corn yields resulting from the application of 800 pounds of 3-9-18 on the beets preceding corn was highly significant over yields where no fertilizer was previously applied on the beets. The fertilizer applied in 1950, while beneficial to yields of forage in 1951 and beets in 1952, did not benefit corn in 1953 and oats in 1954. Oat yields in 1954 were generally higher on plots where the hay had been previously left on in 1951.

The results of this experiment indicate that even though forages are beneficial in a rotation, they are not a substitute for periodic, liberal applications of commercial fertilizer.

(1) Erdmann, M. H., The effect of forage management on a subsequent sugar beet crop, Ph.D. Thesis, 1953, Mich. State College.

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THE EFFECT OF FORAGE MANAGEMENT UPON SUBSEQUENT YIELDS OF CORN AND OATS

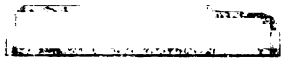
INTRODUCTION

The value of forages in maintaining or increasing soil fertility has long been established. History reveals that the Greeks turned under broadbeans 300 years before the time of Christ, and the planting of lupines and beans for soil-improvement was a common practice in the early years of the Roman empire. (1)

Forage crops, as a group, are included in many rotations not only as a source of roughage for livestock but also because of their beneficial effect on soil structure and fertility. The organic material which is contributed to the soil frequently shows an effect in terms of added crop yields for those crops which follow the plowing down of a forage crop. Among the benefits which accrue from the addition of organic material to the soil are: (1) improved aeration, (2) retarded puddling when soil is worked too wet, (3) easier water penetration, thereby reducing surface runoff and consequent erosion, (4) increased availability of some nutrients.

Forages vary in their ability to produce under given soil and climatic conditions such as temperature, rainfall, and soil drainage. Management of the forage crops likewise may affect the degree to which they benefit subsequent crops in a rotation. Mixtures used, fertilizer rates, plowing down or removal of forage, severeness of cutting or grazing, and time of cutting or grazing are all management problems which may affect the value of forages in a crop rotation.

An experiment was conducted in 1950-52 (2) on several forage species fertilized at various rates and managed in different ways to test the effects of such practices on sugar beet production the year following. The present experiment was set up to study the possible carry-over effect of these forages and practices through the beet crop to corn and oats following in the rotation.



REVIEW OF LITERATURE

The literature which emphasizes the influence forages have upon subsequent crop yields is fairly voluminous. This influence has been evaluated in terms of effect upon soil structure and nutrient availability as well as in its' effect upon yields of various crops. Pieters (9) stated in 1927 that green manuring practices had shown an increase in yield of corn, small grains, cotton, beets, potatoes, sugar cane, and tobacco. He noted that it was not uncommon to find cases where green manure failed to increase yields.

Purvis and Blume (3) in their work in Virginia found that plowing down sorghum and soybeans alone or a mixture of the two induced a marked increase in potato yields. Fresh organic matter was about three times as effective as residual organic matter in producing increased yields due to the release of plant nutrients through decomposition. Hester (4) noted that potato yields in a rotation which included either legumes or non-legumes as a cover crop were 11-18% higher than those in a cash crop rotation. Bushnell (16) reported that corn used as green manure gave larger amounts of organic matter and resulted in higher potato yields than did soybeans or sweet clover. The nitrogen requirements for potatoes were met by including 40-80 pounds of nitrogen per acre in the regular fertilizer.

The work of Gardner and Robertson (8) in Colorado showed that alfalfa in a rotation contributed materially to yields of corn, wheat, barley and sugar beets on soils which were not well supplied with nitrogen-carrying materials, but the benefits of alfalfa did not minimize the necessity for mineral fertilizers. Harrison et al. (6) found that corn

yields from plots which had been previously pastured continuously were significantly higher than yields from plots which had been both pastured and cut for hay or cut for hay alone. These workers also noted a significant increase in subsequent corn yields from mixtures containing alfalfa over those which did not contain alfalfa. Nielsen et al. (5) in their work with corn in Ohio observed that the decomposition of alfalfa in the soil increased the availability of residual phosphorous.

McKraig et al. (7) reported from South Carolina that leguminous green manure in summer, followed by a winter cover crop of rye, maintained the soil carbon and nitrogen at a higher level and resulted in higher yields of cotton and corn than a summer cover crop with winter fallow. Over a nine year period in Arkansas, Martin (10) found that adapted legumes, such as hairy vetch, crimson clover and Austrian winter peas planted in the fall and turned under in the spring, produced marked yield increases of cotton, corn and rice.

