

## AGRICULTURAL EXPERIMENT STATION

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# The Value of Farm Manure

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Manure increases corn yields.

Missouri farms produce over fifty million tons of manure annually. Fifty years of results from Sanborn Field at the Missouri Agricultural Experiment Station, indicate that if this manure were fully utilized it could produce an annual increase in crop yields worth \$150,000,000. This would be the equivalent of more than \$650 annually on an average farm in the State. It is more than double the value of all corn produced in Missouri, and three times the value of all beef cattle in the State. Manure not only increases crop yields,

MANURE MAKES EACH ACRE BIGGER

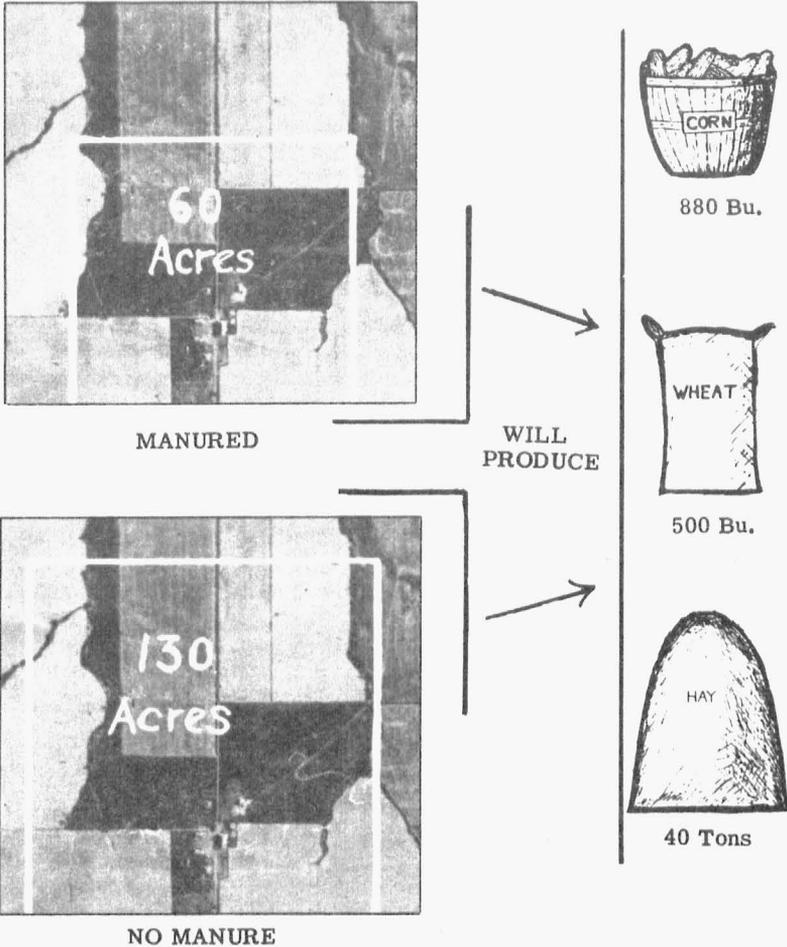


Fig. 1.—Sixty acres of manured land will produce as much as 130 acres of unmanured land.

but it also affects the quality and the nutritive value of the crops produced. The organic matter this manure contains represents twice the amount of humus that is lost from our soils each year through cultivation. Unfortunately, only a small portion of the potential crop-producing and soil-conserving value of manure is realized. Probably over one-half of the manure is never returned to the land where future crops can be benefited by it.

Field tests measuring the value of manure in terms of increased crop yields have been conducted continuously on Sanborn Field

since 1888. The improvements in yields and in crop quality from this soil treatment during the past half century illustrate forcefully the importance of returning manure to soils if the future productivity of the land is to be insured.

