PEAT, MUCK AND MUD DEPOSITS

THEIR NATURE, COMPOSITION AND AGRICULTURAL USES

BY

FRANK T. SHUTT, M.A., D.Sc.
DOMINION CHEMIST

AND

L. E. WRIGHT, B.Sc.
CHEMIST

DIVISION OF CHEMISTRY

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PEAT, MUCK AND "MUD" DEPOSITS

Their Nature, Composition and Agricultural Uses

BY

FRANK T. SHUTT, M.A., D.Sc.,
Dominion Chemist

AND

L. E. WRIGHT, B.Sc.,
Chemist

Among naturally-occurring materials of value for the improvement of soils, may be numbered peat, swamp or black muck, river, pond, mussel and marsh muds and similar deposits from both fresh and salt water. Many of these possess a distinct manurial value and applied liberally can frequently be used to advantage in the upkeep of fertility. They are not, however, to be regarded as in the same class as "fertilizers"—materials furnishing notable and well marked percentages of available nitrogen, phosphoric acid and potash—but rather as amendments, furnishing, chiefly, semi-decomposed vegetable (organic) matter which subsequently increases the humus content of the soil, or carbonate of lime, as the case may be, with small percentages of nitrogen and mineral plant food matter for the physical and chemical improvement of the soil. As a supplier of humus-forming material and nitrogen (largely inert), peat and swamp muck find their chief function and value, while the several classes of "muds" are perhaps more particularly useful for their mineral content and their influence on the texture or tilth of the soil to which they may be applied.

PEAT AND MUCK

Peat and muck are essentially semi-decomposed vegetable organic matter derived from the death and partial decay of many successive generations of aquatic and semi-aquatic plants; they form deposits of varying thickness and extent, many of which represent the accumulations of centuries.

As is well known, peat and muck form the material of bogs and swamps, which are the sites of former ponds or shallow lakes, or in some instances, of mere depressions in the land which had become covered by water. Their formation is made possible by stagnant or standing water.

A large number of varieties and species of plants contribute to the formation of these deposits. These are for the most part aquatic or semi-aquatic, i.e., plants growing under or in water or, at least flourishing in saturated or water-logged soil. The chief of all bog forming plants is sphagnum, commonly known as peat moss. This plant, rapidly and continuously growing above the water level, forms, by its remains, deposits of a true and characteristic peat which in the course of time may become large in extent and of very considerable thickness. Other plants contributing to the formation of these deposits are many species of rushes, sedges, grasses, ferns and mosses and a host of other water-loving plants, e.g., pond lilies, in addition to, and including, certain shrubs and trees which find their natural habitat in more or less saturated soil. These latter more particularly constitute the fore-runners of the swamp muck deposits.

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Formation of Deposits

The mode of formation of these organic deposits is interesting. In the case of shallow lakes and ponds the growth starts around their shores or edge, in the shallows, gradually but surely pushing out towards the centre of these bodies of water, until in many instances, as in the completed bog or swamp the basin is entirely filled and the lake or pond has entirely disappeared. This encroachment is a process of years and is made possible by the fact that these water-loving plants draw their food supply in part from the remains of the previous season's growth, deposits of very considerable depth resulting. When the deposit occupies the site of a depression or very shallow basin, this peripheral mode of formation is not so well marked, the accumulation of plant remains taking place more or less at once over the whole surface. The resulting deposit is comparatively shallow. This, then, very briefly describes the origin of these organic deposits, which, preserved by the presence of water from further decomposition, consist essentially of humus-forming material more or less rich in nitrogen. Thus there is a deposit formed which may be rightly termed a naturally-occurring fertilizing material or soil amendment, which may be advantageously used in the up-keep of fertility of Canadian farm lands, more particularly those sand and clay loams which are poor in organic matter.

It may be of interest to briefly outline the reasons why these deposits form and, resisting further decay, persist. It has been stated that the formation of peat and muck is due in the first place to more or less stagnant water. Such water is very poor in dissolved oxygen and necessarily contains but few of those micro-organisms requiring oxygen for their life and development and the action or function of which would be towards the complete decomposition of the organic matter of the submerged vegetation into gaseous compounds. Thus decomposition or decay is arrested, the water acting as a preservative in excluding oxygen and bacteria, the two factors or agencies which under favourable conditions of moisture and warmth would lead to the entire dissipation of the vegetable matter.

There are, however, certain other contributary causes to the formation of peat and muck deposits and among these are to be numbered an ample rainfall, a more or less humid atmosphere and a moderately cool temperature. Such conditions are found in northern countries and thus it is that in many districts in Canada large areas, probably in all exceeding a total of 30,000 square miles, are covered with these deposits.

Definitions of Peat and Muck

Peat and muck, though of the same origin, are two distinct materials. The failure to recognize this fact has led to confusion and costly mistakes for certain peat areas cannot be economically reclaimed owing to their extremely fibrous nature, whereas muck areas can usually be reclaimed and made into highly productive soils. The terms peat and muck, therefore, should not be used as if synonymous or interchangeable. It is quite true that in some swamps or bogs at certain depths an intermediary product is to be found, one which it would be difficult to rigidly classify and probably best described as a peaty muck, arising from the further decay and disintegration of the peat proper, but in respect to surface deposits, as generally met with, there should be no great difficulty in rightly determining whether the material is peat or muck.

Peat may be briefly defined as semi-decomposed vegetable matter formed by the accumulation of plant remains. In distinguishing characteristics it is more or less fibrous or woody, frequently moss-like, and in the air-dried condition is light in weight and varies in colour from a light to dark brown. As a rule it contains only small amounts, sometimes traces only, of mineral matter (sand, silt and clay).

Muck may be described as a phase of surface peat in which decomposition of the vegetable organic matter has reached a more advanced stage and part of the material has passed into that condition known as humus. The root fibres and plant tissues are usually well broken down and the original structure largely destroyed. When wet, muck is of a black or dark brown colour and essentially of an oozy consistency. When air-dried it can usually be readily reduced to a powder though there are some mucks which dry to hard refractory masses. The percentage of mineral matter, clay, silt and sand, varies between wide limits in mucks; it is usually below twenty per cent but is frequently as high as fifty per cent, depending on the method of formation of the deposit. The true " ash " or mineral content of the vegetable matter of the muck proper will seldom exceed five per cent.

Dr. F. J. Alway of the University of Minnesota, St. Paul, U.S.A. in his bulletin on " The Agricultural Value and Reclamation of Minnesota Peat Soils," distinguishes between peat and muck soils by their content of mineral matter rather than by the degree of disintegration of the plant remains. He states that " the term *muck* will be confined to soils containing more than 50 per cent of ash." This " ash " will be essentially an admixture of sand, silt and clay in varying proportions.

Dr. A. P. Dachnowski, Physiologist, Bureau of Plant Industry, Washington, D.C., states that the term "*peat deposit*" should not be used when the material contains more than 40 per cent of mineral matter; and that *muck* is a phase of surface peat material resulting from extensive weathering and the admixture of large amounts of silt and clay.

For the purposes of this bulletin we may consider that generally speaking, muck may be distinguished from peat, chiefly, by its greater or further degree of decomposition and to a lesser extent by its larger mineral content.

