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Guide to the Experimental Plots - 1913

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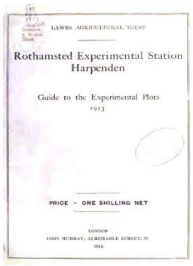
LAWES AGRICULTURAL TRUST

Rothamsted Experimental Station
Harpenden

Guide to the Experimental Plots
1913

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1914

Broadbalk Field - Wheat

Rothamsted Research

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Use of Dung.

Three plots were selected in 1905 to illustrate the effects of dung applied occasionally, either alone or in combination with artificial manures. The quantities applied per acre are as follows :—

Plot 19. 14 tons Dung 1905, and every fourth year.
Unmanured intervening years.

Plot 20. 14 tons Dung 1905, and every fourth year.
1½ cwt. Nitrate of Soda
200 lb. Superphosphate
100 lb. Sulphate of Potash } Every intervening year.

Plot 13.* 14 tons Dung 1905, and every fourth year.
6 cwt. Fish Guano 1907, and every fourth year.†

BROADBALK FIELD

Wheat

The experiments on the continuous growth of wheat were begun in the Broadbalk field in 1843, but for the first eight years the manuring was of a varied description, so that only three of the plots have received the same treatment during the whole period of seventy years. The plots as seen to-day began in 1852, since which time the few changes in manuring have been matters of detail and not of principle.

The chief difficulty experienced in growing wheat continuously is that of keeping the land clean; not only does the crop occupy the ground for the greater part of the year, and so leave little opportunity for cleaning operations, but the weeds whose habit of growth is favoured by the crop tend to accumulate from year to year. Thus in spite of repeated hand-hoeings, some weeds, like the "Black Bent" grass, *Alopecurus agrestis*, are kept under with the greatest difficulty.

On Plot 3 wheat has been grown without manure every year since 1843, for four years previously no manure had been applied to the field, so that the present crop is the seventy-fourth without manure. After a drop in production during the first few years, the yield has been practically constant for the last fifty years, fluctuating only with the season, and showing no immediate prospect of declining. The average crop over this period has amounted to about 12½ bushels per acre, approximately equal to the average yield, taking the whole world over.

Effect of Nitrogenous Manures.

Plots 6, 7, and 8 should be compared with Plot 5, since all receive the same mineral manures, but different amounts of nitrogen as ammonium-salts.

Plot 5, which receives the minerals but no nitrogen, grows very little more than the continuously unmanured plot; its average over the whole period is only 14·5 bushels, as against 12·6 without manure of any descrip-

* The southern half of Plot 13 received a dressing of 2000 lb. of ground lime in 1907.
† The fish guano was applied in 1910 instead of 1911.

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TABLE XV.—*Experiments on Wheat, Broadbalk Field. Manuring of the Plots per acre per annum,* 1852 *and since.*

Plot.	Abbreviated Description of Manuring.	Nitrogenous Manures.				Mineral Manures.			
		Farmyard Manure.	Rape Cake.	Nitrate of Soda.	Ammonium-salts.	Super-phosphate.	Sulphate of Potash.	Sulphate of Soda.	Sulphate of Magnesia.
		Tons.	Lb.	Lb.	Lb.	Cwt.	Lb.	Lb.	Lb.
2	Farmyard Manure	14	...	...	...	...	...	...	...
3	Unmanured	...	...	...	...	...	...	...	...
5	Minerals	...	...	...	...	3·5	200	100	100
6	Single Ammonium-salts and Minerals	...	...	...	200	3·5	200	100	100
7	Double do. do.	...	...	...	400	3·5	200	100	100
8	Treble do. do.	...	...	...	600	3·5	200	100	100
9	Single Nitrate and Minerals	...	...	275	...	3·5	200	100	100
10	Double Ammonium-salts alone	...	...	...	400	...	...	...	...
11	Do. and Superphosphate	...	...	...	400	3·5	...	...	...
12	Do. do. and Sulph. Soda	...	...	...	400	3·5	...	366·5	...
13	Do. do. and Sulph. Potash	...	...	...	400	3·5	200	...	...
14	Do. do. and Sulph. Mag.	...	...	...	400	3·5	...	...	280
15	Double Amm.-salts in autumn, and Minerals	...	...	...	400	3·5	200	100	100
16	Double Nitrate and Minerals	...	...	550	...	3·5	200	100	100
17	Minerals alone, or Double Amm.-salts alone, in alternate years	...	...	...	...	3·5	200	100	100
18		...	...	...	400	...	...	...	...
19	Rape Cake alone	...	1889	...	...	...	...	...	...

