FERTILIZATION OF SPHAGNUM BOGS, ON THE BASIS OF CERTAIN FIELD EXPERIMENTS AT LETEENSUO

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At the experimental station of Leteensuo a number of tests have been established and continued through a prolonged period in order to study the fertlizing questions connected with the cultivation of Sphagnum bogs. So far these tests have been evaluated in thorough treatments of the phosphate fertilizing experiments (7,5). These experiments will therefore not be dwelt upon in the present work. Instead, we are now concerned with an experiment with increasing nitrogen quantities combined with stable manure fertilizing, and with a complete fertilizing experiment combined with liming.

It should be pointed out that, with respect to peat cultivation in Finland, nitrogen fertilizing particularly is a many-sided question requiring careful deliberation, because the necessity of using nitrogen fertilizer and the required quantity is dependent not only on the type of peat but also on the geographical location of the bog in question.

The nitrogen content of peat varies, for instance, with the peat type; on an average it is about 1.2 % for Sphagnum peat and 2.3 % for sedge peat (2). However, the nitrogen is present in the peat in a not easily soluble form; consequently, there is little ammonia and nitrate nitrogen. Actually, the quantity of inherent nitrogen in peat that can be used by cultivated plants is essentially dependent on the amount of nitrogen mobilization that may take place. This, in its turn, is governed by numerous factors; among other things it is a fact that mobilization occurs in a different manner in different types of peat. In high-quality fens mobilization is comparatively lively, although the geographical location of the bog has to be taken into account; in Sphagnum bogs, again, mobilization is poor. Relatively great differences can be noted in this respect. In South Finland, where the soil temperature in the summer is higher than in bogs of more northerly location, nitrogen mobilization in high-quality fens is abundant enough to make nitrogen fertilizing virtually unnecessary for any one of our cultivated plants. However, Sphagnum bogs are always in need of nitrogen fertilizing. The experiments described in the following throw light primarily on the significance of nitrogen fertilizing on a Sphagnum bog in South-Finland.

The tests were established by A. VESIKIVI; they were later continued by J. TÖRMÄ (1944), U. E. HIRVENSALO (1945—1946), A. ISOTALO (1947—1952) and S. MIKKOLA (1953—1956). The results of the experiment have previously been described by VESIKIVI (7, p. 70) and by TAKALA (5).

Test area and plans of experiment

The peat of the test area is Sphagnum peat, mainly originating from *Sph. fuscum* moss. The peat layer has a thickness of more than 3 metres. The area was drained by open ditches, dividing it into strips 20 m in width.

Complete fertilizing experiment

The area was cleared for cultivation in 1932. In the winter of 1934, clay was added as a soil improving agent in a quantity of 300 m³ per hectare. In the same year the test area was also fertilized with stable manure at 35 tons per hectare.

The various treatments represented the fertilizer combinations P, PK, NP,

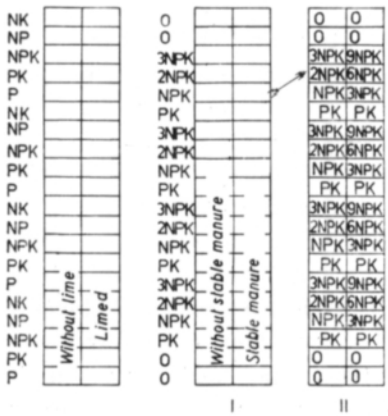

Fig. 1. The positicn of plots in the complets fertilizing and nitrogen fertilizing tests. I = treatments up to 1949, II = treatments since 1949 in the nitrogen fertilizing test.

NK and NPK. Liming was also combined with this experiment. The location of the treatments can be seen from Fig. 1. The fertilizers were given once a year. Liming was done in 1934, when 2000 kg slaked lime per hectare were given. The fertilizers employed in the test were superphosphate or Kotka phosphate, 40 or 50 % potassium salt, and calcium nitrate. The following nutrient quantities were applied per hectare: 40 kg P_2O_5, 80 kg K_2O, and 30 kg N. Stable manure was applied to the entire test area in the spring of 1934 at a rate of 35 tons per hectare. The meadows were established as clover-timothy meadows.

