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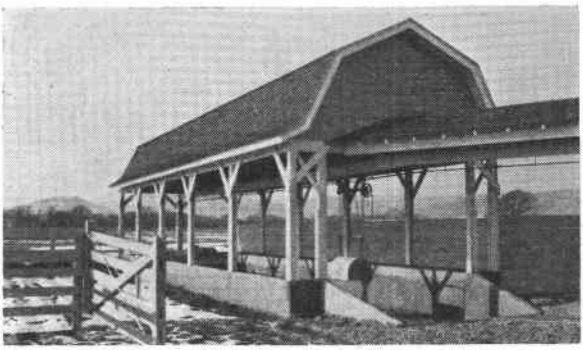
Care, Use, and Economic Value of Farm Manure



Manure shed and litter carrier at O.S.C. Veterinary Barn.

Agricultural Experiment Station
Oregon State Agricultural College
CORVALLIS

TABLE OF CONTENTS

Care, Use, and Economic Value of Farm Manure

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1. **Introduction.** Farm manure should include all animal wastes, litter, and other organic by-product material produced on the farm, such as grain straw, legume straw, and other crop residues.

These materials produced on farms are an important source of fertilizer and for the state as a whole have a large money value. Figures based on the livestock population of Oregon and the value of the excrements produced are given in Table I. This does not include the litter used and although part of the manure produced is dropped directly on the land in pastures and on the range, large amounts are produced in and around barns. The proper care and the use of this latter supply on our cultivated lands will produce increases in yields for the state as a whole of intrinsic value each year. Therefore, it is important to know the value of farm manure so that care will be used in eliminating preventable losses and applying manure to soils under conditions that will result in profitable increases in yields.

The customary arrangement for care of manure is to wheel or transfer it outside the barn and dump the material in a rambling heap, fully exposed to the weather (Figure 1). Frequently it is forked out through small windows under the eaves where it is subject to losses by leaching and of nitrogen by fermentation.

2. **Factors affecting composition.** The exact composition and corresponding fertilizer value of fresh farm manure will vary with age and kind of animals (Table II), composition of the feed used, amount and kind of litter (Table III), or other absorbents used as well as completeness of recovery and subsequent care.

TABLE I. AMOUNT AND VALUE OF MANURE PRODUCED BY FARM ANIMALS IN OREGON

Oregon	Number of head 1925 Census	Estimated number of head 1930	Manure value per animal per year	Approximate annual commercial fertilizer value
Horses	181,000	166,000	$28.30	$ 4,697,800
Mules	19,000	19,000	27.00	513,000
Milk cattle	264,000	264,000	32.55	8,693,200
Other cattle	409,000	436,000	31.00	13,516,000
Sheep	2,501,000	2,501,000	3.60	8,003,600
Hogs	230,000	195,000	6.00	1,180,000
Hens	4,065,000	5,000,000	.09	450,000
Total	....	....	....	$37,053,600

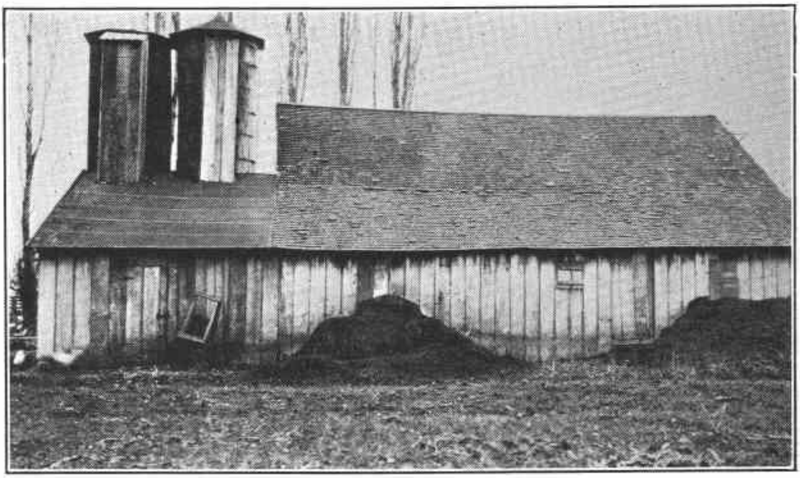

Figure 1. How not to do it: Loose rambling heaps under the eaves are subject to leaching and loss of nitrogen also by fermentation.

