UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
BULLETIN 258

Artificial Manure Production On the Farm

Fig. 1.—Burning a straw pile is a felonious assault upon agriculture. The straw pile can be utilized in the production of artificial manure, quickly removing the pile from the field and returning the fertility to the land.

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UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE

Agricultural Experiment Station

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Artificial Manure Production on the Farm

Wm. A. Albrecht

Abstract.—The insufficient supply of barnyard manure on our farms has directed attention to its artificial production from farm wastes. This was demonstrated as a possibility in England, but by methods not suited to American farming systems. In the work reported here, a simple chemical mixture was designed containing 45 per cent ammonium sulphate, 40 per cent finely ground limestone and 15 per cent acid phosphate. When applied to straw it produced a manure similar to that made by patented chemicals. Artificial manure making was tested on a wheat farm in Southwest Missouri by applying the chemicals through the thresher and making flat straw piles to take the rainfall as water needed for the process. In 1926, straw was rotted by December. In 1927 the process was complete by November. Both were, however, seasons of high rainfall. Th manure resembled ordinary strawy manure. When used as a top dressing on winter wheat, it proved superior to applications of straw and barnyard manure as a means of improving the yield and quality of the wheat and as a guarantee for the stand of clover. The process produced about 3 tons of manure for each ton of straw, and at a cost of less than 85 cents per ton.

The well recognized value of barnyard manure, considered in connection with its decreased supply in this motorized age, has aroused much interest in the possibilities of producing artificial manure from straw and similar waste materials. The recent work of making manure artificially in England has given distinct impetus to this idea in the United States. The English method demands that the waste material be built into a pile by layers, while a special chemical treatment and water are applied to each. The pile must be reworked and water added periodically to keep it moist. This method has several objections, (1) it is too laborious, requiring much attention in supplying moisture periodically and in reworking the pile, (2) there is no small difficulty in making the straw take up the necessary water for proper decomposition, and (3) the method scarcely fits into our general farming scheme. In the more highly developed and intensive systems of farming, such as truck farming, the manure value may be high enough to warrant its production by the English method, but in our more extensive systems such is not the case. However, the American general farm often has much straw left as a waste product occupying valuable land where it rots slowly, and a method of using it cheaply is highly desirable. Great piles of straw accumulate in the wheat farming regions, and there some method of getting this organic matter back as a top dressing for

Note.—The farm trials of artificial manure production and use were made on the extensive farm of Mr. E. M. Poirot, in Lawrence County near Golden City, Missouri, to whose careful attention to details and close observation of the process much of the information in this study is due.

In connection with the production of artificial manure, attention is called to patents Nos. 1,471,979 and 1,619,679 dealing with the manufacture of nitrogenous fertilizers and the utilization of nitrogen solutions. The Station can assume no responsibility in connection with any suits for infringement that may be instituted by the owners of these patents.

winter wheat would be an excellent asset in wheat production as well as in the soil fertility maintenance. With the idea of determining some of the possibilities of the method, a study was undertaken to learn the requisites and conditions of artificial manure making and to test the application of such methods under practical farm conditions.

Fig. 2.—A 160-ton straw pile wasted and two acres of land unused for six years. The artificial manure method might have turned both straw and land to profitable use without the loss of even one cropping season.

EXPERIMENT I

Material Used.—In October 1925 three piles of about 700 pounds each of leaves and of straw were set up to receive the following treatments: (a) check or no treatment (b) "ADCO" reagent, and (c) a chemical mixture or "home made" reagent. The "ADCO" reagent is a chemical product sold for the specific purpose of making artificial manure. According to analyses, this contains about 8 per cent nitrogen, which is mainly water soluble, it is of alkaline nature with significant amounts of lime carbonate present, and it has less than 10 per cent of insoluble phosphoric acid, together with significant quantities of available potash.

Since rotting is merely a process in which certain materials serve as food for bacteria or similar micro-organisms, artificial manure making may be likened to an attempt to feed straw to micro-organisms. A ration for these must contain (a) materials supplying energy, (b) substances producing growth, and (c) certain essential minerals, if these small life forms are to multiply rapidly and bring about the decomposition of the straw in the shortest time. Straw consists mainly of cellulose, an energy giving food, hence the chemical mixture or "home made" reagent was one designed to add to the straw such chemicals as would make the whole a good bacterial ration, according to the requirements determined by various workers and early suggested by the bacteriologist Omeliansky. This mixture supplies available nitrogen as a bacterial growth producing substance in quantities suggested by Hutchinson and Richards, the designers of the English method. It contains limestone as an acid neutralizing agent to prevent the accumulation of certain acids from the decaying organic matter thus encouraging more complete breakdown of the straw; and finally it contains small quantities of minerals carrying phosphorus, sulphur, sodium, and magnesium, while potassium is supplied by the straw. This mixture, according to the foregoing plan, contained 45 pounds of ammonium sulphate, 15 pounds of rock phosphate, 35 pounds of limestone, 2½ pounds of magnesium sulphate and 2½ pounds of sodium chloride per 100 pounds. The quantities of the magnesium sulphate and sodium chloride apparently supplied excessive amounts of their respective elements and later work was undertaken to determine whether they are essential in the process. Experiments indicate that the decomposition goes well without them and that it can be carried on without adding these two salts to the formula.