### Manure Increases Crop Yields

The significance of manure as an aid in increasing crop yields has been appreciated from earliest times. Its value is recognized by most farmers, but many do not understand the perishable character of its most valuable constituents, nor the direct monetary loss incurred through its improper management. The plots on Sanborn Field, which have received manure since 1888, tell a story of soil conservation and of increases in farm income with particular interest to those who wish to study the results, and to follow the simple rules for efficient utilization of ordinary farm manure.\*

In a three-year rotation of corn, wheat and red clover, when applied even at the heavy annual rate of 6 tons per acre as was provided in those experiments fifty years ago, manure has produced very profitable increases in yields of all crops. During the past fifty year period manure has produced annual increases in yields of 13 bushels of corn, 13 bushels of wheat, and 2900 pounds of clover as shown in Figure 2. In calculating the value of these increases, corn was considered worth fifty cents per bushel, wheat eighty cents, and clover hay ten dollars per ton. These are figures that are conservative and are fair averages of the prices received by farmers during the 1930-1940 period. Accordingly, the manured land has

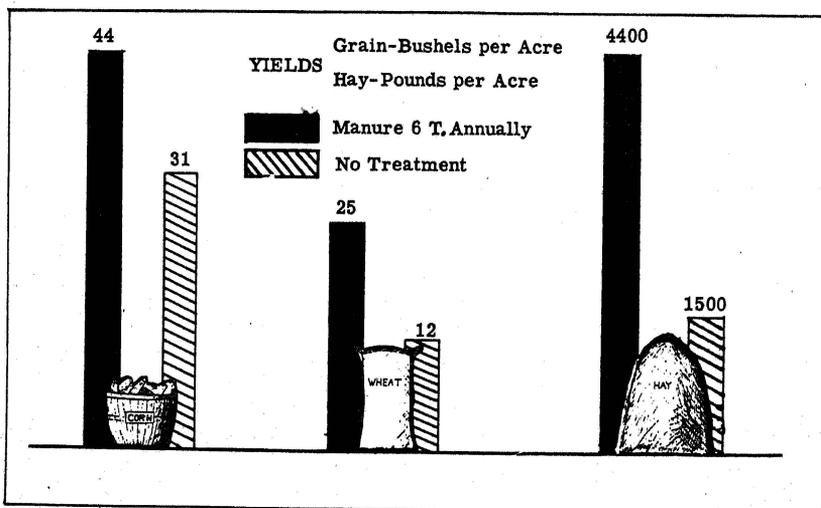


Fig. 2.—Yields of crops (average of fifty years) in a three-year rotation with no treatment, as compared with six tons of manure annually.

\*The complete results from Sanborn Field for fifty years are reported in a more technical publication, Missouri Station Bulletin 458.

produced crops having a value of twenty-four dollars annually, while the untreated land has produced crops with a value of only thirteen dollars. With these conservative prices and with this comparatively heavy rate of application, the return for each ton of manure is about two dollars. With higher prices for farm produce these differences would be accordingly greater.

### Economic Returns From Manure

The labor and investment are about the same whether one is producing a high yield on a fertile soil or producing a low yield on an infertile soil. Usually the fertile soil will have better tilth and the power required for tillage will be less than for the infertile soil that is low in humus and in poor tilth. There will be, however, somewhat higher costs in harvesting the larger yield.

By using the prices commonly charged for custom plowing, combining and other farm operations, and with a fixed rent charge for the land, the unmanured soil shows a net annual return of three dollars per acre, (Table 1), while that which was manured re-

TABLE 1.—ANNUAL NET RETURN PER ACRE FOR FIFTY YEARS OF ROTATION WITH AND WITHOUT MANURE.

	No manure	Manure
Corn yield .....	31.7 bu.	44.4 bu.
Wheat yield .....	12.7 "	25.1 "
Clover yield .....	1656 lbs.	4446 lbs.
Average annual crop value .....	\$13.00	\$24.00
Labor and harvesting cost and rent .....	\$10.00	\$11.00
Annual net return per acre .....	\$ 3.00	\$13.00

turned thirteen dollars, or more than four times as much. This is a return of ten dollars annually for the six tons of manure applied. If higher prices were obtained for the crops produced, this difference in value would be proportionately greater (Figure 3).