It will be recognized that with such a broad classification, no well defined line of demarcation can be drawn between mucks and peats. There will be a wide range, varying in the case of peats from " true peats " to " peaty muck " and in the case of " mucks " from true mucks to muds or loams with high percentages of organic matter. Each type will possess individual characteristics.

The Occurrence of Peat and Muck Deposits in Canada

From the agricultural point of view no complete survey of the peat and muck deposits in Canada has, up to the present time, been made, but from the data and information made available by the Department of Mines a conservative estimate of their extent would be approximately 20,000,000 acres. Very probably this figure would be found much too small were accurate data obtainable. The areas of the deposits vary from a few acres to several square miles depending more or less on the topography of the country and climatic conditions. It would be difficult to travel any great distance in the provinces of Ontario, Quebec, and the Maritime Provinces without encountering areas of peat or muck of various sizes. It is quite common for a farm to contain a small peat or muck section, sometimes designated as a swamp, bog or marsh, and which has been more or less neglected by the farmer as a cultivable area.

Frequently these deposits are underlaid by beds of marl several feet deep. Marl, essentially carbonate of lime, ranks with ground limestone in being one of the most satisfactory forms of lime for the correction of soil acidity and the improvement of soils deficient in lime. Where the overburden of peat or muck is not too deep the marl can be dug at very little cost, making a cheap and effective soil amendment. The accompanying photographs show the occurrence of the muck and marl in deposits of this nature.

View of peat deposit showing underlying bed of marl, Ottawa, Canada.

View of peat deposit showing underlying bed of marl, Bonaventure County, P.Q.

Composition of Peats and Mucks

As previously stated peat and muck are formed by the accumulation of plant remains and consist for the most part of organic matter in varying stages of decomposition. The degree of disintegration and break-down of the plant tissues, and the amounts of sand, silt or clay which have been washed or blown into the bog during its formation, are factors influencing the composition of the deposit. The effect of these factors will frequently result in the material varying in composition from the edge to the centre of the deposit.

Determining the possibilities of a peat or muck area for agricultural purposes, i.e. as cultivable land, is very often a matter of considerable difficulty. There are many instances in which areas have been put under cultivation at considerable expense which would have been better left untouched and used either as hay or pasture land or, if wooded, as a source of fuel supply. Other areas, under proper methods of drainage, cultivation and fertilization have proved productive soils, especially for certain crops.

Some knowledge of the organic matter, its percentage and nature, and of the ash and insoluble mineral matter content of a peat or muck and its reaction, is essential in reaching a decision as to its possible value as a cultivable area or as a material for use as a litter or for composting.

In the accompanying tables data are tabulated which have been obtained from the partial analysis of a number of representative peats and mucks received in past years for examination by the Division of Chemistry of the Experimental Farms System.

TABLE 1.—ANALYSES OF PEATS (AIR-DRIED)

Locality of occurrence	Moisture	Organic matter (loss on ignition)	Nitrogen	Mineral matter (ash)		Remarks
				Soluble in acid	Insoluble in acid (clay, sand, etc.)	
	%	%	%	%	%	
Prince Edward Island						
Cow Head Bay	16·21	58·68	1·78	23·33		Fibrous, in form of yellowish white, thin paper-like tissue.
Nova Scotia						
Gardiner Mines	11·25	58·24	2·31	16·51	14·00	
Brookfield	7·62	90·89	1·51	1·49	trace	Sphagnum moss at surface.
"	8·03	90·97	0·83	1·00	"	Peat at depth of 3 feet.
"	7·99	91·02	1·05	0·99	"	" " 6 feet.
New Brunswick						
St. John	12·91	85·88	1·26	0·90	0·31	Fibrous—acid.
Dalhousie	7·14	98·28	1·50	4·58	trace	Spongy, fibrous brown
"	7·08	88·54	2·17	4·38	"	peat, strongly acid.
Hampton, Kings Co	18·50	75·70	1·76	5·05	0·75	Dark brown, fibrous, containing 2·90% carbonate of lime.
Tabusintac River	11·38	59·00	2·05	12·34	17·28	Dark brown moss-like.
Grand Anse	11·40	77·21	1·91	7·04	4·35	Dark brown peat.
Quebec						
Lac la Fortune	7·11	90·72	2·07	....	....	
St. Donat	7·58	82·95	3·02	....	....	
Farrern's Point	15·69	78·97	2·13	41·50	0·84	Dark brown fibrous peat
La Ferme	14·56	79·24	0·87	2·91	3·29	Pale greenish brown peat moss, strongly acid.
Ontario						
Alfred	18·04	71·76	1·33	6·45	3·75	
Durham	7·61	89·89	....	1·37	1·13	
Colborne	0·00	94·08	....	5·27	0·65	Dark brown fibrous, depth 1 to 3 feet.
Colborne	0·00	64·02	....	5·75	30·23	Dark brown compact, depth 3 to 5 feet, contains much fine sand.
Alfred	24·07	71·23	1·28	3·80	0·90	Fibrous, 1·12% lime, 0·04% phosphoric acid, 0·03% potash.
Bellerica	4·75	89·26	1·08	1·94	4·05	30% lime, ·15% phosphoric acid, traces of
Asphodel	14·72	76·32	1·30	7·45	1·51	lime.
Blackburn	12·33	79·65	1·38	4·28	3·74	Brownish black with much root fibre and woody material.
Kapuskasing	20·88	66·18	1·35	8·39	4·55	Dark brown peat partially decomposed, slightly acid.
Kenora	12·57	68·84	1·71	10·00	8·59	Dark brown, fairly well decomposed.
Pembroke	14·59	78·40	1·25	1·73	5·28	Brown peat moss.
Alberta						
Banff	12·73	60·51	1·87	15·76	11·00	Turf-like and fibrous.
British Columbia						
Lulu Island	1·29	97·10	0·73	1·28	0·33	Yellowish brown fibrous peat, strongly acid.
Burton	21·77	65·52	0·75	8·62	4·09	Partly fibrous, partly semi-decomposed, with woody fragments slightly acid.
Coombs, V, I	10·95	81·45	3·04	....	....	Fibrous.
Elko	19·18	72·72	2·67	6·21	1·89	Fibrous.
Langley Prairie	9·78	59·99	2·29	7·98	22·25	Peaty muck fairly well decomposed.
Porcher Island	8·53	42·72	0·66	5·36	43·39	Brownish black, with considerable gravel.
Discovery	14·50	73·85	2·72	8·53	3·12	Brown peat.

