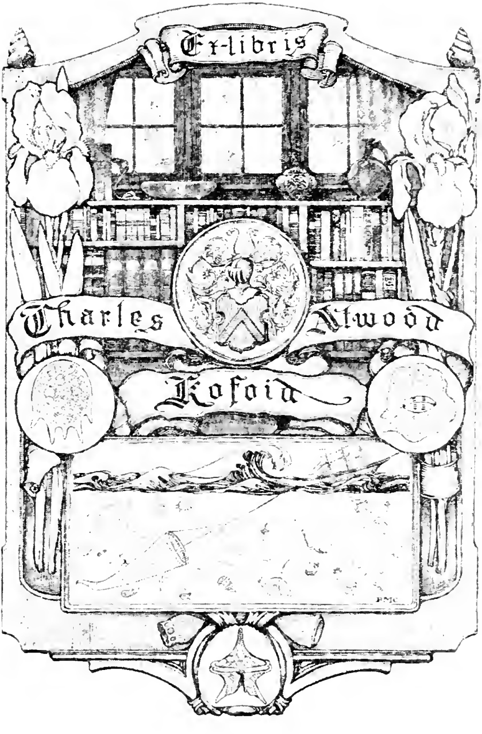
MANURES

THE FARMERS GUIDE AND FIELD COMPANION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MANURES,

THEIR

COMPOSITION, PREPARATION,

AND

ACTION UPON SOILS;

WITH THE

QUANTITIES TO BE APPLIED.

BEING A FIELD COMPANION FOR THE FARMER.

FROM THE FRENCH OF STANDARD AUTHORITIES.

BY

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PRACTICAL AND ANALYTIC CHEMIST.

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PREFACE.

The purpose of the present work, which is taken, almost entirely, from papers, (by F*** and Mallet,) in the "Dictionnaire des Arts et Manufactures," is to present to the Agricultural public, in a familiar and intelligible manner, the methods by which to restore and preserve the fertility of Soils.

The qualitative and quantitative adaptation of all the various manures, their composition, relative value, modes of preparation and behaviour, are fully considered; and the incidental and expressive tabular matter with which the Book is further enriched, render it emphatically the *Farmer's Guide Book and Field Companion*.

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MANURES.

CHAPTER I.

The term *manure* is applicable to all substances, animal, vegetable or mineral, which can augment or restore the fertility of the soil. In former times the title was limited to matters of organic origin; whilst the name of *stimulant* was reserved for those saline or alkaline mineral substances, that were considered as fit only to facilitate the assimilation of the principles which constitute the manures. The well known labours of Boussingault, Payen, Gasparin, Liebig, &c., have removed this distinction, in proving by numerous analyses, and carefully executed experiments, that the earthy and alkaline salts are as indispensable to the nutrition of plants as nitrogen itself. Hence, the best manure is that which can present to the growing plant, under an assimilable form, not only the nitrogen, but all the other principles which enter into its composition.

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We can readily conceive of what great advantage it would be to the farmer to know the exact composition of the plants, and of the soil which grows them; and also of the manure designed for their nutrition. Chemistry has already partially supplied these desiderata, and its researches are certainly destined to play an important part in agriculture. The utility of such knowledge can be better made evident by some examples. The vine, for instance, always contains a large proportion of tartrate of potassa; and it is obvious, that if neither the soil or manure can furnish the base in sufficient proportion, the vine will suffer and yield only a meagre harvest; in fact, this happens under many circumstances. Wheat contains phosphates in such amount, that its ashes frequently yield one-half of their weight of phosphoric acid. Now, the majority of soils contain only traces of phosphates, and therefore it is of the first importance that the manure intended for the nutrition of wheat should hold an adequate proportion. Straw, and the stalks of a great number of plants contain a large proportion of silica; grass or clover require abundance of lime, and some other plants only prosper by the assimilation of soda. These plants, therefore, must find in the soil, or by default, in the manure, those matters which they prefer.

The day is, doubtless, rapidly approaching when, aided by chemistry, we can determine the exact amount of substance removed from the soil by the crops, and then, as Liebig says, the farmer, as in a well organized manufactory, may keep his set of books in which to record, according to the crops, the nature and exact quantity of the principles necessary to sustain the fertility of each of his fields.

Substances contributive to the growth of plants are of two kinds: First, those of the organic kingdom, as nitrogen, oxygen, hydrogen and carbon: Second, those which constitute the ashes of the crops, and consisting of earthy and alkaline salts. The first are absorbed partially from the atmosphere; the second, on the contrary, are furnished to the plant only by the soil or manures. Indeed, Boussingault has proved, by direct experiments, that the organic matter of plants is always harvested in greater proportion than that introduced through the medium of manures; hence, as this result always occurs, the excess must necessarily be furnished by the atmosphere. On the next page is the average of the results of some analyses of the products of six different plats, containing a large number of plants.

Dry Crop : 1000 parts. Manure used: 442 parts.

Com. of the crops.		Com. of the manure.	Difference.
Carbon,	46.4.	15.9.	30.5.
Hydrogen,	54.6.	18.7.	35.9.
Oxygen,	416.0.	114.0.	302.0.
Nitrogen,	12.4.	8.8.	3.6.
Salts,	53.0.	141.7.	88.7.

It is to be particularly remarked, that the oxygen, hydrogen and carbon, contained in the crop, form a total much greater than that of the manures; and these results would even induce the belief that manures have but a secondary importance in furnishing these three bodies, if direct experiments had not proved their efficacy in this respect. Happily, the substances supplying these principles to plants are found abundantly in nature. The leaves of trees and of a great number of plants, the roots and stubble of preceding crops, the straw of the gramineals and all vegetable and animal matters in general, contain them plenteously. In a word, the air by its oxygen and carbonic acid;—water by its elements and the gases which it always holds in solution; and a multitude of other substances procurable at low prices, all contribute in supplying to plants the oxygen, hydrogen and the carbon requisite for their existence.

CHAPTER II.

NITROGEN.

The preceding table shows that the amount of nitrogen in the crops is also greater than that of the manure, but the difference is less remarkable. The rôle of this element in agriculture is most important; and as every thing relating to its mode of action is of great interest, we quote here the opinions of that learned and skilful chemist, Boussingault.

"I have, I believe, established by my numerous analyses, that in extensive cultures, the nitrogen comprised in a succession of crops always exceeds, and frequently in a large proportion, that originally existing in the manures consumed in their production. This excess is evidently derived from the atmosphere, and in that case it is more than probable that a portion of it enters the plants in the form of nitrate of ammonia, a nitrate, which according to Liebig's analyses, is frequently found in rain water falling during a storm. In that event it must be an electrical phenomenon, that disposes the nitrogen of the atmosphere to combine with the plants. But, before speaking decisively as to this explanation, it must be ascertained whether the nitrate of ammonia can really contribute to the production of the nitrogenous principles met with in all the plants."

More recently Boussingault has added, that "the nitrogen can enter directly into the organism of plants if their green parts are qualified for its fixation: it can also be carried into plants by the water (always aerated) which is imbibed by their roots. Indeed, some philosophers are of opinion that the atmosphere probably contains an infinitely small quantity of ammoniacal vapours."

Liebig is of the opinion, that this excess of nitrogen proceeds from the ammonia imbibed by the plants from the atmosphere wherein it is found, but in such minute quantities that the most delicate tests frequently fail to detect its presence.

The nitrogen of the air is, in most cases, far from sufficient for the complete growth of plants, or at least for the production of an abundant harvest. Most agriculturists even believe that many entire families of plants, as the gramineals, are incapable of assimilating it.

Nitrogenous matters are rarer and more costly than other organic substances, but at the same time they are of the first importance in their application to agriculture. Nitrogen, then, is the element most desirable in the manure; or in other words the organic matters most advantageous in the production of manure are just those which give birth, by their *decomposition*, to the greatest proportion of soluble or volatile nitrogenous bodies; we say, by their decomposition, because the mere presence of nitrogen in a matter of organic origin is not sufficient to characterize it as a manure. Coal, for instance, contains nitrogen in very appreciable quantities, and yet it has no ameliorant action upon the soil; for the reason that it resists the putrefactive action of the atmospheric agents, which always produces ammoniacal salts and other nitrogenous compounds favourable to the growth of plants.

For like reasons the activity of manures is proportional to the rapidity of their decomposition. Those which decompose quickly, cease their fertilizing influence after a year, whilst the action of those which decompose slowly is prolonged for several years and more. This duration of action is a matter for serious consideration; it depends frequently upon the cohesion of the substances and their insolubility: the climate and nature of the soil also greatly influence the progress of their decomposition.

Convinced of the importance of nitrogen in manures, Payen and Boussingault undertook a series of analyses for the determination of the proportion of this element in the numerous matters used as fertilizing agents.

The results of these labours have enabled them to establish the comparative rank and equivalents of the manures examined. Barnyard dung, which they consider as the *normal manure,* is taken as the standard. We will insert the tables further on.

There is a difference of opinion as to the propriety of this mode of estimating the value of manures; for while all acknowledge that the influence of nitrogen under assimilable forms is never prejudicial to plants, but is always useful, and even indispensable for certain purposes, Liebig contends that the efficacy of manures is not proportional to their amount of nitrogen. In support of this opinion he cites a large number of examples. He believes that the effect of the ammonia presented to the plants, as a source of nitrogen, by artificial means, is limited to the acceleration of the development of the plants under cultivation; and that there are other circumstances which have a remarkable influence upon the growth of the crops. We will recur to this very important point when speaking of mineral manures.

CHAPTER III.

MINERAL MANURES.

Plants invariably contain earthy and alkaline matters, indispensable to their growth and perfect vitality. A single example is sufficient to show the necessity of the presence of certain salts in plants. The bony frame of animals owes its stiffness to the phosphate and carbonate of lime, and these calcareous salts must therefore be furnished by the food; for all aliments are definitively derived from the vegetable kingdom.

Another evidence of the utility of salts, is the fact that plants do not indifferently receive those which are conveyed to them, but really exercise a power of preference. This property and the utility of selected mineral substances, is well attested by the agricultural experiments and conclusive analyses of Boussingault. Thus, some plants imbibe salt upon the same soil where others take up none or but small quantities. Pellitory, nettle, borage, covetous of nitrates, select them from the soil, while other plants growing by their side contain only traces of them. Wheat upon the same land takes up eight times more phosphoric acid than beets or turnips; oat and wheat straw contain fifty or sixty times more silica than the oats and wheat themselves. These are only a few of a number of conclusive examples that could be cited. On the other hand, it is well known that plaster is favourable to the leguminous plants, and Boussingault has shown that it produces no effect upon wheat. It is known also that certain plants prefer particular kinds of soil on account of the principles which they contain; thus the fern, chestnut, and the vine, require salts abundant in potassa.

These multiplied facts prove, as Gasparin well says, that it is not a definite amount of any one nutritive principle, but the choice of several different ones, which is required for plants. We do not mean to say that the plant does not under certain circumstances take more or less quantity of salts, or that certain salts are not substituted for others; as instance, Soda for potassa, &c., no; but it is certain that when a plant finds in the soil those substances which predominate in its ashes, it prospers much better and yields more abundant harvests.