The straw or leaves were carefully piled by building up in layers, the reagent was added at intervals, and moisture applied regularly to insure no large amounts of water leaching away. It was impossible to get much water absorption by the straw at the outset, and only as the

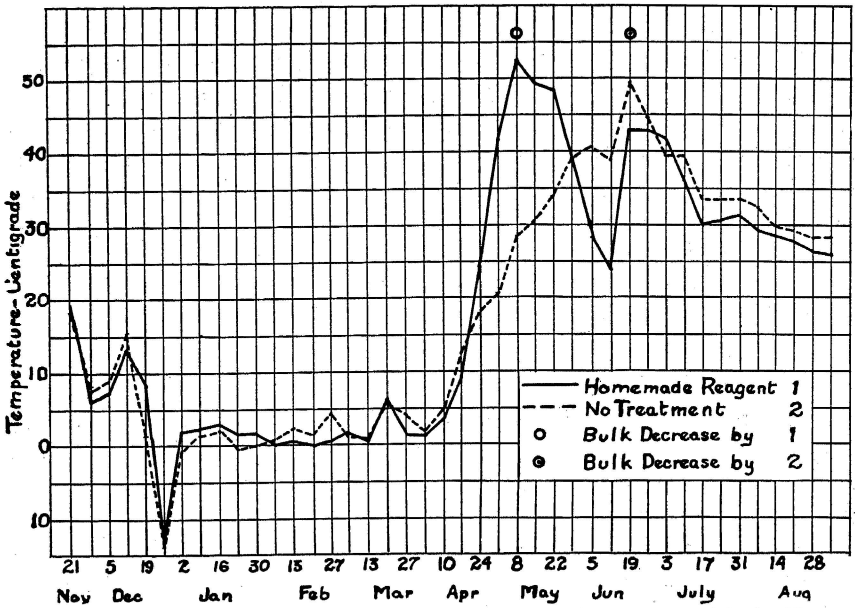

Fig. 3.—Curves showing temperatures of the straw piles treated with the "home made" reagent and with no treatment. Dates of decrease in bulk are noted.

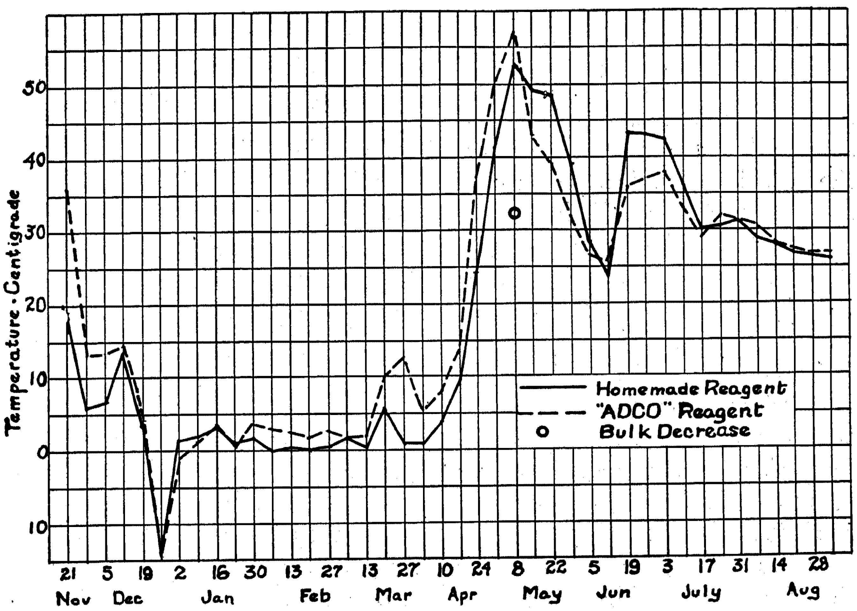

Fig. 4.—Curves showing temperatures of the straw piles treated with the "home made" reagent and with "ADCO" reagent. Date of decrease in bulk is noted as the same for both piles.

material had undergone some decomposition did significant water absorption take place.

Both the "ADCO" and the "home made" reagents were applied at the rate of 150 pounds per ton of air dry straw or leaves, supplying nitrogen at nearly equal rates of about 12-14 pounds per ton of organic matter. According to English experiments about 14 pounds must be added to each ton of straw to favor its decay. Some recent work by the Oregon Experiment Station indicates that artificial manure can be made successfully with 10 pounds of nitrogen per ton of straw, which offers less danger of nitrogen loss during the rotting process. Further experimental work must determine the extent to which a reduction in the amount of nitrogen may be made and still give an efficient manure producing process. It must be remembered, however, that so long as there is no nitrogen lost the higher percentages add to the value of the manure produced.