Figure 2. How to do it: Litter carrier and manure shed at Shumach Bros. dairy, Blachly. Planned and built under supervision of F. E. Price and O. S. Fletcher as an Extension Service Demonstration Project. Photograph by Fletcher.

TABLE II. AVERAGE COMPOSITION OF FRESH MANURES

Item	Water	Pounds per ton*			Commercial† value per ton
		Nitrogen	Phosphoric acid	Potash	
	%	*Lb.*	*Lb.*	*Lb.*	
Poultry	55	20.0	16.0	8.0	$4.52
Sheep	68	19.0	7.0	20.0	3.72
Horse	78	14.0	5.0	11.0	2.37
Swine	87	10.0	7.0	8.0	2.14
Cow	86	12.0	3.0	9.0	2.23
Mixed	80	10.0	5.0	10.0	2.04

*From Van Slyke, L. L., *Fertilizer and Crops*, p. 291, New York.
†With the exception of poultry manure the values in the last column are based on nitrogen at 15¢ in the liquid, 12¢ in the solid; phosphoric acid in the liquid 7¢, in solid 5¢; and potash in liquid 5¢, in solid 4¢.

TABLE III. FERTILIZING CONSTITUENTS IN ONE TON OF LITTER

Item	Nitrogen	Phosphoric acid	Potash
	Lb.	*Lb.*	*Lb.*
Wheat straw	9.6	4.4	12.6
Barley straw	12.0	4.0	22.0
Oat straw	9.2	5.6	35.4
Clover straw	29.4	8.4	25.2
Pea Vine straw	28.6	7.0	20.2
Vetch straw	21.8	5.4	12.6
Peat	40.0	......	......
Sawdust	4.0	2.5	10.0

Liquid excrement, which is most easily and completely lost, is more valuable as a fertilizer pound for pound than the solid, except in case of swine. The nutrients in the liquid portion are in a more readily available form for plant use. These facts emphasize the need of suitable absorbents to take up and conserve the liquid manure.

There are a number of different types of material used for litter with manure of which grain straw is most common. In addition to being an excellent absorbent it contains nitrogen, phosphorus, and potassium in amounts equal to those in average barnyard manure (Table III). The practice of burning straw stacks results in enormous losses of both nitrogen and organic matter. Over much of the state a profitable use of straw can be made as litter, or in artificial farm manure or by direct addition to the soil. The straw of legumes is higher in plant nutrients, especially nitrogen, and the danger of a shortage of available nitrogen for the growing crop which sometimes follows the heavy applications of bulky organic materials is less. When easily obtainable, muck, peat, leaves, fern, or mosses can be used for litter. Sawdust and shavings will absorb large amounts of liquids but may be undesirable since they contain but small quantities of plant food, are slow to decompose, and when used in large amounts will lock up the soil's nitrate supply.

3. **General effects**. Organic manure benefits the soil in several ways: (1) It supplies energy for beneficial microorganisms, (2) increases the water-holding capacity of soil, (3) improves tilth, (4) adds plant food, (5) liberates plant nutrients.

4. **Care.** Barnyard manure is perishable material, and careful handling is necessary for maximum returns. Losses from barnyard manure can be cut down:

(1) By protecting it from leaching during the rainy season, through the use of a covered shed or compost stacks.
(2) By keeping it moist during the dry season.
(3) By adding land-plaster or superphosphate to prevent the escape of nitrogen as ammonia.
(4) By applying promptly to the soil.
(5) By use of absorbents to take up liquid manure.
(6) By use of water-tight floors in stables and manure pits.

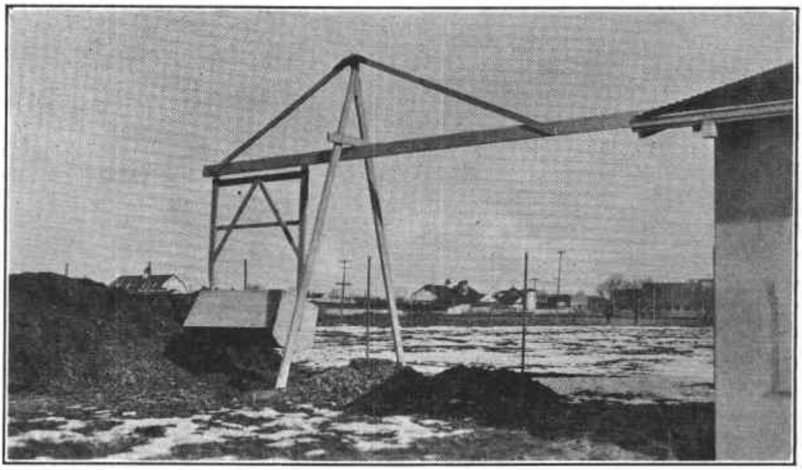

Figure 3. Litter carrier from poultry house. A shelter and use of superphosphate or gypsum as absorbent will save loss of nitrogen here.