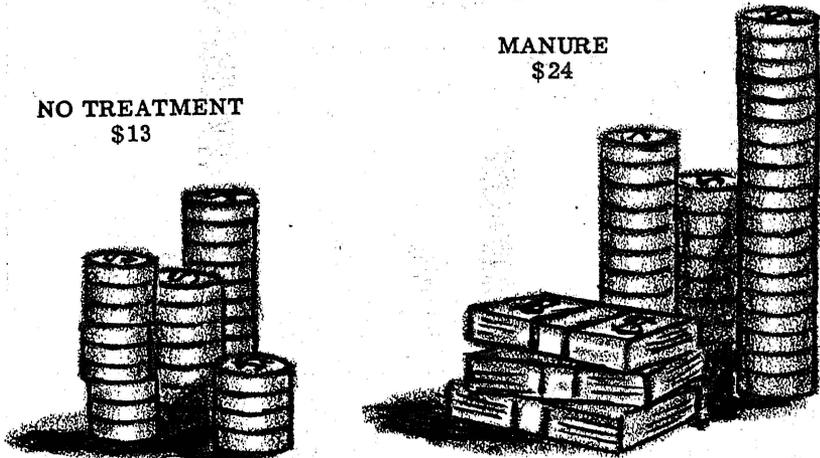


Fig. 3.—Increase in value of crops from the use of manure. Left: average value of crops for fifty years without treatment, \$13.00. Right: six tons of manure annually \$24.00 an increase of \$11.00 for 6 tons of manure (three-year rotation—corn, wheat, clover).

In terms of a farm investment, the net annual return of three dollars per acre for fifty years on the untreated land represents a return of five per cent on land valued at sixty dollars per acre. However, where manure had been applied to give an annual net value of crops amounting to thirteen dollars per acre such land would be worth two hundred and sixty dollars per acre. With its value calculated on the basis of this return as one of five per cent on the land value, even if a charge of one dollar per ton were deducted for the manure (six dollars annually), the remaining return of seven dollars would represent a land value of one hundred forty dollars per acre. This value is still more than twice the value to be had for the untreated soil, (Figures 4, 5, and 6).

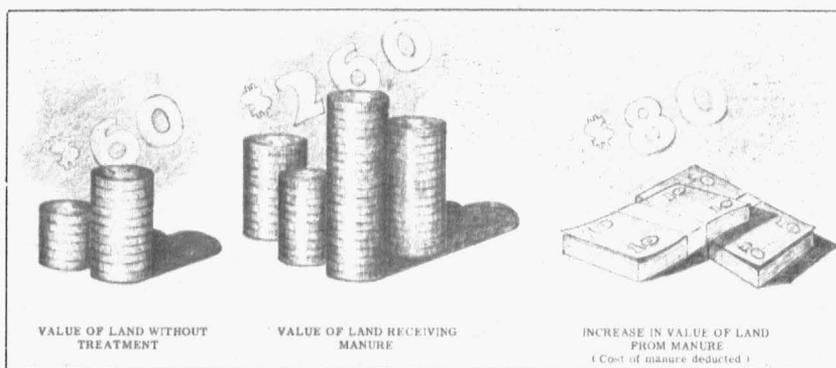


Fig. 4.—Value of land when net profit is considered as five per cent return on investment. The use of manure has increased the land value \$80.00 per acre.



Fig. 5.—Yields of corn (average of fifty years) in a three-year rotation. Left: no treatment 31 bushels per acre. Right: manure annually 44 bushels per acre.

