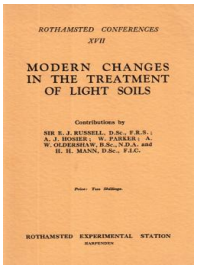
ROTHAMSTED RESEARCH

Modern Changes in the Treatment of Light Soils

Full Table of Content



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SUGAR BEET AND POTATOES ON A SUFFOLK HEATH SOIL

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The problem of poor light land engaged our attention soon after the war. Much of it rapidly became derelict. A great deal of what remained in cultivation was at an extremely low level of productivity Light land in a dry climate is in my opinion very unsuitable for grass. It may be sown with "grass" but what will it grow? Enough to keep a rabbit to an acre! Under lucerne, kidney vetch, sainfoin (if enough chalk is present) and certain clovers it is relaively productive but ordinary "grass" is in my view a mistake for such land.

We commenced the serious study of the problem of poor light land in October, 1925, by taking over 20 acres of land in the parish of Tunstall. The particular fields had not grown a satisfactory crop for at least three years, and were in addition, full of rubbish. The soil is a deep sand which will "blow" under certain weather conditions. One of the fields is named "Cow Walk" and my Chairman very aptly made the exclamation "Poor Cow"! when he heard this.

After consultation with Sir John Russell and the Rothamsted Staff we devised a roation and system of manuring which we thought might be suitable. It is as follows:

	Manuring per acre.
Roots, *i.e.*, Sugar Beet and Potatoes	3 cwt. Nitrate of Soda 3 cwt. Basic Super 3 cwt. Muriate of Potash
Oats	1½ cwt. Nitrate of Soda
Lupins	No manure
Rye	1½ cwt. Nitrate of Soda

The weakness of our rotation is that it does not provide any sheep crops. This however, could be easily remedied by a little modification. We could not rely upon getting a flock to fold our crops or we should certainly have made alterations with this end in view. On the two occasions when we have grown crops for folding, we have seen excellent subsequent results. We have proved that sheep are not essential, but certainly they are useful and prevent waste.

Our rotation, by the introduction of an area of lucerne and other herbage plants, would permit a good head of horned stock, pigs and poultry to be kept, with a few sheep.

I mention these points because I am firmly of opinion that one cannot consider sugar beet and potatoes only. They are merely parts of a general system, the object of which is to build up the

https://doi.org/10.23637/ERADOC-1-210

fertility of the soil and in that means to grow bumper crops, to maintain a high output. The principal points in importance in attaining this object seem to be :

(1) To keep the land thoroughly clean and to till it according to the rules of good husbandry—efficiently and well.
(2) To use a rotation of crops suited for the soil.
(3) To maintain a fair head of live stock partly as a means of cashing unsaleable products.
(4) To apply suitable manures including where necessary, substances containing lime.

Tillage.

As far as the first point is concerned—we cannot afford to grow weeds—they take up plant food, space and moisture—none of which we can spare. Constant vigilance seems to be the only way to keep the land clean.

Tillage on a light sand is very different from what it is on clay.

I am greatly indebted to our foreman, Mr. G. Thurston, for his skill in cleaning the land ; which was in a very bad state when we first took it over. It is important to keep the rubbish on the top, on this soil. In preparing the land for roots we usually " rimple " immediately after harvest. Rimpling is ploughing with the breast off, and we usually go quite 10 in. deep. Then during the winter we rimple again, still keeping the rubbish on the top. The land is worked across in Spring, and if necessary the weeds are gathered and burnt. Then 10 days or a fortnight before drilling, the land is ploughed to a depth of 5 ins. to 6 ins. The interval between ploughing and drilling gives time for the seeds of weeds to germinate, these are killed when the land is harrowed before drilling. When we took over this land, a crop of spurrey as thick as the grass on a lawn invariably made its appearance soon after the last ploughing, but we have not now quite so much spurrey, especially on the chalked plots. We roll, then drill, then roll, and harrow.