Moser (12) noted significant differences in yields of sorghum and rye on soils containing leguminous residues over soils which had received commercial fertilizer alone. He observed also that legumes rendered phosphorous and potassium more available. Andharia et al. (14) reported that corn plots in rotations, which included one or more years of a mixture of alfalfa, red clover and brome grass, contained significantly higher amounts of organic matter and nitrogen than did plots in a corn-oats rotation.

Crowther and Mirchandani (15) found in England that there was no benefit to yields of winter wheat resulting from plowing down vetch and summer mustard. Their suggested reason was that the production of

ammonia and nitrates came at a time when the wheat was unable to use them efficiently and consequently they were lost in drainage water. Tidmore and Volk (11) noted that for the purpose of conserving nitrogen in the soil it was better to plow soybeans under in the spring rather than fall. This was due to the nitrification and subsequent leaching of nitrates during the fall. They further observed that over a nine year period the total organic matter content of the soil was increased 60% as a result of plowing down legumes every other year and that soils where legumes were plowed under were 30% higher in nitrogen when compared to similar soils where no legumes were plowed under.

Robertson (13) reported that yields of corn and sugar beets were markedly increased when forages were included in the rotation, and that one year of forage was as beneficial as two. The average results over a nine year period showed that beets following corn which had followed alfalfa produced yields equal to beets directly after alfalfa. Corn yields were lower when grown after beets following alfalfa-brome than when corn was grown directly after the forage. The forage crops definitely improved the soil structure.

EXPERIMENTAL PROCEDURE

A series of forage seedings were established in the spring of 1950 on Monitor Sugar Division property in Bay City, Michigan. The soil is Kawkawlin loam and had not been planted to a sod crop for over 20 years.

At the time of seeding, 2-14-8 fertilizer was applied at three different rates, 400 lbs., 800 lbs., 1600 lbs. In addition check plots were left unfertilized. Each treatment was replicated 3 times.

Forages and mixtures used in the experiment were alfalfa, ladino clover, orchard grass, smooth brome grass, ladino-orchard grass, alfalfa-orchard grass, alfalfa-brome grass, and ladino-brome grass. Check plots were left on which no forage seeding was made.

The forage plots were 792 ft. long and 28 ft. wide. The fertilizer plots and checks were laid out at right angles to the forages and were 252 ft. long and 66 ft. wide.

The forages were cut twice during the summer of 1951. All the forage from both cuttings was removed from half of each fertilizer plot and was left on the other half. Forage yields were taken for each cutting.

The area was plowed in the fall of 1951 and planted to sugar beets the following spring. One half of each original forage plot was fertilized with 800 lbs. of 3-9-18 at the time the beets were planted.

The results of the forage and sugar beet yields have previously been reported by Erdmann. (2)

In the spring of 1953, the area was planted to corn, using Michigan hybrid 250. The corn was planted in hills with 36 inch spacing in the row and 42 inches between rows and thinned to three plants per hill. Those hills in which less than three plants emerged were replanted in an attempt to gain a perfect stand.

The two center rows of corn in each plot were harvested. In the case of hills where there were less than three plants at harvest, ears were picked from an adjacent row in the same plot so theoretically, a perfect stand of three plants per hill was harvested. The ears in each plot were counted and weighed. Moisture samples were taken from 10 ears selected at random from each of 6 plots for each harvest day. The corn yields are reported on an oven dry basis.

The area was plowed in the fall of 1953 and sown to oats with a seeding in the spring of 1954. The oats were not harvested separately from each individual plot. Using a self-propelled combine, two swaths, each 12 ft. wide, were harvested from each of the orginal fertilizer plots and checks, making a total of 24 swaths. One swath was cut in the area in which the forage had been left on and another where the forage was removed. Moisture samples were taken and yields reported on an oven dry basis.

EXPERIMENTAL RESULTS

The analysis of the corn yields shows a significant difference between plots following the previous forage seedings (Table 1). The highest yield of 90.1 bushels per acre was obtained after ladino clover alone and the lowest yield of 79.9 bushels per acre came after brome grass alone (Table 2). The check plot, where no forage seeding was made, produced 84.5 bushels per acre. This yield was not significantly different from the average yield following the forages. The yield from the check plot was higher than those obtained following alfalfa, alfalfa-brome, brome and ladino-brome. Orchard grass alone produced yields of about 2 bushels per acre more than alfalfa alone but a mixture of alfalfa-orchard gave yields of over 4 bushels per acre more than alfalfa alone.