At the Experimental Station of Northern Ostrobothnia a fertilizing and soil improvement test has been carried out in which the fertilizer combinations were the same as in the present test, except that there was a plot without fertilizing instead of our P treatment and that heavier phosphate fertilization was given. The liming, too, was done with greater lime quantities (1, p. 8).

Nitrogen fertilizing experiment

The area was cleared for cultivation in 1921. The first cultivated plant was sown in 1923, at which time the test proper began. In 1923 the area received clay as a soil improving agent in a quantity of 300 m^3 per hectare. In the same year, moreover, liming was performed, adding 4000 kg slaked lime per hectare.

Originally, increasing nitrogen fertilizer quantities and stable manure were combined in this field experiment as follows: One of two strips 10 m in width and 100 m in length received per hectare altogether 20 tons stable manure in 1923—1924, 30.6 tons in 1929, 30 tons in 1930, and 30 tons in 1933. Otherwise both strips carried the same treatments: 0, PK, NPK, 2NPK, and 3NPK (N = 15 kg N, P = 40 kg P_2O_5, K = 100 kg K_2O; all per hectare). In 1949 the plan of the experiment was altered in that the nitrogen fertilizer quantities given to the test plots in the strip with stable manure were increased so that the new nitrogen fertilizer quantities were 6N and 9N (see location of treatments, Fig. 1). In 1948, the after-effect of nitrogen fertilization was studied. The fertilizers employed in this experiment were calcium nitrate, superphosphate and potassium salt.

Crop yield results

The weather conditions during the years of experiment have been described in a previous publication (4, p. 5).

The hay meadows have been timothy-dominated. Usually a seed mixture containing 20 kg timothy seeds and 5—8 kg red clover seeds per hectare has been used. The seed quantity of oats was 200—220 kg well-germinating seed per hectare, except in 1958, when only 160 kg per hectare were used. The hay and straw crop yields have been given as in an air-dried state, the grain crop yields as dried.

Complete fertilizing experiment

The annual crop results in this experiment are shown in Table I in the Appendix, while Tables 1 and 2 give the average crop yields per year. Table 3 contains calculated values showing the degree of crop increase caused by each one of the three nutrients when given in addition to a basic administration of the other two. These values were computed from the crop yield of the completely fertilized plot, subtracting the figures obtained with the two-component combinations, each one in turn. The results reveal that nitrogen has the greatest significance among the three, with phosphorus next and potassium ranging last. This succession in importance of the fertilizers is consistent with the findings of ANTTINEN (1, p. 13). Most closely

Table 1. Complete fertilizing experiment. Average hay crop yields, kg per hectare and year (17 years).

	Without lime		Limed		Increase in yield due to liming
	Crop yield	Increase in yield	Crop yield	Increase in yield	
P	1 770	–	2 920	–	1 150
PK	1 510	–260	2 840	–80	1 330
NP	3 310	1 540	4 060	1 140	750
NK	2 040	270	2 640	–280	600
NPK	3 080	1 310	4 410	1 490	1 330

Significant differences:

Artificial fertilization	108*	144**	187***
Liming	172*	229**	298***

Table 2. Complete fertilizing experiment on Sphagnum bog. Average grain and straw yields of oats, kg per hectare and year (5 years).

Fertilization	Without lime		Limed		Increase in yield due to liming	Straw yield	
	Grain yield	Increase in grain yield	Grain yield	Increase in grain yield		Without lime	Limed
P	1 450	–	1 420	–	–30	3 140	3 970
PK	1 240	–210	1 550	130	310	2 470	4 070
NP	1 990	540	1 920	500	–70	4 810	4 930
NK	1 890	440	1 690	270	—200	3 600	3 900
NPK	2 090	640	2 010	590	–80	4 700	4 880

Significant differences:

Artificial fertilization	76*	105**	144***

Table 3. Values showing the degree of crop increase (kg/ha) caused by each one of the three nutrients when given in addition to a basic administration of the other two. I = unlimed, II = limed.

