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Production, Care and Use of Farm Manure

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KENTUCKY A LIVE-STOCK STATE

Because of the rolling and hilly topography of so much of its land, Kentucky should naturally be a live-stock state. At the present time, there are about 1,500,000 animal units (an animal unit being 1,000 pounds of live weight) or one animal unit to each 8 acres of improved land in the state. (See table 1.) The area devoted to pasture or grazing should, under efficient management, easily be increased one-half or more by reclaiming waste land. With proper soil management, including drainage, the use of lime and phosphates, rotating crops (with one or more legume crops in a rotation) and returning the crop residues and manures produced, the area and yields of cultivated land may be very materially increased. Thus the number of animal units maintained on the farms of the state, when the farm land is handled as it should be, may become practically twice that of the present. Altho the value of farm manure as an agent in building up the soil and in increasing the yield of crops has long been recognized by the progressive farmer, yet as one observes on every hand the careless and wasteful methods employed in the production and use of manure, he is convinced that the "average and under-average" farmer has not yet awakened to the real worth of his most valuable by-product, farm manure.

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PRODUCTION OF MANURE

A permanently successful system of farming must maintain soil fertility. While the keeping of live stock tends to improve the farm thru the necessity of keeping part of it in pasture and thus reducing the cultivated area, yet to make stock most effective in maintaining fertility, attention must be given to the proper handling of the manure. A conservative estimate places the production of manure in Kentucky at 16,246,000 tons annually. Not to exceed 60 per cent, and very probably less, of this amount is returned to the soil. The total loss on this basis, figuring plant food at commercial prices, would be nearly $23,000,000, or about eight times the total value of fertility brought to the farms in commercial fertilizer. Such a loss is unnecessary.

Manure from different animals varies in character, and to conserve best the fertility, it must be handled differently. Horse manure is rich in plant food, partly because work animals are given rich feed and partly because the manure is comparatively dry. But it loses fertility readily because fermentation and heating occur. This is especially true if the manure is left in loose piles. Steaming and the odor of ammonia so often noticeable indicate that nitrogen is passing into the air. After heating, the manure has a low value. Heating not only wastes nitrogen, but destroys organic matter that is necessary to make humus.

Cattle manure contains much water, which excludes air and prevents heating, while horse manure, being porous, admits air and heats quickly. Therefore, mixing cattle manure with horse manure helps to prevent loss. The greatest loss of cattle manure occurs in feeding in open lots where rains leach out large quantities of soluble plant food. Little or none of the manure from barnyards gets back to the cultivated fields.

Apparently farmers do not value hog manure highly. Yet hogs consume very concentrated feed and produce rich manure. If corn is worth 75 cents per bushel to feed hogs, the 20 cents worth of fertility left in the manure is also worthy of consideration. Tho the value of the manure may represent more than one-fourth the price of the corn, a large part of the hogs in Kentucky are fed in small pens or in barnyards, and none of the manure is utilized. From the standpoint of soil fertility when hogs are fed in this way, the farmer had as well sell grain.

Of all farm animals, sheep make the best distribution of their manure in grazing. Little sheep manure is dropped in stalls or muddy barnyards, because sheep remain in the pastures most of the time.

For the production and composition of manure from different animals see table 2.

CARE OF MANURE

Prevention of waste and the economical use of manure in the Bluegrass section of Kentucky is a different problem from that in other sections of the state. In the Bluegrass section there is pasture for nearly nine months on bluegrass and, in many cases, pasture on rye for at least a part of the other three months. A large part of the feeding is done on the pasture fields and the manure and residues go to increase the growth of grass without much loss.

Outside the Bluegrass region, on the other hand, Lespedeza, which starts growth in June and is killed by the first frost, is one of the chief pasture plants. Even when redtop is grown with it, the grazing season extends over only five or six months.

As a consequence, there is a much longer period in which stock must be fed. Too often the feeding is in an open lot, or the manure is thrown from a shed where the feeding is done into the barnyard to leach and waste for several months. More care is necessary, therefore, outside the Bluegrass region to prevent loss of fertility in handling manure.