TABLE 2.—ANALYSES OF MUCKS (AIR-DRIED)

Locality of occurrence	Moisture	Organic matter (loss on ignition)	Nitrogen	Mineral Matter (ash)	
				Soluble in acid	Insoluble in acid (clay, sand, etc.)
	%	%	%	%	%
Prince Edward Island					
Charlottetown	8·39	74·65	2·65	16·96	
Albany Station	6·36	91·71	1·10	1·46	0·47
Trilby	7·18	85·50	0·63	1·95	5·37
Alberton	6·05	92·02	0·73	0·79	1·14
Cape Traverse	16·07	62·12	1·61	15·74	12·07
Lot 11	18·38	46·78	0·71	14·73	20·11
Little Harbour	10·94	80·77	0·94	2·44	5·85
Searlton	7·20	89·49	0·75	0·98	2·33
Nova Scotia					
Gardiner Mines	8·24	31·33	1·05	18·73	41·70
Guysboro	6·04	57·17	1·00	3·62	33·17
Cambridge Station	8·36	83·80	1·78	8·34	
Antigonish	9·08	80·80	2·19	8·30	1·22
Pictou	16·58	72·70	2·72	5·93	4·79
Waterville	7·76	75·34	1·68	6·24	10·66
River John	12·50	78·91	2·11	6·28	2·31
Clifton	8·89	75·40	1·56	5·49	10·22
Little Bras d'Or	8·48	86·39	1·01	2·23	2·90
New Brunswick					
Nashwaack River	8·43	49·46	1·50	42·11	
St. Stephen	7·58	67·63	2·03	24·79	
Grand Mannan	8·03	86·17	1·50	5·80	
Hillsborough	26·98	65·41	0·70	7·41	0·20
Rogersville	9·30	70·85	0·82	17·45	2·40
Lower Woodstock	8·56	50·71	1·61	9·66	31·07
Harrisville	18·64	66·03	1·22	14·83	1·50
St. John	8·46	44·17	1·68	7·24	40·13
Norton Station	4·02	78·66	1·18	5·43	11·89
Shediac	10·06	69·30	2·15	10·36	10·28
Rochville	5·99	61·62	1·81	16·68	15·71
Quebec					
Metis Beach	35·62	53·85	0·97	9·62	0·91
Broughton Station	24·46	62·58	1·33	12·96	
Walton	16·00	73·83	1·70	7·46	2·71
Shawville	26·82	56·42	1·61	7·18	9·58
Bishops Crossing	11·56	77·04	1·74	9·47	1·93
Sutton	20·43	59·83	1·98	9·33	10·41
Ste. Adelaide de Pabos	10·03	68·68	2·30	13·61	8·13
Hatley	14·09	72·54	2·31	9·64	3·73
Bonaventure	19·47	64·33	1·24	13·33	2·87
La Ferme	15·49	76·72	1·25	4·03	3·76
Ontario					
Sheguiandah	14·06	65·83	2·34	9·19	10·92
Oxdrift, Algoma Co	8·01	27·62	1·24	15·37	49·00
London	32·02	53·52	2·58	11·69	2·77
Ompah	7·89	69·59	2·37	10·26	12·26
Glenroy	12·08	77·85	2·38	9·86	0·24
Orono	16·40	55·23	1·89	13·92	14·45
Phillipsville	15·21	66·01	1·85	18·68	
Picton	6·02	28·51	1·15	63·47	2·00
Lochead	17·25	70·47	1·44	11·66	0·62
Easton's Corners	10·00	33·47	1·17	7·53	49·00
Hawkesbury	9·73	77·28	1·60	11·37	1·62
Colborne	15·72	59·61	2·26	12·99	12·13
Kapuskasing	22·09	53·30	1·39	13·56	11·05
Gloucester Tp. Carleton County	17·13	67·94	2·00	12·40	2·53
British Columbia					
Enderby	16·43	67·01	2·49	15·20	1·36
West Summerland	17·52	59·74	1·95	14·12	8·62
Victoria	23·55	66·02	2·23	4·16	6·27
Chilliwack	8·61	80·57	3·51	7·16	3·66
Kelowna	19·47	71·55	1·26	8·49	0·49
Salmon Arm	11·69	46·24	1·77	12·46	29·61
Cumberland	14·64	61·18	1·67	9·24	14·94

Discussion of Results

A study of the data recorded in tables 1 and 2 will show the great variability in the composition of peats and mucks. In the air-dried condition they are composed essentially of organic matter mixed with varying amounts of mineral matter—clay, sand etc. When freshly dug, peat and muck may contain from 70 to 80 per cent of water which will be reduced on air-drying to from 10 to 20 per cent. In the majority of the samples of peat examined, the percentage of clay, sand or other rock matter is small, frequently less than 2 per cent, in the air-dried material. Invariably, peats are considerably lower in their content of sand and clay than mucks, the latter containing in certain instances as high as 30 to 40 per cent of these constituents.

In their percentages of nitrogen and organic matter, however, there is a marked similarity as will be seen from the summary of the data given in the following tables:

NITROGEN AND ORGANIC MATTER CONTENT OF PEATS

(Water-free Basis)

Thirty-four Samples—	Nitrogen %	Organic Matter %
Maximum	3·41	98·93
Minimum	0·72	46·71
Average	1·91	86.62

NITROGEN AND ORGANIC MATTER CONTENT OF MUCKS

(Water-free Basis)

Fifty-nine Samples—	Nitrogen %	Organic Matter %
Maximum	3·84	97·95
Minimum	0·68	30·02
Average	1·92	76.53

Although these averages would show that the differences in the percentages of the nitrogen and organic matter between peat and muck are comparatively small the agricultural value of these constituents may vary greatly. In peat the organic matter is more or less fibrous, indicating but little breakdown or decomposition, with a very low availability of its nitrogen; in muck the fibrous character of the vegetable matter has been lost through further decay and its nitrogen, compared with that of peat, is more readily converted into forms available as plant food.

In respect to phosphoric acid and potash the value of peats and mucks is negligible; the amounts of these constituents present seldom exceed a small fraction of one per cent. Mucks associated with beds of marl, however, may contain notable amounts of carbonate of lime (present in the form of small shells) and these have an additional value in correcting soil acidity and furnishing lime to soils deficient in this element.

Uses and Treatment of Peat and Muck

Experience with many types of soil—clays, silts and sands—virgin and cultivated, has furnished evidence of a very emphatic character regarding the fundamental and vital importance of semi-decomposed organic matter (humus) as a soil constituent. Humus acts mechanically in improving tilth, lightening and mellowing heavy clays and increasing the moisture holding capacity of all classes of soils. It supports the microscopic life of the soil, the function of which is to prepare plant food for crop use. And, lastly, it is the natural storehouse of nitrogen, the most expensive of all plant foods when purchased in the form of fertilizer. One of the chief objects in view in any intelligent, rational method of soil management is the upkeep and if possible the increase of the soil's humus content. While applications of farm manures and the turning under of green crops—clover, buckwheat, rye, etc.—are the principal means of adding humus-forming materials to the soil, these may be supplemented cheaply and effectively by the use of peat and muck.

Peat and Muck as Soil Amendments

The agricultural value of any particular sample of peat or muck when used as a soil dressing is chiefly dependent upon two factors; the percentages of nitrogen and organic matter which it contains and its state of decomposition. The further the muck is broken down and decomposed the greater will be the ease with which its nitrogen becomes available. Since the organic matter of these deposits is found in many stages of decay, it follows that the value of different samples as soil amendments is very variable, but in none of them is the nitrogen in such combinations as to be immediately available to crops.