Since all the chemicals used in this "home made" reagent are readily obtainable, its preparation involves no great difficulty. Ease in obtaining the chemicals for artificial manure production is essential even though their efficiency may not be quite as great as that of materials which are less easily obtained. Fitting the plan to farm conditions is more important than exceptional speed in the process of decay.

Behavior During Decomposition.—To study the course of decomposition in the piles of leaves and straw under treatments a, b, and c, temperature readings were taken at intervals of one week and samples of the product were taken for analyses each time the material was repiled. Observations on volume were also made. The outstanding characteristic of the straw was its delay in fermentation which may possibly be attributed to (a) the cool weather in consequence of the lateness in the season when the piles were set up, and (b) to the difficulty in getting the straw moistened. The weekly temperatures of the straw are given in the form of graphs in Figs. 3 and 4.

The temperature of the piles remained similar to that of the atmosphere for considerable time, even after they had been reworked and additional water added. The rise in temperature in the treated straw did not occur until March and April, reaching a maximum by early May. The untreated pile of straw began to show a rise in temperature about the same time but did so at a much slower rate and attained its maximum only by the middle of June. In this connection it is interesting to note that there occurred a sudden decrease in the volume of the well settled piles at the same time that the maximum temperature was reached. The temperatures declined about as rapidly as they rose and after the great decrease in bulk had taken place the temperatures again corresponded to that of the atmosphere. The comparison of the bulk in the treated piles with the check is shown in Fig. 5.

The performance by the piles of leaves was similar to that of the straw piles, save that here the temperatures rose immediately after the piles were built and the decrease in bulk took place in about three months, after which the temperatures of the piles decreased and then corresponded to that of the atmosphere. At the time the leaves were put into the pile they were already moist without the addition of the water, since they were collected during a rainy period. Their temperature

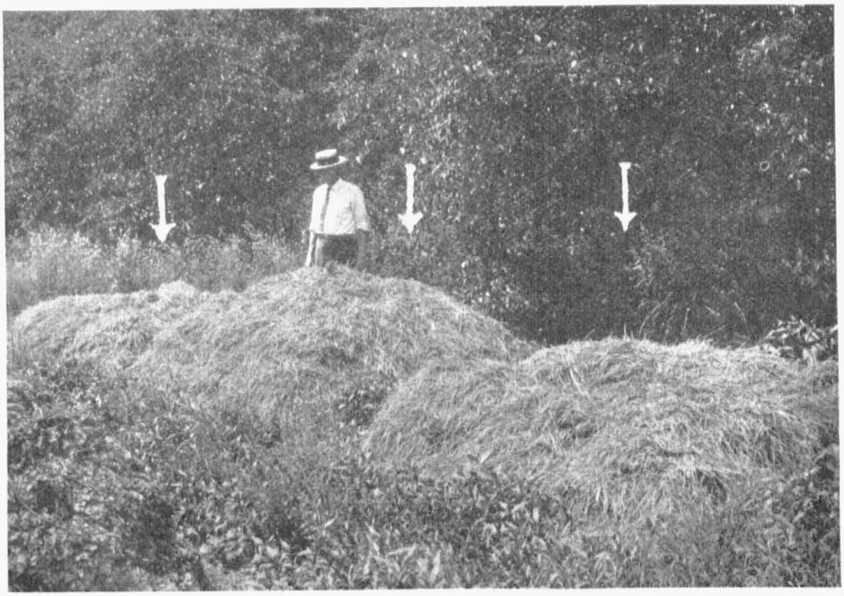

Fig. 5.—Artificial manure heaps after marked volume change in the piles treated and just before such change by the pile without treatment. (Left) chemical mixtures, (center) no treatment, (right) "ADCO" reagent.

rose over night while preparations were being made to put them into piles with the reagents. They also retained moisture better, which may have been the factor responsible for the earlier start in their decay as compared to that of the straw. The performance by the leaves was in most respects similar to that of the straw, but followed more promptly upon the initial treatment of the piles.

Composition Changes During Decay.—The analyses of samples of straw, taken at three intervals during this study, (Table 1) show that the percentage of nitrogen in the dry matter increased significantly, indicating a high carbon loss relative to the nitrogen. During the active temperature rise there was a significant increase in the water soluble nitrogen for the pile treated with "ADCO". This decreased, however, after the maximum temperature was reached. In the check pile the water soluble nitrogen decreased from the beginning.