The exact analyses of the ashes of plants, must determine which of the mineral manures are most favourable to their growth and existence. Many chemists have been occupied upon these analyses, and we give a synopsis of their labours in tabular form, on page 25.

In examining the tables, it will be observed that there is a striking similarity in the principal results, although the plants analyzed came from soils of different compositions. Thus, it is seen that the ashes of clover always contain a considerable proportion of carbonate of lime, and herein is explained the efficacy of plaster or lime in the culture of those plants. The ashes of potatoes, of Jerusalem artichokes, of kidney and common beans contain fifty per cent. and more of potassa; the ashes of wheat give proportionally less, but invariably contain an enormous amount of phosphates.

These remarkable and uniform results indicate therefore what mineral substances are proper accompaniments of the nitrogenous manure, in the culture of the different plants, in order to render them productive.

Hertwig's Experiments.—*Analyses of several Vegetable Ashes.*

Contents of One Hundred Parts.	Beech wood.	Beech bark.	Fir wood.	Fir Bark.	Fir Leaves.	Pine Leaves.	Havana Tobacco.	Hanover Tobacco.	Fanes of Windsor Beans.	Pea Stalks, No. 1.	Pea Stalks, No. 2.	Fanes of Potatoes.	Clover, Luzerne.
Carbonate of Potassa	11.72		11.30				6.18		13.32	4.16	4.34	4.69	23.47
Carbonate of Soda	12.37	3.02	7.42	2.95		10.72	19.40	1.61	16.06	8.27			8.16
Sulphate of Potassa	3.49					1.95		11.11	32.40	10.75	11.99		2.23
Chloride of Sodium							8.64	9.24	0.28	4.63	3.72	2.28	2.27
Sulphate of Soda							7.39	1.09					
Silicate of Potassa						3.90							
Carbonate of Lime	49.54	64.76	50.94	64.98		63.32	51.38	40.00	39.50	47.81	49.73	43.68	41.61
Magnesia	7.74	16.90	5.60	0.93		18.60	7.09	4.27	1.92	4.05	1.38	3.76	6.41
Phosphate of Lime	3.32	2.71	3.43	5.03		6.35	9.04	17.95	6.43	5.15	1.15	5.73	11.80
Phosphate of Magnesia	2.92	0.66	2.90	4.18					6.66	4.37	7.82		0.91
Phosphate of Iron	0.76	0.46	1.04	1.04		0.88			3.49	0.90	3.64	1.30	0.81
Phosphate of Alumina	1.51	0.84	1.75	2.42		0.71				1.20		2.75	
Phosphate of Manganese	1.59												
Silica	2.46	9.04	13.37	17.28		10.31	8.26	15.25	7.97	7.81	15.54	29.81	2.26

* Fanes—the fallen leaves of a plant.

THOU'S EXPERIMENTS.

Analyses of the ashes of several plants from the environs of Solm, in Hesse-Cassel.

CROP OF 1842.

	WILD PEAS.	YELLOW PEAS.	SPRING WINDSOR BEANS.	WHEAT.
Carbon,				0.522
Silica,	0.56	0.29	1.48	1.914
Phosphate of Iron,	0.68	1.94	0.34	0.525
Lime,	2.96	2.70	5 38	3.011
Magnesia,	7.75	6.91	7.35	13.575
Phosphoric Acid,	38 34	34.01	35.33	45.531
Sulphuric Acid,	2.63	4.28	2.28	
Potassa,	27 12	35.20	21.71	24.170
Soda,	17.43	10 32	21 07	10.340
Chloride of Sodium,	1.88	2.56	3.32	

SAUSSURE'S ANALYSES OF THE ASHES OF SEVERAL PLANTS.

CONTENTS OF ONE HUNDRED PARTS.	Ripe fruits of the horse chesnut tree.	Vetch seed.	Wheat straw.	Wheat grains.	Wheat bran.	Corn stalks.	Corn grains.	Barley straw.	Barley grains.	Vetch in flower.	Vetch stems without grains.
Potassa,	51.0	22.45	12.5	15.0	14.0	59.0	14.0	16.0	18.0	57.25	31.0
Phosphate of Potassa,	28.0	43.93	5.0	32.0	30.0	9.7	47.5		9.2	carbon-	
Chloride of Potassium,	} 3.0	0.90	3.0	0.16	0.16	2.5	0.25	0.5	0.25 }	ate	14 0
Sulphate of Potassa,		2.00	2.0			1.25	0 25	3.5	1.5	} 12.0	2 0
Earthy Phosphates,	12.0	27.92	6.2	44 5	46.5	5.0	36.0	7.75	32.5	18 0	6.0
Earthy Carbonates,			1.0			1.0		12 50		5 0	37.5
Silica,	0.5		61.5	0.5	0.5	18.0	1.0	57.0	35.5	2 0	2 75
Metallic Oxides,	0.25	0.50	1.0	0.25	0 25	0.5	0.12	0 5	0.25	0 5	0 57
Loss,	5.25	2.30	7.8	8.59	8.59	3.05	0.88	2.25	2.80	8.25	6.0

BOUSSINGAULT'S EXPERIMENTS.

Composition of Ashes from Plants harvested at Bechelbronn, (Lower Rhine.)

SUBSTANCES WHICH YIELDED THE ASHES.	ACIDS. Carbonic.	ACIDS. Sulphuric.	ACIDS. Phosphoric.	Chlorine.	Lime.	Magnesia.	Potassa.	Soda.	Silica.	Oxide of iron, alumina, &c.	Carbon, moisture, loss.
Potatoes,	13.4	7.1	11.3	2.7	1.8	5.4	51.5	traces	5.6	0.5	0.7
Green beets,	16.1	1.6	6.0	5.2	7.0	4.4	39.0	6.0	8.0	2.5	4.2
Turnips,	14.0	10.9	6.1	2.9	10.9	4.3	33.7	4.1	6.4	1.2	5.5
Jerusalem artichokes,	11.0	2.2	10.8	1.6	2.3	1.8	44.5	traces	13.0	5.2	7.6
Wheat,	0.0	1.0	47.0	traces	2.9	15.9	29.5	traces	1.3	0.0	2.4
Wheat straw,	0.0	1.0	3.1	0.6	8.5	5.0	9.2	0.3	67.6	1.0	3.7
Oats,	1.7	1.0	14.9	0.5	3.7	7.7	12.9	0.0	53.3	1.3	3.0
Oat straw,	3.2	4.1	3.0	4.7	8.3	2.8	24.5	4.4	40.0	2.1	2.9
Clover,	25.0	2.5	6.3	2.6	24.6	6.3	26.6	0.5	5.3	0.3	0.0
Peas,	0.5	4.7	30.1	1.1	10.1	11.9	35.3	2.5	1.5	traces	2.3
Kidney beans,	3.3	1.3	26.8	0.1	5.8	11.5	49.1	0.0	1.0	id.	1.1
Beans,	1.0	1.6	34.2	0.7	5.1	8.6	45.2	0.0	0.5	id.	3.1

Mineral Substances removed from an hectare of land, by different crops, grown at Bechelbronn.

NATURE OF THE CROPS.	Dry crop.	Ashes in 100 parts of the crop.	Quantity of ashes per hectare.	ACIDS. Phosphoric.	ACIDS. Sulphuric.	Chlorine.	Lime.	Magnesia.	Potassa and Soda.	Silica.	Oxide of iron, alumina, &c.
	Kil.	*Kil.*	*Kil.*	*Kil.*	*Kil.*	*Kil.*	*Kil.*	*Kil.*	*Kil.*	*Kil.*	*Kil.*
Potatoes,	3085	4.0	123.4	13.9	8.8	3.3	2.2	6,7	63.5	6.9	18.6
Beets,	3172	6.3	199.8	12.0	3.2	10.4	14.0	8.8	89.9	16.0	5.0
Jerusalem artichokes,	5500	6.0	330.0	35.6	7.3	5.3	7.6	5.9	146.8	42.9	17.2
Wheat,	1148	2.4	27.5	12.9	0.3	0.0	0.8	4.4	8.1	0.4	
Wheat straw,	2790	7.0	195.3	6.0	2.0	1.2	16.6	9.8	18.6	132.0	2.0
Oats,	1064	4.0	42.6	6.4	0.4	0.2	1.6	3.3	5.5	22.7	0.6
Oat straw,	1283	5.1	65.4	1.9	2.7	3.1	5.4	1.8	18.9	26.2	1.4
Clover,	4029	7.7	310.2	19.5	7.7	8.1	76.3	19.5	84.1	16.4	0.9
Peas, dunged,	998	3.1	30.9	9.3	1.5	0.3	3.1	3.7	11.7	0.5	traces
Kidney beans, sound,	1580	3.5	55.3	14.8	0.7	0.1	3.2	6.4	27.1	0.6	id.
Beans, sound,	2121	3.0	63.6	21.8	1.0	0.5	3.2	5.5	28.7	0.3	id.

* A hectare equals two acres, one rood, and thirty-five perches.
† A Kilogramme equals 2 lbs. 3 ozs. and 4 4-5ths drs., avoirdupois.

This important question is even at this day too much neglected, and it is more frequently by chance than otherwise, that the alkaline and earthy salts are found in the manures. It is true, as we before said, that nitrogen is an element of valuable consideration in manure; but it is not all-sufficient, for a soil that receives only a purely nitrogenous nutriment will, though thereby excited to vegetation, be soon exhausted of its mineral elements and rapidly rendered sterile. This view is supported by daily experience. Are we not obliged to rotate our crops, or in other words to cultivate different plants alternately upon the same soil, as a bar to its exhaustion of the same mineral substances? Do we not, in some localities, leave the ground fallow from time to time, so that a slow decomposition may re-produce the assimilable salts favourable to vegetation? It is very evident that if we restore to the earth, annually, the substances which have been abstracted by the crops, it can produce the same results indefinitely, provided all things are concomitant in other respects.

In calculating the value of nitrogenous manures by their content of nitrogen, the farmer should also take into consideration their saline components, though these latter have a depreciated worth compared with nitrogen. It is thus that guano and bones, which contain a large quantity of phosphates, should be preferred, their proportions of nitrogen being equal, to other manures the components of which besides nitrogen are inert.

Those manures which contain but little of mineral matters, as ammoniacal salts, blood, wool, &c., must, previous to their application, be supplied with the elements which are wanting.

It is very strange that the decisive results, from the use of lime and sulphate of lime in the culture of those plants which absorb a large amount of that earth, have not induced an extension of the experiments to all the salts useful in vegetation. It seems evident, that if its application in excess, upon the surface of fields which already contain it, produces good effects in the cultivation of clover, it will be still more efficacious upon those lands which have but traces of this salt.

The best manure therefore is that which will restore to the earth all the substances removed from it by the crops. There is none at present which, in itself, combines all these qualities; barn yard manure, enclosing nearly all the matters necessary to vegetation, is the nearest to the standard, but still is not always sufficient. Its proportion of phosphates is limited, and moreover the supply of this manure is not equal to the demand.

