No. 2

Sugar Beet in the Eastern Counties

1928

DIAGRAM I.

Distribution of Costed Fields in relation to the Factories.

University of Cambridge
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Sugar Beet in the Eastern Counties
1928

Being an Investigation into the Financial Results obtained on One Hundred Farms and Some of the Factors Influencing Them, as well as Contrasts and Comparisons with the Previous Year

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Acknowledgments

IN the following pages the material supplied by one hundred sugar beet growers is sifted and analysed. The provision of such data must often be an irksome and seemingly thankless task to those who undertake it, and at times it must be hard to keep alive the interest which inspires it. It can only be hoped that, in addition to the sincere gratitude of the Department, those who have provided the basic material, many of them for two successive years, may find in this second *Report* some points of interest which will help to compensate them for their untiring support. They desire to remain anonymous, but, none the less, our obligation to them must be recorded. In addition, every reader of this volume will owe a debt of gratitude to Mr. P. E. Graves, who has been responsible for the innumerable mathematical calculations which lie behind a work of this nature.

Some Observations on Sugar Beet Production

It is probable that no crop, since the introduction of the turnip into the rotation of Norfolk husbandry, has caused such widespread discussions, demonstrations and investigations as has sugar beet. Scientists, economists, agriculturists and politicians have vied with each other to convince the farmer, and the country at large, of its merits and demerits. Research workers and county officials have carried out field and experimental investigations, and a mass of information has been accumulated and is being sifted, tested and made more easily available to the practical man with each successive season. In addition, each grower has, in effect, been carrying out private experiments on his own behalf, and thus, within a few years, expansion and progress has been made which, without Government assistance, might not have been achieved within a century.

Looked upon as an ordinary commercial proposition, how does the introduction of the sugar beet crop appear to the "average" farmer? As an addition to the list of "cash" fallow crops it is undoubtedly very welcome, for in these days of narrow profit margins, and limited capital, every fresh opportunity for increasing the rate of turn-over is of considerable assistance. Farming in general, and arable farming in particular, suffers under many handicaps which are unknown to the industrialist, and of these one of the most serious is the necessity of maintaining within the organisation certain departments which can never be made directly profitable. The fallow "shift" is one of these departments, but the substitution of sugar beet for, say, mangolds or swedes, greatly reduces the time-lag between outlay and income, while the availability of pulp, coupled with, perhaps, a judicious modification of the cropping system enables the stock carrying capacity of the land to be maintained and the "out-put" to be increased.

Attention to detail is to-day one of the most important essentials to successful, that is profitable, farming. In so far as successful sugar beet production is concerned certain details stand out as being of paramount importance. The farmer's factory, or as some prefer to call it, his raw material, merits consideration in this respect. Thus, soils may be subjected to many forms of classification, although from the practical man's point of view, the nature of its texture and the degree of its fertility are probably the most common. So far as the three categories of "heavy," "medium" and "light" soils are concerned the first would appear to be unsuited to sugar beet production, for the preparation of a good seed bed and the ultimate harvesting of the crop on this type of land provide economic difficulties which, for the present, are

insurmountable. Where fertility is the basis of classification it may safely be said, however, that many soils which are to-day classed as unfit for sugar beet production, or, at best, capable of producing only an indifferent crop, may, by liming and suitable manuring and cultivation, be made to yield satisfactory results.

Of the many factors concerned in the production of sugar beet, labour is one of the most important and costly. In this connection it is pleasing to be able to record in the following pages that experience in growing the crop is effecting considerable advances in the efficiency of both manual and horse labour, with consequent reductions in acreage and tonnage costs. But there still appears to be wide scope for improvements in the art of hoeing and singling, for all too many disappointing results have been observed which were due to careless work and indifferent supervision during this most critical period in the life of the crop. While emphasising the importance of hoeings and singling, the question naturally arises as to what is the ideal spacing of plants and rows. Local conditions, soil fertility, variety of seed and many other variable factors will influence the decision, but it is clear that the treatment of mangolds is still too frequently taken as being equally applicable to sugar beet. There is no doubt that a large number of growers would benefit from heavier seeding and closer spacing of plants. It is suggested, too, as a result of close observation on a very considerable area of beet land in the province, that many growers, in spite of constant warnings from the factories and the advice of County Organisers, neglect to give adequate supervision to drilling. The 1929 season, with its abundance of tilth, will demonstrate, it is feared, the dangers of burying the seed beyond any hope of obtaining a full plant.

