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R. E. Doolittle. 1896.

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THESIS

THE LOSS IN MANURES BY LEACHING.

The object of the investigations which have been carried out in the preparation of this thesis is eminently a practical one.

"Manures are the fertilizers of the soil", and the object of their use is to replace in the land what has been taken out of it by growing crops.

In all civilized countries of long standing, the continual drain that goes on in the land, due to the growth of crops year after year, is very great.

The virgin soils of Britain, France, Germany and the greater part of our own country have long passed away. Most soils therefore require the addition of manures to keep them in an increasing state of fertility; but to use manures on soils that do not need them, or to add manures in great excess is so much waste of money.

It is desirable then for profitable and also economic farming to know the quality and value of the manures that is already upon or to be put upon the land.

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We often hear it said that after farmyard manure has laid spread out on the field through the winter but little of the fertilizing ingredients remain in it. It was to determine the truth of this statement that I carried out the investigations outlined below.

Plan of Work.

I obtained four samples of fresh, throughly mixed farmyard manure. These samples consisted of the solid and liquid excrements with the straw, etc., used as litter from both horse and cattle stables, and were taken from the manure heap in the yard at the College farm barns. They were taken from different parts of the heap in order to obtain a fair sample. The analysis of these would give me the average composition of the fresh manures.

I next obtained four samples of manure that was drawn and spread out on the field late in the fall of 1895.

These samples were taken from different parts of the field, and were made by raking together the manure over nine or ten

square feet and throughly mixing.

The analysis of these would give me the composition of the manures after being leached by the exposure through the winter, and from these data I could estimate the loss.

I would further say that these samples were taken in this way because it is in the same conditions that the farmer keep his farmyard manure.

The only chance for error is that the manure in the yard was not made at the same time as that taken from the field, but in a mixed manure as this was, there would be very little difference in its original composition.

The samples were taken on the 12th., day of April, 1896, put into air-tight cans, and not opened until analyzed about the first day of June.

Method of Analysis.

I first found the amount of water in the samples and thus got them all on a water-free basis from which I could estimate the per cent of the essential elements.

This was done by taking a definate quantity of each sample and heating at a constant temperature 100 degrees-Centigrade until it would lose no more weight.

In the analysis of the water-free substance for the essential ingredients, viz: nitrogen, phosphoric acid and potash, I followed the official methods given by the Association of Official Agricultural Chemists.

For nitrogen the Kjeldahl method was followed: One gram of the water-free substance was put into a digestion flask with 20 C.C. of concentrated sulphuric acid and about 0.5 gram of metallic mercury and the contents digested until it was a clear liquid.

It was then removed from the flames and finely powdered potassium permanganate dropped carefully in and in small quantities until the liquid remained a perfect green.

After cooling, the contents of the flask were transferred to the distilling flasks with about 200 C.C. of water and 25 C.C. of potassium sulphid solution. Enough sodium hydrate solution was then added (about 70 C.C.) to make the reaction

strongly alkaline,(pouring it carefully down the side) and the flask connected with the condenser and the ammonia distilled over into Erlenmeyer flasks containing 15 C.C. of the standard acid. The distillate was then titrated with standard alkali.

1 C.C. of the standard hydrochloric acid-- equals-.0017051 grams of ammonia, so the number of C.C. of the standard acid that was neutralized by the ammonia for 1 gram multiplied by .0017051 and divided by 100, equals the per cent of ammonia.

For the Phosphoric Acid.

Two grams of the water-free material were digested in a digestion flask with 30 C.C. of strong sulphuric acid until the liquid was clear. 100 C.C. of water was then added, boiled a few minutes, cooled and made up to 200 C.C.

100 C.C. were filtered off, neutralized with ammonia hydrate and then clearified with a few drops of nitric acid; 25 C.C. of the ammonium chloride solution added, heated in a water-bath to 65 degrees C.-- 50 C.C. of the molybdic solution

added, keeping it at 65 degrees C. for one hour.

It was then cooled, decanted off and washed with water by decantation.

The precipitate was then dissolved on the filter with dilute ammonia hydrate and hot water and washed in a beaker to a bulk of not more than 100 C.C.

Nearly neutralized with hydrochloric acid, cooled , and 40C.C. of the magnesium mixture added slowly, stirring it vigorously, and then set it away for some time, usually over night, adding 10 C.C. of ammonia hydrate after it has stood 20 minutes. Filtered, washed with dilute ammonia, burned over the blast lamp and weighed.

The phosphoric acid is then in the form of $Mg_2P_2O_7$, and 1 gram of $Mg_2P_2O_7$ - equals- .6396 gram P_2O_5.

So the number of grams of Mg P O times .6396, divided by 100- equals- percent of P_2O_5.