An intelligent manufacturer, Chaviteau, has responded to this want of the farmer, and, following out the principles of Boussingault, Payen, Liebig and Gasparin, has founded, at Paris, an establishment for the manufacture of manures compounded with regard to the soil and the nature of the crops. His manures contain not only sufficient proportions of ammoniacal salts and nitrogenous matters, but also the alkaline salts and earthy phosphates, sulphates and chlorides; in a word, all the matters beneficial to the different crops. There were others, previous to Chaviteau, who prepared the compound manures with more or less success; but unfortunately these preparations, known by different names, rarely have an intrinsic value equal with their price. Moreover, through ignorance or unskilful manipulation, their composition is seldom or never uniform.

Of all the manures or mixtures compounded for the amelioration of the soil, the most known is that of Jauffret. It consists of shrubbery, stalks, &c., soaked with a ley of dilute animal manures and saline substances. These latter add to the manure the elements which are wanting in the shrubbery, &c.

The recipe is empirical, but notwithstanding its imperfections, it has rendered essential benefits to Provence, a poor country deficient in grasses, but growing upon its exhausted surface a vast extent of wild plants.

After these theoretic considerations, we proceed to examine the principal substances used as manures, as to their composition, value and preparation. Firstly, we will treat of the nitrogenous manures; then follow with those of mineral nature and conclude with the ammoniacal salts.

CHAPTER IV.

NITROGENOUS MANURES.

Barn yard Manure. We treat of this first, as the chief means of the farmer for maintaining the fertility of his soil. It consists generally of an excipient called *litter*, because it serves as the bed of the animals, and this litter is usually straw, stalks, leaves or the like. Those substances possessing the double advantage of absorbing and securing the excrements of the animals, constitute one of the best manures. It is evident that the value of the uniformly wetted manure is proportional to its amount of excrements, for these latter are more nitrogenous than the litter; the best manure is obtained by using the minimum of litter, taking care to remove it as soon as it becomes saturated with the urine. The dung should be removed in a wheelbarrow to a neighbouring department, stacked as fast as it is produced in the stalls, and the juices which flow from the stalls should be collected in a draining-well located beneath or by the side of the dung-heap; a wooden grating will prevent the passage of the straw. By means of a pump, the heap can be irrigated with the juices of the well as often as the dryness of its surfaces requires. The impregnated litter should be stacked carefully, and so as to prevent a too active fermentation, which will occasion a loss. It is better to keep it sheltered from both sun and rain, and especially from contact with running waters. When the high price of straw compels an economical use of that material, the litter may be washed, and the wash water caught with the urine in the draining-well. The liquid manure thus obtained is used alone, and is conveyed to the fields in hogsheads.

The urine of cattle is also occasionally used separately. In Switzerland they add sulphate of lime (plaster,) or sulphate of iron (copperas,) to transform the volatile carbonate of ammonia into sulphate of ammonia, which is a fixed salt.

It has been frequently questioned whether there is advantage or injury in the application of dung before or after its fermentation; but experience having proved that the dung, fresh from the stalls, undergoes the same alteration and generates the same products under ground as when left to ferment in the air, the question then is, whether it is beneficial to permit its fermentation in the same soil which it is to manure? Gazzeri, has shown, by numerous experiments, that the practice of leaving dung to ferment before applying it to the fields, occasions a loss of valuable principles, and hence it is more advantageous to use it fresh from the stable. These fresh excrements, used moderately, give no hinderance to vegetation, as is in fact proved in the manuring of land by the folding of sheep and cows whose excrements, in such case, pass directly into the soil.

Notwithstanding the loss in nitrogenous matters produced by the fermentation of the dung, it is the practice frequently to ferment the juicy portion previous to applying it to the soil. The only advantage of this process is, that it hastens the action of the manure.

The *normal* manure of Payen and Boussingault came from the farm of Bechelbronn belonging to Boussingault. This manure, furnished by thirty horses, thirty horned cattle, and twelve to twenty hogs, dried at 230° Fahr. has the following composition :

Carbon,	35.8
Hydrogen,	4.2
Oxygen,	25.8
Nitrogen,	2.0
Salts and earth,	32.2
	100.0

In its normal state, that is, fresh from the stable, it contains—

Carbon,	7.41
Hydrogen,	0.87

Oxygen,	5.34
Nitrogen,	0.41
Salts and earth,	6.67
Water,	79.30
	100.00

The average composition of the ashes according to Boussingault, is:

Acids—Carbonic,	2.0
Phosphoric,	3.0
Sulphuric,	1.9
Chlorine,	0.6
Silica, Sand, Clay,	66.4
Lime,	8.6
Magnesia,	3.6
Oxide of Iron and Alumina,	6.1
Potassa and Soda,	7.8
	100.0

We now pass to the consideration of the matters excreted by different animals, and shall separately speak of the dung of the horse, cattle and hog as components of barn yard manure, and of which we have as yet only summarily treated.

CHAPTER V.

EXCRETED MATTERS, (Nitrogenous Manures.)

Horse Dung. Although the excrements of the horse are richer in nitrogen than those of the cow, the latter are preferred by the farmers as being more serviceable; for as horse dung is less humid, it ferments and dries rapidly if it is not wetted and heaped up so as to prevent the action of the air. During this fermentation, a considerable proportion of nitrogenous principles are dissipated, and hence a depreciation of the value of the manure. The 2.7 per cent. of nitrogen which the fresh dung actually contains, is by a complete decomposition reduced to one per cent.

Horse dung is appropriate to all soils; in a dry state it contains, as we have said, 2.7 per cent. of nitrogen; when moist, only 0.65 per cent.

Cattle Dung. This manure is much more aqueous than the preceding, particularly when the cattle are in pasture. Its preparation is very easy. Cow dung in a dry state contains 2.6 of nitrogen; when moist, 0.36, only.

Hog Dung. Fattened hogs drop very nitrogenous excrements, which consequently are more energetic than the preceding. In a dry state, their fæces contain 3.4 nitrogen; when humid, 0.61 only.

Sheep Dung. A very energetic manure, but slightly aqueous, and frequently used without any previous preparation. The dung is swept from the pens daily, and heaped into piles whence it is sold, by measure, at from ten to twenty cents per bushel. Generally, it is applied to the fields by folding the sheep in the enclosures. According to Boussingault, one sheep can, during the night, manure a surface of about three and a half square feet.

Bat Dung. The bottom of caves frequented by these birds are often covered with their excrements. Their application to the soil produces good results.

Colombine. The excrements of pigeons are known by the name of *Colombine.* They are favourable to all crops, but being very energetic must be used prudently. In the department of the Straits of Dover, where there are vast numbers of pigeons, twenty dollars are paid per annum, for the excrements of six or seven hundred, which is a large wagon load. This quantity suffices to manure two and a half acres of surface.

Chicken dung is also very active, but has a less value than colombine, though much esteemed in southern localities.

Guano. Guano is the accumulated excrement of multitudes of birds which congregate upon a number of small islands in the Pacific ocean, the coasts of Peru and Chili. Upon some of these islands it is found in deposits of sixty to seventy feet in thickness. Being an extremely valuable manure, it has become an article of commerce, and is imported in large quantities for the fertilization of the soil. Peru and Chili are indebted to it for their fertility.

Fownes' analysis gave as its composition :

Oxalate of Ammonia, Uric Acid, Traces of Carbonate of Ammonia, Organic Matter,	66.2
Phosphate of lime and magnesia,	29.2
Alkaline phosphates & Chlorides, Traces of Sulphate,	4.6
	100.0

Girardin found in guano 18.4 dry uric acid, equal to 6.13 nitrogen, and 13.0 ammonia, equal to 10.73 nitrogen, making in all 16.86 nitrogen. Payen found in a specimen which he first dried, 15.73 per cent. of nitrogen; in its normal state the sample had only 13.95.* Other guanos gave but 6 to 7 per cent., and this discrepancy in composition

* See the "Encyclopedia of Chemistry," for analyses of all the different guanos.

is owing either to the sample having been taken from different strata, or else to the transformation of the urate of ammonia, of some of them, into carbonate of ammonia, which is very volatile.

The cost of guano in this country, varies from twenty-five to forty dollars per ton, according to quality.

Experiments made in France have determined 250 to 500 lbs., as the proper proportion per acre. Like colombine it acts energetically, and should therefore be used with discretion. The composition of guano confirms its origin, and moreover the island, which furnishes it still serves as a refuge for a multitude of birds. According to Humboldt's calculations, even supposing the surface of these islands to be covered with the birds, three centuries would be required to form a layer of excrements of 0.3937 inches in thickness, and hence we can only conjecture the length of time consumed in the formation of these vast deposits.

New deposits of guano have been found upon the coasts of Africa, whence it is exported in large quantities. This guano is less nitrogenous than that from Peru.

Excrements of Fish. The deposit formed at the bottom of well stocked fish ponds, is an excellent manure, and according to Gasparin, produces remarkable results.

Human Excrements. These constitute one of the most energetic manures. They may be applied fresh from the privies, as is done around Grenoble, Lyons and Tuscany. To facilitate their more uniform distribution over the surface of the land, they are thinned with water. In China these fæcal matters are carefully collected in mains, running the length of the principal streets and distributed into reservoirs, to be diluted with water previous to application to the plants. The Chinese sometimes also knead them with clay to form them into bricks, which when dried and pulverized are spread over the fields. In Paris the fæcal matters are converted into poudrette.

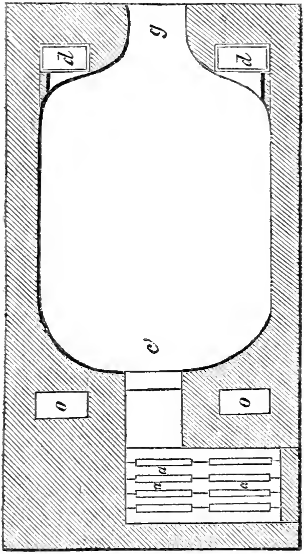
Poudrette. The ordure of Paris is transported to Montfaucon and emptied into a graduated series of large reservoirs; the two most elevated of these cisterns serve alternately as the receptacles for the nightly collections of the contents of the privies. When one of the basins is full, the more liquid supernatant portion is drawn off into a third cistern below; this third basin being filled, its contents, after repose, deposits, as in one of the first two, a part of its suspended solid matter. The more fluid portion of this third basin is led into a fourth. The last waters are conveyed through a sewer into the Seine. The completion of this process leaves only the pasty matters of the fæces, which are then to be removed with drags or shovels and spread upon the hill-sides and stirred and turned until perfectly dry. After five or six days the matter becomes pulverulent, and forms poudrette, which must be piled into heaps and beaten on their surface to prevent the infiltration of rain through the mass.

In its normal state this manure contains 41.4 per cent. water, and 1.56 per cent. nitrogen; in its dry state, the nitrogen, equals 2.67 per cent. Poudrette weighs 55 pounds per bushel, and sells at $1.50 cts. per 225 pounds. It is used in the proportion of 20 to 30 bushels per acre, and should be applied at the time of ploughing.

