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Experiment Station Work,

XII.

SEAWEED.
THE TILLERING OF GRAINS.
FERTILIZERS FOR GARDEN CROPS.
SWEET CORN AND POLE BEANS UNDER GLASS.
GIRDLING GRAPEVINES.
CEREAL BREAKFAST FOODS.
FOOD VALUE OF STONE FRUITS.
WHEN TO CUT ALFALFA.
SPONTANEOUS COMBUSTION OF HAY.
PRESERVATION OF MILK BY PRESSURE.
CREAM RAISING BY DILUTION.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

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CONTENTS OF THE SERIES OF FARMERS' BULLETINS ON EXPERIMENT STATION WORK.

EXPERIMENT STATION WORK.

Editor: W. H. BEAL.

CONTENTS OF No. XII.

ILLUSTRATIONS.

EXPERIMENT STATION WORK—XII.[1]

SEAWEED.

A valuable agricultural resource of our Northern coast regions is the seaweed or seaware, which collects upon shelving beaches or in inlets (drift weed, of which kelp is the principal component) or which may be cut from the rocks at low tide (cut weed, of which rockweed[2] constitutes the larger part). This material is used to a considerable extent, especially as a fertilizer, on the New England coast, but it is doubtful whether its value is fully appreciated and whether it is utilized to the extent to which it might be economically employed.

A number of the experiment stations have made analyses of seaweed and seaweed ashes, and a few years ago the Rhode Island Station published the results of a very thorough study of the characteristics, composition, and uses of the various more common species of seaweed found on the New England coast. A more recent study of the subject in its bearing upon Scotch agriculture has been made by James Hendrick, of Aberdeen University, Scotland. These studies throw much light upon the question of the value of seaweed and the extent to which it may be profitably used.

They show that a variety of uses have been made of seaweed. Several species are edible, the most important of these being Irish or carrageen moss, used in the preparation of jellies (blanc-mange and similar dishes). Dulse, or dillesk, and kelp, or tangle, are also used to a limited extent as human food. Irish moss and some other species have also been found valuable as cattle foods, especially when boiled (to

[1] This is the twelfth number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

[2] Harvey states that the rockweeds (round and flat stalked) constitute at least three-fourths of the covering of the tidal rocks on the east coast of America.

destroy the rank taste) and mixed with meal. The food constituents in two species of seaweed (partially dried) are shown in the following table:

Food constituents in seaweeds.

	Water.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Eelgrass	26.64	6.03	0.19	32.02	9.05	26.07
Flat-stalked rockweed	27.11	8.21	.67	41.14	4.40	18.47

The table shows that these two species of seaweed compare favorably with average hay as regards probably the most important constituent, i. e., protein. They are deficient in fat, but contain a very large amount of ash. The nutritive value of any feeding stuff depends largely upon the digestibility of its constituents. No investigations on the digestibility of seaweed have been made, so far as the writer is aware. It is reasonable to assume, however, that the coarse eelgrass would prove much less digestible and consequently a poorer feeding stuff than the more succulent, mucilaginous rockweed.

Eelgrass has been used in filling mattresses, cushions, etc., and in sheathing houses. Seaweed ashes were formerly utilized to a considerable extent for the manufacture of alkali for use in soap and glass making and for the preparation of iodin and other substances useful in medicine and the arts, and it is stated that substitutes for horns, shell, etc., have been prepared from gelatinous substances of certain seaweeds. As a rule, however, cheaper sources of most of the materials furnished by seaweed have been discovered, and as a consequence the number of uses to which they are put has greatly decreased.

The principal use of seaweed at the present time is as a manure. It is extensively used for this purpose on the coasts of Great Britain, Ireland, France, Germany, Scandinavia, and New England, some of the best farms of the last-named region, according to Storer, being maintained largely by the use of seaweed. Exact data as to the quantity of this material used in the United States are not available. It is reported that in 1885 the value of seaweed used as a fertilizer in Rhode Island alone was about $65,000.

The use of seaweed as a manure is necessarily confined to within a short distance of the seacoast. The material is very bulky and watery (containing from 70 to 90 per cent of water), and consequently can not be profitably transported to a great distance. It has been carried inland, however, to a distance of from 8 to 10 miles. It is undoubtedly an economical practice to allow the seaweed to partially dry on the beach before carting it to the land. It is, however, not advisable to allow the material to dry out so thoroughly that it will not readily decompose in the soil or to subject it to any considerable amount of fermentation or leaching, as in this case a large proportion of its valuable constituents—nitrogen and potash—will be lost. On account of its bulk and watery condition it is necessary to apply seaweed in very large amounts, 20 to 30 tons per acre, in order to supply sufficient amounts of nitrogen, phosphoric acid, and potash for the needs of crops.

The fertilizing constituents in various kinds of seaweed, as compiled from analyses made at the Rhode Island Station and elsewhere, calculated to a uniform basis of 80 per cent of water, are shown in the following table:

Fertilizing constituents in different kinds of seaweed.