TABLE 1.—NITROGEN CONTENT OF ARTIFICIAL MANURE FROM STRAW AT VARIOUS PERIODS
(Percentage in Dry Matter)

Treatment	Date	NITROGEN Total	Water-soluble	Water-insoluble
No treatment	2/3/26 4/19/26 6/14/26	1.07 1.31 1.55	0.27 0.24 0.18	0.80 1.07 1.37
Chemical mixture	2/3/26 4/19/26 6/14/26	1.71 2.07 2.62	0.82 0.57 0.86	0.89 1.50 1.76
"ADCO" Reagent	2/3/26 4/19/26 6/14/26	1.69 2.03 2.12	0.32 0.67 0.40	1.37 1.36 1.72
Straw	At Beginning	0.70	0.16	0.54
"ADCO" chemicals		7.96	7.66	0.36

Analyses by Department of Agricultural Chemistry, Missouri Agricultural Experiment Station.

Chemical tests for the value of the insoluble nitrogen were made by two methods. Both the "ADCO" and the "home made" mixture gave a high degree of activity for the insoluble nitrogen, whether these treatments were used on the straw or the leaves. According to Dr. L. D. Haigh, chemist of the Missouri Agricultural Experiment Station, this activity for manure, by the one method of testing, ranges from 45 to 55 per cent, and by the second method, from 25 to 30 per cent. The average figure for the two treatments in composting both leaves and straw was 56.35 by the first method of testing and 26.23 by the second, and 5 per cent greater in each case than that for the untreated straw. The figures indicate, according to Dr. Haigh "that the activity seems to be increased by this composting until the material is as good as manure or better."

Final Appearance.—Shortly after the decrease in volume took place, or when the temperatures of the piles approached that of the atmosphere, the straw had taken on the appearance of manure commonly produced in lots by livestock around the straw stack, or in barnyards where straw is liberally used as bedding. The resemblance of this material was similar in almost every way to manure made under the above conditions, and it handled in all respects like it.

EXPERIMENT II

Farm Methods for Production. (First Year).—In late July of 1926 farm trials of artificial manure making were undertaken on the farm of E. M. Poirot in Lawrence County. In these trials the "home made" chemical mixture, modified to include acid phosphate instead of rock phosphate, was used. In one pile (No. 1) both chemicals and water were applied to straw during threshing. The chemicals were added through a simple machine fitted to the rear of the separator and driven by a belt from a shaker shaft, and the water by means of a fish-tail nozzle mounted at the end of the blower pipe. The flow of both water and chemicals was so adjusted that 150 pounds of the reagent was thoroughly mixed with each ton of dry straw and all of the water that the straw would retain without loss. The weight of straw threshed per bushel of grain, was determined by subtracting from the weight of a load of sheaves the weight of the grain contained, and dividing the difference by the number of bushels. Accordingly, the chemicals were supplied at a sufficient rate per bushel of grain threshed to equal 150 pounds per ton of straw. Another pile (No. 2) was supplied with chemicals only, but reworked after threshing in such a way as to admit the maximum amount of rainfall, for the purpose of learning whether ordinary rainfall would supply sufficient moisture for the process. A third pile (No. 3)

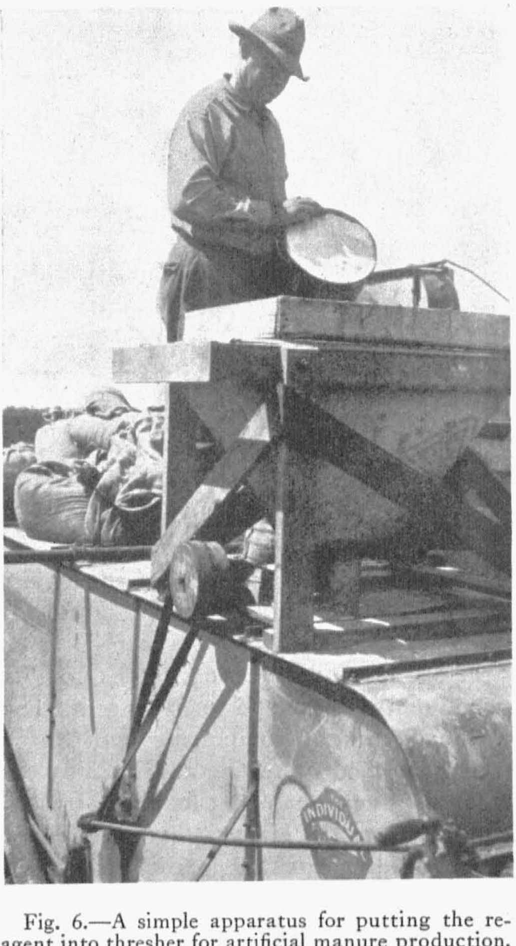

Fig. 6.—A simple apparatus for putting the reagent into thresher for artificial manure production. (Designed by E. M. Poirot, Golden City, Missouri.)

received no treatment, except reworking to encourage maximum rainfall absorption.