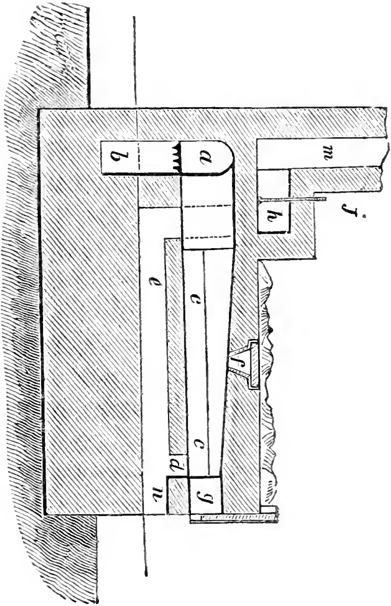
The effects of the poudrette are unfortunately not very lasting; sometimes not extending even to the fructification of the cereals.

It imparts to grass a great vigour, but at the same time, it is said, a taste repugnant to animals. Boussingault, in his observations, has not verified this assertion. Salmon succeeded in completely disinfecting fæcal matters by mixing them with the carbonaceous product of the calcination, in close vessels, of a calcareous earth containing organic matters, the nitrogen of which adds itself to that of the manure. It is the "*animalized black.*" On the next page is given the plan of a furnace for the preparation of this black.

Fig. 1. is a vertical cut, fig. 2. a horizontal cut of the furnaces. The same letters in the two indicate the same objects; *a*, the hearth whereon the combustible is placed, *b*, the ash pan; *c*, a bed for the reception of the matter to be calcined; *d*, a vent hole establishing the communication between the furnace *c c* and its lower gallery *a a*. It is seen, in fig. 1, that the vent hole is in each side of the kiln; *e*, the gallery under the hearth of the furnace, into which the products of combustion enter in passing out of the furnace, and again heat the hearth by contact; *f*, the orifice opening through the arch of the furnace, closed by an iron plate, and serving as an inlet for



the substance to be calcined, which latter must first be spread over the top of the furnace to dry; *g*, the furnace door, serving for the entrance of a large poker with which to stir the calcining matter; *o*, vent hole establishing communication between the galleries; *e* and *h*, *h*, the gallery conveying the products of



the combustion into the chimney; *m, m,* the chimney conducting off the gaseous products of both the combustible and calcined matter; *i,* a damper for regulating the draft.

Flemish Manure. The method usually followed in Flanders for the utilization of ordure, is much more rational and less injurious to health than the manufacture of poudrette. This term of Flemish manure, or *gadoue*, (night soil,) is applied to the human excrements from privies, prepared in vaulted cisterns sunk in the ground by the road-sides convenient to the farms. These cisterns, walled with brick and bottomed with stone, are filled during the leisure periods of farm labour, and their contents left to ferment, for some months previous to their being used. The casks should be kept constantly filled. The gadoue is intended principally to accelerate the growth of oleaginous plants and tobacco, which derive the most benefit from it. It is used in the liquid form, and is conveyed to the fields in barrels, whence, after being thoroughly stirred, it is dipped in large iron ladles and spread upon the seeds. The seeds are warmed into a rapid developement by the fermentation of this matter, and acquire abundant nourishment. Its use is also advantageous to young plants, but in the application, to avoid touching the leaves, it should be carefully poured on by a hand-dipper.

It requires some time to become habituated to the repulsive odour emitted by the night soil; these emanations, however, are not insalubrious.

Those who use this manure very frequently mix with it the powder of oleaginous seed-cake. These seed residues, by reason of their content of vegetable azotized matter, are themselves a very good manure.

The reservoirs for the collection of the gadoue, generally contain 35 square yards of matter, or 25 casks each of from 300 to 400 lbs. and costing five cents.

According to Payen and Boussingault, the Flemish manure contains, in its normal state, 0.19 to 0.22 per cent of nitrogen.

For the modes of rendering fæcal matters inodorous, and more powerful in their fertilizing influence than poudrette, see Appendix.

CHAPTER VI.

ANIMAL DEBRIS, (Nitrogenous Manures.)

The debris of dead animals, and the animal matters from slaughter-houses, are powerful manures; and when they can be readily and economically procured, are valuably useful in agriculture. The flesh, skin, horns, hair, tendon and bone pieces—all are useful.

Flesh. The muscular flesh of animals is rarely used as a manure, because, it is of greater value for feeding hogs; but, such as is not used for the latter purpose can be dried after previous boiling, and then powdered, in which state, it is an excellent manure. In its normal state, it contains more than the half of its weight of water; dried in the air, it still retains 8 to 9 per cent. Perfectly dried, it has 14.25 per cent. of nitrogen. As sold in commerce, ($5 per 225 lbs.) it contains 13.04 per cent. of nitrogen.

Blood. The blood of slaughtered animals is less suitable, for the nutrition of hogs, than muscular flesh; it sometimes even creates disease, and should therefore be preferred for the fertilization of the soil. For this purpose, it must be coagulated by ebullition, and then dried in a furnace. In a liquid state, it is an improper manure, for its decomposition is so rapid as to dissipate the resultant products, and thus depreciate its fertilizing effects. To obviate this, however, it is only necessary to dilute the blood largely with water and therewith irrigate the fields; or it can be soaked into calcined humus, and then spread upon the soil. According to Payen, blood perfectly dried, contains 17 per cent. of nitrogen; when prepared upon a large scale, it has 14.87 per cent. of nitrogen, and costs two dollars per one hundred pounds.

Bone. Bones, when freed of greasy matter and crushed between grooved iron rollers, are well fitted for agricultural use. In England, their consumption is so large that companies have been formed for their importation from foreign lands. If the grease is not carefully removed by boiling, the fat reacts upon the carbonate of lime of the bony net work, forming a soap of lime which resists all atmospheric influences; and hence an impediment to the fertilizing influence of the bones, especially when they are not finely powdered. Payen has shown, that old whole bones lost, after having been in the earth for four years, but 0.18 of their weight, whereas, when previously boiled, they lose, under the same circumstances, 0.25 to 0.30. But fresh bone-dust, in a dry state, contains 7.58 per ct. of nitrogen. As found in commerce, it contains 0.30 water, and 5.30 nitrogen, and sells for $1 per 100 pounds.

Bones are applicable to all soils, and are persistent in their action through four or five years. The scraps, from the bone turners and button makers, are mostly absorbed in the manufacture of animal black. The turnings only are used in agriculture, and for manuring the rich vineyards and olive. On account of its extreme division, its durability does not extend beyond two to four years.

Boiled bones, which have also been exhausted of their gelatin in Papin's digester, are still useful as a manure. These residues, however, act only through one year, and moreover, when thrown into heaps, rapidly ferment and lose a great portion of their animal matter. To preserve them securely, Payen recommends their thorough desiccation and subsequent pulverization.

Horn Shavings and Clippings. These are also appropriate to all soils. In England, the proportion is thirty bushels per acre. Tendons, hide clippings, hair, feathers, and bone glue residues, are all applicable in the same mode and under the same circumstances as bone and horn turnings. The proper proportion per acre can be calculated from their equivalent of nitrogen.

Fish. Fish in an incipient state of decay, when dried and powdered, form an excellent manure. Dried herring contain 10.54 per ct. of nitrogen; when moist, only 0.19. Thoroughly dried Codfish has 10.86 nitrogen.

Glue maker's Residue. The residue from the glue kettles consists of tendinous and cutaneous matters, hair, residue of bones, horn, muscles, calcareous soap and earthy matters. This mixture, when dried, can be preserved for a long time, and having 4 per ct. of nitrogen, is consequently a good manure.

Cracklings. The dregs of all kinds of rough suet are termed cracklings. They consist chiefly of adipose membranes, still impregnated with a little fat, of blood, muscle and bone. Formerly they were used as food for dogs, but they also yield good results as a manure. They contain 11 to 12 per cent. of nitrogen, and reach the market in hard pressed cakes, which must be crushed previous to application to the soil.

Woollen Rags. These are of the richest manures. The slow decomposition of the wool renders it potential for six or eight years, and as its proportion of nitrogen is considerable, it is very convenient for transportation.

Two thousand and five hundred pounds of woollen rags suffice to manure an acre of soil, but unfortunately this valuable agricultural element is only to be had in large cities. England imports it from Sicily for the culture of hops. In Provence it is used for all the crops. The rags should be as finely divided as possible, so as to facilitate their uniform distribution over the surface of the fields. According to Boussingault and Payen, woollen rags contain 12.28 per cent. water, and the dry matter gives 20.26 of Nitrogen. In Paris these rags cost 50 cts. per 100 pounds, in England $1.25 cts. per 100 pounds.

Refuse Animal Black. In the refining of sugars, the melted syrup is mixed with bone black and clarified with blood. The filtered mixture leaves upon the cloth a deposit, which, washed, contains all the charcoal employed, the coagulated blood, a little syrup and some vegetable matters contained in the rough sugar. This product, dried, contains nearly 21 per ct. of blood, to which is mainly due its fertilizing action. In 1824, Payen made known its value as a manure, and since then more than twenty millions of pounds of refuse animal black are annually used for the fertilization of the soil, much of which has even been imported from abroad. The syrup contained in this residue, by its fermentation, generates alcohol and then acetic and lactic acids, which are unfavourable to the development of plants, and hence the use of this residue, immediately after its removal from the filters, will prove disadvantageous. If, however, it is left in heaps for a month or two before being applied, the prolonged action of the air transforms the animal matter and generates ammonia, which not only neutralizes the acids resulting from the fermentation of the sugar, but even imparts an alkaline reaction to the product; a reaction always favourable to vegetation. Payen found in a quantity of animal black representing two hundred and twenty-five pounds blood, 2.04 per ct. of nitrogen, but the results given by this manure are greater than could be expected from this proportion. This black costs in Paris from 60 to 75 cts. per 100 pounds.

CHAPTER VII.

NITROGENOUS MINERAL SUBSTANCES.

There are some mineral substances admixed with nitrogenous matters used as manures; for instance, shells, river or swamp muck, and the saltpetre earths of all the provinces. The sea sand used in Brittany is called *merl.* The merl is a muck filled with shells and animal matters, from which it derives its principal properties. It is found abundantly at the mouth of the river Morlaix, whence it is drawn up by a drag. The roadstead of Brest and the river Quimper, also yield large quantities. The harvest of merl is made from May fifteenth to October fifteenth in lighters, the contents of each of which (16,000 pounds,) sells for 80 cts. to $1.00. This manure should be used soon after it is taken from the water, for it rapidly disintegrates in the air and partially loses its properties. Merl, by reason of its calcareous matter, is peculiarly fitted for argillaceous soils. According to Payen and Boussingault, the Morlaix merl contains in a dry state, 0.12 per cent. of nitrogen. Fresh from the sea, it contains one-half its weight of water, and is used in the proportion of 1260 to 2320 pounds per acre. This manure being rapidly decomposed, is consequently of only limited durability.

* *Tangue*, the seaside sand, constitutes the soil of the seaside shores in many localities in the vicinity of Morlaix. It should be washed to remove the greater portion of its salt. The little of animal matter which it contains is dissipated, by putrefaction, when too long exposed to air. Hence the established distinction between live and dead *Tangue;* the latter being evidently the least nitrogenous of the two.

Roscoff's dried *Tangue* contains 0.14 per ct. of nitrogen, and is applied in the proportion of one and a half tons per acre.

Products of the Combustion of Plants. *Soot.* Soot is used in large quantities by farmers, and is a good manure. According to Braconnot, the soot of a wood fire chimney consists of:

Ulmic Acid,	30.00
Nitrogenous matter soluble in water,	20.00
Insoluble Carbonated matter,	3.9
Silica,	1.0

* Tangue, literally sea sand.