While up to the present sugar beet does not appear to have been allotted any definite place in the rotation, owing, no doubt, to the influence of the subsidy, there is a tendency for it gradually to fall into the normal fallow "break." It would appear fairly safe to assume that, with the accumulated experience in the technique of its production, as well as an ever increasing appreciation of the value of its by-products and after-effects, the crop seems to have come to stay throughout a large area of the eastern counties in which the growing of alternative "cash" fallow crops is not an economic proposition. Whether the factories' requirements will be satisfied with the production from the present fallow area, or whether the fallow acreage will be increased, it is difficult to predict; but it does seem reasonably certain that the sugar beet crop, coupled with other factors in the economics of present-day farming, will materially influence the rotation of the future.

As new growers take up the production of the crop it is but natural that many queries should arise in their minds as to the correct method of manuring. Here, as with points of a cultural nature, local conditions will influence the decision, and it is safe to leave the matter in the hands of the local agricultural advisors who, year by year, conduct manurial experiments for their own particular districts, and who can base advice on their experience and judgment of

the requirements of each particular field. There are not, and never can be, set types and quantities of manures suitable for the whole country, or even for one individual county.

Turning to implements, the past season has not produced much of an outstanding character in this direction. Mention may be made of what is claimed to be an improved horse-hoe. The feature of this implement is that the lateral movement of the framework carrying the hoes is made almost finger-light by means of a small wheel which runs on the fixed carriage; and although the hoe can be made to take the width of an ordinary corn drill, the work is not too heavy for one horse. A new combined horse-hoe and manure distributor has been designed for top-dressing while horse-hoeing. This implement will no doubt appeal to those growers who favour the method of "dobbing," as it is called in some districts, i.e., placing a pinch of some nitrogenous top-dressing at the base of each plant after singling. It will certainly save the growers many plants, for when this operation is done by hand the employees are often observed wearily dropping, from an upright position, some potent manure directly into the crown of the plant. A new implement which tops, cleans and loads the beet needs no comment here, as a full discription appears elsewhere in this volume. It may be said, however, that seen at work on one of the worst days of the late season and under the most vile conditions, its performance was most impressive. The outstanding features of this machine were the speed with which the work was accomplished, the thorough cleaning given to the roots, and the ease with which the unsoiled tops could be collected afterwards—this last point being of no mean consideration to those dairymen and stock-owners who appreciate their feeding value, whether fresh or ensiled. One other outstanding advantage of the implement lies in the fact that a great proportion of the adhesive soil is deposited in its original site, and not carted away to swell the already high freight rates and cause inconvenience and expense to the working of the factory. Whether the price of the implement will place it beyond the reach of the average grower remains for the future to decide, but it would appear that the inclusion of such a useful machine in the outfit of the steam cultivator or threshing tackle contractor is worthy of consideration on his part.

The advantage of being able to utilise the by-products of the crop,in the form of dried pulp and tops, was most marked during the last season, and in the majority of cases where enquiries were made enthusiastic accounts were given of their value. All classes of stock-owners spoke in glowing terms, and in many cases dried pulp is now being asked for in quantities far in excess of the grower's quota. A number of flock-masters found the pulp a veritable sheet-anchor during the spell of severe frost, and in no case has adverse criticism been heard. During the early period of the beet campaign it was feared in some quarters that, owing to the displacement of forage crops, a reduction in the numbers of livestock might result. The reverse appears to have been the case, for there is evidence of a tendency, where capital is available, to increase

the head of stock formerly carried. This, in itself, is a healthy sign in more ways than one. The visit recently paid to the Continent by a party of farmers left many of them impressed with the advantage of ensiling tops, either in clamp or pit, and those in this country who have already practised this method are very well satisfied that the idea is sound and that the product provides excellent food for all classes of stock. On account of the interest which has thus been aroused, this subject is expanded in the present *Report*. As a digression, it may be mentioned that a movement is on foot to utilise the plant at some factories for the purpose of drying surplus potatoes for cattle food, either alone or mixed with the pulp. As this process, however, is not yet beyond the experimental stage, it can, for the present, only be watched with interest.