These deposits are often distinctly acid or sour (due to their mode of formation) and consequently it is frequently necessary to render them alkaline by composting with lime or wood ashes before the process of nitrification (whereby the nitrogen is made available for plants) can be induced. Marl which very often underlies the deposit may be used for this purpose. This sweetening process may apparently also be induced to a certain degree by digging, piling and allowing the material to lie for several months exposed to the air.

For application to the land in their untreated form, mucks by reason of their being much further decomposed and broken down, are to be preferred to peats. However, speaking generally, the application of either of these materials in the crude and raw condition is not to be advised for, as already pointed out, their plant food does not exist in immediately available forms. Fermentation is necessary to set it free and this may be accomplished either by composting the peat or muck with barnyard manure or by using it as an absorbent litter.

Compost

Peat and muck may be composted with barnyard manure and their fertilizing value thereby greatly enhanced. Sufficient manure to set up active fermentation in the peat and muck should be used to bring about the decomposition of the latter. One method of constructing a compost heap is to spread the peat or muck on the ground to a depth of 1 or 1½ feet making the width of the heap about 8 to 10 feet and length in accordance with the size desired. Cover this with a layer of manure from 8 to 12 inches thick, and continue with alternate layers of peat or muck and manure until the heap is 4 to 5 feet high. The heap should be *kept fairly compact and moist* but not saturated and after standing for a few weeks should be forked over. This operation may be repeated about once a month for three or four months, moistening if necessary with liquid manure or water, when the compost should be in excellent condition for application to the soil. Vegetable waste, viz., potato tops, cabbage leaves, dead leaves, kitchen waste, waste straw, etc., can also be added in making the compost heap and will be converted into valuable manure.

Peat and muck treated as above outlined make valuable dressings for both clay loams and sandy loams, and furnish an increased bulk of good manure which is greatly to be desired on farms of low fertility and on which the supply of manure is usually limited. Lime and wood ashes may be used in composting the peat and muck to destroy acidity but when these materials are used in conjunction with manure the amounts should not be excessive, otherwise loss of nitrogen may result.

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Absorbent Litter

Peat and muck when air-dried make excellent absorbents and are used as such on many Canadian farms. They make a very effective medium for soaking up liquid manure or drainings from the manure pile. The importance of saving the urine of stock will be recognized when it is stated that more than one-half the nitrogen and at least three-fourths of the potash of manure is contained in the liquid portion; these elements being in solution are immediately available and represent the most valuable portion of the manure.

In preparing the peat or muck for use as a litter it should be piled to allow of air-drying and then roughly crushed. It may then be placed behind the stock in the gutter of the cow barn or any place in which liquid is apt to accumulate. Its use keeps the buildings sweet and clean and facilitates the cleaning of the stables. If these materials are used in sufficient quantity to absorb all the liquid from the stable, the manure produced on the farm will be largely increased in bulk and value, and the nitrogen contained in the organic matter of the peat and muck will, in a large degree, be rendered available for plant use

Air-dried peat and muck will absorb from 2 to 6 times their weight of liquid and in this respect they compare very favourably with straw, the bedding material almost universally used on the farm. Owing to its coarser and more fibrous nature, peat often makes a better absorbent than muck. Peat moss, commonly known as moss litter may absorb from ten to fifteen times its own weight of liquid.

The following table gives the absorptive capacities of various samples of peat and muck as ascertained by the Division of Chemistry. For comparison the absorptive capacity of straw is included.

ABSORPTIVE CAPACITY OF AIR-DRIED PEAT, MUCK AND PEAT MOSS

Material	Locality	Moisture	Organic matter	Nitrogen	Pounds of liquid absorbed per 100 pounds of litter
		%	%	%	
Straw, uncut	C.E.F., Ottawa, Ont	5·50	85·0	0·90	200
Straw, finely cut	C.E.F., Ottawa, Ont	5·50	85·0	0·90	600
Muck	Kapuskasing, Ont	22·1	53·3	1·39	175
Muck	La Ferme, Que	15·5	76·7	1·25	375
Peaty muck	Kapuskasing, Ont	20·9	66·2	1·35	200
Peat	Dalhousie, N.B	7·0	88·5	2·17	335
Peat moss	Cowhead Bay, P.E.I	16·2	58·7	1·78	600
Peat moss	La Ferme, Que	14·6	79·2	0·87	760
Peat moss	Musquash, N.B	19·4	79·0	0·71	900
Peat moss (upper layer)	Point Cheval, N.B	13·5	84·2	0·38	1,830
Peat moss (lower layer)	Point Cheval, N.B	14·3	77·9	0·48	1,170
Peat moss (lower layer)	Big Plain Bog, N.S	15·7	82·5	0·53	1,400
Peat moss (lower layer)	Weldon Bog, N.S	16·2	81·7	0·60	1,530

Peat for Horticultural Uses

Fibrous peat, broken down, finds an important place in potting and greenhouse work, chiefly in the propagation and growing of plants of the heath family, e.g. azaleas and of bulbs and orchids. The chief function in this use would appear to be in increasing the waterholding capacity of the soil and in improving its aeration and texture.

Peat mull—finely divided fibrous peat—is used to a considerable extent in greenhouse work as a mulch; a thin coating on the surface of the pot or flat prevents washing of the fine seeds during watering and tends to prevent the surface layer of the soil from becoming hard or " baking ". This material has also been found very satisfactory for use in the growing of blueberry and other acid loving plants.

Spagnum moss is used for packing purposes in very large quantities. Being light in weight, elastic and clean it makes an excellent packing material. Owing to its high moisture holding capacity it is particularly valuable for wrapping around the roots of shrubs, young fruit trees, etc., when preparing them for shipment. The majority of peat mull and spagnum moss used in Canada in horticultural work has in the past been imported, chiefly from European countries.

Disintegrated peat is finding an important place in recent years in the top dressing of golf courses and lawns. Its value for these purposes is greatly enhanced if it is first composted with a good loam and a small quantity of manure and the resulting product screened. This treatment also increases the fertilizing value of the product as peat in itself does not contain any appreciable amount of " available " plant food.

THE CONVERSION OF PEAT OR MUCK INTO CULTIVABLE LAND

In the reclamation of peat and muck areas for cultivation the following points should be given special consideration viz (*a*) Drainage, (*b*) Clearing and preparation of the land for cropping, (*c*) Crops adapted to peat and muck soils, (*d*) Manurial and fertilizer treatment

Drainage

As a preliminary step in the reclamation of peat or muck areas for cultivation suitable surface drainage must be established. Occasionally the cost of drainage may prohibit the economical reclamation of an area but frequently the bog or swamp may be drained without undue expense. The usual method is by open ditches placed at regular intervals, the distance intervening between ditches depending on the amount of drainage necessary. In this connection it is important that the area be not too deeply drained as it may then dry out

View of main drainage ditch. Peat land reclamation project, Caledonia Springs, Ont.

View of lateral ditch. Peat land reclamation project.
Caledonia Springs, Ont.

Newly broken peat land showing drainage ditch. Illustration Station, Caledonia Springs, Ont.

too much in dry weather with subsequent injury to crop growth. Under drainage and cultivation the peat or muck will tend to shrink so that the ditches may require deepening from time to time. Drainage should therefore be gradual and eventually the surface ditches should be replaced by tiles.