Carbonate of Lime,	14.7
Carbonate of Magnesia,	trace
Sulphate of Lime,	5.0
Ferruginous Phosphate of Lime,	1.5
Chloride of Potassium,	0.4
Acetate of Lime,	5.7
Acetate of Potassa,	4.1
Acetate of Magnesia,	0.5
Acetate of Iron,	trace
Acetate of Ammonia,	0.2
Acrid and bitter principle,	0.5
Water,	12.5
	100.0

Payen and Boussingault have found, that the soot of coal contains more nitrogenous matter than that of wood. It is spread over clover and young wheat in the proportion of 12 to 15 bushels per acre, and it should only be applied in a calm and rainy season, according to the recommendation of Mathieu of Dombasle. Soot is used in Flanders for coleseed, in the proportion of sixty bushels per acre; it is supposed that they preserve the young plants against the attack of insects. Its cost varies from thirty to forty cents per 100 pounds.

Picardy Ashes. These ashes result from the slow and incomplete combustion of the pyritous peats used for the manufacture of alum and sulphate of iron. When the peat is heaped up it is moist, and in presence of water the sulphuret which it contains is transformed into sulphate. The heat, developed during the oxidation of the iron, gradually increasing, hastens the reaction, and finally inflames the peat, which continues to burn slowly. By this spontaneous combustion, we obtain a gray ash which serves as an amendment for meadows. The sulphate of lime which it contains, is not the sole cause of its beneficial action upon vegetation, as its influence in this respect, is mainly due to its nitrogenous constituents; for analysis shows that it has half per ct. of nitrogen. Boussingault thinks that sulphate of ammonia is produced during the incineration of pyritous peats. Picardy ashes are sold upon the spot for about three cents per bushel, and they are applied to meadows in the proportion of 4½ to 6 bushels per acre.

Vitriolic Ashes. These so called residues, from the manufactories of copperas, are analagous to the preceding. Sometimes the leeched pyritous earths are mixed with one-fourth their weight of peat ashes, in which mixture they are applicable to meadows and to sandy soils. These ashes, more nitrogenous than the Picardy, contain 2.72 per ct. of nitrogen.

Below is their analysis by Girardin and Bidards:

Soluble organic matter,	2.7
Insoluble Humus,	49.8
Sulphate of proto and per oxides of iron,	1.8
Fine sand,	39.0
Sulphuret and per oxide of iron,	6.7

CHAPTER VIII.

ECOBUAGE.

Ecobuage is the process of burning the organic matters of a soil upon their own locality, especially when they are poor in nitrogenous principles. This operation transforms the surface of the soil into a porous and carbonaceous earth, which condenses and retains the ammoniacal vapours disengaged during combustion; it moreover produces alkaline and earthy salts which are indispensable to vegetation. A too perfect combustion will, as in the preparation of pyritous ashes, cause the dissipation of the organic principles, and consequently the manure ceases to be nitrogenous.

In America they practise Ecobuage by setting fire to the fields when the grass is dry enough for ignition. Some days after the fire, a new and vigorous vegetation will be observed shooting above the soil. Ecobuage can also be accomplished, by removing the uppermost layer of soil containing the organic matters, and forming therewith a kind of furnace to which set fire. As the flame makes its way through this mass of earth, roots, turfs, &c., add green turf to close the issues which are formed. Thus may be obtained a slow combustion, which enables a thorough absorption, by the carbonated earthy envelope, of all the gases disengaged during the operation.

The object of this process (Ecobuage,) is to set at liberty, by a slow decomposition, the principles contained in the vegetable matters, and thus render them available to the soil. In this way we can hasten the circulation of the elements of the plants and present them in a state for immediate assimilation; whilst the same plants, when left to spontaneous putrefaction, decompose but slowly and partially, and produce results inappreciable to any one crop.

CHAPTER IX.

VEGETABLE SUBSTANCES.

Green Manures. Under this title, are comprised all the green sprouts of roots and tubercles ; such are the fallen leaves of carrots and potatoes, the leaves of beets and turnips. As these materials are serviceable both as manure and forage, the farmer must determine which of the two uses is most profitable. According to Boussingault, these substances are only middling food, but excellent manures. He found that the potato tops from two and a half acres represent 1800 pounds barn yard dung, supposed to be dry ; and that beet leaves from the same extent of surface are equal to more than 5800 pounds of same manure in the same state of dryness.

Marine plants are a species of green manure which serve for the amelioration of the soil neighbouring to the sea coasts. These strongly nitrogenous plants are applicable directly as they come from the water, or in a semi-dried state, macerated or even partially incinerated. They act as well by their saline constituents and hygroscopic properties as by the nitrogen which they contain. Salmon uses them, after having been dried in the sun and powdered, for the disinfection of fæcal matters, with which, in a dry state, they form an excellent manure, containing 2.4 per ct. of nitrogen.

Sea-weeds. In England, Scotland, and Ireland, they use, under this title, the different plants of the alga family. The harvest is made from the surface of rocks and at the bottom of the sea with large hoes and rakes. There are certain regulations peculiar to each locality, as to the time and mode of harvest. This manure, rich in salts of soda and potassa, has the great advantage of being entirely exempt from injurious seeds. The different fuci, after being drained, have 0.75 of nitrogen; dried in the air, they still retain 0.40. In this state the *Fucus saccharinus* possesses 1.38 per ct. of nitrogen, and the *Fucus digitatus* 0.86 only: completely dried, the first holds 2.29, and the second 1.41. The burnt sea-weed contains 0.40 of nitrogen.

The aquatic plants of fresh waters are also applicable as manure.

Reeds. Reed is the most used of fresh water plants. When mowed green it readily decomposes; cut at the time of blossoming and dried on the place, such as we find it in commerce, it still retains 0.20 of water, and 0.75 Nitrogen; completely dried, it gives 1.10 of its weight ashes and 1.0678 per ct. Nitrogen. Rendered, by maceration, to the same state of moisture as dung, it contains 0.267 Nitrogen. It is used for manuring the base of olive trees, and prolongs its effects through two years.

Ferns. Among other plants used for fertilizing the soil are the ferns. Their proportion of Nitrogen has not been rated, but they contain a notable quantity of potassa which is very advantageous to soils deficient in that alkali.

Heath. This, like the preceding, is also useful in agriculture. The leaves contain 1.74 Nitrogen, but the stems are much poorer and more valuable as fuel than as manure.

Box. Box, as a manure, is a valuable resource in countries bordering calcareous mountains, upon which it grows abundantly. The leaved branches, after having been trodden under feet and crushed by horses and wheels, ferment very readily. In the green state they contain 1.17 per ct. Nitrogen, and 1.60 water; in the dry state, 2.89 per ct. Nitrogen.

In some mountainous countries, the leaved pine twigs are used for the same purpose.

Meadows. Meadows require to be, from time to time, cleared up, for the nature of the soil sometimes prevents their indefinite preservation in a proper state. In a field bearing 33,750 lbs. of grass, per 2½ acres, the crop furnishes a manure equal to 1,500 lbs. Nitrogen for a like surface, and yields three crops of wheat, amounting in all to 205 bushels.

Lupine. The Lupine used in France, as a green manure, is not sown until March, and must be turned under as soon as it is in flowers. This plant has not been analyzed; but its powerful effects allow the inference that it is very rich in Nitrogen. Lupine seeds, as analyzed by Payen, contain, in a normal state, 3.49 Nitrogen, in a dry state, 4.35. This, then, is a rich manure.

Beans. Bean-stalks, in flower, may be considered as a *demi manure;* they are used chiefly in fertilizing lands for the growth of hemp.

Vetch. An expensive green manure.

Rye. When turned under green, has a slight fertilizing influence, but not equal to its cost.

Spurrey. Woght's Spurrey is much used, and with good results. If a field is consecutively sown, and turned under green in March, June and August, the effect of these three herbages will equal 2,600 lbs. manure per acre. This plant thrives only in sandy soils and moist climates.

Buck-wheat. According to Schwartz, Buck-wheat, in Germany, is never turned under until all hopes of a harvest are lost. Its (dry) straw contains 0.54 of Nitrogen, and 0.48 after having been further dried in the air.

Madia Sativa. This plant has been used, as a green manure, by many farmers. Boussingault and Payen consider, that the resinous exudations, enveloping it, render necessary a maceration previous to its being turned under. The fanes of this plant contain 0.66 per ct. of nitrogen, in a dry state, and after being further dried in the air 0.53.

Rape-seed. This, of all other plants, has been, and is the most generally used, as a manure. Its seed has the great advantage of being cheap, and 10 to 15 lbs. suffice to sow an acre.

The debris of plants, the stubble of the different cereals, and the leaves of forest trees are also considered as green manures. The latter, however, should be subjected to fermentation previous to their application to the soil.

Of all green manures, those furnished by the meadows are the most abundant and least costly. The use of other plants is subordinate to their success, especially as regards their equivalent of Nitrogen. In the majority of cases, it is preferable to cultivate those plants proper for the nutrition of animals; so that the soil may again receive a greater part of the elements, while the other portion gives rise to an animal product of greater value.

CHAPTER X.

VEGETABLE DEBRIS.

Spit-dung. The muck formed at the bottom of ponds and marshes in calcareous localities, though poor in Nitrogen, is used as a manure. Its large amount of Carbon renders it appropriate to land deficient in that material. The richest mucks, and the most advantageous to agriculture, are those which have not been formed under water.

Peat. Peat is very analagous to mould, differing, however, in an absence of matters soluble in water; nevertheless, when exposed to air and moisture, it generates a certain quantity of soluble alkaline principles, and hence its employment in certain localities as manure. Peat being charged with tannin, vegetable and mineral acids, hydrogenated matters, &c., requires some preparation previous to its application. Used as a litter, in a dry state, it is an economical substitute for straw, and the matters which it absorbs readily neutralize its acids, and augment its value as a manure. It is also used admixed with dung; but is only applied to agriculture when an excessive supply diminishes its value as a fuel.

We now proceed to speak of the residua of different plants, whose fruits, roots or stems have been treated for the extraction of their juices.

Barley-waste (Malt-dust). The waste barley which has served for the production of beer, is used, with success, as a manure. Dried upon kiln-beds it equals 2½ times its weight of dung, and takes the name of *touraillons.* In England, they use fifty to sixty bushels per acre, for the culture of wheat.

Grape Cake. The pressed residuum of grapes contains a goodly quantity of nitrogen, and being of gradual decomposition, is a very durable manure for vines. Dried in the air, it contains 1.71 to 1.83 nitrogen; completely dried, 3.31 to 3.56.

Cider Cake. The residual apple cake, from the cider press, being acid, must be neutralized with lime, before being used as a manure, if the soil for which it is intended is not itself calcareous. By admixture with dung it becomes neutralized without manipulation.