[Calculated to a uniform basis of 80 per cent of water.]

	Nitrogen.	Phosphoric acid.	Potash.	Lime.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Ribbon weed, kelp, or tangle (*Laminaria saccharina*)	0.327	0.116	0.488	0.789
Broad ribbon weed, broad-leafed kelp, devil's apron, or tangle (*Laminaria digitata*)	.347	.092	.498	.470
Drift weed, mostly kelp (*Laminaria* spp.)	.444	.131	1.217	.524
Round-stalked rockweed (*Ascophyllum* (*Fucus*) *nodosum*)	.373	.072	.706	.355
Flat-stalked rockweed (*Fucus vesiculosus*)	.347	.084	.542	.444
Fucus furcatus	.256	.059	1.109	....
Eelgrass, or grass wrack (*Zostera marina*)	.328	.128	.368	.597
Irish, or carrageen moss (*Chondrus crispus*)	.564	.105	.850	.366
Dulse, or dillesk (*Rhodymenia palmata*)	.614	.104	1.620	.115
Cladostephus verticillatus	.314	.156	.984	.604
Polyides rotundus	.660	.120	.288	.489
Phyllophora membranifolia	.642	.085	.580	2.927
Ahnfeldtia plicata	.338	.078	.700	.176
Average	.409	.097	.701	.597

The above table shows that average seaweed in the moist state contains about 0.4 per cent of nitrogen, 0.7 per cent of potash, and less than 0.1 per cent of phosphoric acid. If we allow 10 cents a pound for the nitrogen, 2 cents for the phosphoric acid, and 4 cents for the potash (and these were the lowest prices at which these constituents could be bought in 1898 in any materials from which commercial fertilizers are made), a ton of seaweed (with 80 per cent of water) is worth $1.42 as a fertilizer.

The potash of seaweed, which is probably its most important fertilizing constituent, is subject to wide variation. Fresh seaweed often contains 1 per cent and more of this constituent, but it is soluble and is rapidly lost if the weed is subjected to washing. The lime is also very variable, owing to the adherence of shells, etc., but normally it is probably less than 1 per cent.

Seaweed belongs to the same class of manures as barnyard manure and green manures. At the same time that it furnishes more or less of all the constituents required by plants, it supplies the soil with a large amount of humus to improve its physical properties. For this reason it proves especially valuable on porous, sandy soils. It differs from average barnyard manure in its higher percentage of potash and lower percentage of phosphoric acid. While, like barnyard manure, it is a general fertilizer, it is not so well balanced, and its continued use without the addition of other fertilizers is likely to result in a one-sided exhaustion of the soil. In order to prevent a deficiency of phosphoric acid as compared with the other fertilizing constituents and an undue draft on this element in the soil, it is necessary to apply seaweed in very large amounts, thus furnishing nitrogen and potash far in excess of the needs of the crop and subjecting them to danger of loss. To get the best results seaweed should undoubtedly be used in connection with bone or other phosphate.

Since seaweed contains a considerable amount of potash which is largely soluble in water, it is correctly considered a potassic manure and especially valuable for soils deficient in potash and crops like potatoes, clover, etc., which are "potash feeders." According to Storer, "there is perhaps hardly another locality in New England where red clover may be seen growing as freely and abundantly as upon the tract of country back of Rye Beach, New Hampshire, * * * which has been manured with seaweeds ever since the country was first settled. Clover grows there naturally and spontaneously, in the sense that it perpetuates itself and remains in the land year after year, much as June grass does in other localities."

The nitrogen of seaweed is in organic form, and is therefore not available to plants until decomposition and nitrification have taken place. With the majority of seaweeds, however, this rapidly occurs in the soil, and it is not considered necessary, as a rule, to ferment the weed before applying it to the soil. It may be applied fresh as a top-dressing (on grass) or may be plowed in. On account of its rapid decomposition seaweed furnishes a valuable means of starting fermentation in manure, compost heaps, peat, etc. These statements apply especially to the more succulent and mucilaginous kinds of seaweed. They do not apply to eelgrass, as a rule. While this kind of seaweed is about as rich in fertilizing constituents as the other kinds analyzed, its actual fertilizing value is much lower because it decomposes very slowly in the soil. In fact, it has been condemned as worthless as a manure for this reason, although useful as a mulch. Its value as a fertilizer could no doubt be greatly increased by composting with manure or lime. The burning of the material and the use of the ashes as a fertilizer has been suggested, but the objection to this practice is the difficulty and expense of burning and the loss of the nitrogen.