The effective drainage of extensive bog areas frequently calls for a large central drain with collaterals, the drainage scheme being determined by a preliminary survey.

Preparation of the Land for Cropping

After clearing the bog of bushes, small trees, etc., which for convenience may be piled to dry and subsequently burnt, the land is broken for cultivation. The breaking is usually done with a wide plough turning the furrow slice as flat as possible. From this point on, the treatment will vary with the character and depth of the deposit.

Surface Burning.—Surface burning is more particularly adapted for pure peat areas, though these may be reclaimed in certain cases by other and less drastic treatments; muck areas are more readily brought under cultivation and a seed bed obtained without the use of fire. This system of burning peat lands has been more or less universally followed in the past and has proved quite satisfactory provided the deposit is of good depth, say, four feet or over, and the burning can be controlled. The bog should not be dry to a greater depth than four or five inches when setting the fire; if dry below the furrow slice, the fire is liable to get beyond control, particularly in dry windy weather.

Fire out of control on cultivated peat land, causing total loss of crop, Caledonia Springs, Ont.

The ash resulting from the burning of the peat supplies small amounts of available phosphoric acid, potash and lime, all of which elements are usually present in the raw material in forms practically unavailable to crops. The subsequent incorporation of this thin coating of ash leads to the formation of a very fair soil which will produce good crops for three or four years. At the end of that time it may become necessary to repeat the burning operation.

On shallow peat deposits or on those areas on which the depth of the peat has been lessened to, say, one or two feet by burning and cultivation, the practice of burning should not, as a rule, be followed. It has been found extremely difficult to confine peat fires to the surface four or five inches when the deposit is shallow; frequently the fire gets beyond control, and the whole peat material down to the subsoil is destroyed. When this happens the subsoil may be practically worthless for crop production for several years.

Admixture with Underlying Soil.—When the depth of the surface peat or muck will permit and the underlying soil is a sandy loam or clay, it is advisable to mix in some of the latter by *deep ploughing.* Subsequent cultivation will bring about an intimate admixture of the loam and muck, and a soil well supplied with organic matter and containing a good proportion of clay or sand will result. Where possible this is perhaps the best procedure to follow in preparing these lands for cultivation. Reclamation has also been successfully accomplished by carting sand and clay on the muck area, but with the exception of small areas which are to be used for intensive cultivation of market garden crops this procedure of improving the composition of the soil would prove too costly.

Ploughing, Disking and Rolling.—Ploughing, disking, etc., of the raw, unburnt surface to prepare the seed bed of deep peat deposits may also be followed. In the case of new areas, ploughing leaves the surface, as a rule, in a very rough condition; the peat is often tough and felt-like and the surface springy. Frequent disking to break up the fibrous constituents of the peat and rolling with a heavy roller to keep the surface compact are very desirable. For the first crop after breaking it may be difficult to obtain a " fineness " of the surface material which will be entirely satisfactory for even and good seed germination. The seed bed improves, however, on cultivation from year to year and if careful attention is given to keeping the land well rolled and to the applications of plant food constituents (chiefly mineral) this method of preparing peat lands for cropping will probably be found quite satisfactory.

With true muck soils no great difficulty should be experienced in obtaining a good seed bed by ploughing, disking, etc., provided the drainage is satisfactory.

Crops adapted to Peat and Muck Soils

These types of land are, at the outset, best adapted for hay or for use as pasture, especially if the application of plant food is not possible. If the mineral elements are furnished it may be possible to produce very fair crops of grain and hoed crops such as potatoes and mangels. When first broken the surface is usually rough and lumpy, making it difficult to obtain a suitable seed-bed for small seeds. After a number of seasons' work, however, the fibrous matter becomes broken down and finely divided and the soil becomes more suitable for market garden crops. When this stage in the cultivation of these lands has been reached the growth of vegetable crops may be attempted. Celery, lettuce, spinach, carrots, onions, etc., very frequently flourish upon muck lands when a suitable physical condition of the seed bed is obtained and suitable fertilizers are applied. It is suggested, however, that a certain amount of experimental work be done on a small scale in determining the crops best adapted for each type of muck soil before extensive planting is carried on with any one of the abovementioned crops.

Potatoes grown on peat land. Illustration Station, Caledonia Springs, Ont.

Mangels grown on peat land. Illustration Station, Caledonia Springs, Ont.

Manurial and Fertilizer Treatment of Peat and Muck Soils

The mineral matter content of peat and muck is usually quite low, often less than 10 per cent. Consequently in considering the plant food requirements of these soils particular attention should be given to supplying lime, phosphoric acid and potash. Frequently, they are extremely deficient in potash.

These types of soil are often quite strongly acid in reaction, a condition which is not suitable for the best development of most farm crops. The practical method of lessening acidity and of furnishing lime for plant growth is that of applying lime in the form of ground limestone, marl or slaked lime; a dressing of ground limestone or air-dried marl at from 1 to 3 tons per acre will usually be found sufficient for these purposes. Deposits of peat or muck are sometimes underlaid with layers of marl; under such conditions the supply of lime may be had for the digging. Certain deposits contain sufficient lime to promote excellent stands of clover.

Fertilizer for Peaty Soils.—On newly broken peaty areas on which there has been very little decomposition and where the peat is of a fibrous nature, a light application of manure, at the outset, is strongly recommended. The manure in addition to furnishing plant food, will supply the bacteria necessary for the breakdown and decomposition of the fibrous matter of the peat, a process by which the nitrogen is rendered available for plant use. In addition to the manure, a dressing of commercial fertilizer carrying all of the three elements of plant food usually contained in fertilizer mixtures, viz., nitrogen, phosphoric acid and potash, would probably be required. The following mixture is suggested:—

	Pounds
Sulphate of ammonia (or nitrate of soda or nitro chalk)	200
Superphosphate (16 per cent P_2O_5)	1,250
Muriate of potash	500
Filler	50
	2,000

One ton of this mixture is the equivalent, approximately, of one ton of a commercial mixture having the formula 2-10-12. For grain and hay crops it might be applied at from 300 to 400 pounds per acre; for hoed and garden crops from 500 to 1,000 pounds per acre.

Fertilizers for Muck Soils.—On muck areas, in which the organic matter has reached a more advanced stage of decay than in peats and the material has lost its original structure, a light dressing of manure would probably be found beneficial, especially if the land has recently been broken.

For special leafy crops such as celery, lettuce, spinach etc. a complete fertilizer mixture of the nature outlined above (2-10-12) will be required on most muck soils. The rate of application might vary from 500 to 1,000 pounds per acre. It may also be found desirable with these leafy crops to supplement the complete fertilizer treatment with side-dressings of a nitrogenous fertilizer during the early growing season. The need of the crop for this side dressing treatment can be quite closely determined by observing the appearance and vigour of the plants. With well decomposed muck sufficient available nitrogen for crop growth is often liberated by natural fermentation or conversion processes and further applications of nitrogen are uncalled for.