Fully half the value of manure is in the urine or liquid part, often little regarded by the farmer. Waste of the liquid means a loss of the most active part. But it is comparatively easy to save the liquid with the solid by using plenty of bedding. Tight cement floors give the most complete saving, but a level, hard clay floor, well bedded, is very satisfactory. A leaky board floor is wasteful.

To prevent heating and loss of nitrogen, manure should be kept moist and well packed. Where animals run loose in a well bedded stall usually no other precaution is necessary. Acid phosphate is recommended as a good preservative to stop bacterial action and to absorb ammonia. Since manure is low in phosphorus, the use of acid phosphate in the stall would produce a much more valuable manure. For the purpose, 5 to 10 pounds per week for a 1000-pound animal would be sufficient.

To prevent leaching by rains, and consequent loss, manure should be kept under cover until spread on the land to produce crops. Piles in either the barnyard or field are very wasteful. When manure must be removed from the stall or shed, least loss will occur if it is spread directly on the land. Care should be taken not to spread on a steep hillside and to spread on grass or a growing crop, unless it is spread a short time before breaking the land.

The manure shed is a necessity only when it is necessary to remove the manure frequently for sanitary reasons as in case of dairy barns. By removing the manure to a shed it can be preserved without loss until spread on the field. The shed for this purpose need not be expensive and the saving in fertility will in a short time pay the cost of construction. (Plans for constructing a manure shed may be obtained from the Kentucky Agricultural Experiment Station.)

Another satisfactory plan that is used by some dairymen is to have a few stanchion stalls that are kept clean. In these the cows are turned a few at a time and fed grain while they are milked. The cows are then turned into a large shed that is well bedded, where hay and other roughage are fed.

Cattle feeders can very economically prevent waste of manure by feeding on grass for as long a period as is feasible.

Coarse fodder fed on the higher ground in a pasture field will both save and distribute the fertility. Care should be used not to follow this practis where tramping a soft field will do injury that will more than offset the value of the fertility saved.

Hog feeding should always be done on grass and never in small pens where the manure cannot be saved. Hogging off corn and other crops insures the greatest return and the best distribution of fertility.

VALUE OF MANURE

Manure is the cheapest fertilizer that the farmer can get and, when supplemented with phosphate, it is also the best. Besides supplying plant food that commercial fertilizers contain, manure has other important values.

Next to the value of the plant food in manure is its humus forming value. No commercial fertilizer supplies any appreciable amount of humus, and more than anything else on a poor soil, humus is needed. Lime and phosphate without humus will fail to make poor soils productive, except for legumes such as sweet clover. If humus is supplied by plowing under manure and crop residues, good crops may be expected, where limestone and phosphate are used on poor soils.

The value of manure depends upon several factors. Young animals use more of the minerals and protein of the feed and consequently produce poorer manure than mature animals. Fattening and work animals require mineral and protein nourishment only to replace body waste, and produce manure that is richer in nitrogen, phosphorus and calcium than growing animals or animals giving milk.

The feed is a big factor in determining the value of the manure. Rich feeds make rich manure, and vice versa. Manure from corn and tankage, clover, pea and bean hays, cottonseed meal and alfalfa is much richer than manure made from straw and stover or from timothy and redtop hay.

Manure that has been carefully handled to save the liquid and to prevent heating or leaching has the highest value. With care, two-thirds to three-fourths of the nitrogen and phosphorus and nine-tenths of the potassium of the crop may be returned to the land in the manure.

Farmers sometimes think that too much bedding makes a poor quality of manure. The reverse is more likely to be true. Straw or any residue used for bedding not only contains more plant food than animal manure, but also helps save the urine, the richest part of the animal manure. The tramping and mixing that occurs in the stall breaks up the bedding and when the manure is taken to the field it is in the best condition to produce good results. From 200 to 300 pounds of straw per ton of manure can be used as bedding to advantage. If enough straw is not available, the refuse from coarse stover will add materially to the bedding.