		N	P	K
Hay	I	1 570	1 040	–230
	II	1 570	1 770	350
Oats, grain yield	I	850	200	100
	II	460	320	90
Oats, straw yield	I	2 230	1 100	–110
	II	810	980	– 50

comparable with the present experiment are the basic treatments in his investigation, i.e., stable manure plus clay, and stable manure plus clay plus lime. One observes particularly the slight effect of potassium, in fact the yield-lowering effect of potassium. The effect of phosphate fertilizers on Sphagnum bog can be seen in detail in the investigation of TAKALA (5). In table 4 are shown the results of one phosphate trial, which has been evaluated by TAKALA (P = 20 kg P_2O_5 per ha).

Tables 1 and 2 reveal that liming considerably increases the hay crop yields but has a lowering effect upon the grain crops of oats. The same observation was made in all other Sphagnum bog liming experiments at Leteensuo (3, 4, p. 8—11).

Table 4. Average annual yields of hay in one phosphate trial at Leteensuo, kg per ha (during 9 years) (according to TAKALA). P = 20 kg P_2O_5 per ha, sf = superphosphate, tf = basic slag.

Fertilization	Yield	Increase in yield	Fertilization	Yield	Increase in yield
0	1 904	—	0 + liming	2 256	352
Psf	4 149	2 245	Psf + »	4 588	2 684
Ptf	3 341	1 437	Ptf + »	3 375	1 471
2Psf	4 481	2 577	2Psf + »	5 254	3 350
2Ptf	3 470	1 566	2Ptf + »	3 422	1 518

Table 4 shows that in connection with liming the effect of phosphorus was particularly enhanced in regard to the hay crops. Furthermore, the figures relating to the crop increase produced by potassium seem to indicate that the relation between potassium and calcium might also have significance with respect to the effect of potassium. The same trend can also be observed in ANTTINEN's findings (1, p. 13).

Nitrogen fertilizing experiment

The preceding experiment has revealed the great importance of nitrogen in the fertilization of Sphagnum bogs. The nitrogen fertilizing experiment provides an opportunity to study the effect of varying nitrogen dosages.

The annual crop yield results in this experiment can be seen from Table II in the Appendix.

Table 5. Average hay crop yields up to 1949, kg per hectare and year (13 years).

Artificial fertilization	No stable manure		With stable manure		Crop yield increase caused by stable manure
	Crop yield	Increase	Crop yield	Increase	
0	1 590	—	2 160	—	570
PK	2 940	1 350	3 240	1 080	300
NPK	3 610	2 020	3 810	1 650	200
2NPK	4 340	2 750	4 480	2 320	140
3NPK	4 970	3 380	4 950	2 790	— 20

Significant differences: Artificial fertilization 276* 369** 485***

Table 6. Average crop yields of hay and oats since 1949, kg per hectare and year (Plan of experiment altered in 1949).

Fertilization	Hay (7 years)		Oats (3 years)		
	Crop yield	Increase	Grain yield	Increase	Straw yield
0	2 010	—	960	—	2 110
PK	3 510	1 500	1 240	280	3 040
NPK	3 980	1 970	1 720	760	3 680
2NPK	4 840	2 830	1 820	860	4 300
3NPK	6 140	4 130	2 120	1 160	4 780
6NPK	7 330	5 320	2 680	1 720	6 920
9NPK	7 110	5 100	2 730	1 770	7 720

Significant differences 680* 920** 1 200*** Significant differences 450* 630** 890***

Meadows. Tables 5 and 6 and Figs. 2 and 3 show the average hay crop yields per year up to 1949 and since that year. The results were grouped in this way because the plan of the experiment was altered in 1949. It can be seen that the highest

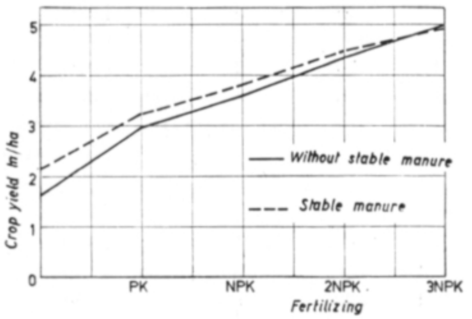

Fig. 2. Average hay crop yields per year in the nitrogen fertilizing test up to 1949 (13 years).