Deep cultivation is very important to let the roots down to the moisture. If there is any sign of a pan, subsoiling should certainly be performed. After the land has been cultivated deeply for some years the depth of soil is increased and subsoiling probably need not be repeated continuously.

We drill our beet not very early, usually about May 1st., the rows being 17 ins. apart. In one or two seasons, where beet were drilled early on similar land and a cold wet spell followed, I have noticed they stood still and made very poor growth subsequently.

I like them to go straight on, without a check. We horsehoe as soon as possible, and chop out and single aiming at 5 ins. to 6 ins. between the beet.

Often we get a plant population of 45,000 to 50,000 per acre, we

https://doi.org/10.23637/ERADOC-1-210

cannot grow large beet, therefore we must have a large number per acre. We grow Klein E. or Dobrovice.

We lift by hand, again not very early. The land is so light that it is not necessary to use a beet lifter and we have no need to worry about soil clinging to the roots, or about difficulties in carting the beet off in autumn.

Potatoes.

We have not experimented with farmyard manure and might very likely be able to increase our crop if we had some available. But we have none. We have grown Great Scot in the past but are changing to Arran Banner. Great Scot is a vigorous variey—which is what we want. We have tried Kerrs Pink, but I like Great Scot better. We do not want a delicate and small cropping variey. I may say, however, that we have not properly investigated the question as to what is the most suitable variety for our special soil.

The seed potatoes are ploughed in 4 ins. deep on the flat, after the two rimplings and cleaning operations as given for sugar beet. The width of row is 28 ins., two 14 in. furrows. The seed potato is put on the plough-wheel mark and is ploughed under.

In a dry season we do not ridge up. We get a few green ones but to ridge means to lose moisture and this we cannot afford to do.

The potato crop seems much more affected by drought than are sugar beet. In a year of sufficient moisture we get a good crop, but in very dry years such as 1929 and 1933 there is a great falling off, especially on the unchalked area.

Rotation.

Our first standard rotation was

1. Sugar beet and Potatoes.
2. Oats (January sown if possible).

We have not done well with winter oats. They seem to feel drought severely).

3. Lupins. These are essentially the one leguminous plant which will thrive on light land poor in lime. They may be ploughed in green, folded with sheep or harvested for seed. There can be no doubt that however they are disposed of, they greatly enrich the soil and their strong tap roots penetrate the subsoil, aerate, and in fact cultivate it.

4. Rye. Very heavy crops of this can be grown with the aid of nitrates. The grain is low in price but abundant straw is produced and the roots till the land. I think that all extensive root systems increase fertility.

Since the land has been chalked we have grown wheat with considerable success, also barley, peas, tares, and various leguminous plants, even beans.

https://doi.org/10.23637/ERADOC-1-210

Fertilisers.

Very soon in our work, we found that the most serious trouble was lack of lime in our soil. The unchalked soil on the Heath Walk field had a pH. of 5.8 with a lime requirement of about 27 cwt. (the analysis being performed by Mr. F. Harey). Half of this field received a dressing of 5 tons an acre of chalk in the winter 1925-26. This lay on the surface of the ground and became thoroughly shattered, before being ploughed in. The rotation crops have been grown, in duplicate, on this field, over chalked and unchalked land for seven seasons.

The result has been a demonstration of the utter futility of trying to grow certain crops especially beet, on land lacking in lime and of the extreme ease and cheapness with which this want can be remedied when one is reasonably near a supply of chalk or other cheap source of lime.

The original cost of the chalk was 50/- per acre, including spreading and 4 years crops produced extra produce worth £18 on the chalked area. The results over a period of years, both for beet and potatoes are given in the following table :

Tunstall "Heath Walk."

The figures in brackets indicate the number of the entire plot (½ acre) in each year, half of which was devoted to Sugar Beet and half to Potatoes. The "Chalked" area received 5 tons per acre of lump chalk during the winter 1925-26. In all other respects the treatment was uniform.