5. **The manure pit or shed.** The manure pit has been a profitable investment to most stock farms. The location is preferably at a lower level than the stable floor and on a side hill, so that filling and emptying the pit may be facilitated. The cost of a pit will be approximately $10 per cow, with a capacity of 125 cubic feet per cow (Figure 4).

A tank wagon with a round-pointed shovel blade placed in a horizontal position with the point extending backward from just below the outlet at the back of the tank will serve for distribution of liquid manure. Rotation grazing should be practiced where liquid manure is applied to pasture land.

A great amount of work has been carried on in determining the losses that occur in stable manure as it is ordinarily handled on the average farm. Two tons of fresh manure may shrink to one ton in a year of exposure. Losses to a large extent are governed by climatic conditions, especially the amount of rainfall and the method of handling. In order to get data for Western Oregon with a rainfall of 42 inches or more and wet, open winters and dry summers, the Soils department of the Agricultural Ex-

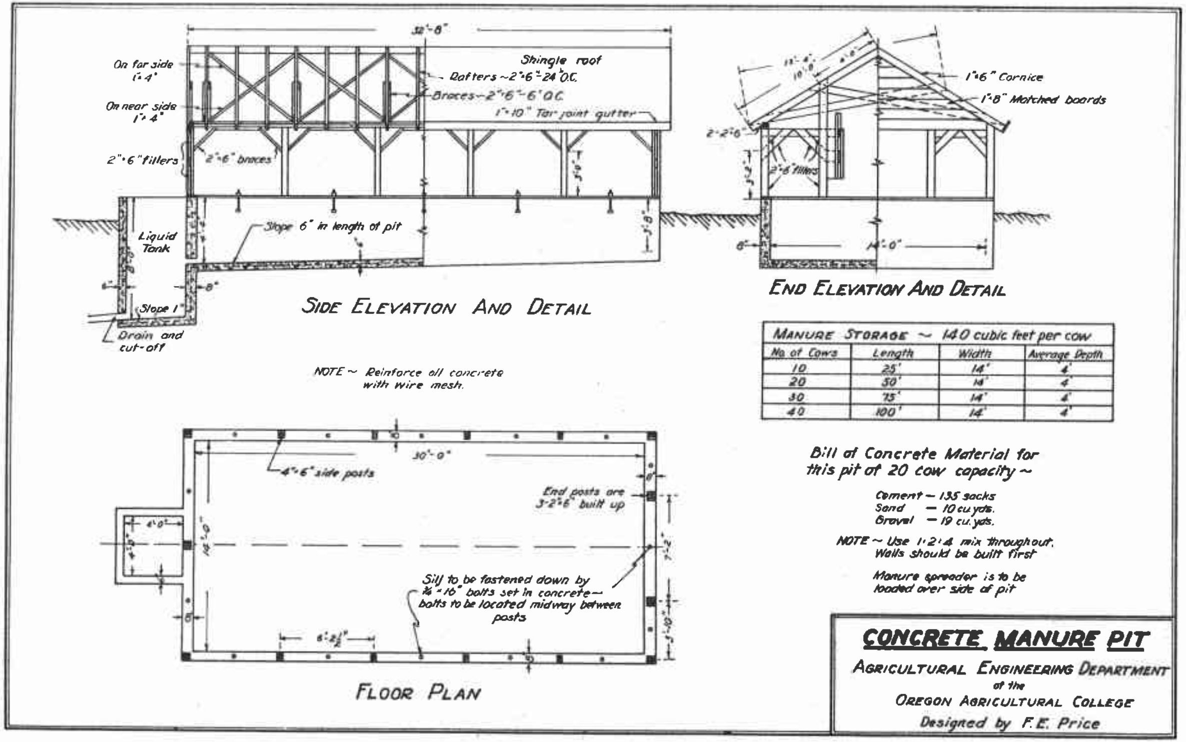

Figure 4. Plan and bill of materials for manure shed.

periment Station carried on work determining the losses that occur in stable manure stored under different conditions for twelve months.