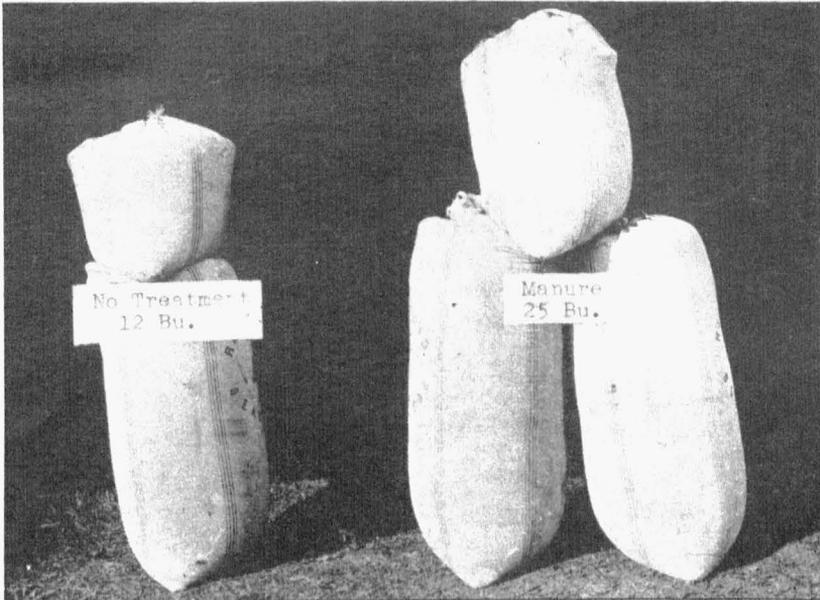


Fig. 6.—Yields of wheat (average of fifty years) in a three-year rotation. Left: no treatment, 12 bushels per acre. Right: manure annually, 25 bushels per acre.

### Rate of Manure Application

During the last twenty-five year period of the Sanborn Field experiments the application of manure on certain plots was reduced to three tons per acre. The results for this period show the greatest return per ton was secured when the manure was applied at the lower rate. The heavier amounts per acre gave greater total yields but the return per ton applied was less. With wheat, for example, six tons of manure produced only 4.3 bushels more per acre than was

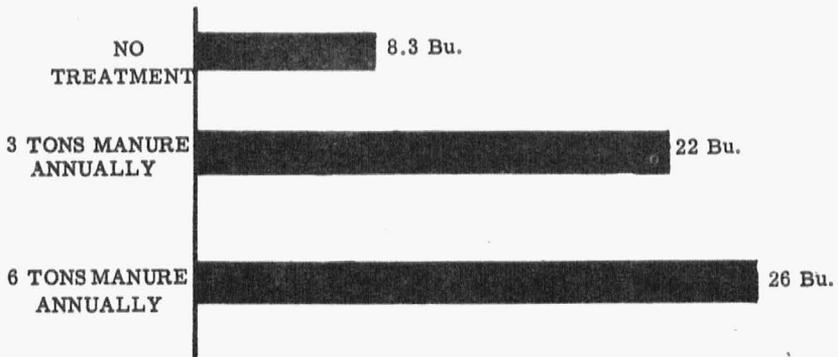


Fig. 7.—Yields of wheat (average twenty-five years, 1913-1938) in a six-year rotation according to rates of application of manure.

produced by three tons. The three tons, in turn produced 13.7 bushels more than the land receiving no treatment, (Figure 7). This and other experiments show that in general farm practice and where the amount of manure is limited, it should be made to cover as much land as is feasible.

### Trends of Soil Productivity and Crop Yields

In any system of agriculture that is to be permanent, attention must be given to the soil and its capacity to produce future yields. No better general measure of soil productivity can be obtained than the nitrogen content of the soil.

The land receiving regular applications of manure contained over ninety per cent as much nitrogen in the soil as when it was first plowed, while the untreated land had lost nearly sixty per cent of the original nitrogen (Figure 8). Accompanying this decline