The testing out of varieties of seed has met with a considerable amount of attention during the last season, and the results have been published individually by the county authorities and collectively by the Ministry of Agriculture. English grown seed again gave promising results, and there certainly seems to be quite a future for those farmers who specialise in seed production under contract. It is well within the realms of speculation that this country may at no distant date be able to provide its own requirements.

The rail congestion which occurred during the earlier years seems to have been overcome, no mean achievement, and this, coupled with greatly improved road transport, has meant much to the industry, even though freight charges are still a serious burden. Any difficulty in regard to the supply of labour to those growers who contract for large acreages, or those who grow beet in excess of their normal fallow "break," appears to have been overcome by the recent factory arrangements for providing gangs at reasonable terms. This has been much appreciated, and the results appear, in every case, to have been satisfactory. It is a system which has much to commend it, if only as a safeguard against the disorganisation of the regular farm staff at those times of the year when other essential operations are demanding attention.

The spell of brilliant weather experienced during the summer of 1928, coupled with the excellent harvesting conditions in the early autumn, presented a remarkable contrast to the 1927 season. The psychological effect was most encouraging, and optimistic forecasts of a record yield were made by many growers. The dry, hot spell experienced in the early summer with its accompanying insect and fungoid diseases had, however, been overlooked, and greatly diminished yields were experienced over many of the very light soil areas. It is yet too early in the life of the crop in this country to say much of pests as understood by Continental growers, but where beet followed beet, wireworm attacks seemed to be more prevalent than usual. Whether this was due to more thorough cultivation, a greater abundance of residual food supply, or higher farming generally, it is difficult to say, since many farmers contend that by this latter means reputed "wireworm" land can be freed of the pest. Experience, however, will doubtless bring with it a better understanding of sugar beet diseases.

CHAPTER I.

INTRODUCTION

1. THE SAMPLE

THE following pages form the second interim *Report* on an investigation, into the economics of sugar beet production, which was commenced in the autumn of 1926, and will be concluded with the delivery to the factory of the 1929 crop. The results of the first year's investigation, dealing with the crop grown during the 1927 season, were published in considerable detail a year ago,* and the numerous tables of data included in the appendices of that volume provide a reference for research workers and others. The present *Report* is an analysis, on similar lines, of the results of the crop grown and harvested during 1928, but, owing to the close similarity between much of the basic data obtained in the two years, the individual field costs are not reproduced in the present publication. The main objects are to test, in the light of a second year's experience, the conclusions arrived at in the earlier *Report* and to elucidate the financial results of the 1928 crop. The very diverse climatic conditions associated with the two seasons 1927 and 1928, together with the reduction in the price paid by the factories to the growers, render comparison particularly interesting, and no excuse is made for still further extending those sections which treat with the farmer's by-products.

As was the case with the *Report* on the 1927 crop, the present investigation covers exactly 100 farms scattered throughout Norfolk, Suffolk, Essex, Hertfordshire, Cambridgeshire, Bedfordshire, the Isle of Ely, the Soke of Peterborough and all three divisions of Lincolnshire. Of these 100 farms, 57 were represented in the former *Report* and have thus been costed for a second season, 42 are entirely new, and the remaining one, while being a new farm, is under the management of a grower who supplied information during the previous year. This change in sample has not affected, as the following table shows, the representative nature of the farms, and does not, therefore, vitiate comparison between the two years' results.

TABLE 1

COMPARISON OF MAJOR CHARACTERISTICS OF FARMS COSTED DURING 1928 WITH THOSE COSTED DURING 1927, AND WITH NORMAL CONDITIONS

	% arable land of total under crops and grass.	Rent per acre.	Density per 100 acres.	
			Regular labour.	Working horses.
E. and N.E. Divisions ..	69	29/-	3·2†	3·5
100 Farms costed in 1927	75	29/5	3·8‡	3·2
100 Farms costed in 1928	74	30/10	3·9‡	3·6

* All references to an earlier Report refer to *Sugar Beet in the Eastern Counties*, 1927 (W. Heffer & Sons Cambridge. 3*s*. net).