Table IV gives the different treatments the manure received and the percentage losses that occurred during the 12-month period.

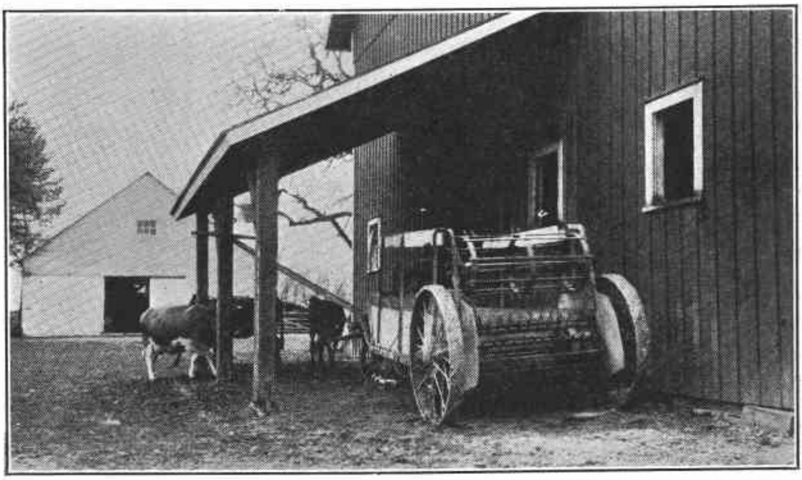

Figure 5. Hauling direct to the field and turning under promptly lessens losses.

The data from this work gave results which are in accordance with those of other investigators. The loss in organic matter varied considerably with an average of about 40 to 50 percent for the period. The addition of soil to the manure lowered the rate of decomposition as compared to the check, while phosphates, sulfates, and straw increased it. The loss of nitrogen was high in every case and was stimulated by organic matter. The loss of phosphorus was exceptionally high and showed no consistent relation to the different treatments. The loss in the elements calcium,

TABLE IV. PERCENTAGE LOSSES IN HORSE MANURE AFTER ONE YEAR EXPOSURE WITH DIFFERENT TREATMENTS

Treatment	Organic matter	Nitrogen	Phosphorus	Sulfur	Potassium
	%	%	%	%	%
Manure	38.9	43.4	54.8	62.7	69.4
Manure-gypsum	48.5	59.3	68.0	34.7	31.8
Manure-acid phosphate	59.1	66.8	68.0	48.3	32.2
Manure-rock phosphate	52.2	67.5	90.5	51.2	37.2
Manure-rock phosphate-sulfur	54.5	70.6	93.6	87.9	49.3
Manure-soil	22.8	57.0	73.0	12.9	28.4
Manure (watered)	44.1	46.7	50.2	61.8	36.6
Manure-straw	54.7	52.2	85.5	64.3	37.2
Manure-straw-gypsum	56.2	54.5	83.5	25.2	36.5
Manure-straw-acid phosphate	52.1	52.1	88.9	......	39.5
Manure-straw-rock phosphate	55.1	65.0	79.6	64.5	24.6
Manure-straw-rock phosphate-sulfur	36.6	41.6	81.3	72.3	35.5
Manure-straw-soil	33.1	47.8	54.2	......	36.5
Manure-straw (watered)	53.4	46.8	63.6	61.0	29.4
Manure (covered)	42.2	48.2	......	......	......
Manure-straw (covered)	48.5	55.5	......	......	......

sulfur, and potassium varied but ran less than either nitrogen or phosphorus.

6. **The exercise shed.** A covered straw storage and exercise shed puts the barnyard under cover and thus eliminates losses by leaching and