The yields following forage combinations were significantly higher than yields following single forage species (Table 3). Yields after legumes alone were significantly higher than those following grasses alone. Orchard grass alone was significantly better than brome in increasing corn yields. Likewise, mixtures containing orchard grass produced yields significantly higher than those containing brome grass. The difference in yields following ladino alone and those after alfalfa alone was significant in favor of ladino. Yields following combinations containing ladino were significantly better than those after mixtures containing alfalfa.

The response of corn to the original fertilizer application was not significant (Table 1). The average yield for the check plots was 84 bushels per acre while the average yield from plots receiving 1600 pounds 2-14-8 was 86.1 bushels per acre (Table 2).

Table 1 -- Analysis of Variance of Corn Yields.

Source of Variation	DF	SS	MS	F
Main Plots				
R	2	14.13	7.06	.23
F	3	274.80	91.60	3.04
Error 1	6	180.87	30.14	
Sub Plots				
M	8	4425.29	553.16	27.64**
f x m	24	230.40	9.60	.48
Error 2	64	1280.33	20.01	
Sub Sub Plots				
H	1	111.63	111.63	8.94**
f x h	3	55.39	18.46	1.48
m x h	8	31.22	3.90	.31
f x m x h	24	150.86	6.29	.50
Error 3	72	898.61	12.46	
Sub Sub Sub Plots				
A	1	66.11	66.11	7.19**
f x a	3	11.52	3.84	.42
m x a	8	586.83	73.35	7.98**
h x a	1	6.50	6.50	.71
f x m x a	24	207.47	8.64	.94
f x h x a	3	69.11	23.03	2.50
m x h x a	8	40.30	5.04	.55
f x m x h x a	24	93.55	3.90	.42
Error 4	144	1323.75	9.19	

** Significant at 1% level
R- Replications
F- Original fertilizer
M-Forage species and mixtures
H-Hay left on or taken off
A-Fertilizer applied or left off beets

Table 2 -- Average Yield of Corn in Bushels per Acre Regardless of Whether or not the Forage was Removed from the Plot and Whether or not the Previously Planted Beets Received Fertilizer.

Forage Species and Mixtures	Average Yield of Corn in Bushels per Acre Pounds of 2-14-8 Fertilizer Applied per Acre on Original Forage Seeding 0	400	800	1600	Average
Check	83.9	83.5	84.5	86.0	84.5
Single Grasses					
Orchard	83.9	83.6	86.1	85.9	84.9
Brome	79.6	79.0	79.5	81.4	79.9
Single Legumes					
Ladino	89.8	89.7	89.9	90.9	90.1
Alfalfa	81.7	83.3	84.4	81.9	82.8
Mixtures					
Ladino-orchard	87.3	89.2	89.4	91.8	89.4
Ladino-brome	82.5	82.9	84.5	86.3	84.0
Alfalfa-orchard	87.1	85.6	87.3	87.6	87.0
Alfalfa-brome	80.5	82.1	81.7	82.7	81.8
Average	84.0	84.3	85.5	86.1	84.9

Table 3 -- The Division of the Forage Species and Mixtures (M) into Single Degrees of Freedom.

Source of Variation	DF	SS	MS	F
Check: Mixtures	1	10.37	10.37	
Singles: Combinations	1	121.16	121.16	6.05*
Grasses: Legumes	1	797.08	797.08	39.85**
Between Grasses	1	613.07	613.07	30.65**
Between Legumes	1	1265.85	1265.85	63.29**
Between Grass Combinations	1	1361.60	1361.60	68.08**
Between Legume Combinations	1	256.00	256.00	12.80**
Interaction	1	.16	.16	
Error 2 from Table 1	64	1280.33	20.01	

* Significant at 5% Level

** Significant at 1% Level

Table 4 -- Average Yield of Corn in Bushels per Acre Comparing Plots Where Hay Was Left on and Where it was Removed Regardless of Whether or not Beets Were Fertilized.