In the consumption of feed by live stock, about two-thirds of the organic matter is digested and assimilated. Manure does not produce as much humus as the original hay and fodder would have made. This makes it doubly important to use bedding and to return crop residues to the soil in every way practicable.

The return from manure depends to a large extent upon the crop grown after its use. An increase of 100 pounds in the yield of tobacco would bring probably four times as much as an increase of 10 bushels of corn. Either result would be satisfactory. The average increase in corn on five Kentucky soil experiment fields was nine bushels per acre. (See table 3.)

ECONOMICAL USE OF MANURE

There is little soil in the state so rich that it will not be benefited by manure. The poorer lands, of course, need manure most. Fertilizer may give good results on soils rich in humus, but on badly depleted soils it is seldom profitable until humus is supplied.

Because manure is good fertilizer, many farmers apply it extravagantly, thinking that if a little is good, much is better. Since the supply of manure is limited, there is much greater economy in making a light application over several acres, rather than a heavy application on a few acres. An application of 9 tons (which is twice too much) in Indiana for 23 years, produced nearly 40 per cent more crop increase per ton of manure than did an application of 14 tons per acre.

Frequent hauling and spreading make manure more effective. Rotted manure is a little richer, weight for weight, than fresh manure, but it takes about two tons of fresh manure to produce a ton of rotted manure. When manure is dropped in the yard it loses plant food rapidly unless hauled and spread. Stall manure at the Ohio Experiment Station was worth $1.00 per ton more for growing corn, wheat and clover than the same amount of manure left in the yard three or four months before spreading.

Whether to plow under or to topdress with manure is not so important. When coarse manure is used it should be well disked in before plowing under. This gives better mixing with the soil and causes the manure to rot more quickly. Even straw, however, is good for topdressing such crops as wheat and clover, if spread very thinly. The Ohio Experiment Station found that straw used at the rate of one ton per acre or less increased the yield of wheat several bushels and greatly improved the stand of clover.

When topdressing is to be done, either rotted or fine fresh manure is preferable. A light dressing of manure on young clover is an excellent aid to securing a good stand when the clover is seeded in small grain. Both the grain and the clover will be benefited.

Farmers too commonly assume that where manure is used nothing else is needed. As a matter of fact, manure, like most soils outside the Bluegrass region, is very deficient in phosphorus. To get the best results from either manure or phosphate on poor land, the two should be used together. (See table 4, Indiana results.) The Ohio Experiment Station obtained crop increases from manure alone worth $3.00 for each ton of manure used, but by using 50 cents worth of phosphate with each ton, the return was increased to $5.25 per ton of manure.

An application of from 4 to 8 tons of manure and 200 pounds to 300 pounds of acid phosphate per acre may be used very profitably. When rock phosphate is used, as much as 1,000 pounds per acre is advisable. The larger application should show good results on all the crops of one rotation.

CROP RESIDUES

Crop residues have a high fertility value. Kentucky has perhaps 3,000,000 tons of corn stover, half a million tons of straw and 60,000 tons of tobacco stalks. There is also an indefinite amount of various residues, such as stubble and second growth clover and grass.

A considerable portion of these various residues is wasted, by careless handling in some cases and by intentional destruction in others. When stalks or any organic material is burned, the nitrogen they contain is lost and the humus-making properties destroyed. The ashes remain in one spot and are also practically wasted. Burning should never be practist except to destroy weeds or insects which cannot be controlled otherwise. Allowing material to rot in piles without spreading is nearly as wasteful.

Not all farmers appreciate the value of corn stover as a source of plant food and it is not uncommon to see stalks burned in the spring to get them out of the way of the next crop. Corn stalks contain nearly twice as much nitrogen and potash as an equal weight of stable manure. Stalks should, therefore, be carefully returned to the soil. When the corn is husked from the standing stalks, the stalks should be cut or broken down as early as possible. This helps to keep the soil from washing and hastens the rotting of the stalks. They are also easier to plow under. A better way to handle corn in many cases, however, is to cut it and feed the stover. Shredded fodder is at least half as valuable as timothy and redtop to feed and the residue from feeding is unsurpassed for bedding. This is a practical way of supplying bedding where straw is not available. Better than this, where silage is needed, is to put the corn into the silo. Silage is an economical feed, but more straw will be needed for bedding than when shredded fodder is used.