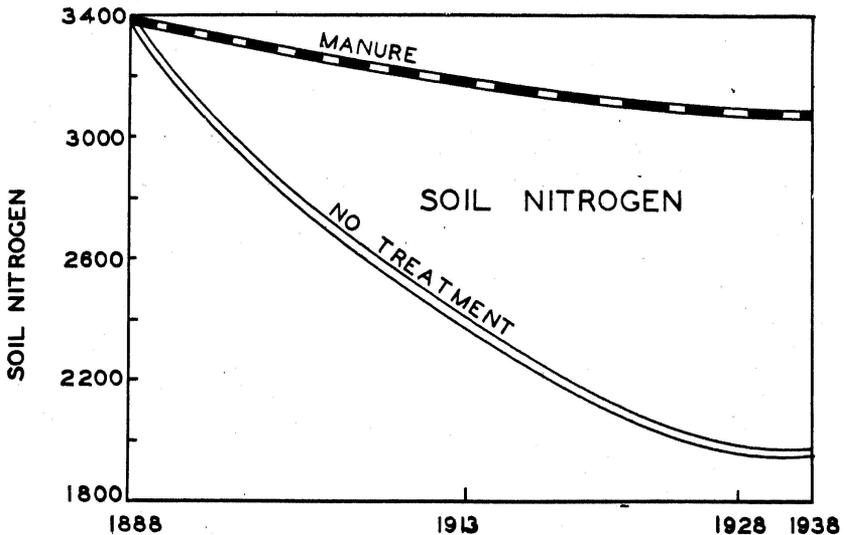


Fig. 8.—Trends in soil nitrogen during fifty years in soils manured and given no treatment. Three-year rotation of corn, wheat, and red clover.

in nitrogen there was a change in the soil's productive capacity. On the manured plot during the first twelve years of this cropping system, the average annual value of all crops was twenty-two dollars per acre, (Figure 9). Its value increased to more than twenty-five dollars during the last twelve years. The untreated plot produced crops worth only slightly more than thirteen dollars annually during the first twelve years of the experiment. Yet despite better crop varieties, better implements, and better methods now in

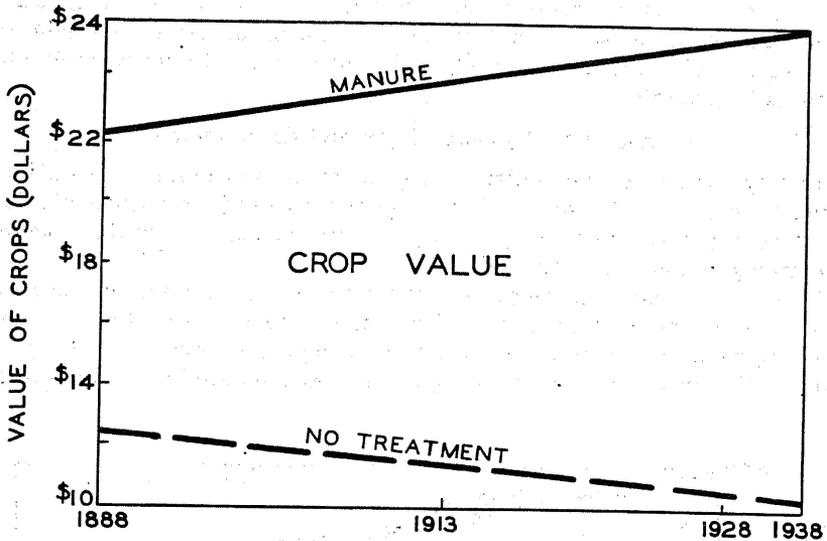


Fig. 9.—Trends in value of crops during fifty years on soil manured and given no treatment. Three-year rotation of corn, wheat, and red clover.

use, the annual value of the crops has declined nearly two dollars per acre to ten dollars for the last twelve year period. Not only are the yields less on the unmanured land, but this soil has much poorer tilth, and requires more labor in preparation for each crop. It is much more sensitive to weather hazards than is the manured land. In recent years it has produced fair crops in good seasons, but in poor seasons all crops have been failures. The manured plot has given satisfactory yields under most any conditions of the season.

The yields from these plots in the last rotation were those given in Table 2.

TABLE 2.—YIELDS OF CROPS IN LAST ROTATION OF THREE YEAR ROTATION PLOTS RECEIVING NO TREATMENT AND SIX TONS OF MANURE ANNUALLY.

	No treatment	Manure	Increase
Corn .....	20.0 bu.	84.3 bu.	64.3 bu.
Wheat .....	1.0 "	16.8 "	15.8 "
Clover .....	650 lbs.	2850 lbs.	2200 lbs.