TABLE XVI.—*Experiments on Wheat, Broadbalk Field. Produce of Grain and Straw per acre. Average over* 61 *years* (1852-1912); *and over* 10 *years* (1903-1912); *also Produce in* 1911.

Plot.	Abbreviated Description of Manuring.	Dressed Grain.			Straw.		
		Average, 61 years (1852-1912).	Average last 10 years (1903-1912).	Season 1911.	Average, 61 years (1852-1912).	Average last 10 years (1903-1912).	Season 1911.
		Bush.	Bush.	Bush.	Cwt.	Cwt.	Cwt.
2	Farmyard Manure	35·2	32·8	35·2	34·8	38·2	36·9
3	Unmanured	12·6	10·0	12·5	10·3	9·3	9·8
5	Minerals	14·5	12·5	14·8	12·1	11·9	12·8
6	Single Ammonium-salts and Minerals	23·2	19·0	17·2	21·4	20·7	17·9
7	Double do. do.	32·1	27·9	25·6	32·9	32·3	27·6
8	Treble do. do.	36·6	33·8	36·4	41·1	42·1	35·7
9	Single Nitrate and Minerals	...	26·0	29·9	...	28·7	29·0
10	Double Ammonium-salts alone	20·0	16·3	22·8	18·4	16·7	17·2
11	Do. and Superphosphate	22·9	17·1	20·1	22·3	20·2	15·2
12	Do. do. and Sulph. Soda	29·1	24·6	27·0	28·0	26·2	20·6
13	Do. do. and Sulph. Potash	31·0	28·7	29·7	31·5	33·1	27·4
14	Do. do. and Sulph. Mag.	28·8	22·0	24·1	28·0	24·1	18·9
15	Double Amm.-salts in autumn, and Minerals	29·9	26·4	24·1	29·7	29·0	22·3
16	Double Nitrate and Minerals	...	30·2	40·4	...	39·1	42·4
17	Minerals alone, or Double Ammonium-salts alone, in alternate years *	14·9	12·9	13·8	13·0	12·4	11·7
18	†	29·9	27·6	27·3	29·5	29·7	24·6
19	Rape Cake alone ‡	25·4	22·8	28·6	25·7	24·8	24·7

* by Minerals. † Produce by Ammonium-salts. ‡ 20 years (1893-1912).

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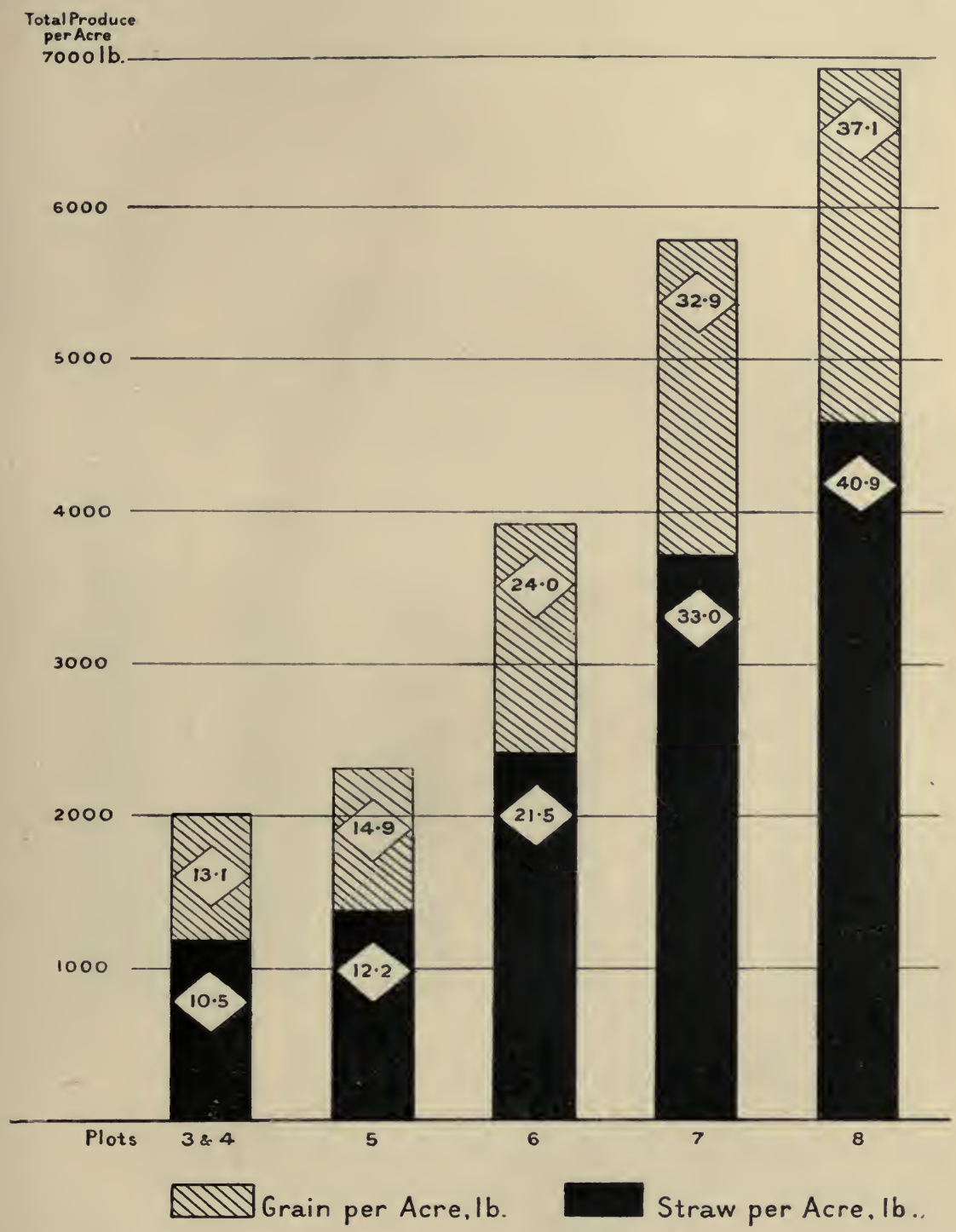