† Does not include family labour. ‡ Includes family labour.

Of the one hundred farms, 20 are of 100 acres or less, 34 exceed 100 but not 250 acres, 25 are over 250 but not greater than 500, and 21 are more than 500 acres in extent. The total area covered by all the farms is 36,135 acres.

Only two of the 100 growers had not had previous experience with the sugar beet crop; eight were growing it for the second, and 25 for the third year, while sixty-five were growing at least their fourth crop. Over the whole 100 farms, the acreage under sugar beet in 1925 represented 5·3 per cent. of the arable land, but if the farms on which it was not grown are excluded, the proportion is 8·1 per cent. The corresponding figures for 1926 were 9·3 per cent. of the total arable and 10·5 per cent. of the arable land on farms where sugar beet was grown. In 1927 these figures had increased to 12·8 per cent. and 13·0 per cent. respectively, and for the year under review (1928) the percentage of the sugar beet acreage to the arable land on the 100 farms had risen to 15·6 per cent. A more interesting result is obtained, however, when only those farms on which beet has been grown for all four years are considered. From 8·1 per cent. of the arable land in 1925 the sugar beet acreage expanded to 11·5 per cent. in 1926 and 14·5 per cent. in 1927. During the 1928 season, in spite of the substantial drop in the total sugar beet acreage in the country, on these 65 farms where it had been grown continuously for at least four years the proportion of the total arable land which was sown with sugar beet increased still further to 15·1 per cent.

The present enquiry covers 2036½ acres, or almost exactly two-thirds of the total area of sugar beet grown on these 100 farms in 1928. This sample amounts to 1·6 per cent. of the total area of beet grown in the counties which are represented, and 1·2 per cent. of the total acreage grown in England and Wales. The costed acreage consists of 173 separate fields, giving an average area of 11·77 acres per field. The county distribution of the farms, fields and acreages of beet, together with the proportion of the costed area to the total area grown in each county in 1928 is given in Table 2.

TABLE 2

COUNTY DISTRIBUTION OF THE COSTED AREA

County.	Covered by the present enquiry.			Total acreage under sugar beet in 1928.	Costed acreage expressed as a % of total acreage under beet.
	Farms.	Fields.	Acres.		
Suffolk	26	60	731	30,098	2·4
Norfolk	32	55	717	41,063	1·8
Kesteven (Lincs.) ..	7	14	108	8,028	1·4
Isle of Ely	10	12	198½	14,110	1·4
Lindsey (Lincs.)	6	9	58	11,143	0·5
Essex	5	6	40	5,254	0·8
Cambridgeshire	4	5	43	6,517	0·7
Soke of Peterborough ..	4	5	36	1,798	2·0
Holland (Lincs.)	3	3	78	3,954	2·0
Hertfordshire	2	3	20	1,044	1·9
Bedfordshire	1	1	7	950	0·7
Totals	100	173	2,036½	123,959	1·6
England and Wales ..	—	—	—	175,734	1·2

Of the 18 sugar beet factories in operation in England and Wales, 14 were supplied with beet from the costed acreage. The distribution of these factories, and of the fields concerned, is illustrated in Diagram I (*frontispiece*). It is not an uncommon practice for a grower to supply two or more factories, and the 100 growers had 128 contracts to supply beet. Table 3 shows the factory distribution of the costed acreage, together with yield, sugar content and the total quantity of beet worked by each factory.

TABLE 3

FACTORY DISTRIBUTION OF COSTED BEET

	No. of growers costed.	Costed acreage.	Costed beet. Washed tons.	Average % sugar of costed beet.	Average yield of costed area.	Average lb. sugar per acre on costed area.	Total washed beet worked by factory.*
Bury St. Edmunds	25	493¾	3852	18·6	7·80	3251	157,998
Cantley ..	21	301¼	2904	18·0	9·64	3887	165,504
Ely	21	238¾	2504	16·8	10·49	3947	202,314
King's Lynn ..	7	314	2358	17·0	7·51	2860	88,167
Ipswich	15	230½	2087	18·4	9·05	3732	75,580
Peterborough ..	8	94	896	17·7	9·53	3779	79,765
Bardney	9	102½	888	17·4	8·66	3376	52,358
Spalding	3	60½	589	18·3	9·74	3991	58,286
Wissington ..	4	45	418	16·2	9·29	3371	67,441
Kelham	3	37½	284	17·0	7·57	2884	34,181
Colwick	2	22½	235	17·0	10·44	3977	55,352
Brigg	3	13	142	17·8	10·92	4355	36,935
Felsted	5	23¾	132	17·8	5·56	2216	38,204
Selby	2	1½	14	17·2	9·33	3596	50,697
Totals ..	128	1978½	17303	—	—	—	1,162,782