Seaweed has been extensively used as a fertilizer for potatoes. It is claimed, however, that the quality of the tubers is impaired if the weed is applied in the spring or at time of planting. This is probably due to the chlorin which the seaweed contains in considerable amounts, it being a well-known fact that chlorin in large amounts in the soil has a tendency to lower the starch content of potatoes, and thus injure their quality. This objection may be met in large part by applying the weed the preceding summer or fall, as is quite generally done by New England farmers. In any case the seaweed should be given sufficient time to decay in the soil before planting the potatoes. In experiments made by James Hendrick, in Scotland, seaweed was compared with barnyard manure and commercial fertilizers applied in the spring to early potatoes. Seaweed alone and barnyard manure alone were about equally effective in increasing the yield. Seaweed combined with superphosphate gave a larger yield than manure alone or manure and superphosphate. The potatoes grown with manure, however, were of better quality than those grown with seaweed. The potatoes grown with seaweed were apparently more immature and deficient in starch than those grown with the manure. It is suggested that the seaweed prolonged the period of growth and would have given better results with late potatoes.

It has been observed at the Rhode Island Station and by farmers in that State that seaweed applied at the time of planting tends to decrease scab in potatoes. In this respect it possesses a decided advantage over barnyard manure, which is known to favor the development of scab. Another advantage which seaweed possesses is its freedom from weed seeds, eggs of insects, and germs or spores of plant diseases. Where both stable manure and seaweed are available, it is considered good practice to use the former on grass and the latter on plowed land.

SUMMARY.

While seaweed has been used for a variety of purposes, it is chiefly valuable as a manure. For this purpose it may be classed with green manures and barnyard manure, though differing from the latter in its higher content of potash (largely soluble) and lower content of phosphoric acid. On account of its high content of potash, seaweed is best adapted to soils deficient in this element and to crops which are "potash feeders," such as potatoes, clover, etc. To secure a well-balanced fertilizer adapted to general purposes the seaweed should be combined with a phosphate of some kind.

While the different species of seaweed are very similar in chemical composition, they are not all of the same fertilizing value. Eelgrass, on account of the slowness with which it decomposes, is probably the least valuable species as a manure, although useful as a mulch. When rotted in composts its fertilizing value is greatly increased. The seaweeds of most importance as fertilizers are kelp and rockweed. These rapidly decompose in the soil, readily yielding up their fertilizing constituents to crops. It is therefore most economical to apply them to the soil as a top-dressing or to plow them in in the fresh condition without previous fermentation. Seaweed gives best results on warm, sandy soils, which it stocks with humus.

Seaweed, when applied in the spring, has been found to injure the quality of potatoes, probably on account of the chlorin which it contains. It also apparently delays maturity as compared with barnyard manure. It seems, however, to reduce scab when applied at planting. Undoubtedly the safest practice with potatoes and other plants injured by chlorin is to apply the seaweed the previous summer or fall.

An advantage of seaweed over barnyard manure is its freedom from weed seeds, insects, and germs or spores of plant diseases.

Since the bulky character of seaweeds makes it unprofitable to transport them very far inland, it has been suggested that they be burnt and the ashes used, but the difficulty and expense of this practice renders it of doubtful economy.—THE EDITOR.

THE TILLERING OF GRAINS.

Grains tiller or stool when they throw up shoots from the root after the seed has sprouted and the main stem has made its appearance. A stool of grain thus consists of the stems and shoots produced from a seed, and may be considered a single plant. This method of growth is characteristic of the grasses to which all cereal crops belong. The number of shoots which grow and develop into grain-bearing stems depends mainly upon the fertility of the soil, the influence of weather conditions, and the distance between plants. Worn-out soils, or soils in which the plant food is not readily available; cold weather, either too wet or too dry, and sowing the grain too thickly, are conditions which are detrimental to tillering. In considering the subject, it is taken for granted that the seed is of good quality.

The fertility of the soil and the spacing of the plants are factors which are under the control of the farmer, but the weather conditions vary with locality and season. In dry regions, where the important factor of soil moisture is unreliable, the tendency is not to rely very extensively upon the tillering process, but to sow greater quantities of seed per acre in order to obtain the required stand.

Comparatively little work has been done in this country on the tillering of grain, but extensive investigations of the amount of wheat, oats, and barley to be sown per acre have been made, and the effect of tillering may be inferred to some extent from the data obtained. However, direct investigations on the subject are few as compared with work on other phases of the culture of cereals. The Wyoming Station has recently published the result of investigations on the tillering of wheat, oats, and barley grown at five different places in the State, namely, Laramie, Lander, Wheatland, Sundance, and Sheridan. The results of this work are of interest not only in so far as they concern the tillering of cereals, but also inasmuch as they throw light on the growing of grains at high altitudes and in arid climates. The altitude of the different places where these experiments were made varied from 4,000 to 7,200 feet. In one case only were the plants grown without irrigation. The tillering experiments were conducted with a comparatively small number of plants, but in order to show what the results might be in actual field practice, a series of plat experiments with different amounts of seed per acre was made for the purpose of comparison.

In general, the results indicate that the number of mature heads produced by each seed varies greatly with the locality and the season,