Fig. 8.—Broadbalk Wheat. Effect of increasing amounts of Nitrogen on the production of Wheat (Grain and Straw). Average, 51 years (1852-1902).
The figures in the labels indicate bushels of Grain and cwt. of Straw.

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tion. The yield of the other three plots increases with each addition of nitrogen; the grain increases from 23 bushels with 43 lb. of nitrogen, to 32 bushels with 86 lb. of nitrogen, and to 36½ bushels with 129 lb. of

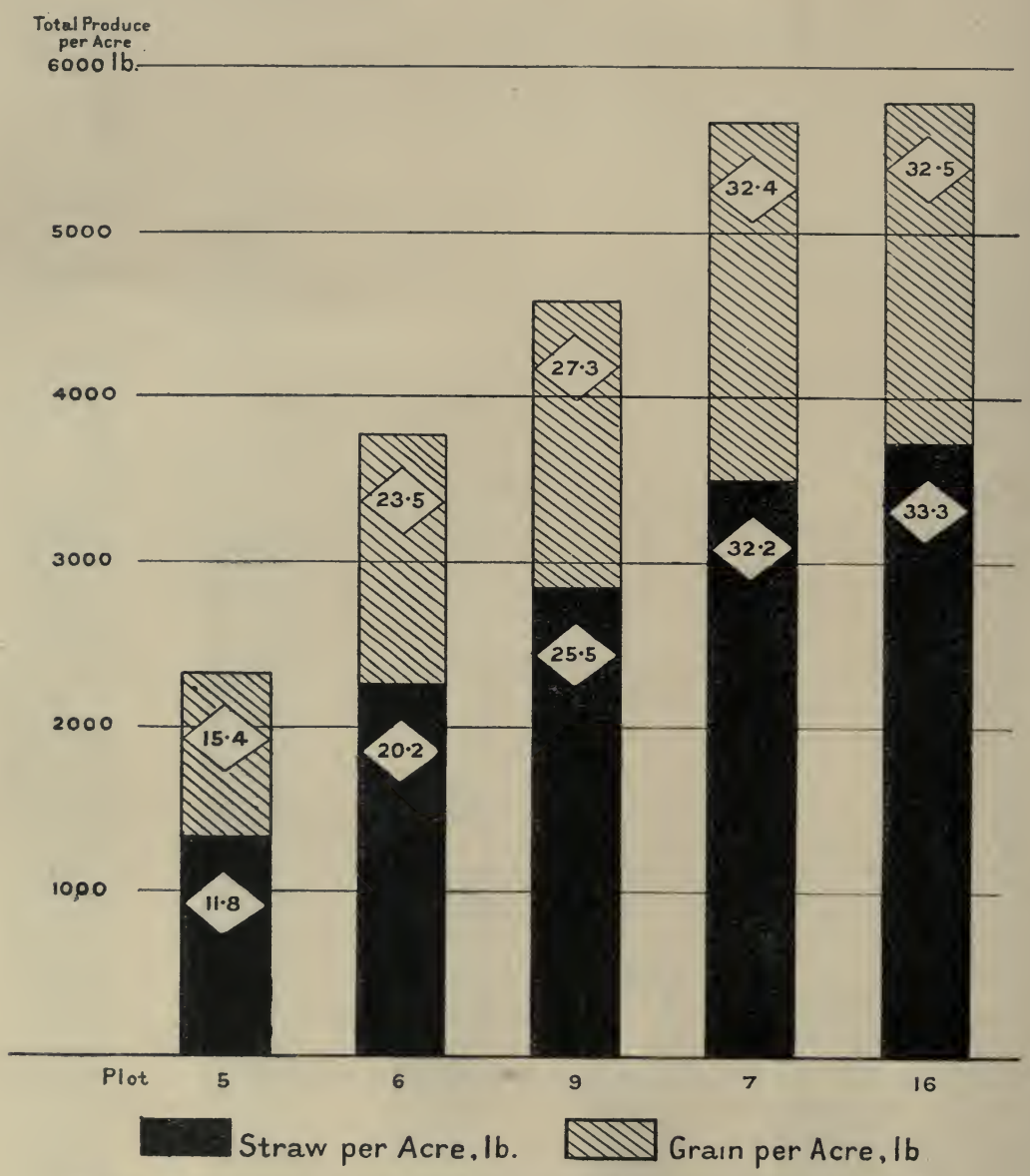

FIG. 9.—Comparison of Nitrate of Soda and Ammonium-salts on Wheat. Ten years (1893-1902). All Plots receive Minerals alike. The figures in the labels indicate bushels of Grain and cwt. of Straw.

nitrogen; the straw is even more affected by a free supply of nitrogen, rising from 21½ cwt. to 33 and 41 cwt. as the nitrogen is doubled and trebled.

Comparative Effect of Nitrate of Soda and Ammonium-salts.

Plot 6 should be compared with Plot 9, and Plot 7 with Plot 16. Plots 9 and 16 receive nitrate of soda and mineral manures, so that

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Plot 9 has the same manuring as Plot 6, and Plot 16 as Plot 7, except that the ammonium-salts on Plots 6 and 7 are replaced by equivalent amounts of nitrogen as nitrate of soda. The manuring of Plots 9 and 16 has, however, been changed during the progress of the experiments, so that they are only comparable with 6 and 7 since 1885. Taking a recent ten year average, as set out in the diagram, Fig. 9, it will be seen that nitrate of soda is a more effective source of nitrogen than the ammonium-