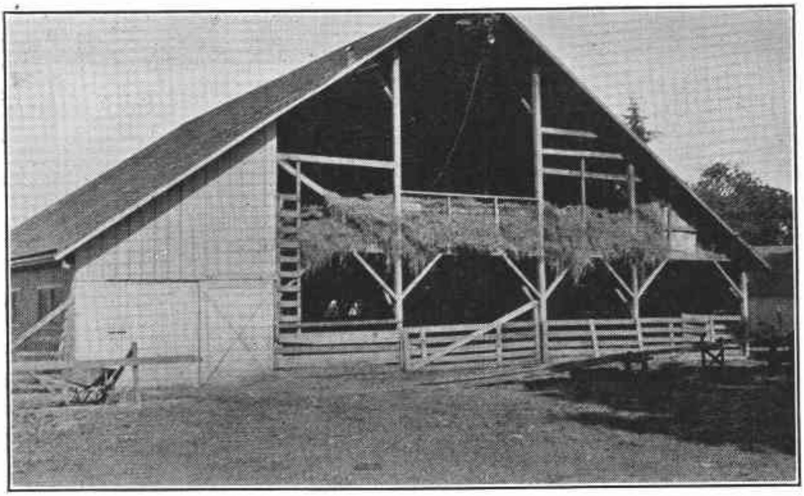

Figure 6. Straw shed and covered exercise yard with concrete foundation and piers. Manure about 2 to 2½ feet deep.

checks losses of nitrogen by fermentation and of the liquid manure. The type shown in Figure 6 also results in the use of larger amounts of straw for litter and protects the stock during bad weather.

7. **Application.** A field experiment at the Corvallis Station was started in 1921 on Willamette silt loam to determine:

(1) The best rate of application.

(2) The proper manner of application.

(3) The most practicable reinforcement to use with farm manure.

Four crops—barley, clover, corn, and wheat—have been grown (Table V).

8. **Rate of application.** On Willamette silt loam soil, applications of 10 tons of manure yearly, 20 tons each two years and 30 tons each three years have been made. In these trials the less frequent, heavier applications produced larger yields per acre during the first five years of the experiment. Since 1925, however, the lighter, more frequent applications have been best. On coarse, sandy soil at the Umatilla Branch Experiment Station, 8-ton applications per acre of barnyard manure gave higher increases in yield per ton of manure than 32-ton applications. The 8-ton applications gave better efficiency than the 12-ton applications in a six-year trial on Newberg silt loam soil. For best results manure should be spread evenly and, in general, increased efficiency per unit of manure results from moderate to light applications.

TABLE V. USE AND VALUE OF MANURE ON WILLAMETTE SILT LOAM

Plot No.	Treatment	Yield per acre									
		1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
		Yield* Barley	Clover	Corn ensilage	Wheat	Green weight, oats and peas	Corn ensilage	Wheat	Clover 1 cut	Corn ensilage	Wheat
		Bu.	*Tons*	*Tons*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Tons*	*Tons*	*Bu.*
1	Check	11.0	3.57	7.975	60.16	4.50	8.32	33.00	3.59	5.92	68.1
2	10 tons manure yearly	13.5	4.37	8.825	54.33	4.62	8.11	47.50	4.38	6.95	61.8
3	20 tons manure each two years	16.6	4.62	9.375	85.66	4.87	7.46	31.66	4.21	6.42	71.8
4	30 tons manure each three years	12.5	4.72	8.525	57.00	5.95	7.05	44.00	3.51	5.80	72.3
5	Check	21.0	4.14	6.850	45.66	5.07	6.67	28.00	3.58	3.90	63.5
6	20 tons manure top dressed	18.5	4.15	7.725	77.00	3.55	7.43	56.00	3.43	4.70	74.3
7	20 tons manure disked in	33.9	4.97	8.250	64.00	3.50	6.70	36.68	3.63	4.67	63.1
8	20 tons manure disked and plowed in	30.6	7.03	9.525	55.16	4.10	7.81	42.00	4.15	5.40	77.3
9	Check	32.9	5.34	9.825	72.16	3.37	7.92	28.33	3.75	5.65	64.1
10	10 tons manure+300 pounds superphosphate	32.7	4.68	10.175	72.00	3.82	9.90	43.83	3.81	7.15	69.3
11	10 tons manure and 2 tons lime	26.7	1.47	9.675	62.66	3.92	9.65	42.00	3.61	6.65	70.8
12	10 tons manure and 2 tons lime, 600 pounds rock phosphate, 100 pounds sulfur	42.5	5.05	9.450	67.33	4.22	9.32	36.33	3.95	5.72	70.1
13	20 tons manure not renewed	38.5	5.65	8.850	39.66	3.75	7.48	27.83	3.61	6.30	52.0
14	3 tons straw disked in	25.2	6.83	9.650	68.66	3.37	7.77	28.66	3.08	7.20	51.3
15	Vetch cover in corn	27.0	5.66	9.125	42.33	3.37	8.45	31.66	3.55	7.60	53.1
53	Check	30.2	4.50	8.025	66.16	3.35	8.00	....	3.27	5.65	45.5
	Average of checks	23.8	4.39	8.17	61.03	4.07	7.73	29.78	3.55	5.20	60.2

*Crops irrigated except grain.