The most common way of handling straw is to allow the stacks to rot. Like stover, straw contains more plant food, weight for weight, than stable manure. Economy demands that straw be returned to the land. Instead of allowing a straw pile to occupy land which should produce a crop, the straw should be used for bedding and distributed with the manure. When cattle feed about the straw stack the manure and straw remaining should be spread. If straw rots in a pile a good part of the fertility is lost by leaching and one spot is made too rich.

The chief cause for placing a low value upon straw and stover as fertilizer is that rotting of such coarse, woody material is slow. Half the plant food in good stable manure, on the other hand, is available almost at once. But straw and stover contain just as valuable plant food, which becomes available after sufficient time is allowed for decay.

Tobacco stalks contain seven times as much plant food as an equal weight of manure. The sale of tobacco in Kentucky removes every year nearly twice as much fertility as is returned in commercial fertilizer on all crops. When the stalks are wasted the drain upon the fertility is still greater. Tobacco stalks are especially valuable for topdressing grass on thin land.

All crop residues, and even weeds, have a fertility value. Legume residues, such as second growth clover, are especially rich. A ton of cured legumes contains the equivalent plant food of four tons of manure. More legumes are needed and more grazing of legumes is desirable, as there will then be a large residue to return to the land.

For the composition of crop residues see table 5.

An equivalent amount of plant food in crop residues is nearly as effective in maintaining fertility as in stable manure, over a long period of time. Tho it takes residues longer to decay, when sufficient time is given, somewhat more humus is produced and nearly as much mineral plant food is liberated.

A study of results on the Illinois Experiment Fields over a period of years from eighteen fields, comparing stable manure and crop residues, shows that residues when not supplemented with limestone and phosphate gave a somewhat smaller crop increase than did the stable manure when used in the same way. This was probably because residues are poorer in phosphorus than manure, tho both need to be supplemented with phosphate. The greater part of the phosphorus of plants is in the grain, and when grain is fed to stock, the manure should be richer in phosphorus than the residues from which all grain has been removed. When both manure and residues were supplemented with limestone and phosphate, the crop residues gave fully as large crop increases on the average as did the stable manure. (See table 6.)

A PERMANENT SYSTEM OF SOIL FERTILITY

Only comparaively few farmers are following a system of farming that will maintain fertility, and still fewer are making the soil better. Tobacco has been the main money crop and tho it is not hard on land, the persistent drain on the plant food by a small crop removed every year slowly exhausts the soil.

Kentucky needs more diversification. Tho tobacco is profitable, its production need not interfere seriously with the production of feed and stock. One way to replace the fertility removed by tobacco is to purchase concentrated feeds, such as tankage and cottonseed meal, which are needed on a stock farm.

Except on bottom lands and permanent pastures it is not possible to maintain fertility economically without a crop rotation. No farmer can afford to purchase any large amount of nitrogenous fertilizers. Every farmer can afford to grow legumes, and on the stock farm legume feeds are much needed. Clovers, beans, peas and alfalfa will make it unnecessary to purchase a large amount of protein feeds, which are expensive. With a legume once every three to four years in a crop rotation, the nitrogen and humus in the soil may be maintained if crops are fed and the manure returned.

Live stock is essential not only to graze the pasture land, but to supply a system of farming which makes less plowing necessary. The census report shows a total of nearly 7,000,000 acres of pastures, a considerable part of which is quite rolling and unsuited to tillage. The rolling bluegrass lands produce grazing, however, that is unsurpassed. As long as the rolling fields are grazed judiciously they will continue to be productive and profitable.

Besides the area classified as pasture land, there is another nearly equal area of waste land. A part of this area became waste because of too much plowing and too little grass. To reclaim it most economically requires live stock and pastures, as well as phosphate and limestone. Scarcely any soil is too poor and washed to grow Lespedeza and redtop, and with animals to graze, the soil will gradually improve in fertility and at the same time return an income.