Examination of the straw heaps during early decomposition showed that Nos. 2 and 3, which were worked into flat piles, took the rain very well, while the one supplied at the outset with both chemicals and water seemed to be taking the rain on the surface only. This resulted probably from the significant packing of the wet straw at the time of threshing, and its distinct arrangement within the pile. One could see definite layers sloping in such a way that water would run off instead of being absorbed. This condition brought about a drying out of the original moisture shortly after the first heat of decay started, and a decrease in the ultimate decomposition of the pile.

TABLE 2.—RAINFALL (INCHES) AND TEMPERATURES (DEGREES CENTIGRADE) OF ARTIFICIAL MANURE IN FARM TRIALS

Pile number and Treatment	Temperatures — Dates Recorded: Aug. 1	Aug. 8	Aug. 15	Aug. 20	Aug. 22	Aug. 30	Sept. 5	Sept. 14	Sept. 23	Sept. 28	Oct. 2	Oct. 15
No. 1—Chemicals and water at outset	44	45	54	51	70	53	38	59	59	10	32	50
No. 2—Chemicals only	26	26	26	47	62	54	28	51	51	9	28	30
No. 3—No treatment	26	25	26	24	37	38	20	38	38	7	18	22
Air Temperatures	37	37	35	26	35	27	24	28	28	10	18	24
Rainfall between recorded dates	.45	----	.36	4.30 (a)	----	.85	5.92 (b)	3.90	----	2.24 (c)	2.31 (d)	3.90

(a) Total for 5 successive days including date of record.
(b) Total for 2 successive days including date of record.
(c) Total for 4 successive days including date of record. Very low temperatures prevailed 3 days including date of record.
(d) Total for 3 of 4 days just preceding date of record.

Behavior During Decomposition. Temperatures and samples were taken at intervals. Decomposition began promptly, as was shown by temperature readings in Table 2, so that by December the pile of straw receiving chemical treatment only (No. 2) had taken on its manure-like appearance. The straw receiving both water and chemicals (No. 1) had undergone decomposition in very limited but scattered areas in the pile, while the untreated pile (No. 3) gave no signs of decay. The pile receiving chemicals only (No. 2) showed the most complete decomposition, even though its temperature was generally lower than that of the pile receiving chemicals and water at the outset. It is interesting to note that the rise in temperature and the decomposition of the straw started more promptly in the farm trials than they did in the experiment with the small piles at the beginning of the study of this process. This might be expected, since the farm trials were set up on July 30 and had the summer season to encourage decomposition while in the first study the small piles were not set up until late October when much lower temperatures prevailed.

The samples taken were tested for the degree of decomposition according to the hydrogen peroxide method of Jones of England, the results being given in Table 3. According to this test a 6 per cent solution of hydrogen peroxide will burn out organic materials which have been decomposed to the "humus" form, but does not attack fresh or "unhumified" straw. Samples from the piles were treated with hydrogen peroxide and their loss of the organic matter by this method was taken as an index of the degree of humification or degree of breakdown of the straw toward the manure stage. At the various sampling periods, pile No. 1, which received both chemicals and water, exhibited such an irregularity in the degree of decomposition that several sample were taken with a view towards representing the true conditions. Evidently one single wetting at the time of threshing gives insufficient moisture to insure decay. This irregularity in the decay in this pile is shown by the data in Table 3. Only one composite sample was taken in

TABLE 3.—DEGREE OF DECOMPOSITION OF ARTIFICIAL MANURE AFTER 70 DAYS

Treatment given straw	Appearance of sample	Percentage combustible matter removed by hydrogen peroxide	
Chemicals and water added (Pile No. 1)	Bright, strawy Slightly decayed Very well decayed	11.8 25.5 45.3	27.5
Chemicals only (Pile No. 2)	Well decayed		37.5
No treatment (Pile No. 3)	Bright, strawy		14.3

the case of each of the other two piles because their degree of decomposition was so uniform that such a sample could readily be considered representative. The importance of the chemicals in hastening this process as well as the possibility of obtaining rapid decomposition when chemicals only are added to the straw and dependence is placed on rainfall for moisture, are clearly indicated by the figures from this test showing the slight decomposition in the check or no-treatment pile.

Excessive Rainfall Favored Test.—It is well to note from the data given in Table 2 that there was significant rainfall in the case of the early part of this test. In fact, during August, September, and October the rainfall was 5.96, 12.07, and 3.50 inches when the 28-year averages of rainfall for these months are 4.17, 4.00, and 3.45 inches, respectively. During these three months of the experiment the total rainfall was more than double the normal. Furthermore, the temperature of the straw

Fig. 7.—Differences in quality and yield in harvests of 40 wheat heads resulting from application of lime and acid phosphate (left), and from the application of lime, acid phosphate and artificial manure (right).

rose each time after the additional moisture of the rain was received. This is especially true of Pile No. 2, when the straw received chemical treatment only, and is not necessarily the case in Pile No. 1, where water was applied at threshing time, since this pile was not constructed for rainfall absorption. In the case of the untreated pile, no such correlation is noticeable. Though the rainfall of this test was above the normal of 11.62 inches, even the normal amount will serve for considerable depth of straw when it is remembered that the excessive rain during this trial served for piles as high as 10 feet and more.