#### Quality of the Crop

In all of the calculations of the crop value it has been assumed that crops have the same value regardless of soil treatment. It is known that those crops produced on fertile, or treated, soil may have a much higher nutritive value when fed to animals than is true for

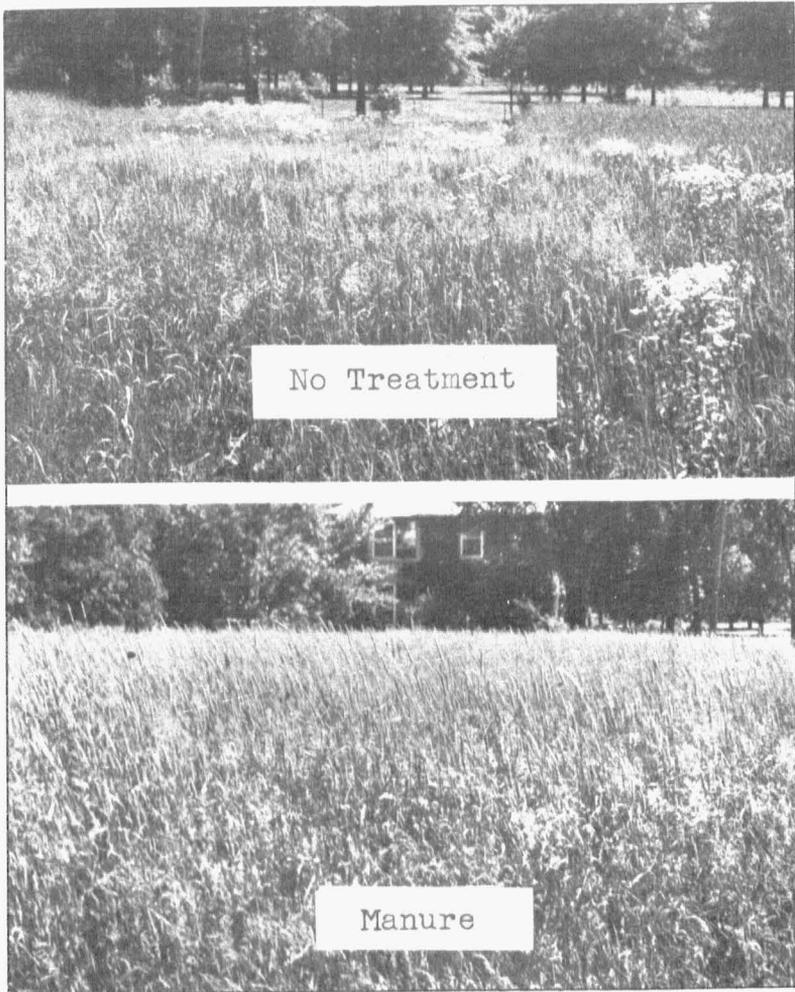


Fig. 10.—Quality of timothy is improved by manure—annual yields, average 1888-1938. Above: no treatment, 2,500 pounds per acre. Below: manure six tons annually, 5,100 pounds per acre.

those from soils of low productive capacity. Counts of the plants on timothy plots that had received manure and on those given no treatment showed that after the grass had been seeded for two or three years the manured plot contained over eighty per cent timothy, while on the untreated plots timothy seldom made up more than ten per cent of the plant stand. The rest of the vegetation was largely red sorrell, poverty grass and redtop (Figures 10). Not only are plants of higher nutritive value able to grow on good land, but these plants are capable of producing more satisfactory animal gains when fed than are the same kind of plants without treatment.

### Manure Alone is not a Complete Soil Treatment

Manure, with all its beneficial effects, is by no means a complete soil treatment. Manure varies in composition according to the kind of feed and the age and kind of animal producing it. It usually contains much more nitrogen and potash than phosphorus. On such crops as the small grains, the application of phosphorus with the manure is beneficial. Phosphorus added to manure has increased the yield of wheat by eleven bushels as is shown in Figure 11.