With grain and root crops the development of the straw and tops should be noted carefully. If there proves to be too great a vegetative growth with slow ripening of the grain or poor root development it is probable that excess nitrogen is the cause. Under these circumstances a fertilizer which contains only phosphoric acid and potash viz. an 0-10-12 or an 0-12-12 mixture should be employed. If these elements are furnished by superphosphate and muriate of potash the following amounts are suggested:

	Pounds per acre
For Grain Crops—	
Superphosphate (16% P_2O_5)	200 to 300
Muriate of potash (50% K_2O)	75 to 125
For Hoed Crop—	
Superphosphate (16% P_2O_5)	400 to 600
Muriate of potash (50% K_2O)	150 to 250

Celery grown on newly reclaimed peat land. Caledonia Springs, Ont.

Wood ashes have been found especially suitable for fertilizing peat and muck soils. Good quality ashes, i.e. unleached and free from excess sand and clay or other foreign matter will contain, in the air dried condition from 1 to 2 per cent of phosphoric acid and from 4 to 6 per cent of potash. In addition they contain from 40 to 60 per cent of carbonate of lime. Thus an application of 1 ton of wood ashes of average quality will furnish approximately the same amount of phosphoric acid, potash and lime as would be contained in 200 pounds of superphosphate, 200 pounds of muriate of potash and 1,000 pounds of ground limestone.

Carrots grown on newly reclaimed peat land. Caledonia Springs, Ont.

THE RECLAMATION OF PEAT LANDS AT CALEDONIA SPRINGS, ONT.

Reclamation of peat land was undertaken at Caledonia Springs, Ontario by the Division of Chemistry working in co-operation with the Division of Illustration Stations, in the spring and summer of 1930. The object of this experimental work is to obtain data with respect to methods of working peat lands and to make a study of the plant food requirements of peat soils.

The area of peat land selected from this large bog consisted of six acres. The peat of this area is of a very fibrous nature and varies in depth from three to seven feet and is underlaid by heavy clay. The peat immediately above the clay appears to be somewhat more decomposed than the surface material. Samples at various depths were collected and analyzed with the following results:

Clover hay on peat land broken two years previously. Caledonia Springs, Ont.

ANALYSIS OF AIR-DRIED PEAT—CALEDONIA SPRINGS, ONT.

—	A At depth 0″–8″	B Between two and three feet	C At five feet	D At six to seven feet
Moisture	7·80	8·65	8·80	10·85
Loss on ignition (organic matter, etc.)	89·33	87·26	86·62	80·91
Mineral matter soluble in acid	1·54	3·45	3·72	7·30
Mineral matter insoluble in acid	1·35	0·64	0·86	0·94
	100·00	100·00	100·00	100·00
Nitrogen	1·67	2·09	2·69	2·51
Phosphoric acid (P_2O_5)	0·102	0·057	0·057	0·064
Potash (K_2O)	0·024	0·043	0·036	0·060
Lime (CaO)	0·476	1·330	1·330	2·702
Magnesia (MgO)	0·214	0·371	0·504	1·090
pH value	3·94	5·34	5·96	6·78

Description

" A " contains a fair proportion of woody tissue, with fragments of small stems and rootlets. Air-dried it forms somewhat hard, distinctly brown masses, which can be more or less easily broken down and powdered.

" B " very similar in structure and colour to " A," but less friable when air-dried.

" C " does not show much fibre or root material; very dark brown on air-drying, forming distinctly hard masses.

" D " of the nature of a muck with little structure showing; air-drying to black, very hard masses.

Discussion of Analytical Data

The organic matter (loss on ignition) decreases and the ash (mineral matter) increases with depth, i.e. from the surface downwards. This increase (or decrease) to a depth of 7 feet on the water-free material amounts to, approximately 6.0 per cent.

The percentage of nitrogen increases with the depth; the organic matter of the peat is decidedly richer in this element in the lower strata of the deposit than at the surface.

With respect to reaction, the surface peat is decidedly acid, that at a depth of 7 feet is practically neutral the trend towards alkalinity with depth being gradual.

Of the mineral elements the most noticeable feature is the increase in lime and magnesia with depth, the lime content increasing approximately five times between the surface and a depth of 7 feet.

The phosphoric acid content of "B," "C" and "D" is fairly constant and slightly lower than in "A." The percentage of potash is decidedly low in this peat, especially in the surface layer.

The initial step in the reclamation of this area was the installation of drainage and this was accomplished by digging open ditches along the four sides and through the centre. The ditches were opened down to the clay, the depth varying from three to five feet and connected with a large central drain.

The whole area was next cleared of scrub, a short growth chiefly of willow and poplar with some blue-berry plants, and then it was ploughed.

The east half was left in the ploughed condition to dry out the surface six inches for burning according to the general practice of the district. Unfortunately, owing to continued wet weather, a satisfactory burn was not obtained in 1930 and this area was not cropped in 1931. The surface burning was a success in 1931 and the land was seeded in 1932.

The west half was heavily disked several times during the season of 1930 and the spring of 1931 to bring this part of the area into a cultivable condition without burning. It was cropped in both 1931 and 1932.

The field plot work on both the "burned" and "unburned" areas included treatments with manure at 20 tons per acre, manure at 10 tons per acre plus 750 pounds of a 4-8-10 fertilizer mixture and fertilizer alone at the rate of 1,500 pounds of the 4-8-10 mixture per acre. In addition there were several treatments in which each of the three elements contained in the above fertilizer mixture was omitted in turn. Provision to test the influence of lime was also made. In the preparation of the fertilizer mixture, nitrate of soda, superphosphate and muriate of potash were used to furnish the nitrogen, phosphoric acid and potash, respectively.

The cropping was in two sections (1) vegetables (lettuce, spinach, celery, carrots, beets, corn, tomatoes and onions) followed by barley and two hay crops and (2) a four year rotation of hoed crops (potatoes, mangels and turnips) barley, clover hay and timothy hay.

The crop yields obtained in 1932 are given in the following table:—

CROP YIELDS ON PEAT LANDS: CALEDONIA SPRINGS, ONT., 1932

Vegetable Section

Plot	Treatment per acre	Yields per acre: Burned area Range "A" Beets	Burned area Range "A" Celery	Burned area Range "A" Corn	Unburned area Range "E" Celery	Unburned area Range "E" Corn	Yields of barley in 1932 on unburned area fertilized in 1931
		lb.	lb.	lb.	lb.	lb.	bush.
1	Manure—20 tons..................	42,600	12,200	4,200	15,870	10,428	30·4
2	Manure—10 tons and 750 lb. 4-8-10	36,600	10,400	6,400	13,200	18,404	48·3
3	Check..........................	18,200	4,600	2,600	7,700	6,666	18·9
4	1,500 lb. of 4-8-10................	34,400	9,200	15,000	12,320	10,824	15·8
5	1,500 lb. of 0-8-10................	27,400	9,600	5,000	11,220	8,712	10·5

CROP YIELDS ON PEAT LANDS: CALEDONIA SPRINGS, ONT., 1932

Hoed Crop Section

Plot	Treatment per acre	Yields per acre: Burned area Range "A" Potatoes Large	Burned area Range "A" Potatoes Small	Burned area Range "A" Mangels	Burned area Range "A" Turnips	Unburned area Range "E"* Potatoes Large	Unburned area Range "E"* Potatoes Small	Yields of barley in 1932 on unburned area fertilized in 1931
		bush.	bush.	lb.	lb.	bush.	bush.	bush.
6	Manure—20 tons...................	161·4	58·6	39,072	31,328	376·6	60·2	33·6
7	Manure—10 tons and 750 lb. of 4-8-10	217·8	53·6	31,502	29,040	346·8	57·4	33·6
8	1,500 lb. of 4-8-10................	168·6	71·8	37,486	18,040	318·8	46·6	34·7
9	1,500 lb. of 4-8-0.................	49·8	70·4	24,992	11,880	252·0	59·8	21·0
10	1,500 lb. of 0-8-10................	126·8	74·0	26,400	19,360	275·8	74·6	35·7
11	1,500 lb. of 4-0-10................	103·4	68·0	25,264	20,680	276·8	64·8	28·3
12	Check (no manure or fertilizers)...	70·4	69·6	12,496	14,520	188·6	63·0	18·9

* On this area the mangel and turnip crops were badly damaged by insect pests and yields were not recorded.