Forage Species and Mixtures	Average Yield of Corn in Bushels per Acre									
	Pounds of 2-14-8 Fertilizer Applied Per Acre									
	0		400		800		1600		Average	
	Hay									
	On	Off	On	Off	On	Off	On	Off	On	Off
Check	83.9	84.0	85.7	81.3	85.2	84.0	85.4	86.6	85.0	84.0
Single Grasses										
Orchard	83.6	84.3	83.9	83.6	86.7	85.6	87.2	84.6	85.3	84.5
Brome	80.7	78.5	81.2	77.6	80.3	78.7	81.2	81.6	80.8	79.1
Single Legumes										
Ladino	89.1	90.5	89.8	89.6	90.5	89.6	91.2	90.6	90.2	90.1
Alfalfa	81.9	81.5	84.0	82.6	84.5	84.4	82.2	81.5	83.1	82.5
Mixtures										
Ladino-orchard	87.1	87.4	89.0	89.4	90.8	88.0	91.8	91.7	89.7	89.1
Ladino-brome	82.5	82.5	84.3	81.5	85.6	83.3	86.7	85.9	84.8	83.2
Alfalfa-orchard	87.3	87.0	87.5	83.7	88.0	87.6	87.5	87.8	87.6	86.5
Alfalfa-brome	80.7	80.5	83.0	81.2	81.9	81.6	84.7	80.7	82.6	81.0
Average	84.1	84.0	85.4	83.4	85.9	84.8	86.4	85.7	85.4	84.4

Table 5 -- Average Yield of Corn in Bushels per Acre Comparing Fertilizer with no Fertilizer on Beets but Regardless of Whether or not Forage was Removed.

Forage Species and Mixtures	Average Yield of Corn in Bushels per Acre Pounds of 2-14-8 Fertilizer Applied per Acre									
	0		400		800		1600		Average	
	Fertilizer									
	On	Off	On	Off	On	Off	On	Off	On	Off
Check	82.9	84.9	82.7	84.2	84.2	85.0	85.9	86.0	83.9	85.0
Single Grasses										
Orchard	85.0	82.9	86.0	81.5	87.2	85.1	87.9	83.9	86.5	83.3
Brome	82.3	76.8	80.5	77.6	81.2	77.7	82.5	80.3	81.6	78.1
Single Legumes										
Ladino	89.2	90.3	88.1	91.2	90.9	89.1	89.5	92.3	89.4	90.7
Alfalfa	81.5	81.9	83.8	82.8	82.9	86.0	81.3	82.4	82.4	83.3
Mixtures										
Ladino-orchard	89.3	85.3	91.9	86.5	91.0	87.7	93.9	89.6	91.5	87.3
Ladino-brome	83.6	81.3	83.6	82.2	84.5	84.4	85.4	87.1	84.3	83.7
Alfalfa-orchard	86.9	87.3	83.7	87.4	86.5	89.0	85.5	89.7	85.6	88.3
Alfalfa-brome	81.6	79.6	82.1	81.9	81.6	81.9	85.1	80.2	82.6	80.9
Average	84.7	83.4	84.7	83.9	85.5	85.1	86.3	85.7	85.3	84.5

The average response to 1600 pounds of 2-14-8 previously applied, for ladino and mixtures containing ladino was 2.8 bushels per acre in comparison to a 1 bushel increase for alfalfa and mixtures containing alfalfa and a 1.9 bushel average increase for brome and orchard grass alone. The check plot where no forage seedings were made showed an increase of 2.1 bushels per acre on those plots receiving 1600 pounds per acre on the original forage seedings over those where no fertilizer was applied.

The average corn yields from plots where the forage was left on was higher for every forage species and mixture than yields where the hay was removed (Table 4). This difference is highly significant (Table 1) although the difference in actual corn yields were small.

The increase in corn yields resulting from applying 800 pounds of 3-9-18 on the beets was highly significant over yields where no fertilizer was previously applied on the beets (Table 1) but 20 out of 45 pairs of figures in Table 5 indicate that fertilizer on the beets did not benefit corn yields. The increases ranged from .6 to 4.2 bushels per acre. A difference of 2.7 bushels in favor of no fertilizer over fertilizer on beets was found following the alfalfa-orchard grass mixture. The smallest difference favoring no fertilizer on beets was .9 bushel after alfalfa alone. Additional fertilizer on sugar beets resulted in increased average corn yields on all of the original fertilizer plots (Table 5). The largest difference between fertilizer and no fertilizer on beets (1.3 bushel) was noted on the check plots and the smallest difference (.4 bushel) was found on those plots which received 800 pounds of 2-14-8.

It will be noted from Table 6 that fertilizer on the beets resulted in significantly higher corn yields on those plots following forages when compared to the check plots where no forage seeding was made.