For the Potash.

Five grams of the water-free substance was moistened with sulphuric acid and burned to destroy the organic matter.

The residue was transferred to an Erlenmeyer flask and boiled with 150 C.C. of water and 15 C.C. of hydrochloric acid for one hour; then cooled, made alkaline with ammonia hydrate, enough ammonium oxalate added to precipitate the lime and made up to 250 C.C.

50 C.C. were filtered off and evaporated nearly to dryness then 1 C.C. of dilute sulphuric added and evaporated to dryness and burned.

The ash was dissolved in hot water acidified with a few drops of hydrochloric acid and 20 C.C. of platinic chloride solution added.

Evaporate this down until it would crystalize when removed ~~then~~ washed it with 80 per cent alcohol and the ammonia chloride solution into the Goochs' filter, and weighed.

The potash is then in the form of K_2PtCl_6, and 1 gram of K_2PtCl_6-equals- .19303 grams of K_2O.

So the number of grams of K_2PtCl_6 times .19308, divided by 100 -equals- the per cent of K_2O.

Results of Analysis.

Following out the analysis as given above for each of the samples, I obtained the following results.

Water.

No. 1.

Fresh Manures.		Leached Manures.	
No. of sample	Per cent of water	No. of samples	Per cent of water
1	76.89 per cent	1	22.48 per cent
2	76.00 " "	2	12.33 " "
3	75.50 " "	3	26.44 " "
4	72.17 " "	4	19.40 " "
Average	75.14 per cent	Average	20.16 per cent

Analysis of the water-free material.

No. 2.

(a) Fresh Manures.

No. of sample	Nitrogen as Ammonia	Phosphoric acid as P_2O_5	Potash as K_2O.
1	1.86 per cent	1.21 per cent	1.20 per cent
2	2.47 " "	1.02 " "	1.41 " "
3	1.95 " "	1.22 " "	1.58 " "
4	2.48 " "	.75 " "	1.14 " "
Average	2.19 per cent	1.05 per cent	1.33 per cent

(b) Leached Manures.

No. of sample	Nitrogen as amonnia	Phosphoric acid as P_2O_5	Potash as K_2O.
1	1.86 per cent	.52 per cent	.19 per cent
2	1.78 " "	.48 " "	.10 " "
3	1.42 " "	.45 " "	.17 " "
4	1.73 " "	.51 " "	.18 " "
Average	1.69 per cent	.49 per cent	.16 per cent

Comparison of Results.

	Nitrogen	P_2O_5	K_2O
Fresh Manure	2.19 per cent	1.05 per cent	1.33 per cent
Leached "	1.69 " "	.49 " "	.16 " "
Per cent of Loss	.73 per cent	.23 per cent	.88 per cent

But the last table does not represent the whole loss as there is a loss from decomposition, as well as from leaching making the weight less.

The Cornell bulletin number 27 gives the gross loss as 50 per cent.

The Kansas report for 1888-92 confirms this per cent.

Accepting this, and figuring from a ton of the original manure which gives 1000 pounds of the leached manure we have the gross loss.

Gross Loss.

	Am't at beginning or in one ton.	Am't at end or in 1000#	Loss per cent.
Nitrogen	43. 8 pounds	16.9 pounds	61.
P_2O_5	21 "	4.9 "	76.
K_2O	26.6 "	1.6 "	94.

A glance at the above shows that there was a great loss in the potash (88%) and also in the phosphoric acid (53%), but of the nitrogen only a small loss (23%).

But let us figure this to a commercial basis and the loss will be more apparent. Figuring ammonia as worth 16 cents a pound, P_2O_5 at 8 cents, K_2O at 6 cents, and we have the following:

No. 1.

Of the water-free material from the fresh manure.

2.19% of 2000 pounds =	43.8 pounds	Ammonia	a	16c	$7.00
1.05 " " " =	21. "	P_2O_5	a	8c	1.68
1.33 " " " =	26.6 "	K_2O	a	6c	1.60
Total value					$10.28

No. 2.

Of the water-free material from the leached manures.

1.69% of 2000 pounds =	33.8 pounds	Ammonia	a	16c	$5.41
.49% " " " =	9.8 "	P_2O_5	a	8c	.78
.16% " " " =	3.2 "	K_2O	a	6c	.19
Total value					$6.38

By this we find there is a difference of $3.90 in the water-free material of the manures and this is equal to about three tons of the original manures.

Of course the farmer does not lose the leached out portion if his manure is drawnout upon the field he intends to crop for it goes into the ground, unless the soil be a leachy one.

But where he leaves his manure exposed in the same manner in the barnyard, the leaching is the same and so is his loss.

This is a loss that no farmer can afford, and results from not taking proper care of his farmyard manure.

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