Manurial Treatment both Sugar Beet and Potatoes— 3 *cwt. Nitrate of Soda* 3 *cwt. Basic Super* 3 *cwt. Muriate of Potash*	*Weight of Washed Sugar Beet per acre.*		*Average Percentage of Sugar.*
	Chalked. T. C.	*Unchalked.* T. C.	
1927 Plot (2)	9 14	Nil	19.1
,, (2a)	6 14	Nil	
1928 Plot (1)	13 6	Nil	21.3
,, (1a) ..	8 16	Nil	
1929 Plot (4)	10 16	1 1	18.3
,, (4a)	12 7½	0 14	
1930 Plot (3)	13 9	0 5	—
,, (3a) ..	11 8	0 3	—
1931 Plot (2)	12 10	Nil	18.0
,, (2a)	14 5	Nil	
1932 Plot (1)	17 7	4 3	18.0
,, (1a)	15 7	1 11	
1933 Plot (4)	13 3	0 12	15.7
,, (4a)	18 4	0 6	
Average Yield Per Acre	12 13	0 13	

https://doi.org/10.23637/ERADOC-1-210

Potatoes

Note the effect of the dry years 1929 and 1933 upon the unchalked potatoes.

	Chalked T.	Chalked C.	Unchalked T.	Unchalked C.
1927 Plot (2)	13	4	10	5
,, (2a)	12	16	7	19
1928 Plot (1)	13	16	11	15
,, (1a)	12	7	10	1
1929 Plot (4)	11	10	6	2
,, (4a)	14	3	6	11
1930 Plot (3)	12	19	8	7
,, (3a)	12	4	6	2
1931 Plot (2)	12	0	9	7
,, (2a)	10	15	8	1
1932 Plot (1)	12	0	10	12
,, (1a)	12	2	10	5
1933 Plot (4)	10	4	4	14
,, (4a)	11	10	4	6
Average Yield per acre	12	5	8	3

In the case of sugar beet we also have the advantage of replicated plots conducted by Mr. Garner, Captain Gregory and the Rothamsted Staff, showing the influence of varying quantities of chalk. Ground chalk was applied on January 12th, 1932. The following is a summary of the results.

Tons per acre of Washed Roots

	No Chalk	*1 ton Chalk*	*2 tons Chalk*	*3 tons Chalk*	*4 tons Chalk*
1932	1.82	12.61	14.30	14.27	14.74
1933	2.94	11.40	13.23	13.26	13.91

Results, 1932. A large response to the first dressing of ground chalk. There is also a significant response to the sceond dressing. The sugar percentage does not appear to have been affected by the chalk.

1933. A large response to the lowest dressing of chalk applied in 1932 and a further significant response to the second dressing.

The sugar percentage was significantly increased by the first dressing of chalk, but not by further dressings. The yields on the the No Chalk plots represent carry over by the cultivation from adjacent land which receives chalk.

Potatoes. It is frequently said that the potato is a crop which does not require the addition of lime. No doubt this is usually true. But, especially in dry seasons, I think our soil is too acid even for the

https://doi.org/10.23637/ERADOC-1-210

potato. Mr Garner reported on replicated plots in 1930 "Chalk appears to have no effect." Subsequently, however, he somewhat modified his opinion and regarded the line of demarkation between chalked and unchalked which I had observed, as evidence in favour of chalking. In 1931, with further replicated plots he again reported "The chalked half of the field did not give markedly different results from the unchalked."

This is, however, only two seasons. In dry seasons, especially, in my mind there can be no doubt whatever that chalking has increased our crops.

Moreover, especially in 1933, the effect on the size of the potatoes was remarkable, thus :

Heath Walk.	*Rotation Plots,* 1933. *Manuring Identical in other ways*	*Potatoes*
	5 tons chalk 1925-26	*Unchalked*
Plot 4	63% of ware	34% of ware
,, 4a	66% of ware	33% of ware

Cow Walk Nitrate of Lime Plots	*10 tons chalk*	*5 tons chalk*	*Unchalked*
	50% of ware	72% of ware	38% of ware
	65% of ware		27% of ware

In the very dry year of 1933, the haulm on the unchalked areas died down some weeks sooner than that on the chalked, in both fields.