The use of fertilizer on the beets produced significantly better corn yields following ladino and alfalfa alone than it did after orchard and brome grass alone. There was a significant difference in yield following mixtures containing ladino over those containing alfalfa as a result of fertilizer on the beets. When all of the forage combinations (Table 6) were compared with each other, a highly significant difference existed in the way in which they responded in corn yields to fertilizer on the beets.

The average oat yields from plots where the hay had previously been left on were higher than where the hay was removed except on those plots where 1600 pounds of 2-14-8 was applied in the original application (Table 7). The largest average oat yield was on plots which previously had received 800 pounds of 2-14-8 and had the hay left on. The smallest oat yield was obtained where 400 pounds of fertilizer was applied originally and the hay was removed. The yields from the check plots were exceeded only by those where 800 pounds were applied and the hay was left on.

Table 6 -- The Division of the Interaction of Forage Species and Mixtures, and Fertilizer on Beets (m x a) into Single Degrees of Freedom.

Source of Variation	DF	SS	MS	F
Check: Mixtures	1	49.32	49.32	5.37*
Singles: Combinations	1	1.08	1.08	
Grass: Legumes	1	234.52	234.52	25.50**
Within Grasses	1	.88	.88	
Within Legumes	1	1.36	1.36	
Within Combinations				
g x a	1	.98	.98	
l x a	1	99.62	99.62	10.80**
g x l x a	1	199.06	199.06	31.70**
Error 4 from Table 1	144	1323.75	9.19	

* Significant at 5% Level

** Significant at 1% Level

Table 7 -- The Average Yield of Oats in Bushels per Acre Regardless of Forage Species and Mixtures and Whether or not the Beets were Fertilized.

Pounds of 2-14-8	Average Yield of Oats in Bushels per Acre	
	Hay On	Hay Off
0	45.2	44.9
400	44.4	42.4
800	46.7	44.4
1600	43.1	44.3
Average	44.9	44.0

DISCUSSION

The yield averages of the corn did not follow the yield pattern of the sugar beets preceding the corn reported by Erdmann (2). The largest yield of corn followed ladino clover; however, the previous beet yield following the original ladino plots was exceeded by yields from ladino-orchard, alfalfa, and orchard grass. The greatest yield of beets was obtained from the ladino-orchard grass plots and were exceeded in corn yield only by plots previously in ladino. The lowest yields of both corn and beets were obtained following brome grass. The fertilizers applied to both the forages and the beets were low in nitrogen. Harrison and Rather (17), found brome grass very responsive to nitrogen; consequently, the low corn yield on the brome grass plots might be a reflection of the lack of necessary nitrogen for adequate growth.

The difference in average bushels produced between the highest and lowest yielding plots (those following ladino alone and brome grass alone) was greater than the difference between average yields after no fertilizer on the orginal forages and a 1600 pound application of 2-14-8. This indicates that forage species and mixtures were comparatively more effective on corn yields than was the fertilizer applied on the forages.

Work done by Harrison *et al.* (6), Nielson *et al.* (5), and Andharia *et al.* (14), showed alfalfa in a rotation resulted in increased availability of residual phosphorous, higher amounts of organic matter and nitrogen, as well as increased yields. The corn yields following beets after alfalfa in this experiment did not bear out these results. The data indicates that the large yields of forage and beets following

alfalfa might have depleted the nutrients causing lower corn yields. The data, however, do not support this theory because even though the corn yield where alfalfa was left on is greater than where it was removed, the average corn yield following alfalfa is exceeded by all forages except brome and alfalfa-brome. Pieters (9) stated, "It has long been known that crops differ in their effect on succeeding crops, but practically nothing is known as to the cause of the phenomenon". Perhaps the best explanation of why corn yields following alfalfa were low is given by Pieters (9). He says, "The failure of a green-manure crop to increase yields is not uncommon, but such bad results are believed to be due to special conditions, many of which may be corrected with increasing knowledge."

Erdmann (2) reported that a limited amount of forage was produced by volunteer alsike clover and weeds on the check plot. Under the conditions of this experiment the corn yield on the check plot was higher than corn yields following alfalfa, alfalfa-brome, brome, and ladino-brome. These results indicate that perhaps it would be more advantageous to plow down weeds and volunteer vegetation rather than a seeded forage but the economic value of the forage for livestock roughage must be considered in comparing the value of the two practices.

The difference (4.1 bushels) between average corn yields following legumes alone and grasses alone is highly significant in favor of the legumes. This is in accordance with the results reported by Harrison et al. (6), stating that mixtures containing alfalfa produced significant increases in corn yields over mixtures which did not contain alfalfa.