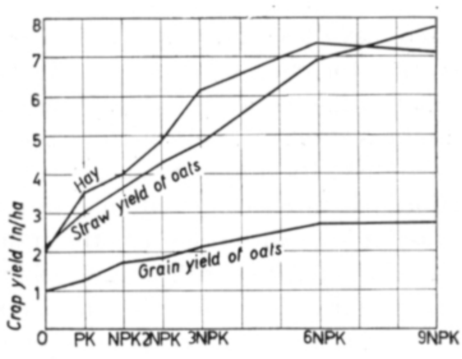

Fig. 3. Average crop yields of hay and oats per year in the nitrogen fertilizing test since 1949.

nitrogen dosage included in the original plan, 45 kg N per hectare, has been too small for hay meadows, since the crops increased fairly linearly up to the dosage of 6N. Table 5 and Fig. 2 reveal that stable manure increased the hay crop yield when little or no nitrogen was used; its hay crop-increasing effect becomes less with increased nitrogen fertilizing. However, the difference is not statistically significant.

Cereals. In addition to hay, only oats and mixed peas and oats were used as experimental plants, except in 1959, when also barley was cultivated. The average crops, per year, of oats and of mixed peas and oats are shown in Tables 6 and 7

Table 7. Average grain and straw yields up to 1949, kg per hectare and year, for oats (grain crops of 6 years, straw crops of 5 years) and for mixed peas and oats (5 years).

Artificial fertilization	No stable manure			With stable manure			Crop yield increase caused by stable manure	
	Grain yleid	Increase	Straw yield	Grain yield	Increase	Straw yield	Grain yield	Straw yield
				Oats				
0	650	–	1 680	1 000	–	2 900	350	1 220
PK	700	50	2 440	1 060	60	3 720	360	1 280
NPK	950	300	3 050	1 270	270	4 310	320	1 260
2NPK	1 120	470	3 670	1 460	460	4 940	340	1 270
3NPK	1 330	680	4 150	1 540	540	5 300	210	1 150
Significant differences: Artificial fertilization					41*	55**	75***	
Stable manure					65*	88**	119***	
				Peas and oats				
0	860	–	1 660	1 270	–	2 490	410	830
PK	1 680	820	3 250	1 780	60	3 740	100	490
NPK	1 880	1 020	3 930	2 060	790	3 990	180	60
2NPK	1 920	1 060	4 050	2 030	760	4 230	110	180
3NPK	2 150	1 290	4 500	2 110	840	4 540	–40	40
Significant differences: Artificial fertilization					159*	219**	301***	

and Figs. 3 and 4; they, too, have been given separately for the period before and after 1949. It can be seen that the curves representing the crop yield figures have a course largely similar to that of the hay crop yields. However, Table 7 reveals that the effect of stable manure was different, both with respect to grain and to straw yield, from that in the case of hay. Its crop-increasing effect was equal in magnitude in connection with all artificial fertilizer combinations. Also, this effect was statistically significant in every case at least with respect to the grain yield, as the F values indicate. The corresponding characteristic for the straw yield was not computed.

Prolonged effect of stable manure. The effect of stable manure can still be observed in 1948, as late as 15 years after the most recent addition of stable manure to the proper test member. The crop yield increases possess statistical significance, the F value, 8.5, rating one asterisk. The prolonged effect of stable manure is also evident from the fact that in the years 1934—1940, when no more stable manure was added, the increases in hay crops as well as in the grain crops of oats, caused by stable manure, were equal in magnitude to those during earlier years.

If we compute the average effect of stable manure from the PK combination test and from all PKN tests, we find that it increased the average hay crops of the four hay meadows in the period 1934—1940 by 340 kg per hectare and year, while the corresponding figure for the period 1925—1928 (four hay meadows) was only 78 kg per hectare and year. Similar calculations show that the oats grain yield increased, owing to stable manure, by 570 kg in 1938, while in the three years when the stable manure addition was performed, i.e., 1923, 1930, and 1933, the average increase was 400 kg per hectare and year. The cause for the favourable effect of stable manure is likely to be found, partially at least, in the changes in microbial activity in the soil produced by it.