Other plant foods. Sugar Beet.

In 1932, replicated plots, for which again we are indebted to the assistance of the Rothamsted Staff, showed :

	Tons of Washed Roots per Acre		
	No Super	*Super*	*Mean*
No Potash ..	16.81	17.52	17.16
Potash	17.62	18.05	17.84
Mean	17.21	17.78	17.50

The responses to potash and superphosphate are significant. The potash produced an increase of 0.22 in the sugar percentage which however is not significant. Superphosphate had no effect upon the sugar percentage.

1933. Replicated plots to test the effect of increasing quantities of nitrogen.

https://doi.org/10.23637/ERADOC-1-210

Tons of Washed Beet per acre.

Uniform manuring	*No Nitrogen*	144 *lb.* *N. Soda*	288 *lb.* *Soda*	434 *lb.* *N. Soda*
3 cwt. Super 3 cwt. Muriate of Potash ..	13.17	15.04	15.91	15.92
Sugar	17.81	17.46	17.66	17.14

The difference between 15.04 tons and 15.91 can safely be regarded as due to the extra nitrogen.

It seems probable that the exceptionally dry season prevented the additional nitrogen on the plot receiving 432 lbs. of nitrate of soda from having effect.

Potatoes.

The Rothamsted replicated plots at Tunstall have shown a highly significant response to nitrogen, a significant improvement has been given by superphosphate and by sulphate of potash in presence of superphosphate. Previous experience indicated that nitrogen on this exceptional soil was the dominant ingredient, but evidently the other plant foods are necessary. The rather unusual combination of 3 cwt. of nitrate of soda, 3 cwt. basic superphosphate, and 3 cwt. muriate of potash, which we use as a manure for both potatoes and sugar beet ledge of the requirements of poor light land. It was only a guess. was due to our knowledge, or perhaps, I should say, our lack of know-

Even when no farmyard manure is used but only chemical fertilisers, there would appear to be a gradual building up of fertility in the soil. Time also would appear to be of value in allowing chalk to become thoroughly incorporated in the soil.

As evidence of the gradual increase in soil fertility I may mention that seven years ago we tried to grow sugar beet on the Cow-walk field. The resulting beet were most of them no bigger than a walnut —hardly worth lifting—and of a most peculiar shape—the roots being curved. Apparently the tap root would not face the acid subsoil. During the past three years we have had well over 12 tons per acre in the field, no farmyard manure has been used in the meantime

The replicated trials have indicated that after reasonably good treatment for several years, our soil responds to applications of phosphates and potash as well as very strikingly to nitrogen.

In some seasons we get badly dried up—notably so in 1933. In this case the tops of the beet died down and it looked as though the crop was worthless—but on lifting we were very agreeably surprised.

I may mention that with oats and wheat we have quite definitely come to the conclusion that it is not safe to use more than $1\frac{1}{2}$ cwt. of nitrogenous manure—more may do harm rather than good, in a dry time, and burn the crop up.

I should like to take the opportunity of thanking Sir John

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Russell, and the Rothamsted Staff for assisting us in many ways, especially for help in designing the experiments and in connection with the replicated trials. The latter have enabled us to speak more definitely regarding the requirements of the soil. Many others also have greatly helped us, especially those whose names I have mentioned and to whom thanks are due. In conclusion, I am making a claim, which I hope will be considered justifiable. It is that, even in the dry Eastern Counties, very light sandy soil of the heath type may be brought to a relatively high level of productivity without undue expenditure : by chalking where necessary ; by the use of a suitable rotation ; and by the aid of chemical manures adapted to the peculiar type of soil.

Given reasonably remunerative prices there seems no reason why such a system of farming should not be adopted wherever a similar type of land exists in this country. If this were done a substantial area would be added to the agricultural land of England.

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