The area of cultivated land comprises another 7,000,000 acres, or about 4½ acres per animal unit maintained. The average yield of crops is low, scarcely more than sufficient to pay the cost of production. A part of the area yields crops that are not sufficient to pay production costs and are therefore unprofitable. Perhaps a third of the now cultivated land could be more profitably utilized for pasture.

Crop production costs are largely labor charges and the most effective way to reduce labor charges on poor land is to convert it into pasture. When the pasture is once started there is practically no labor cost. Even weeds and bushes can be largely controlled with sheep and goats and a little man labor.

Fewer acres better fertilized and better tilled would often mean not only more profits but more and better feed. With more grazing, for which a large part of Kentucky is adapted, less winter feeding would be necessary and the cost of producing live stock would be reduced.

With sufficient live stock to utilize all land where grazing is needed and to return the fertility from all the feed produced, there would yet remain a margin between the fertility returned in the manure and that removed by the crop. Legumes may make up the margin for the nitrogen and humus, but additional phosphate will be needed except in the central bluegrass region. About 200 pounds per acre per year of 16 per cent acid phosphate should be used until the soil is made productive, after which the amount may be reduced one-half.

Special soils and special crops may need a potash fertilizer, but for ordinary farm crops on loam soils it will be more economical at present and perhaps for years to come to use phosphate only, rather than to divide the expenditure and put part into potash. Soils contain 25 to 30 times as much potash as phosphorus (except in the central Bluegrass) and nine-tenths of the potash removed by crops can be returned in the manure.

A permanent system of fertility maintenance therefore resolves itself into the use of a crop rotation with legumes to supply nitrogen, live stock to return the fertility in the manure and the use of phosphate to supply that removed by the animals. On sour soils, which comprise three-fourths of the state, limestone will be needed in order to grow legumes, especially clover and alfalfa. This type of farming is practical in Kentucky and will also prove profitable.

TABLE 1.—Classification of Kentucky Farm Land

Total area in farm land	21,600,000 acres
Improved farm land	13,975,000 acres
Land devoted to crops	7,280,000 acres
Land devoted to grazing	6,800,000 acres
Waste land	7,663,000 acres

TABLE 2.—Annual Production of Manure in Kentucky

Kind of Animal	Manure per 1000 lbs. live weight, tons*	Number animal units in Kentucky	Total manure tons
Horses and mules	9.1	675,299	6,145,000
Milk cows	12.7	416,532	5,290,000
Other cattle	7.3	286,394	2,091,000
Hogs	15.5	136,766	2,220,000
Sheep	6.2	88,481	549,000
		1,603,472	16,295,000

The above estimates represent the approximate production of manure in Kentucky. It is estimated that 40 per cent of the manure produced is dropped on pasture, 25 per cent in pens and lots and 35 per cent in barns and sheds. Of this amount it is estimated that 25 per cent of that dropped on pasture, 80 per cent of that dropped in pens and lots and 35 per cent of that dropped in barns and sheds is wasted. The total waste is about six million tons annually. Nearly five million tons is used on cultivated fields, or more than one-half ton per acre per year.

TABLE 3.—Crop Yields Due to Use of Manure on Kentucky Soil
Greenville Experiment Field
Corn-Soybeans-Wheat-Clover Rotation

Treatment	Corn, bus. per acre	Soybean hay, lbs. per acre	Wheat, bus. per acre	Clover hay, lbs. per acre
	Ave. 7 yrs.	Ave. 7 yrs.	Ave. 6 yrs.	Ave. 7 yrs.
Manure and residues	32.4	1748	6.1	1148
No treatment	20.2	1194	2.9	438
Increase	12.2	554	3.2	710

*Figures for unit production taken from "Nature and Properties of Soils," by Lyon and Buckman.