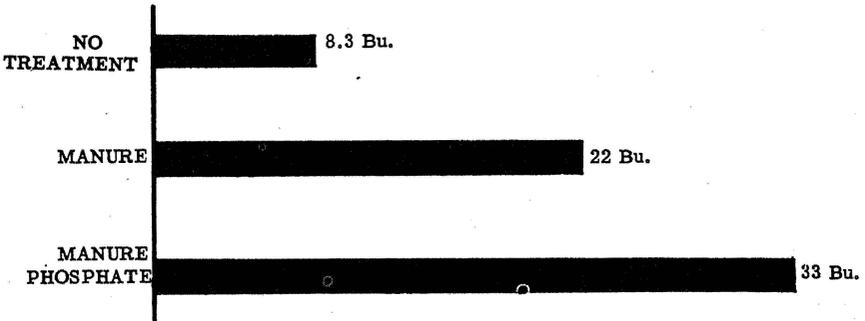


Fig. 11.—Yields of wheat as influenced by manure and by manure and phosphates. Yields as average, 1913-1938.

Most soils in Missouri are in need of lime. Manure is comparatively low in lime. Where difficulty is encountered in obtaining stands of clover it will be necessary to use lime in connection with the manure and phosphate.

### The Conservation and Use of Manure

The handling of manure is one of the disagreeable tasks that is constantly confronting farm operators. A lack of understanding of its true value and its perishable nature lead to inefficient conservation and use of it. The results of fifty years of continuous experimentation with manure indicate that no farm practice can bring such large returns with so little cost. If the equivalent value of this farm by-product, that is so commonly wasted, were purchased in the form of commercial fertilizer it would represent a large sum of money. It seems exceedingly neglectful to allow this farm resource to go to waste when it is so valuable and when it can be so easily saved.

Experiments have shown that the following practical methods of handling manure will return the largest possible amounts of it with the retention of maximum content of its crop-producing and soil-building values.

1. **Plenty of Bedding Should be Used in Making Manure.**—An abundance of bedding of high absorptive capacity is essential for saving the urine. More than one-third of the nitrogen and two-

thirds of the potassium voided by animals are in the urine. Straw is the most common bedding material used, but many materials, such as lespedeza straw and chaff, clover hulls, cottonseed hulls and corn stover can be used. In addition to absorbing the liquid manure, these will add minerals and organic matter to the soil.

**2. Manure Should be Hauled When the Program of Farm Work is Not Crowded.**—The greatest quantity of nutrients in manure may be saved by the use of adequate bedding, with immediate spreading and working into the soil. However, this may necessitate hauling when other farm work is pressing. If it is impossible to haul the manure to the field as made, it should be firmly packed or tramped in the stall or shed. Manure can be effectively utilized during the winter on fall-seeded small grain if hauled and spread when the ground is frozen so that the nutrients it contains will leach into the soil and be absorbed by the young plants. This will also help to insure a stand of clover. Manure is very commonly used by plowing under before corn. For best results it should be turned under or disced into the soil as soon after spreading as possible, since exposure to the air, particularly on warm spring days, will result in some of the nitrogen being lost by volatilization. Fresh manure can be spread on pastures or meadows, but the immediate cash return will usually be larger if applied to a grain crop.

**3. Manure Should Not be Allowed to Accumulate in Loose Open Piles.**—If manure must be removed from the barn frequently, it should be hauled and spread immediately or stored under a shed and kept compacted. If a shed is not available it should be stored in deep ricks with straight sides. Water helps to prevent heating, but the quantity should not be so great as to run through the piles. It should never be put into small piles located at random over the field to be scattered at a later date. Under such conditions much of its nitrogen will be lost.

**4. Manure Should be Applied Evenly.**—Light applications give greater returns per ton than heavy applications. Where manure is limited in amount, it should be made to cover as much land as is feasible.

**5. Returns From Manure are Greater on Less Fertile Soil or on the Poorer Parts of the Fields.**—Where manure is very much limited in quantity it should be applied in largest amounts to the poorer parts of the fields.

**6. Manure is not a Complete Plant Food.**—Manure is low in phosphorus. Superphosphate should be applied to crops in addition to manure. It is a good practice to add fifty pounds of this phosphate to each ton of manure before it is spread on the field.

**7. Efficient Handling of Manure Will Permit the Production of Maximum Yields.**—A program of efficient use of manure will insure profitable crop production and produce better yields of crops of higher quality.