Fig. 8.—Alsike clover plants showing effects of artificial manure treatments. Left to right: Lime and acid phosphate; lime, acid phosphate, and straw; lime, acid phosphate, and artificial manure.

Field Tests of Artificial Manure.—To fully test the possibility of using artificial manure on the farm, the rotted materials from the three different piles were spread at the rate of six loads per acre in December on separate sections of a field of winter wheat. The soil is of the Gerald silt loam type with a level topography whose surface soil is a gray silt loam about 8 to 10 inches deep, and whose subsoil is distinctly tight or impervious. This land was limed at the rate of 2½ tons per acre in July previous to the seeding of wheat in October. An application of 200 pounds of 20 per cent acid phosphate was used on the wheat. A clover mixture was seeded about the 15th of March in 1927.

During the early period following the application of the artificial manure no distinct differences in the wheat could be observed. Effects on the clover, however, were noticeable about the time the wheat was maturing. No attempts were made to take acre yields on the wheat, but samples of 40 heads were taken at random from the various plots and the amount of grain, as well as its quality, noted. The differences in these respects are shown in Fig. 7. The influence on quality was especially noticeable. The application of the straw from the untreated pile (No. 3) gave less yield and more shrivelled grains than those from the plot with

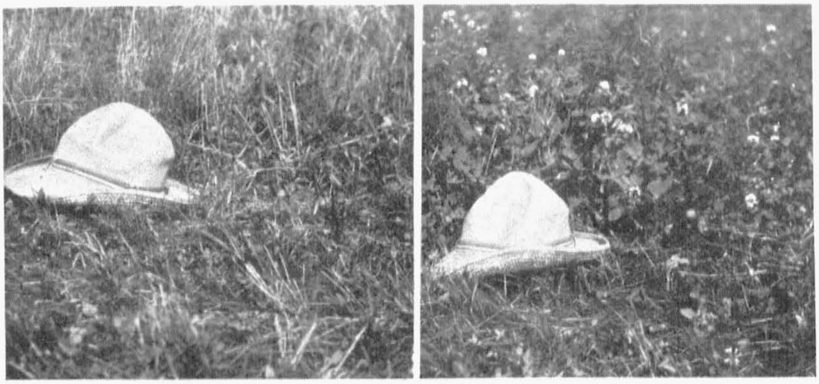

Fig. 9.—Stubble clover with lime and phosphate treatment (left) as compared with clover where this treatment was supplemented with artificial manure (right).

no manure or straw treatment. Significant improvement in quality occurred as a result of the use of the artificial manure whether from pile No. 2, well decayed, or from pile No. 1, only partly decayed, and whether the well rotted manure was applied in December or even as late as April. The differences in clover were intensified after the wheat was cut. These differences are shown in Fig. 8 representing ten alsike clover plants harvested as representatives from the different plots while Fig. 10 shows the same for sweet clover plants. The differences in the amount of clover in the stubble are shown in Fig. 9.

On this gray prairie soil the effect of the artificial manure on the stand of clover was especially noticeable, even above the effects of lime and acid phosphate, or these combined with a top dressing of straw. It suggests that the effect of the manure is due largely to the readily usable nitrogen it carries. The effect in this case was even greater than that of barnyard manure, however, since this latter treatment failed to give the response with sweet clover that was given by the artificial manure. Perhaps as a result of the low nitrate supply and small nitrifying activity within the soil during the cold and wet spring season when the clover seedings were started, the comparative advantage of the artificial manure as a carrier of nitrogen was intensified. Nevertheless, the artificial manure manifested its superiority in this respect over straw or even ordinary barnyard manure.