Starch Grains. The pulpy mass from the Starch factories, differing slightly in value from that of the potato, is still useful for the nutrition of animals, but when the quantity produced exceeds the demands for that purpose, they may be advantageously employed as manure, especially as their preservation is difficultly effected. This pulpy matter contains seven-tenths of its weight of water, and 0.526 per ct. of Nitrogen; when completely dry, the Nitrogen amounts to 1.95. The scum and sediment of the lees of the Starch factories contain 0.005 Nitrogen, nearly equal to the amount in moist farm-yard dung. Daily, the proprietor of a Starch manufactory near Versailles, uses the waste waters of his establishment very advantageously. After allowing them to settle, he draws off the supernatant clear portion upon the neighboring fields; and drys the sediment, which forms a manure of half the value of ordinary poudrette.

Beet Pulp. This residue, of the manufacture of Beet sugar, is most generally used as food for cattle. Fresh from the press, its content of nitrogen is 0.378 per ct.; when dried in the air, 1.14; in vacuo, 1.26.

The macerated sliced beets, from the sugar process of Mathieu, contain too little nitrogen to pay the expense of their transportation.

Tan. Leeched Tan, from the leather vats, after being dried and treated with lime, to neutralize its residual tannin, can also be used as a manure.

Torteaux. The oleaginons grains, after the extraction of their oil, leave a residue, known as *torteaux.* These residua contain nearly all the nitrogenous matter contained in the plant, and, being but slightly moist, form an excellent manure, convenient and profitable for transportation.

The most used are the marcs of olives, coleseed, madia, flax-seed, arachis, all very rich in Nitrogen. There are also the torteaux of cotton, hemp, camaline seeds, beech nuts and poppys. The walnut cake is reserved exclusively for the nutrition of animals. To render these residua suitable for the soil they must be powdered, and spread upon the budding plants, or turned under the soil by ploughing. As moisture is indispensable to the successful influence of the powdered cake, it should be wetted previous to its application. In England, the proportion is 900 lbs. per acre; the quantity, however, varies with the crops. They are peculiarly adapted to light and sandy soils.

We conclude our remarks upon Nitrogenous manures with a table of their comparative values. This table is compiled from the labours of the distinguished Savans, Payen and Boussingault.

The fifth column of the table is the most useful, as it shows the amount of Nitrogen contained in the dry manure; for it is only in their dry state, that we can make a comparison of manures.

CHAPTER XI.

Table of the comparative value of Manures, deduced from the Analyses of Payen and Boussingault.

NAME.	Normal Water.	Nitrogen in 100 of Material.		Quality as to State.		Equivalent as to State.	
		Dry.	Humid	Dry.	Humid.	Dry.	Humid.
Farm-yard dung, medium, from Bechelbronn,	79.3	1.95	0.41	100	100	100	100
Livery stable dung, from the South of France,	60.6	2.08	0.79	107	197	94	51
Dung juice,	99.6	1.54	0.96	78	2	127	68
Fresh Wheat straw from Alsace, 1838,	19.3	0.30	0.24	15	60	650	167
Old Wheat straw from the environs of Paris,	5.3	0.53	0.49	27	122.5	367	82
" " " upper ends,	5.3	0.43	0.41	22	102.5	453	98
" " " ends included,	9.4	1.42	1.33	73	332.5	137	30
Rye straw from Alsace,	12.2	0.20	0.17	10	42.5	975	235
" environs of Paris, 1841,	12.6	0.50	0.42	26	105	390	95
Oat straw from Alsace,	21.0	0.36	0.28	18	70	542	143
Barley straw,	11.0	0.26	0.23	13	57.5	750	174
Wheat chaff,	7.6	0.94	0.85	48	212.5	207	47
Pea straw,	8.5	1.95	1.78	100	447.5	100	22
Millet straw,	19.0	0.96	0.78	49	195	203	51

NAME.	Normal Water.	Nitrogen in 100 of Material.		Quality as to State.		Equivalent as to State.	
		Dry.	Humid	Dry.	Humid	Dry.	Humid
Buckwheat straw,	11.6	0.54	0.48	27	120	361	83
Lentil "	9.2	1.12	1.01	57	250	174	40
Jerusalem Artichoke stalks,	12.9	0.43	0.37	22	92.5	453	108
Fanes of Madia, after having borne seed,	14.3	0.66	0.57	33	142.5	295	70
" " green manure before seeding,	70.6	1.53	0.45	79	113	126	89
Dry broom, stem and leaves,	10.4	1.37	1.22	70	305	142	33
Fanes of beets,	88.9	4.50	0.50	230	125	43	80
Potato fanes,	76.0	2.30	0.55	117	137.5	85	73
Carrot,	70.9	2.94	0.85	150	212.5	66	47
Heath leaves dried in the air,	7.0	1.90	1.74	97	435	103	23
Pear leaves, (autumnal),	14.5	1.59	1.36	81.5	340	127	29
Oak " "	25.0	1.57	1.18	80	293	125	34
Poplar " "	51.1	1.17	0.54	66	134	167	74
Beech " "	39.3	1.91	1.18	78	294	102	34
Acacia " "	53.6	1.56	0.72	80	180	125	56
Box, leaves and branches,	59.3	2.89	1.17	147	293	68	34
Clover roots turned under, dried in the air,	9.7	1.77	1.61	90	402.5	110	25

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NAME.	Normal Water.	Nitrogen in 100 of Material.		Quality as to State.		Equivalent as to State.	
		Dry.	Humid.	Dry.	Humid.	Dry.	Humid
Fucus digitatus dried in the air,	39.2	1.41	0.86	72	215	139	46
" " "	40.0	1.58	0.95	81	237.5	123	42
Fucus saccharinus,	40.0	2.29	1.38	117	345	85	29
" " fresh from the sea,	75.5	0.0	0.54	"	135	"	74
Sea-weed, incinerated,	3.8	0.40	0 38	20	95	488	105
Oyster shells,	17.9	0.40	0.32	20	80	488	125
Dried sea shells from Dunkirk,	0.0	0.05	0.05	3	13	3750	762
Mud from the river Morlaix,	3.7	0.42	0.40	21	100	464	100
Muck from the roadstead of Roscoff,	0.5	0.14	0.13	7	32.5	1393	308
Merl, sea sand,	1.0	0.52	0.51	26.5	128	377	76
Salt fish,	38.0	10.86	6.70	557	1675	18	6
" washed, pressed and dried in the air,	10.0	18.74	16.86	961	4215	10	2.5
Fir saw-dust,	24.0	0.22	0.16	11	40	886	250
"	24.0	0.31	0.23	15	57.5	629	174
Oak saw-dust,	26.0	0.72	0.54	36	135	256	74
White grains of Tuscany Lupin, boiled and dried,	10.5	4.35	3.49	223	872.5	45	11.5
Touraillons of Barley,	6.0	4.90	4.51	251	1127.5	40	9

NAME.	Normal Water.	Nitrogen in 100 of Material.		Quality as to State.		Equivalent as to State.	
		Dry.	Humid	Dry.	Humid	Dry.	Humid
Grape cake (exhausted by pressure),	48.2	3.31	1.71	169	427.5	57	23
Linseed " "	13.4	6.00	5.20	307	300	33	8
Colza " "	10.5	5.50	4.92	282	1230	35	8
Arachis " "	6.5	8.89	8.33	455	2082.5	31	4.5
Madia " "	11.2	5.70	5.06	292	1265	34	8
Camelin " "	6.5	5.93	5.52	304	1378	33	7.25
Hempseed cake (after pressure),	5.0	4.78	4.21	245	1052	41	9.5
Poppy " "	6.0	5.70	5.36	292	1340	34	7.5
Beechnut " "	6.2	2.53	3.31	181	828	55	12
Walnut " "	6.0	5.59	5.24	287	1310	35	7.5
Cotton seed " "	11.0	4.52	4.02	232	1000	32	10
Lees of vegetable oils purified by Poplar saw-dust,	10.0	3.92	3.54	201	885	50	11.25
" fish oils " "	7.7	0.58	0.54	30	135	332	75
Apple cake (from cider) dried in the air,	6.4	0.63	0.59	32	147	309	68
Hop cake,	73.0	2.23	0.56	114	140	88	67
Beet pulp. dried in the air,	9.3	1.26	1.14	64	285	155	35
" from the press,	70.0	"	0.58	64	85	"	106

NAME.	Normal Water.	Nitrogen in 100 of Material.		Quality as to State.		Equivalent as to State.	
		Dry.	Humid	Dry.	Humid	Dry.	Humid
Exhausted beets, from the sugar process of Dombasle,	94.5	1.76	0.01	90	2	111	4137
Potato pulp,	73.0	1.95	0.53	100	131.5	100	76
Decanted potato juice,	95.4	8.28	0.38	425	94	23	106
Wash waters from starch factories,	99.2	8.28	0.07	425	17.5	"	571
Sediment " " " drained in heaps,	80.0	1.81	0.36	92	90	108	111
" " " " dried in the air,	15.0	1.81	1.54	92	384.5	"	24
Solid excrements of Cows,	85.9	2.30	0.32	117	80	84	125
Urine of Cows,	88.3	3.80	0.44	194	110	51	91
Mixed excrements of Cows,	84.3	2.59	0.41	132	102 5	75	98
Solid excrements of Horses,	75.3	2.21	0.55	113	137.5	88	73
Urine from a Horse that drank but little,	79.1	12.50	2.61	641	652.5	15.5	15.33
Mixed excrements of Horses,	75.4	3.02	0.74	154	185	64	54
" " of Hogs,	81.4	3.37	0.63	172	157.5	58	63
" " of Sheep,	63.0	2.99	1.11	153	277.5	65	36
" " of Goats,	46.0	3.93	2.16	201	540	50	18.5
Liquid Flemish manure, in its normal state,	"	"	0.19	"	47.5	"	210
" " " " "	"	"	0.22	"	55	"	182
Belloni Poudrete, dried in the air,	12.5	4.40	3.85	225	962	44	10.33
Montfaucon Poudrette,	41.4	2.67	1.56	137	390	73	25 5

NAME.	Normal Water.	Nitrogen in 100 of Material.		Quality as to State.		Equivalent as to State.	
		Dry.	Humid.	Dry.	Humid.	Dry.	Humid.
Evaporated urine,	9.6	17.56	16.85	900	4213	11	2.3
Liquid urine, ammoniacal,	96.9	23.11	0.72	1133	179	8.5	56
Animalized black, 11 months old,	44.6	1.96	1.09	100.5	272	98	37
" " from the fields near Paris,	42.0	2.96	1.24	151.6	310.5	66	32
Black manure, called Dutch manure, made at Lyons,	44.1	2.48	1.36	127	340	79	29.5
Animalized manure plants, from Marseilles, dried by heat,	12.1	2.73	2.40	140	600	7	16.5
Bechelbronn Colombine,	9.6	9.02	8.30	462	2075	21.5	5
Guano, as imported into England,	19.6	6.20	5.00	323	1247	31.5	80
" sifted,	23.4	7.05	5.40	361	1349	28.5	74
" as imported into France,	11.3	15.73	13.95	807	3487	12.5	28.5
Litter of Silk worms, 5th period,	14.3	3.48	3.29	178.7	827	56	12
" " 6th "	11.4	3.71	3.29	190	822	53	12
Chrysalis of Silk worms,	78 5	8.99	1.94	461	485	21.5	20.5
Maybugs,	77.0	13.93	3.20	714	801	14	13
Muscular flesh dried in the air,	8.5	14.25	13.04	730	3260	13.5	3
Dry blood (soluble), for exportation,	21.4	15.50	12.18	795	3045	12.5	3.25
Liquid blood, from the slaughter houses,	81.0	"	7.95	795	736	"	13.33
" " from jaded Horses,	82 5	"	2.71	795	580	"	15
Coagulated blood, as it comes from the press,	73.5	17.00	4.51	871	1128	11.5	9