Crop quality

Studies relating to the quality of the crops exist only from the nitrogen fertilizing experiment. In 1958, the timothy content of the hay (from a seventh year ley) was investigated (5, p. 34). The timothy percentage of the different treatments, starting with the plot, withouth treatment, was found to be: 2.4; 13.1; 11.0; 26.8; 56.9; 72.5; 54.3. The timothy percentage was thus highest in the test member with 90 kg N per hectare. In the instance of the test member with the highest nitrogen fertilizer dosage the lodging of the hay, which would have given other plant species a better chance to gain the upper hand, is thought to be responsible for the fact that the timothy percentage went down once more (5, p. 35).

Table 8. Strength of straw, 1000-grain weight and shooting capacity in 1958. Experimental plant: Orion III oats.

Fertilization	Strength of straw (0—10)	1000-grain weight, g	Shooting, %
0	10	31.8	29
PK	10	31.1	8
NPK	10	30.2	6
2NPK	10	29.7	5
3NPK	10	31.4	8
6NPK	6.5	31.0	5
9NPK	2.5	31.2	4

Table 8 shows the results and observations from the crop quality determinations to which the oat crops of 1958 were subjected. Nitrogen fertilizing did not lower the 1000-grain weight to any noteworthy extent but it effected a slight reduction in the germinability. Impaired germinability was, namely, experienced that year, owing to night frosts. However, there are no significant differences in germinability between the crops reared with different nitrogen fertilizer dosages. The lodging of the crops in two test members, too, was caused by severe night frost (—13.0° C). This lodging serves to indicate that the highest nitrogen fertilizer dosages have produced a straw of different structure. On the other hand it does not necessarily indicate that the development of the cereal would have been markedly delayed in the test members with the highest nitrogen dosage, seeing that the germinability was reduced in all test members.

Conclusions

The present investigation is an account of the results from two fertilizing experiments established on Sphagnum bog at the Experimental Station of Leteensuo. The experiments were carried out in 1923 and 1934. The following conclusions can be drawn from the results.

Most important in significance among the different nutrients is nitrogen, phosphorus ranging next, and potassium last. Potassium could even cause a reduction in the crop yields.

The effect of liming was evident in the form of increased hay crops, whereas the grain yields of oats were reduced by it. Liming has improved the effect of phosphorus particularly in the case of hay. The results also seem to indicate that the relation between potassium and calcium has significance in regard to the reduction of crop yield caused by potassium.

Remarkable crop yield increases were obtained by nitrogen fertilizing. The hay crops and the grain and straw crops of oats increased almost linearly with the addition of nitrogen, in the form of calcium nitrate, in quantities up to 90 kg N per hectare. Quantities in excess of this caused hardly any further increase in the crops. The said quantity is suitable for cover manuring of hay meadows, but the most advisable quantity for cereals is thought to be 45—60 kg N per hectare, so that lodging of the crops might be avoided.

Nitrogen fertilization does not essentially affect the quality of the grain crops of cereals; on the other hand nitrogen promoted the retention of timothy in the meadow when nitrogen was used in quantities up to 90 kg per hectare.

Stable manure increased the crops. This effect was most distinctly evident in the grain and straw crops of oats. The effect of stable manure was still present 15 years after the most recent addition of stable manure.

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SELOSTUS:

RAHKASUON LANNOITUS ERÄIDEN LETEENSUON KOKEIDEN PERUSTEELLA

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Tutkimuksessa on selostettu Leteensuon koeaseman rahkasuolle perustettujen lannoituskokeiden tuloksia. Koealueen turve on vähän maatunutta, Sphagnum fuscum rahkaturvetta. Koealueelle on lisätty savea maanparannusaineeksi 300 m^3/ha. Seuraavat päätelmät voidaan esittää.

Eri ravinteista on tärkein merkitys typellä, sitten fosforilla ja viimeksi kalilla. Kalilannoitus on jopa saattanut alentaa satoja.

Kalkituksen vaikutus on ilmennyt siten, että heinäsadot ovat sen vaikutuksesta lisääntyneet, mutta kauran jyväsadot alentuneet. Kalkitus on parantanut fosfaattilannoituksen vaikutusta erityisesti heinällä. Tulokset viittaisivat myös siihen, että kalin ja kalkin suhteella on merkitystä kalin vaikutuksen kannalta.