9. **Method of incorporating manure into soil.** Another phase of the experiment at the Corvallis Station compares the relative value of (1) top dressing with (2) disking in and with (3) disking in and plowing under manure. Disking in and plowing under has given the largest increases in yields. Good results have been obtained by top dressing meadow with a light dressing of well-rotted manure in the same experiment field. The effect of a single application made in 1921 is still evident in the current crops (Table V).

10. **Phosphated manure.** The field trial includes use of phosphate, with manure vs. ground limestone, and manure and a combination of sulfur, rock phosphate, limestone, and manure. Best returns have been realized where phosphate and manure were used. At the Branch Experiment Station at Astoria phosphated manure has given more economical returns than manure alone. Manure is not a balanced fertilizer. Phosphated manure is a better balanced fertilizer.

Green manure provided by a catch crop of vetch in corn has little more than paid its way in this experiment. Grain straw disked in has given a gain of $12 per acre in crop value per year or per ton straw for a 3-ton application once in three years.

11. **Value of manure on different soils and crops.** Transportation is an important item in the cost of bulky organic fertilizer whether obtained on the farm or from outside sources. The agricultural value of such fertilizer depends on the crop increase it will make and the net value of such increase. Crops giving high gross returns per acre can be expected to justify a higher price for bulky organic fertilizers than ordinary field cops. This is partly responsible for a commercial value which may be different from agricultural value.

Figure 7. Effect of manure on rutabagas. Treated ground at right. Astoria Branch Experiment Station, 1929.

Manuring experiments at the Home Station and various branch experiment stations of from 4 to 16 years' duration have generally given best returns from application of manure to a meadow crop. On the red-hill soil at Astoria a six-year average shows that the rutabaga has been the best customer for manure (Figure 7).

A 10-ton application of manure in a four-year experiment on Powell silt loam, Multnomah county, has given a greater return on potatoes than on corn, oats, or clover.

On Willamette silt loam in the old fertilizer range at the Home Station and on Newberg silt loam, small grain has yielded as good returns as meadow.

Arid soils are usually low in organic matter and the maintenance and increasing of humus in these soils is of first importance. In work carried on coarse sandy soil at the Umatilla Branch Experiment Station by Superintendent H. K. Dean, barnyard manure was applied at the rate of 8 tons and 32 tons per acre to alfalfa. The initial applications were made in 1915 and continued each year through the season of 1921 with the exception of 1918. No manure was added since 1921 and a total of 48 tons and 192 tons applied in the trials. The data of this work done and reported by Superintendent Dean are as follows: The eight-ton application of manure gave a total increase of 19,425 pounds of alfalfa for the first seven years, with a total application of 48 tons of manure, or an increase of 404 pounds of alfalfa per ton of manure. In the 32-ton application with a total of 192 tons of manure for the seven-year period, the total increase was 34,213 pounds of alfalfa hay or 177 pounds per ton of manure. The total increase in yield of alfalfa hay for the fifteen years 1915-1929 for the lighter application of manure was 39,885 pounds, or 831 pounds per ton of manure. In the heavier application the total increase for this period was 70,863 pounds, or 369 pounds per ton of manure. These data show very definitely that greater returns per ton of manure are obtained from the 8-ton applications than from those of 32 tons; and that the increase in yields in the case of both treatments is still quite marked in 1929, even though the last application was made in 1921. With alfalfa hay at $10.00 a ton, the increase in yield from the manure applied at the rate of 8 tons gave a return of $4.15 per ton of manure. This applied at the rate of 32 tons per acre returned $1.85 per ton of manure.

The importance and value of manure on the dairy farms of the Coast section of Oregon are presented very clearly in Oregon Agricultural Experiment Station Bulletin 203. Table VI summarizes some of the results.

12. **Manure worth more with moisture control.** (Table VII.) On Amity silty clay loam in the irrigation field at the Corvallis Station, ten tons of manure once in a three-year rotation of barley, clover, and beans has increased the annual net profit from beans with rainfall farming $6.12, and with irrigation farming $17.79. This has been associated with a gain of 320 and 408 pounds of soil nitrogen an acre to plow depth, or 2,800 pounds more organic carbon without, and 5,280 pounds more with supplemental irrigation. The water requirement per pound dry matter has been reduced 513 pounds per acre dry matter by manure without irrigation, and 753 pounds per acre where irrigated.