The average corn yield following orchard grass was 5 bushels greater than the yield after brome grass alone. This difference is highly significant. The superiority of orchard grass to brome grass in affecting corn yields is reflected in a comparison of mixtures containing orchard grass and mixtures containing brome grass. This comparison shows a difference of 5.3 bushels in favor of orchard grass.

A highly significant difference (7.3 bushels) favoring ladino is noted when corn yields following ladino and alfalfa alone are compared. Likewise yields were better following mixtures containing ladino by 2.3 bushels than yields after mixtures containing alfalfa.

The practice of plowing down all of the forage resulted in significantly better average corn yields than removing the forage. This relationship was true following all forages and after all of the original applications of 2-14-8. This substantiates the widely accepted fact that the value of forages in a rotation is reduced if the top growth is removed from the land and no livestock manure is returned. Harrison et al. (6) reported continuous pasturing and subsequent return of manure produced significantly higher corn yields than the practice of cutting hay from the first crop and second crop pasture or hay alone.

Even though 800 pounds of 3-9-18 on beets produced a significant carry-over increase in average yields of corn, there were many plots on which the higher yields were obtained following no fertilizer. Average yields after alfalfa-orchard and on the check plots were higher in every case where no fertilizer was applied on the beets. The corn yields following single grass species were consistently higher where fertilizer was applied on the beets than where it was not. The average corn yields following single legumes were higher where beets were not fertilized than

where they were fertilized in every case except two. This contrast in response seems to indicate that nitrogen was the limiting factor. Even though the fertilizer was low in nitrogen, it produced a response following grasses but evidently nitrogen was not limiting following legumes as corn yields on these plots showed no response to fertilizer.

It is difficult to explain why corn yields following both mixtures containing ladino responded to fertilizer on beets whereas corn yields from only one of the mixtures containing alfalfa (alfalfa-brome) benefited from such a practice. If it is assumed that the difference was because the orchard grass did not use as much of the nitrogen fixed by the alfalfa as did the brome grass, then why wasn't the same relationship evident in the case of ladino clover inasmuch as the data indicates ladino was generally more beneficial to the corn yields than was alfalfa.

The oat yields follow no definite pattern but show that even though forages were beneficial in a rotation, they were no substitute for regular applications of commercial fertilizer. This observation is also reported by Gardner and Robertson (8). The fertilizer applied in 1950 was beneficial to yields of forage, beets, and corn but this effect was no longer evident in oat yields in 1954.

This experiment was conducted on land which had not grown a sod crop over 20 years prior to 1950. The soil is quite heavy and even though it was tiled in 1950 at 4 rod intervals, it is impossible to work it very early in the spring. The past cropping methods have evidently resulted in poor soil structure and consequent improper drainage. During a period of heavy rainfall in 1952, water was standing in several places on the experimental area. While the surface soil appears to have

a fairly good structure, the soil below the plow layer is apparently too tight to allow proper drainage and aeration.

It is very possible the effect of the forage species and mixtures used in this experiment would be easier to understand if after the land was deep tilled and a balanced rotation followed for several years, this experiment was repeated.

SUMMARY

1. A field seeded to various forage crops in 1950 and managed in different ways in 1951, was plowed and sown to beets in 1952, was planted to corn in 1953, and sown to oats in 1954 to measure any carry-over of the previous forage crops.

2. Under the conditions of this experiment, there was a marked difference in the way forages affected subsequent corn yields.

3. Ladino clover and mixtures containing ladino resulted in higher subsequent corn yields than did alfalfa and mixtures containing alfalfa.

4. Corn yields following the two mixtures containing orchard grass were higher than those after the two mixtures containing brome grass.

5. The response of corn to the original fertilizer application on the forages was not significant.

6. The corn yields from plots where the forage had been previously left on were higher for every forage species and mixture than yields where the hay was removed.

7. The increase in corn yields resulting from the application of 800 pounds of 3-9-18 on the beets preceding corn was highly significant over yields where no fertilizer was applied.

8. The fertilizer applied in 1950 while beneficial to yields of forage in 1951 and beets in 1952, did not benefit corn in 1953 and oats in 1954.

9. Oat yields in 1954 were generally higher on plots where the hay had been previously left on in 1951.

10. The results of this experiment indicate that even though forages are beneficial in a rotation, they are not a substitute for periodic, liberal applications of commercial fertilizer.

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