Typpilannoituksella on saatu huomattavat sadonlisäykset. Heinäsadot sekä kauran jyvä- ja olkisadot ovat nousseet lähes suoraviivaisesti lisättäessä typpeä kalkkisalpietarin muodossa aina 90 kg N/ha. Tätä suurempi määrä ei ole juuri lisännyt satoja. Heinänurmen pintalannoitukseksi mainittu määrä soveltuu, mutta viljalle lienee suositeltavin 45—60 kg N/ha lakoviljan välttämiseksi.

Viljan jyväsadon laatuun ei typpilannoituksella liene sanottavaa merkitystä, mutta timotein säilymistä nurmessa on typpilannoitus edistänyt käytettäessä typpeä aina 90 kg/ha.

Karjanlanta on lisännyt satoja. Selvimmin tämä vaikutus on esiintynyt kauran jyvä- ja olkisadoissa. Karjanlannan vaikutus on ilmennyt vielä 15 vuoden kuluttua viimeisestä karjanlannan lisäyksestä.

Table I. Complete fertilizing experiment on Sphagnum bog. Crop yields, annually, kg per 0.1 hectare. I = unlimed, II = limed.

Year	Plant		P	PK	NPK	NP	NK
1934	Oats grain	I	188	190	249	239	242
		II	178	184	237	237	205
	straw	I	349	324	475	480	478
		II	353	394	471	456	380
1935	1st year ley hay	I	357	360	410	394	285
		II	457	475	538	550	385
1936	2nd » » »	I	419	432	532	507	294
		II	469	469	592	572	297
1937	3rd » » »	I	219	213	319	291	104
		II	272	266	381	366	53
1938	Peas and oats grain	I	180	124	201	220	72
		II	218	150	210	238	87
	straw	I	240	170	277	311	97
		II	363	270	362	360	139
1939	Oats grain	I	227	223	271	263	253
		II	175	212	235	223	219
	straw	I	433	423	527	521	289
		II	520	559	565	550	499
1940	1st year ley hay	I	138	138	347	332	291
		II	275	303	444	410	310
1941	2nd » » »	I	263	227	381	334	228
		II	263	278	413	391	294
1942	3rd » » »	I	75	62	213	319	163
		II	216	184	319	363	138
1943	Peas and oats grain	I	77	99	152	131	118
		II	146	144	170	163	138
	straw	I	153	123	300	287	234
		II	335	353	440	395	293
1944	No results						
1945	Oats grain	I	107	78	167	180	161
		II	147	143	164	179	141
	straw	I	264	198	452	492	408
		II	435	418	494	553	401
1946	1st year ley hay	I	134	106	203	161	179
		II	358	354	393	336	314
1947	2nd » » »	I	203	133	381	352	296
		II	323	296	511	444	519
1948	3rd » » »	I	300	150	414	445	306
		II	408	361	491	491	321
1949	4th » » »	I	215	100	298	365	142
		II	317	291	355	393	177
1950	Oats grain	I	98	67	131	123	112
		II	91	89	103	88	104
	straw	I	250	144	332	314	219
		II	282	244	275	279	231
1951	Oats grain	I	106	61	226	188	178
		II	121	145	265	233	177

Year	Plant	P	PK	NPK	NP	NK
	straw I	252	148	565	599	406
	II	397	419	635	625	437
1952	1st year ley hay I	146	116	413	422	215
	II	305	303	417	399	236
1953	2nd » » » I	56	40	257	259	164
	II	291	293	464	419	304
1954	3rd » » » I	91	33	249	302	173
	II	291	280	470	434	309
1955	4th » » » I	68	17	208	285	170
	II	186	174	390	330	264
1956	5th » » » I	114	46	263	318	192
	II	247	220	465	403	290
1957	6th » » » I	106	35	198	266	98
	II	158	154	463	328	121
1958	7th » » » I	104	41	144	281	163
	II	137	135	386	283	151

Table II. Experiment with increasing nitrogen quantities. Crop yields, annually, kg per 0.1 hectare. I = without stable manure, II = with stable manure.