The yields tabulated above compare favourably with average yields for the same crops grown on productive mineral soils. In view of the adverse seasonal conditions of the spring of 1932 and the rough and coarse nature of the seed bed the results may be considered very satisfactory. The late spring and early summer of 1932 was characterized by low temperatures and a very scant rainfall; on June 10 frost was encountered in many places at depths of 12 to 15 inches. Consequently germination was very slow and uneven. In addition insect pests, chiefly the turnip fly, damaged the plants on emergence and most of the turnip and mangel area had to be reseeded. Late spring and early summer frosts also proved detrimental to growth.

The most successful crop grown in 1932 was potatoes and the yields of this crop from the " unburned " area were much superior to those on the " burned " area. Corn did not do well but this crop was much better on the " unburned " area than on the " burned " area. Beets thrived well and appeared to grow better on the " burned " area. Celery was an excellent crop on both areas. Grain sown on the " burned " area without manure or fertilizer produced a good crop. The new seeding of clover was excellent on both areas.

It is certainly worthy of note that this peat, manured and fertilized but without preliminary burning has produced excellent crops; in the majority of cases the growth was better and the yields were higher on the unburned area.

This investigation has not been in progress long enough to make definite statements in regard to the most suitable fertilizer treatment on this type of peat land. However, some valuable inferences may be made from the results so far obtained.

As might be expected from the analysis of the peat, the field results indicate that potash is the most essential of the three elements furnished in the complete fertilizer mixture. The yields stress the necessity of an application of manure at the outset at least; they indicate that from 10 to 15 tons of manure supplemented with, say 500 to 600 pounds of a 2-10-12 fertilizer for hoed crops should give fairly good results. The application of lime on this plot area does not appear to have been of special benefit as no marked response to this element by any of the crops sown could be noticed.

While the results from this reclamation work have been most encouraging, it should be pointed out that certain difficulties may be met with at the outset in peat land reclamation, as follows:—

(1) The obtaining of a suitable seed-bed after the first ploughing or " breaking." A great deal of disking and rolling is necessary to break up the coarse fibre and keep the surface compact.

(2) Damage from wire-worms. This was quite severe especially in 1931 on the unburned area.

(3) Slow germination—the peat holds the frost late in spring and the seed bed has a low temperature until very late in the season.

(4) Late spring and early fall frosts may damage the crops to a considerable extent.

MUDS

Muds are deposits formed by tides or found in the beds of lakes and rivers. Their composition is extremely variable and dependent more or less upon their method of formation. They consist largely of ground up rock matter, clay and sand, together with shells (partially broken) and organic debris (the remains of plants and animals) in variable quantities.

The analysis of certain samples of mud received by this Division for examination as to their value as soil dressings, shows that, as a rule, their percentages of plant food are not high: in many cases they do not exceed those of good soils. Certain muds contain notable amounts of nitrogen and organic matter but the majority of the deposits seldom approach the richness of peat and muck in these constituents. Their chief value as a soil dressing lies in the influence they exert on the physical condition of the soil. Those which contain fair amounts of organic matter will prove of value in improving the mechanical condition of worn and exhausted soils; those characterized by a high lime content, as for example, " mussel mud " and " oyster shell mud " will be found useful amendments for acid soils and soils in need of lime. While the lime contained in the shells of these classes of mud acts somewhat slowly, the results are lasting and these materials have been used with good effect in the correction of soil acidity.

In the Maritime provinces and Quebec, muds in the past, have been largely used for soil enrichment and good results as a rule have followed the first applications. It has been found in many cases, however, that from repeated and continued applications there is but little response.

Of late years the practice of " mudding " the soil has become less popular and is gradually dying out. This is probably due to the fact that recent advances in scientific agriculture have made it possible to more economically increase the productiveness of the soil by improved methods of farming—the application of commercial fertilizers, the turning under of green crops, etc.—than by application of this class of soil amendment. There are, however, many soils on which it would, no doubt, be found profitable to apply a dressing of mud, provided the cost of labour for digging, hauling, etc. is not too high. In this matter, the character of the mud and the nature of the soil to be treated should be carefully considered; thus a mud consisting largely of sand might well improve the tilth of a heavy clay loam.

Tidal Muds

Tidal muds, also known as "marsh" muds, "salt" muds and sometimes as "river" muds, are deposited by the tide at the mouths of rivers and creeks emptying into the sea and on low lying borders of bays and inlets. They consist largely of ground-up rock matter in the form of very fine sand, silt and clay in varying proportions. Owing to the rather extended use of these materials as soil dressings several years ago, a large number of samples of this type of mud have been examined by the Division to determine their fertilizing value. Analysis of a few typical muds from various localities in the Maritime provinces bordering on the Bay of Fundy are as follows:—

ANALYSIS OF BAY OF FUNDY TIDAL MUDS (AIR-DRIED)

Locality of Occurrence	Moisture	Loss on ignition	Mineral matter (ash)		Nitrogen	Lime (CaO)	Phosphoric acid (P_2O_5)	Potash (K_2O)
			Soluble in acid	Insoluble in acid				
	%	%	%	%	%	%	%	%
1. Yarmouth, N.S.	2·06	4·86	9·64	83·44	0·215	1·02	0·109	0·010
2. Head of Bay of Fundy	0·00	6·02	18·15	75·83	0·122	0·65	0·146	0·902
3. Habitant River, Cornwallis Valley, N.S.	3·45	4·14	16·82	75·59	0·128	1·40	0·150	0·250
4. Nappan, N.S.	3·78	5·86	15·03	75·33	0·136	....	....	....
5. St. Martins, N.B.	7·66	7·61	12·77	71·96	0·281	0·42	....	....

The samples given in the above table may be considered as fairly representing the mud deposited by the tide of the Bay of Fundy. This type of mud has been used as a soil dressing from the time of the earliest settlement of the Maritime provinces. Its use has necessarily been confined to farms which adjoin or are situated near the seaboard and tidal muds have occupied an important place in the treatment of those lands for crop production. The deposition of these tidal muds has been largely instrumental in the building up of the dyked lands of Nova Scotia and New Brunswick which have proved very valuable for the production of field crops and more especially hay.