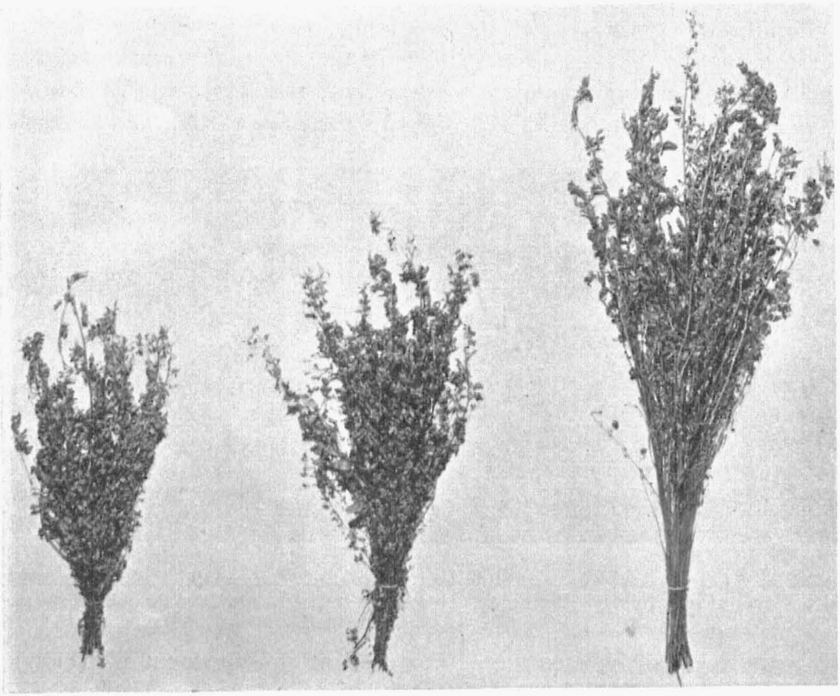

Fig. 10.—Sweet clover plants showing effects of artificial manure treatments. Left to right: Lime and acid phosphate; lime, acid phosphate, and barnyard manure; lime, acid phosphate, and artificial manure.

EXPERIMENT III

Farm Methods for Production (**Second Year**).—The results of the farm trials in 1926 were favored by excessive rains, hence the process was tried again in 1927. The chemicals were introduced during threshing as previously and the straw left in flat piles about 5 to 6 feet high. This was the estimated depth of straw that would be moistened by the average rainfall during the autumn months. On one pile the reagent was scattered by hand to test the possibility of this method of application. The piles were made flat so they would readily take up the rainfall, on which dependence was placed for moisture for the process.

But 1927, like 1926, also had excessive rains. The piles were soon compact, and decay started in a short time. There was no significantly high temperature in these shallow piles, as had occurred in the previous trial with deeper piles. Nevertheless, decay was rapid and the straw that had received the reagent through the machine had the appearance of manure by the first of October and could have been handled and spread like it as early as the wheat seeding season. Where the reagent had been added by hand there was not the uniformity of decay as where the reagent was applied through the thresher. This suggests the importance of the uniform distribution of the reagent through the straw such as was accomplished by the latter method.

Although the trials during both years were favored by a plentiful supply of rain, nevertheless they indicate the possibility of adjusting the depth of the straw so that average rainfall will complete the process in a short time. Less than average rainfall will require more time, since the rotting process begins at the top and moves downward at such a rate as the added moisture allows. In the first trial, with piles as deep as 14 feet, decay was not complete until December, while in the second trial with piles not over 6 feet deep the straw was converted into manure by October. These two periods of time as related to the depth of the straw suggest strongly, that even when rainfall is depended upon for moisture, wheat straw may be converted into manure by this process in ample time to serve as top dressing for winter wheat.

Practical Conclusions.—By the results of the production and use of artificial manure under farm conditions, the possibilities of this material in the common farming scheme are shown to be very promising. A reagent consisting of 45 pounds of ammonium sulphate, 15 pounds of acid phosphate, and 40 pounds of limestone in 100 pounds, when added at the rate of 150 pounds per ton of straw and when the mass is left in a flat pile to absorb rain, has given remarkably good results in the production of an artificial manure. The amount of manure produced in this trial was approximately three loads from each ton of dry straw, while its composition was similar to that of barnyard manure, with possibly a slightly lower content in phosphorus. If a ton of wheat straw were produced per acre, this method of manure making would permit top-