Year	Plant	O	PK	NPK	2NPK	3NPK
1923	Oats grain I	71	68	128	165	200
	II	107	109	157	186	216
	straw I	209	217	352	495	559
	II	246	270	392	484	544
1924	Peas and oats grain I	197	250	340	505	607
	II	243	252	357	505	622
1925	1st year ley hay I	123	535	555	610	637
	II	160	522	595	595	600
1926	2nd » » » I	20	315	377	392	417
	II	20	355	392	442	472
1927	3rd » » » I	84	152	220	315	383
	II	63	189	262	325	362
1928	4th » » » I	26	155	225	302	410
	II	44	174	196	279	365
1929	Peas and oats grain I	53	105	124	141	166
	II	113	126	152	183	188
	straw I	160	352	387	387	472
	II	230	321	335	362	367
1930	Oats grain I	30	43	58	67	74
	II	65	90	125	122	110
	straw I	128	244	314	348	396
	II	323	520	609	690	730
1931	1st year ley hay I	62	160	217	313	442
	II	157	212	302	407	517

Year	Plant		O	PK	NPK	2NPK	3NPK
1932	Oats grain	I	87	106	130	159	182
		II	105	115	134	167	192
	straw	I	167	205	239	309	348
		II	181	230	261	350	399
1933	Oats grain	I	34	34	43	54	56
		II	74	74	85	89	106
	straw	I	110	290	292	310	362
		II	297	382	437	417	455
1934	1st year ley hay	I	72	205	262	365	487
		II	185	255	300	372	492
1935	2nd » » »	I	140	327	419	482	513
		II	289	336	416	508	594
1936	Peas and oats grain	I	99	143	194	196	205
		II	131	161	175	190	195
	straw	I	161	288	395	449	493
		II	230	341	420	460	474
1937	Peas and oats grain	I	92	142	196	207	214
		II	106	138	172	182	207
	straw	I	161	276	378	401	469
		II	223	393	405	455	474
1938	Oats grain	I	114	94	129	147	163
		II	176	177	178	206	201
	straw	I	226	264	328	372	412
		II	404	458	455	528	520
1939	1st year ley hay	I	96	201	275	399	445
		II	184	267	327	393	440
1940	2nd » » »	I	19	238	294	366	402
		II	97	286	363	419	452
1941	Peas and oats grain	I	102	282	255	265	268
		II	162	303	362	292	280
	straw	I	145	332	325	332	332
		II	212	366	352	367	390
1942	Peas and oats grain	I	87	168	170	182	220
		II	125	160	170	170	186
	straw	I	202	379	480	456	482
		II	351	451	483	470	567
1943	Oats grain	I	52	77	81	83	125
		II	71	70	84	108	99
1944	1st year ley hay	I	496	418	503	526	549
		II	408	398	392	448	447
1945	2nd » » »	I	362	435	535	643	702
		II	498	508	582	681	695
1946	3rd » » »	I	370	396	450	527	604
		II	417	392	458	542	530
1947	4th » » »	I	201	292	358	403	477
		II	286	321	372	411	473
1948	5th » » »	I	212	271	252	170	222
		II	246	337	296	214	206

Altered fertilizing plan		0	PK	NPK	2NPK	3NPK	6NPK	9NPK
1949	Oats grain	157	184	261	287	304	317	340
	straw	284	323	356	411	464	524	492
1950	Oats grain	73	100	120	124	187	280	270
	straw	167	288	243	261	264	566	562
1951	1st year ley hay	259	509	540	607	692	744	720
1952	2nd » » »	105	392	449	530	647	838	775
1953	3rd » » »	198	392	474	596	738	766	715
1954	4th » » »	236	320	351	403	563	631	596
1955	5th » » »	237	254	292	378	519	744	714
1956	6th » » »	165	320	366	444	552	634	614
1957	7th » » »	205	269	317	431	584	771	841
1958	Oats grain	59	88	134	134	145	206	208
	straw	181	300	506	619	706	987	1262
1959	Barley grain	38	52	66	81	124	214	180
	straw	176	225	295	339	430	517	423