It is evident from a study of the analysis of tidal muds that these deposits are not richer in plant food than many soils of average productiveness. Though doubtless they are materials that might improve certain types of soils, they cannot be regarded in the same light as commercial fertilizers, for their percentages of the so-called "essential" elements of fertility—nitrogen, phosphoric acid and potash—are very small.

In any fertilizing material the "availability" of the plant food elements has an important bearing on the results which may be obtained from its application. In commercial fertilizers the greater part of the plant food is usually in the form of readily soluble materials. In the case of the tidal muds while their total plant food content is very small it is interesting to record that the availability of this plant food is very high; in the case of sample No. 3 it was found that 33 per cent of the total phosphoric acid present would be considered as "available" when determined by the Dyer method in which a solvent of 1 per cent citric acid is used. By the same method 25 per cent of the total potash was found to be available. No doubt the beneficial effects on crop yields resulting from the application of these muds is due in a large measure to the high availability of the small amounts of phosphoric acid and potash which they contain. This would be especially the case when the application is made to "worn and run down" soils; on good productive loams it is doubtful if dressings of mud would prove profitable except in so far as it might improve the physical condition of the soil.

As these deposits vary in their proportions of sand, silt and clay, the results of their application will depend much upon the nature of the soils to which they are applied. It thus may happen that frequent applications of a "mud" rich in clay may do positive harm to a heavy soil, destroying its tilth; the same material on a light soil would probably give excellent results owing to an improvement in its mechanical condition.

Mussel and Oyster Shell Muds

Shell muds are of importance by reason of their carbonate of lime content. They have been used to a very large extent in many sections of the Maritime provinces as a dressing for acid soils and soils in need of lime. The analysis of a number of mussel and oyster shell muds are given in the following table:—

ANALYSIS OF MUSSEL AND OYSTER SHELL MUDS

Locality of occurrence	Moisture	Loss on ignition	Mineral matter (ash)		Nitrogen	Carbonate of lime ($CaCO_3$)
			Soluble in acid	Insoluble in acid		
	%	%	%	%	%	%
1. Mussel shell mud, Bear River, N.S..	0·90	7·23	38·87	53·00	0·225	29·62
2. Mussel shell mud, Shediac, N.B.....	1·72	10·52	50·25	37·51	0·294	38·64
3. Mussel shell mud, Souris, P.E.I......	0·44	4·12	85·74	9·70	0·092	84·88
4. Mussel shell mud, Escuminac, P.Q...	2·88	6·10	36·78	54·24	0·230	26·38
5. Mussel shell mud, Chatham, N.B....	1·76	2·41	66·83	29·00	0·130	60·03
6. Mussel shell mud, Mitchel River, P.E.I.	2·09	5·29	32·31	60·31	0·310	19·62
7. Mussel shell mud, Buctouche River, N.B.	1·30	5·05	69·90	23·75	....	66·58
8. Oyster shell mud, St. Peter's Bay, P.E.I.	1·80	15·15	43·25	39·80	0·207	40·56
9. Oyster shell, Shediac, N.B..........	....	....	....	2·14	....	92·50

There is a very great variation in the chemical composition of the several shell muds tabulated. This is to be expected since the composition will depend on the relative proportions of shell and mud in the material.

The shells contained in these muds are composed essentially of carbonate of lime as shown in the analysis recorded for the oyster shell (No. 9). Consequently, where "mudding" the soil is carried out with the object of furnishing lime a mud with as high a proportion of "shell" as is obtainable should be used. Thus sample No. 3 containing practically 85 per cent of carbonate of lime is much superior to all the shell muds of the above series.

In making a dressing of shell mud the rate of application will depend on the proportion of shell present; when the mud is composed largely of shell, an application of from 5 to 10 tons per acre should furnish sufficient lime to meet the immediate needs of crops. As a rule a large proportion of the shell present is not crushed or broken. The lime from such course material will be liberated very gradually with the result that the beneficial effects of the application will usually extend for a long period of years.

Most farm crops will be benefited by a dressing of shell mud if the soil is acid in reaction. The potato crop, however, thrives best on a fairly acid soil and where the land is to be used for this crop, mudding the soil with shell mud or applying any form of lime is not to be advised. It has been found that the soils which have been given a dressing of shell mud or ground limestone favour scab development and thus the market value of the crop is greatly impaired.

Pond, Lake and River Muds

These classes of mud are usually formed by the settling out of the fine material carried down in the waters of rivers and streams. This sediment, composed largely of finely ground up rock material, often contains a considerable amount of organic debris and as a consequence the mud is usually richer in organic matter than tidal or salt water muds. The term "river muds" is sometimes used to designate tidal muds—previously discussed—formed at the mouth or outlets of rivers emptying into the sea. Certain pond and lake muds contain small shells. When the proportion of shell is large the material partakes of the nature of marl.

In the following table the composition of a number of muds of this class is given.

POND, LAKE AND RIVER MUDS

Locality of occurrence	Moisture	Loss on ignition	Mineral Matter (ash)		Nitrogen (N)	Lime (CaO)	Phosphoric acid (P_2O_5)	Potash (K_2O)
			Soluble in acid	Insoluble in acid				
	%	%	%	%	%	%	%	%
1. River mud, Gaspe, P.Q.	1·71	8·36	9·69	80·25	0·274	....	....	....
2. River mud, Summerside, P.E.I.	2·37	9·30	22·63	65·70	0·330	0·92	....	....
3. River mud, Algoma, Ont.	4·04	17·14	15·18	63·64	0·610	1·34	0·240	0·610
4. River mud, Shediac, N.B.	2·23	13·18	16·91	67·88	0·409	0·48	0·140	0·230
5. River mud, Chatham, N.B.	3·70	8·73	10·17	77·40	0·220	....	....	....
6. Pond mud, Miminegash, P.E.I.	2·24	13·52	22·72	61·52	0·460	0·85	0·160	0·480
7. Pond mud, Kinsman's Corners, N.S.	2·26	14·20	16·57	66·97	0·540	....	....	....
8. Lake mud, Waterville, N.B.	2·49	19·80	76·34	1·37	0·729	high		
9. Lake mud, Brantford, Ont.	8·54	40·39	6·22	44·85	1·675	....	....	....
10. Lake mud, St. Quentin Station, N.B.	0·65	39·96	19·83	39·56	1·480	....	....	....
11. Lake mud, Ste. Adelaide de Pabos, P.Q.	6·01	19·59	63·90	10·50	0·765	35·56	....	....
12. Lake mud, Five Fingers, N.B.	3·94	23·13	10·03	62·90	0·825	....	....	....

The data of analysis show that pond, lake and river muds are on the whole distinctly richer in nitrogen and organic matter than the tidal and shell muds previously discussed. Certain of the lake muds examined approach the richness of mucks in these constituents and no doubt such would make valuable soil amendments. These deposits as a rule are very poor in mineral plant food—lime, phosphoric acid and potash. Their value, from this point of view, may therefore be almost negligible.

It is very evident from the recorded data that these muds are very variable in composition and therefore it is desirable that some knowledge of the composition of a mud be obtained before any large expenditure for digging and hauling is incurred.