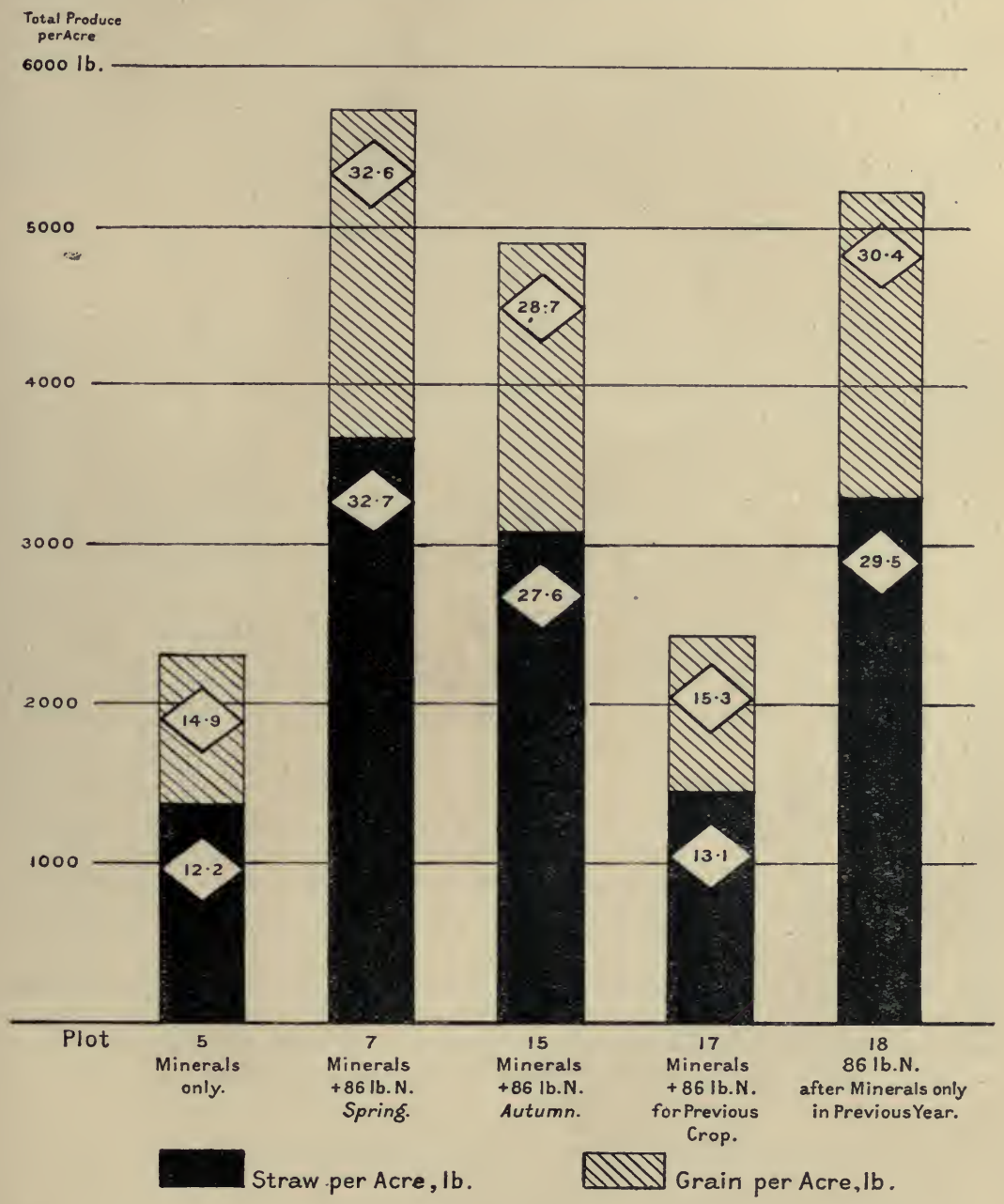

FIG. 10.—Comparative Effects on Wheat of Ammonium-salts applied at different times.
Averages—Plots 5, 17, and 18, 51 years (1852-1902).
Plots 7 and 15, 25 years only (1878-1902).
The figures in the labels indicate bushels of Grain and cwt. of Straw.

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salts; the single application yields 16 per cent. more grain and 26 per cent. more straw than the corresponding amount of ammonium-salts; the double application, however, yields practically the same amount of grain, and only about 1 cwt. more straw.

Effect of the Mineral Constituents.

The series of Plots 7, 10, 11, 12, 13, and 14 all receive the same amount of nitrogen—86 lb., in the form of 400 lb. of ammonium-salts per acre—but differ in regard to their mineral manuring. Plot 10 receives nothing beyond the nitrogen, Plot 11 has superphosphate also, while 12, 13, and 14 receive a further addition of sulphate of soda, sulphate of potash, or sulphate of magnesia respectively, all three of which are combined to form a complete mineral manure on Plot 7.

Retention of Manures by the Soil.

As a rule 100 lb. of the ammonium-salts are applied in the autumn when the seed is sown, the rest being reserved for a top-dressing in the spring. On one of the plots, however, Plot 15, the whole 400 lb. of ammonium-salts is applied in the autumn, otherwise the manuring is identical with that of Plot 7. The crop, however, on Plot 15 is on the average below that of Plot 7, showing that some loss takes place when the ammonium-salts are applied before the plant is able to utilise them. Plots 17 and 18 further illustrate the fate of ammonium-salts. These plots receive the dressing of Plot 7—400 lb. ammonium-salts and complete minerals—but the ammonium-salts and the minerals are applied in alternate years to the two plots. Thus in 1912 Plot 17 receives ammonium-salts but no minerals, and Plot 18 the minerals without the ammonium-salts, and the treatment is reversed in 1911 and again in 1913. The plot which in any year is receiving minerals without nitrogen derives little or no benefit from the ammonia it had the year before. The crop shows every sign of nitrogen starvation, and amounts on the average to only 14·9 bushels of grain, as compared with 14·5 bushels on Plot 5 which has received minerals without any nitrogen every year since 1852. On the Rothamsted soil, then, we may conclude that the effect of sulphate of ammonia applied to a cereal crop is confined to the season of its application. In the seasons when the ammonium-salts are applied the crop is but little short of that on Plot 7, and sometimes (as in 1911) is even greater where minerals are used every year with the same amount of ammonium-salts, thus showing that the previous mineral manuring is carried forward and has an effect in seasons beyond the year of its application.

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