13. **Artificial manure.** Orégon's grain area is nearly a million and a half acres and yields more than a million tons of straw annually. Over much of this area, the soils would be benefited by the addition of organic matter in which the nitrogen-carbon ratio is narrow. In order to meet this need over much of the area and avoid the undesirable effects of plowing under fresh straw, the use of artificial farm manure or the process involved may prove advantageous.

Artificial farm manure is a term used for material produced by a process developed in England for the decomposition of straw, leaves, corn stalks, and other plant residues, under more or less controlled conditions, into a product similar to farm manure. The process is carried on by mixing these bulky organic materials with a powdered reagent patented under the name of ADCO and keeping the entire compost moist.

The method used and tried in this country by a number of the agricultural experiment stations is similar. As the straw or other crop residue is stacked, the layers are treated with reagent material. Satisfactory results have been obtained by using 50 to 100 pounds of sulfate of ammonia plus an equal amount of ground limestone per ton of straw. A soluble phosphate such as superphosphate at the rate of 20 to 30 pounds may be added to the mixture. As the compost is built, it is sprinkled with water and the entire mass thoroughly moistened. In warm weather, decay begins immediately and within six or eight months the materials resemble farm manure in appearance and are similar in physical and chemical composition. Field

TABLE VI. SOIL FERTILITY RESULTS, ASTORIA EXPERIMENT STATION
Lime—Phosphorus—Manure

Fertilizer	Hay—three years	Roots—one year	Value	Cost	Profit
	Tons	*Tons*			
None	5.16	0.75	$ 54	$ 0	$ 54
Manure	6.52	22.52	155	50	105
Lime	7.68	9.65	115	20	95
Lime and manure	8.94	33.83	224	70	154
Phosphate and lime	6.51	20.42	146	24	122
Phosphate, lime, and manure	7.97	35.80	222	74	148

Note: 1. Fertilizer applied once in four years and preceding roots.
2. Crop rotation (four-year) roots—vetch and oats—clover—clover.
3. Manure at 20 tons per acre once in four years.

TABLE VII. VALUE OF MANURE ON AMITY SILTY CLAY LOAM
Irrigation Field, Oregon Experiment Station
Beans—15-year average (to 1929)

	Unmanured bushels per acre	Manured bushels per acre	Gain bushels per acre	Net gain per acre	Gain nitrogen pounds per acre	Organic carbon pounds per acre	Saving in water cost per pound dry matter
	Bu.	*Bu.*	*Bu.*		*Lb.*	*Lb.*	*Lb.*
Dry	11.07	13.84	2.77	$ 6.12	320	2,800	513
Irrigated	16.11	21.22	5.11	17.79	408	5,280	753

tests indicate that such material is equal to farm manure as a fertilizer. Chopping or grinding, control of temperature, moisture, aeration, reaction, and nutrients required by decomposition microorganisms, afford means of regulating the rate of decomposition. A knowledge of composition and base exchange capacity of available litter or farm waste should be helpful.

Experiments carried on by the Oregon Agricultural Experiment Station indicate that the production of artificial farm manure is feasible on many of our farms, provided the farmer spends the necessary time and effort in preparing the composts. For general farm use the chief difficulty is in getting the water and keeping the entire compost wet. Composts in which 0.5 percent of nitrogen or 47.6 pounds of ammonium sulfate and 100 pounds of ground limestone were added to a ton of dry straw gave excellent results. This amount of original material will absorb about five tons of water, making a total weight of six tons. Proper decomposition will result in a loss of about 50 percent of the dry material, leaving three tons of artificial farm manure. Under present prices for nitrogen fertilizers and for ground limestone, the cost of the treatment for three tons of the artificial manure would be $2.40 plus straw and cost of applying water or approximately 80¢ per ton. The expense will vary according to the particular farm conditions and available equipment. The cost must be kept at a minimum if it is to be recommended for general farm use.

14. **Green manure.** Green manures are crops grown for the purpose of being plowed under and thus making conditions more favorable for the growth of succeeding crops. According to Pieters, where livestock is kept at a profit legumes can be profitably fed, but if the only profit is from the manure produced, it will be more economical to turn the legumes under for green manure. Even when manure is available, the turning under of a green manure crop may be profitable.