From the above it is evident that the sample on which this *Report* is based has been drawn from typical farms in representative proportions from all the producing areas in the Province, and includes proportional consignments to each of the factories operating in the Eastern Counties. It is perhaps necessary to explain that the total area costed which appears in Table 3 does not agree with the total as previously given on account of the fact that two growers failed to complete the season's costs.

2. METHOD OF OBTAINING STATISTICS

In the earlier *Report* a full description was given of the methods of obtaining the necessary information from the growers, and a Diagram illustrated the weekly return form with which growers were supplied. A similar system was employed during the 1928 season, and again personal contact was maintained and information supplemented by the periodic visits of Mr. G. Ll. Rogers, M.A., the Out-door Representative of the Branch. As formerly, yield and sugar content data, as well as the cash receipts, were obtained direct from the advice notes, numbering in all some 3400, sent to the growers by the factories on receipt of each consignment.

* *Agricultural Statistics*, Part I, 1928.

3. COSTING METHODS

A full account of the costing methods employed was given in the *Report* (page 4) on the 1927 crop. Exactly similar methods have again been used, and reference should be made to the earlier *Report* for details of this nature. A similar procedure has been adopted, also, in assessing the residual values brought forward from the preceding crop, and those to be carried forward to the crops which follow the sugar beet. In this connection, as well as in the matter of overhead charges and several other apportionments, fresh ground had to be broken, and, in each case, subsequent information has supported and strengthened the methods adopted. For example, the *net* charge for residual values after a bare fallow was taken as £2 10*s.* 0*d.* per acre, and after roots which were folded off, or sugar beet, the tops of which were ploughed in, an allowance of £2 per acre was made. A subsequent analysis showed that the cash receipts per acre for sugar beet grown after a bare fallow or fallow crop exceeded those for beet after a straw crop by £2 3*s.* 11*d.*, and that, in addition, the cost of preliminary cultivation and preparing the seed-bed was 14*s.* 7*d.* per acre less, giving a total advantage of £2 18*s.* 6*d.* in 1927 and £2 19*s.* 3*d.* in 1928. Further, over the whole acreage the amount of residual values brought forward averaged 17*s.* 2*d.* per acre in 1927 and 16*s.* 10*d.* in 1928, which figures compare with 16*s.* 6*d.* per acre as the average in a separate investigation carried out over four years, and in which the residual values were calculated on the agreed principles, from full particulars of cropping and manuring in the years previous.* Such a result shows the method of assessing the residual values brought forward from the previous crop to be conservative, and suggests that the residual values carried forward from the sugar beet to the succeeding crops, which, in 1927, amounted to an average of £2 2*s.* 10*d.* per acre, were not excessive.

It may be of interest to record that the system adopted for calculating the residual *cultivation* values after sugar beet resulted in an average allowance of 13*s.* per acre in 1927 and 13*s.* 5*d.* per acre during the year under consideration. During the same two seasons the allowance for the residual *manurial* values amounted to 14*s.* 5*d.* and 13*d.* 4*d.* per acre respectively for artificial manures, and 15*s.* 5*d.* and 20*s.* 11*d.* per acre respectively for dung. The more general use of dung during 1928 is commented upon elsewhere (page 8). Details of the methods of calculating residual values both brought forward to, and carried forward after the sugar beet crop, were given in the earlier *Report*. There, also, the feeding and manurial value of tops was examined at some length, and further experience has again suggested that the figures then used (5*s.* 6*d.* and 7*s.* 6*d.* per ton respectively for ploughing in and feeding, with a deduction of 1*s.* per ton for fen-land tops) were not unreasonable. The same figures have, therefore, again been used.