NAME.	Normal Water.	Nitrogen In 100 of Material.		Quality as to State.		Equivalent as to State.	
		Dry.	Humid	Dry.	Humid	Dry.	Humid
Dried blood, insoluble,	12.5	17.00	14.88	871	3719	11.5	2.75
Residue of Prussia blue,	53 4	2.80	1.31	144	326	7	30.5
Bones, dried in the air,	7.5	7.58	7.02	388	1754	26	6
Moist bones,	30.0	"	5.31	"	1326	"	7.5
Raw bones, containing 0.10 of fat,	8.0	"	6.22	"	1554	"	6.5
Residua of bone glue,	42.0	0.91	0.53	47	133	214	76
" common glue,	33.6	5.63	3.73	288.4	933.5	35	11
Cracklings,	8.2	12.93	11.88	663	2969	15	3.33
Animal black, from sugar refineries, for exportation,	47.7	2.04	1.06	104	265	96	38
" " " (Parisian),	27.7	19.01	13.75	974	3437	103	28
Scum of the defecation of the sugar house of	67.0	1.58	0.54	81	134	127	75
English black, blood, lime and soot,	13.5	8.02	6.95	411.4	1738	24	6
Feathers,	12.9	17.61	15.34	903	3835	11	2.5
Cow hair,	8.9	15.12	13.78	775	3445	13	3
Woollen rags,	11.3	20.26	17.98	1039	4495	9.5	2.25
Horn clippings,	9.0	15.78	14.36	809	3590	12.83	3
Coal soot,	15.6	1.59	1.35	81	337.5	122	30
Wood soot,	5.6	1.31	1.15	67	287.5	149	35
Picardy ashes,	9 2	0.71	0.65	36	162.5	275	62
Dunged peat, dried by heat,	"	1.03	"	53	"	189	33

The use of this table will be made evident by a practical example quoted from Boussingault's "Economie rurale," vol. 2, p. 149.

"The pressed oil cakes (marc of oleaginous seeds) are in demand this year, (1842) and it is desirable to know if there is any advantage in their application to the soil for the cultivation of wheat. The inference to be drawn, and it is otherwise the least favourable, is that the wheat abstracts from the soil the whole of its Nitrogen, save that derived from the atmosphere. In the second place, let us admit that all the Nitrogen of the marc is appropriated during the culture. Under certain conditions of heat and moisture, these suppositions may be realized. In either case, the active matter left in the soil exerts its influence in the sequent years."

"Observe now the principles of the question:

1. As an average, the amount of Nitrogen in the Bechelbronn wheat is 0.025.

2. In the straw of 1841, there is 0.003 Nitrogen.

3. The marc of Cameline, the use of which is proposed, contains 0.055. Its actual price (in powder) is 70 cts. per 100 pounds.

4. The ratio of the weight of grain to that of the straw is :: 47 : 100.

An hectolitre (3 3-10 bushels,) weighs 175 pounds. Its average price is $3.50.

The price of straw per 100 pounds is about 25 cents.

A sheaf of 100 Kilogrammes (225 pounds,) is composed of

Grain, 32 Kilogs, (72 lbs.) containing of nitrogen,	0k.800	(1.8 lbs.)	of value	$1,15
Straw, 68 " (153 lbs.) "	0 .189	(0.42 lbs.)	"	0,41
Total of nitrogen,		(2.22 lbs.)		$1,56
0k.989 (2.22 lbs.) are found in the cameline cake, value				29
Difference				$1,27

Thus 18 Kilogrammes (40 lbs.) of marc becoming a sheaf of wheat, is augmented in proper value, 6 fr. 36 c. ($1.27.) But supposing that we realize but one half or even a third of the amount indicated by theory, it is still evident that the application of the seed cake or marc should be tried, and that nothing should be neglected to ensure its success as a manure."

CHAPTER XII.

MINERAL MANURES OR AMENDMENTS.
(AMELIORATORS.)

Practice has preceded science in the application of mineral manures, for we know not yet, clearly, what is their mode of action, and hence the necessity of a careful study of the subject.

Lime. Lime is used as a manure, both in a caustic state and as carbonate. Magnesian lime is injurious to vegetation, and its use should be avoided. Caustic or calcined lime is an useful ameliorator, especially in the culture of the cereals. Its application to calcareous lands is superfluous. Quick lime, says Liebig, acts apparently in rendering the earthy substances assimilable by the plants.

In the vicinity of Dunkirk they use forty five bushels per acre, and the effect of this proportion is perceptible for 10 or 12 years. The quantity recommended by Puvis (4 bushels per acre, *annually,*) is more than sufficient.

Though the lime, applied to the soil while caustic, readily becomes carbonated under the influence of the carbonic acid of the atmosphere and of the moisture of the soil, it is better to hasten this neutralization (in order to preserve the plants from the action of the caustic lime,) by distributing it over the surface as uniformly as possible.

Marl. Marl owes its power as a manure to its calcareous matter, and marling therefore is analagous to liming. Argillaceous marl acts by reason of both its lime and clay, and hence is very appropriate for sandy soils where the clay, it contains, acts mechanically. Very probably, marl may also operate as a nitrogenous manure, as Payen and Boussingault have found organic matter in many marly substances.

As the plants remove the lime from the soil, it is evident that the action of one marling is not illimitable. Three and a half bushels are the usual proportion, and, by comparing its composition with that of the plants, it will be readily seen that this amount is sufficient.

Wood ashes. Notwithstanding the good effects of this manure, it is but little used in agriculture, because of its great value as material for the extraction of potassa. In England, ashes are preferred for gravelly soils, and applied every spring in the proportion of forty bushels per acre.

Leeched ashes. The refuse ashes from the ley vats of soap factories yet retain, besides the soluble salts which escaped lixiviation, carbonate of lime resulting from the caustification of the carbonate of potassa and insoluble salts, such as the phosphates, sulphates and carbonates, with a little silica. In the proportion of 60 to 80 bushels per acre, they extend their fertilizing effects through ten years.

Peat ashes. These ashes are of advantageous application in agriculture. They contain lime, sulphate of lime, alkaline chloride, carbonates and sulphates, gelatinous silex and calcined clay. Their precise composition, however, varies with that of the peat, and consequently they are not always uniform in their effects. Generally, they are an excellent substitute for plaster. The ashes of the pyritous turfs contain sulphate of iron generated by the action of the atmosphere upon its sulphuret, and hence are injurious to vegetation. Good ashes are white and light, and, in a dry state, are not of greater weight than forty pounds per bushel. The proportion per acre is eleven bushels.

Coal ashes. Excepting that the quantity of alkaline salts are in less proportion, the coal ashes are similar, in mineral constitution, to those of peat. They are suitable for argillaceous soils, the tenacity of which they diminish.

Alkaline salts, as has been confirmed, are favourable to vegetation; and certain crops even require a special alkali.

Nitrate of Potassa. Salt-petre in small quantities acts very energetically, and is especially beneficial to the cereals, the leguminous, and to buckwheat. The high price limits its use, but it can be very well replaced by the cubic Nitre, (Nitrate of soda,) which comes from Peru and is sold much cheaper.

Nitrate of Soda, (*Cubic Nitre.*) To render its effects certain, it should be mixed with an organic manure. The proportion is 112 pounds per acre, and to insure success the soil must also be treated with a nitrogenous manure.

Common salt. Salt promotes the growth of barley, wheat, luzern and flaxseed, and should be applied to the amount of 150 to 300 pounds per acre. *Chloride of Calcium and Sulphate of Soda,* used in small quantities, afford similar results.

Plaster. Sulphate of lime (Gypsum,) is one of the most useful mineral manures. It is specially adapted to artificial meadows of clover, lucern and fœnugreck. Upon the cereals it has no effect, and but little more upon the hoed crops and natural meadows. It should be powdered and spread in the spring, when the crops have acquired a certain growth, and during the morning, so that it may adhere to the leaves whilst still wet with dew. Raw plaster is as good as the calcined, though the latter has the advantage of being more easily powdered. The proportion, per acre, is 200 to 2000 pounds. Plaster is absorbed by the plants especially those of rapid growth, and it is presumed that its beneficial action results from the lime which it furnishes to the soil.

Ammoniacal Salts. Schattenman has found, that solutions of ammoniacal salts of one degree strength, (Baume's hydrometer,) and in the proportion of one and half gallons to 10 square feet of surface, afford very satisfactory results upon meadow, wheat, oat and barley fields. These solutions have no effect upon lucern and clover, but are beneficial to the natural meadows, when distributed over as soon as vegetation becomes active. Thus, for example, Schattenman harvested from 120 square yards of high and dry meadow, irrigated in proportion as above mentioned, two hundred pounds of grass, while the same extent of untreated land, by the side of the ammoniated plat, gave only 115 pounds.

Tolly has observed, that the hydrosulphate of ammonia, diluted with water, promotes the growth of pot-herbs. Yet notwithstanding these positive experiments of the above Savans, Bouchardat declares that ammoniacal salts even in very weak liquor are prejudicial to vegetation.

According to some experiments of Boussingault, it appears, that ammoniacal salts convey Nitrogen to the plants, though they enter as carbonate; the sulphate, muriate, and other salts of ammonia being decomposed by the carbonate of lime put within the soil; as it is well known, whenever there is a junction of two salts in powders, in presence of the exact quantity of water necessary to their reaction without dissolving the products, the volatile compound of those that are formed is disengaged. It is this reaction which takes place in the soil. The contrary behaviour is exemplified, by pouring together solutions of sulphate of lime and carbonate of ammonia; double decomposition ensues, and the insoluble carbonate of lime is formed and precipitates.

Water. Water is indispensable to the existence of plants. It acts both in facilitating the reactions occurring in the soil, and as an organic and mineral manure. The rain which falls during a storm contains, as Liebig has proved, nitrate of lime and ammonia. Ordinary rain contains but little more than traces of common salt, though in both instances it carries down all the organic matters which it meets, as dusty particles, suspended in the air.

River water, and spring or fountain water, are both used for irrigation, but the two latter contain much larger quantities of saline matters. These salts, very variable in their nature, are derived from the soil over which these waters flow.

That water which is richest in alkaline salts is most preferable for the irrigation of lands, and also for the watering of cattle, provided it does not contain enough to impair its potability.

Boussingault found that the waters, used for watering the cattle at Bechelbronn, introduced, annually, into the dung more than two hundred pounds of alkaline salts.

NOTE.—There is an omission in the preceding Chapter, of two important fertilizing agents, *Gas Lime* and *Green Sand.*

Gas Lime. The refuse lime from the Gas Works, though containing much Sulphuretted Salt, is rich in uncombined lime, and consequently is an effectual manure when used judiciously. When spread upon the soil it becomes decomposed, and gradually transformed into sulphate of lime, (gypsum). It is said to be an excellent addition to land, technically termed, "clover tired;" and, also a good preventive of noxious grubs and insects. Care must be taken in applying it to the land to prevent immediate contact with the seed.