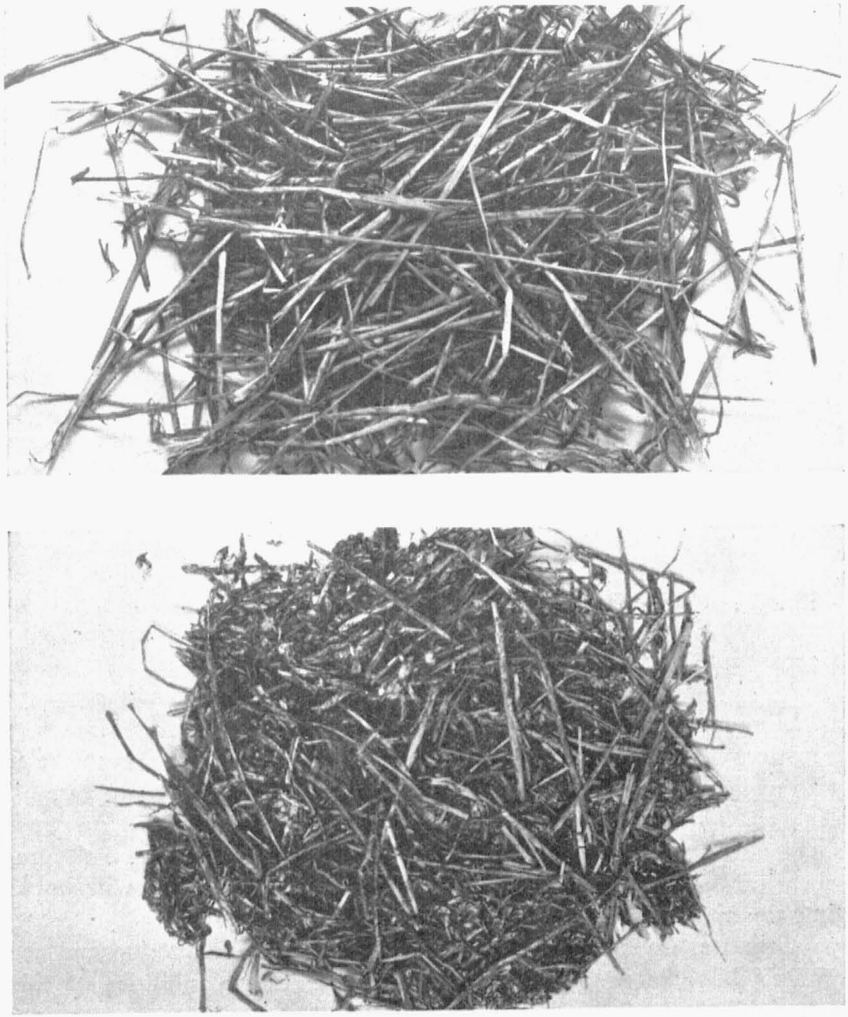

Fig. 11.—Dried manure showing the rotting effects of added chemicals. Weathered two months without chemicals (above). The same treatment with chemicals (below).

dressing half the wheat acreage with six tons of manure annually from the material grown on the wheat land. This would mean covering the wheat land of the farm with manure once every two years, which is more often than any present method of manure making permits.

The cost of manure produced by this practice under farm conditions in this case has been less than 85c per ton when an allowance is made for a liberal loss in bulk. A careful record kept on the farm where this study was made indicates that the labor cost of hauling the straw as sheaves to the feed lot to be threshed and back to the field again as manure amounts to 60c per mile per ton of manure. On more than half of this farm this saving through artificial manure production in the field will alone offset over half of the cost of the treatment of the straw, while it retains the full fertility value for use the following winter. At this rate, or even at the rate of 85c per ton under average farm conditions, this method may well receive consideration. In the light of a prospective decrease in the cost of nitrogen, which is the main item of expense in this process, the cost may become quite moderate.

The use of such manure as a top dressing on winter wheat, which practice has long been known to be justifiable from results at the Missouri Agricultural Experiment Station and other stations, may prove very profitable. Furthermore, the plan encourages the early return of the straw to the soil as organic matter and eliminates the waste resulting in rotting straw piles or old stack bottoms. This decomposition process removes the excessive carbon from the straw, narrows its carbon-nitrogen ratio and changes the effect of its application to wheat land from a generally detrimental one to a beneficial one. According to the indications of this study, not only straw but other organic materials, including corn stalks, might be converted into manure. In view of the apprehension now occasioned by the threatened spread of the European corn borer, the production of artificial manure from corn stalks would be a wise practice not only in maintaining soil fertility but in the possible destruction of the borer by the heat resulting from fermentation. Other wastes may be utilized in this process of manure production when conditions warrant their use.

SUMMARY

1. The decrease in the supply of farm manure has aroused interest in its artificial production from straw and other farm wastes.

2. Trials of artificial manure production were made by a method similar to that used in England and suggest the possibilities of adapting this method to farm practice.

3. A chemical mixture of simple formula gave better results than a commercial substance designed for artificial manure making.

4. A mixture consisting of 45 pounds ammonium sulphate, 15 pounds of acid phosphate, and 40 pounds of finely ground limestone per 100 pounds, used at the rate of 150 pounds per ton of straw will, with moisture, convert the straw into a brown product having all the general properties of manure.

5. The artificial manure process was used under farm conditions by applying the chemicals to wheat straw through the thresher, and making flat piles to take rain water and bring about the decay.

6. A product of manure-like appearance and behavior resulted in the farm trials as early as December in one trial, and as early as October in another, following the threshing in late July.

7. The application of this artificial manure as a top dressing on wheat seeded later to clover improved the quality of wheat and was of significant benefit in getting a stand of clover.

8. The artificial manure showed its superiority over applications of straw or ordinary barnyard manure in benefits to the wheat and the clover.

9. The process of making artificial manure from farm wastes deserves wider attention as a good farm practice to increase the return of organic matter to the soil and to prevent the waste of straw and other farm residues that may well go back to the land.