Russellville Experiment Field
Corn-Soybeans-Wheat-Clover Rotation

	Ave. 7 yrs.	Ave. 6 yrs.	Ave. 4 yrs.	Ave. 3 yrs.
Manure	33.4	1822	10.0	1730
No treatment	30.4	1446	8.0	1518
Increase	3.4	376	2.0	212

Lone Oak Experiment Field
Corn-Soybeans-Wheat-Clover Rotation

	Ave. 7 yrs.	Ave. 5 yrs.	Ave. 5 yrs.	Ave. 4 yrs.
Manure and residues	32.3	2689	9.8	1378
No treatment	28.8	2092	7.8	967
Increase	3.5	597	2.0	411

Mayfield Experiment Field
Corn-Soybeans-Wheat-Clover Rotation

	Ave. 6 yrs.	Ave. 6 yrs.	Ave. 4 yrs.	Ave. 4 yrs.
Manure	29.9	2380	8.3	724
No treatment	24.2	1731	5.5	330
Increase	5.7	649	2.8	394

Berea Experiment Field
Corn-Soybeans-Wheat-Clover Rotation

	Ave. 6 yrs.	Ave. 5 yrs.		Ave. 5 yrs.
Manure	36.7	3114	....	1213
No treatment	15.4	1532	....	163
Increase	21.3	1582	....	1050

Approximately 6 tons of manure per acre were used on the corn. The other crops received the residual effect of the manure.

Where acid phosphate was added to the manure, the yield of corn was increased 12½ per cent, soybean hay 23 per cent, wheat 35 per cent and clover hay 49 per cent.

TABLE 4.—Results for Manure Alone and for Manure with Acid Phosphate on Indiana Experiment Fields.

Bedford Field

Corn-Wheat-Clover Rotation

Treatment	Corn, bus. per acre	Wheat, bus. per acre	Clover, lbs. per acre
	1916-20	1917-20	1918-20
Manure	36.4	3.3	1030
No treatment	26.6	2.6	943
Increase	9.8	0.7	87
Acid phosphate and manure	52.9	7.7	2035
Acid phosphate	40.5	5.6	1688
Increase	12.4	2.1	347
Lime, acid phosphate and manure	53.1	8.7	2108
Lime and acid phosphate	40.5	7.2	1897
Increase	12.6	1.5	211

Worthington Field

Corn-Wheat-Clover Rotation

	1914-20	1914-20	1915-20
Lime, acid phosphate & manure	48.3	17.1	4503
Lime and acid phosphate	30.6	12.5	3793
Increase	17.7	4.6	710
Manure	43.5	15.8	3460
No treatment	32.7	9.7	2398
Increase	10.8	6.1	1062

* Indiana Experiment Station, "Results of General Soil Fertility Study."

TABLE 5.—Composition of Manure and of Crop Residues.

	Pounds per ton		
	Nitrogen	Phosphorus	Potassium
Horse manure	10	2.5	8
Cow manure	8	2.0	10
Steer manure	10	2.5	10
Sheep manure	12	3.0	10
Hog manure	10	3.0	8
Stover	17	2.0	18
Straw	13	2.0	18
Soybean hay	50	6.0	38
Clover hay	40	5.0	30
Cowpea hay	42	4.0	25
Sweet clover	46	6.0	21
Alfalfa hay	50	5.0	24
Timothy hay	24	3.0	24
Redtop hay	23	7.2	20.4
Tobacco stalks	70	5.0	70
Tobacco leaf	80	4.5	100

TABLE 6.—Relative Effects of Manure and Residues on Crops in a Rotation of Corn, Oats, Clover, Wheat. Average of 18 Illinois Experiment Fields, about 5 Years.

No Treatment	Manure	Manure, limestone, rock phosphate	No treatment	Crop Residues	Crop residues, limestone, rock phosphate
Corn, bus. per a., 31.4	39.7	46.0	31.3	36.5	45.6
Oats, bus. per a., 39.1	43.4	48.6	39.1	42.0	49.3
Clover, tons. per acre, 1.69	1.98	....	....	....	....
Wheat, bus. per acre, 18.3	20.9	27.2	18.8	21.0	27.6