The primary purpose of turning under green manure crops is to increase the soil supply of organic matter for humus formation. Where legume crops are used the nitrogen supply is also increased. Owing to a lack of sufficient farm manure to maintain organic matter and nitrogen, particularly where livestock is not maintained, green-manure crops should be used. Their value and the resultant increase in yield depends upon the fertility of the soil, available moisture, and the type of farming. Soils well supplied with bulky nitrogenous organic matter have a store of energy for aiding activity of beneficial soil organisms and contain traces of rarer elements now known to be of an essential nature. Under most conditions legume crops should be used for green manure. They contain large amounts of nitrogen, resulting in a narrow nitrogen-carbon ratio and the part of this nitrogen gathered through the nodule organism is a distinct gain so far as the soil is concerned.

Green-manure crops should be turned under when they are still green and full of moisture so that decay will take place rapidly. This occurs at about the beginning of bloom and when the nitrogen-carbon ratio of the plant is narrow. In regions where rainfall is scanty or in seasons of limited rainfall extreme care should be practiced in handling and with reference to time of turning under green-manure crops. The soil's moisture supply that should go to the succeeding crop may be used up in part by the growing green-manure crop and then in the decay processes after turning under.

The soil is thus left in a light and open condition with an excess of undecomposed plant tissue and a lack of available water. Under such conditions earliness in turning under green-manure crops takes preference over the size of the crop to be turned under. The growth of cover-crops especially in orchards can be substantially increased and hastened by the early spring application of soluble nitrogen fertilizers. Under such conditions, these materials can be used advantageously to turn under larger amounts of organic matter earlier in the season and avoid a drain on the soil-moisture supply.

The nitrogen content of green manures and other bulky organic fertilizer materials is important as a nutrient and as a means of increasing the active organic matter content. The amount of active humus formed in soils is approximately proportional to the nitrogen content of the organic matter supplied.

Table VIII will aid in studying the comparative values of bulky organic materials.

Further experiments are needed and are projected to determine the value of various green-manure crops and of different forms of stable litter in economic improvement of Oregon soils.

TABLE VIII. NITROGEN IN BULKY ORGANIC MATERIALS

	Percentage of nitrogen	Pounds per ton of nitrogen	Value of nitrogen at 15¢ pound	Approximate relative humus value
	%	*Lbs.*		
Alfalfa hay	2.4	48.0	$ 7.20	5.0
Alfalfa before bloom	3.5	70.4	10.56	7.0
Alfalfa in bloom	2.4	48.0	7.20	5.0
Alfalfa in seed	1.8	39.0	5.85	3.5
Sweet clover hay	2.3	46.4	6.96	5.0
Red clover hay	2.0	41.0	6.15	4.0
Red clover before bloom	2.9	59.8	8.97	6.0
Red clover in bloom	2.1	42.0	6.30	4.0
Red clover after bloom	1.8	37.2	5.58	3.5
Vetch hay (Hairy)	3.2	63.6	9.54	6.0
Vetch hay (Common)	2.8	55.4	8.31	5.5
Vetch straw	1.0	20.0	3.00	2.0
Oats-and-vetch hay	2.0	40.0	6.00	4.0
Wheat straw	0.5	10.0	1.50	0.5
Rye hay	1.0	21.0	3.15	2.0
Brake Fern	1.1	22.0	3.30	2.0
Average barnyard manure	0.5	10.0	1.50	1.0
Sheep manure	2.0	40.0	6.00	4.0

SUMMARY

As a source of fertilizer material farm manure is one of the most important and valuable by-products of the farm.

Farm manures vary greatly in chemical composition and hence fertilizer value.

Farm manure is an unbalanced fertilizer and is especially low in phosphorus. This deficiency should be remedied by the addition of phosphates.

Losses of plant nutrients from barnyard manure as ordinarily handled run as high as 80 percent. Proper handling will reduce this to as low as 20 percent.

Best returns are obtained from light to medium applications of manure.

The agricultural value of farm manure is based on the increase in crop yield produced per ton of manure. It varies with the type of soil and crop.

The use of green manures must be increased to keep up the nitrogen and organic-matter supply of the soil.

Artificial manures may prove of value in reducing bulky organic material to a form that may be added to soils without widening the nitrogen-carbon ratio.