Green Sand. This Manure, now largely used in Agriculture, produces a remarkable effect upon crops, which is due to its content of potassa, lime and phosphates. The proportion per acre varies from 30 to 300 bushels. For full particulars, see "*Encyclopædia of Chemistry*," and "Booth's Report upon the Geology of Delaware."

APPENDIX.

DISINFECTION.

In order to permanently deodorize the fæcal matters and urines, it is necessary to prevent their putrefaction, by incorporating them with substances which will neutralize or absorb the volatile and odorant products of decomposition, as fast as they may be generated.

In urine there are small quantities of lactate, urate and phosphate of ammonia, a larger proportion of urea, some sulphur (according to Proust,) and undefined animal matters. The fæcal matters consist chiefly of vegetable and animal debris, in which there is necessarily an appreciable quantity of sulphur. Now, urine decomposes at a moderate temperature, and is transformed into carbonate of ammonia; the sulphur seizes upon the Hydrogen of the organic matters in a state of decay, and forms sulphuretted hydrogen. It is therefore the Hydrosulphate and carbonate of ammonia which chiefly constitute the fetid gases arising from privies.

To absorb and neutralize these vapors, recourse must be had to neutral or only slightly acid metallic salts, of which, the cheapest and most abundant is the sulphate of the protoxide of iron or common green vitriol of the shops. (If it should be too acid, neutrality can be readily obtained, by adding, to the solution of the salt, a little quick or slacked lime in powder.) In fact a double decomposition ensues, producing sulphate of ammonia and sulphuret and carbonate of iron. A certain proportion of plaster (sulphate of lime,) may be added to the sulphate of iron; it decomposes the carbonate of ammonia more readily and completely than the hydrosulphate; a little charcoal dust is also an useful addition for the absorption of the other peculiar odors (independent of the volatile ammoniacal salts,) which are emitted.

This mixture can be applied to the sinks, either in dry powder or thinned with water. Perhaps it is preferable to use it in solution, the soluble portion by all means, for more or less of the powder reaches the bottom of the sink before being dissolved, and hence a partial loss of its efficacy. In dwellings of several stories, it will be well to introduce the dissolved or thinned substances, through the opening in the conduit-pipe of the upper story, so that the preservative may act upon the matters remaining in the pipe, and by the decomposition of which, offensive vapors would be generated.

The efficacy of sulphate of iron, as a disinfectant of urine and fæcal matters, has been shown by Mallet in the following experiment.

On the 2d of October, 1844, he added to the urine, of eighteen hours, at most, from different individuals, $\frac{1}{20}$th of a solution of sulphate of iron, making 27° by Baume's hydrometer, and left the mixture in a room of temperature from 55° to 60° F. Upon the 11th of December, the mixture emitted no odor, whilst the same urine, alone and untreated, under the same circumstances, exhaled in six days an insupportable stench.

The transformation of the urea into carbonate of ammonia had taken place, for the mixture, upon the addition of quick lime, in the cold, gave a strong smell of ammonia.

By reference to the proceedings of the

academy of arts and sciences, at Digon, for 1767, it will be seen that sulphate of iron was known and recommended as an antiseptic, long anterior to the present time. Knowing, therefore, the means, it becomes necessary to have a knowledge also of the methods of disinfection, and so we proceed to speak of those most applicable to the purpose.

Siret of Meaux was the pioneer in this important work, so full of interest and profit to the public. His experiments were under the authority of Payen, Boussingault and Gasparin, a committee of the French academy of sciences. According to Siret's successful results, 15 to 18 grammes (4 to 5 drams,) of his powder (consisting of sulphate of iron, lime, pit coal, pitch, charcoal and quick lime,) are sufficient to disinfect and prevent the putrefaction of the daily amount of excrements of each individual. *The per diem expense of this disinfecting powder is an ½ centime, and the success of its application is dependent upon the regularity with which the prescribed

* The solid and liquid excrements of a man equal daily 27 ounces, or about 620 pounds annually, and they contain 3 per cent. of Nitrogen.

quantity is each day introduced into the privy well.

Suquet, Kraft and Schattenmann, (Directors of the mines at Bouxvillers,) have contributed much valuable information, but this mode, permanent and preventive, is so far preferable to disinfecting at the time of clearing the wells, that it entirely dissipates the repulsive and disagreeable odor which so frequently infects the apartments of a dwelling; and furthermore, also, because of the difficulty in perfecting the disinfection at the time of emptying, for in stirring the materials, the deposition of the solid portions of the matter in a compact mass presents an impediment to their thorough incorporation. Still, however, disinfection at the moment of clearing is not impracticable. When you operate at the time of emptying the sinks, the sulphate of iron must be perfectly neutral, for the excess of acid in the green vitriol of commerce suffices to generate hydrosulphuric and carbonic acids by the decomposition of the hydrosulphate and carbonate of ammonia. The hydrosulphuric acid gas is however the most deleterious of the disengaged gases.

Fæcal matters are not uniform in their

richness in ammonia, and therefore the proportion of sulphate of iron must vary with the proportion of ammonia; generally speaking, however, according to Schattenmann, 5 to 7 lbs. suffice to saturate 25 gallons putrid matters. The period of saturation can be readily ascertained by adding a drop of the solution of red prussiate of potassa to one of the liquor; as soon as there is an excess of copperas, (iron salt,) prussian blue is formed, and this is a certain sign that the matters are saturated, and that there is an excess of sulphate of iron.

The disinfecting liquor is poured into the privy wells through the openings, by which they are emptied, and well incorporated by thorough stirring.

Schattenmann very properly recommends that neither vegetable debris, or meat, or fish be thrown into the sinks, as their putrefaction generates a peculiar infectious odor difficultly neutralized by metallic salts.

The disinfection of privy wells by sulphate of iron or other metallic salts, has the double advantage of contributing to the public health, and of securing to their contents, all its value and force as a manure by reason of the ammonia which it contains. In fact, the ammoniacal salts contained in the fæcal juices are very volatile, and readily vaporizable, either when the liquors are spread upon the soil as manure, or when kept in loosely closed reservoirs before being used. The sulphate of ammonia, on the contrary, is fixed, and hence the manure is, without exaggeration, not only augmented in value but rendered so that it can be preserved indefinitely.

Human excrements, urine and solid matters, by reason of the variety of salts, and especially of the ammonia and other nitrogenous substances, as also the phosphates which they contain, are an abundant source of manure, meriting more attention than has yet been given. In many countries they experience the benefits of its use but partially, because of their neglect to fix the volatile ammoniacal salts; in others they discard the use of urines altogether, and let them flow to waste as so much useless material; whilst in some places again, they neglect the urines and solid matters and pay no attention to their collection. This indifference, especially in large cities, deserves to be seriously censured. In Paris they use about one-third of the urines for the manufacture of sulphate of ammonia; the other twothirds after having remained at least a year in the reservoirs, are run off into the Seine.

We have said that the excrements of a man for one year contain about 20 pounds of Nitrogen, a sufficient quantity, says Boussingault, for the growth of 900 pounds of wheat, rye or oats, or for 1000 pounds of barley. That is to say, these excrements can fertilize a field of 250 square yards, with an assurance of an abundant crop.

The utilization of the total product of human excrements, of wood and peat ashes, of vegetable and animal matters, would wholly or at least partially supersede the use of barn yard dung. This result would enable the farmer to dispense with a portion of cattle in those localities where forage is scarce, or the soil is more profitable for the growth of food for a numerous population.

Schattenmann has very properly insisted upon the value of the phosphates contained in the human excrements, for they certainly play a most important part in vegetation.

According to Schattenmann, an half gallon of matters, disinfected and saturated with sulphate of iron, making 2° Baume's hydrometer suffice to manure 3½ square feet of meadow, and a quart only, for the same surface of wheat, barley or oats. A greater quantity upon cereals renders their growth too vigorous, and increases the amount of straw at the expense of the grain.

Fæcal matters are of no benefit to clover or lucern, but upon hemp, tobacco, flaxseed and pot-herbs, they are an advantageous manure.

The disinfected urines are also available in the manufacture of ammoniacal products. By treating them with quick lime, and heating the mixture, the ammonia is eliminated.

There are other processes for the disinfection of fæcal matters which have been proven more or less successful.

In 1835, Salmon suggested the application of charcoal dust to the cleanings of the privy wells as serviceable, particularly, in the disinfection of the solid portions. Before giving the process, let us premise that previous to this time Salmon had already manufactured a disinfecting powder by the calcination, in cast iron cylinders, of river and pond mud or mire, which generally contain organic matters enough to form a highly absorbent disinfectant powder. All similar matters, containing carbon and organic matters, such as the debris of peat, wood, saw-dust, tan and the like, are perhaps equally appropriate to this purpose.

A mixture of an argillaceous earth, with a tenth of its weight of some organic matter, fæcal matters for instance, after being calcined and crushed between channelled rollers and bolted, is a very suitable disinfectant.

Salmon used this powder with success in disinfecting the fæcal matters of privies, which by admixture therewith became pulverulent, and consequently of easy removal. The proportions are 25 gallons of powder to 25 gallons of fæcal matters. As soon as the incorporation is completed, all disagreeable odor disappears and the organic matter is transformed into a very energetic manure, and with the great advantage of being nearly dry, pulverulent and of easy transportation. This process was not applied by the inventor to the disinfection of the fæcal juices.

Derosnes's process of disinfection consists in the immediate separation, in the sinks, of the solid from the liquid portion; in adding, at each visit to the privy, a disinfecting powder analagous to that of Salmon's, and also in preventing the putrefaction of the urines, by adding a solution of chloride of lime or very dilute sulphuric acid. The fæcal matters thus disinfected were then treated and rendered into proper manure.

We must yet mention the process of Huguin and Co. Their system is to separate the solid from the liquid portion by suitable apparatus and to disinfect the first and secure the latter against putrefaction. The separating apparatus consists of two cylinders, the diameters of which differ an inch or two. One is placed in the other; the interior cylinder being cullendered at the bottom and throughout its circumference, retains the solid matters, whilst the liquid portion drains through the holes into the space between the cylinders, and collects at the bottom of the exterior vessel, whence it is conducted through a galvanized iron conduit, into a reservoir.

The pipe through which the excrements enter, is fitted to the inner cylinder by means of a coupling screw, and is removed when the apparatus is about to be emptied. The reservoir which receives the fæcal juices is of oak wood, lead lined, or if more convenient, of stone. It is emptied by means of a portable double acting pump, to which is fitted a pipe for conveying the juices to a cask fixed upon a cart for transportation. In the covers of the reservoir is a man-hole which is covered by an iron lid and fastened by an iron bar and padlock. Previous to removing the juices from the reservoir (the capacity of which is generally about six hundred gallons,) add in, forthwith, the disinfecting liquor, for instance, sulphate of iron, and stir for some time until its incorporation is completed. The juices are then drawn off through the same hole as above, by means of a pump which will remove about five hundred gallons per hour. The solid matters are converted into poudrette by admixture, either with a secret powder of H. & Co., or else with that of Salmon, which dries and disinfects them simultaneously.

FINIS.