* *Four Years' Farming in East Anglia*, 1923–1927 (Heffer & Sons, Cambridge. 3*s.* net).

CHAPTER II.

1. FIELD DATA

INFORMATION has been obtained in respect of 173 fields on the 100 farms, as against 182 from the same number of farms in the previous year. A single field was costed on 59 of these farms; 24 farms contributed two, and 11 farms three fields; while of the remaining 6 farms, half supplied five and the rest six fields each. This distribution is very similar to that of the previous year.

As compared with the fields considered in the 1927 *Report*, the over-all average size of rather under 12 acres represents a decrease of half-an-acre. No less than 36 of the 173 fields of beet were less than five acres in extent, and a further 59 were under ten acres. Of the remainder, 37 were of ten, but less than fifteen acres, 14 more are added if the limit is raised to thirty acres, and 7 exceeded that size. Thus, 55 per cent. of the fields were under ten acres, and 76 per cent. under fifteen acres in extent. This preponderance of small areas of beet is typical of the industry in this country, and is doubtless partly due to the experimental attitude with which many growers still regard the crop. There may, however, be other factors, such as the labour supply and a disinclination to disturb to a large extent the organisation of the farm, which combine to prevent more extensive production. The bearing which this fact has upon costs is considered on page 43.

In the earlier *Report* attention was drawn to the frequency with which sugar beet was grown after sugar beet on the same land, and it was suggested that, so long as this practice was not extended sufficiently to invigorate diseases, or to become detrimental to the rest of the farm, it was, perhaps, the most profitable procedure. Support for this suggestion is found in its more extensive practice, for, whereas the 1927 crop was grown after sugar beet in 15½ per cent. of the cases, the 1928 crop follows beet on 19 per cent. of the fields. Altogether, the 1928 crop was grown after a root or fallow crop on no less than 30 per cent. of the fields, as against 29 per cent. last year. As would be expected, therefore, the proportion of sugar beet after fallows or roots other than beet, has fallen from 14 per cent. to 11 per cent., and this may be on account of the reduced contract price, which, coupled with the experience of 1927, has removed the incentive to break up rotations.

Further indications of a return to normal rotations are found in the fact that, whereas in 1927 barley preceded the sugar beet crop more often than wheat, during the year under consideration wheat occurred in 26 per cent. and barley in 18 per cent. of the cases. Oats, too, have become more common as a preceding crop, appearing on 17 per cent. of the fields, and all white straw crops together occupied 62 per cent. of the land before the 1928 sugar beet.

Seeds and mustard account, in equal parts, for more than half of the remaining 8 per cent.

As was the case in 1927, barley is the predominant crop after beet, appearing on exactly half the fields. Just as the 1928 sugar beet crop was grown after beet in 19 per cent. of the cases, it is being followed by beet in 1929 on 19 per cent. of the fields. In 6 per cent. of these this is the third crop of beet in succession. Other roots account for 9 per cent. of the succeeding crops, making a total of 28 per cent. for all roots grown after the 1928 beet. Wheat and oats occur in 8 per cent. and 8½ per cent. respectively of the crops following the beet, and all white straw crops together amount to 67 per cent. The remaining 5 per cent. includes some mustard, and two fields which are being put down to permanent pasture.

A study of these figures suggests that in 1928 sugar beet assumed a far more normal place in the farm rotation than was the case in the previous year. Wheat and oats account for a larger proportion of the preceding crops (43 per cent. against 35 per cent.) and, but for the practice of growing beet after beet (a practice which may develop into a system) the number of cases in which beet has followed a root or fallow crop, or has preceded a root or fallow crop, decreased considerably. In other words, the reduced price, consequent upon the reduction in the subsidy, has lessened the temptation to depart from customary practices, and is a step forward in the direction of stabilising sugar beet in the normal sequence of farm crops.

The average quantity of seed sown, at just under 14½ lb. per acre, was the same as in 1927. This figure does not include the two fields on which spacing drills were used or the three cases in which part of the field was resown. Where a spacing drill was used, 9 lb. or 10 lb. were drilled. With the above exceptions, and excluding the cases where the experiment of drilling both ways was tried, the average quantity of seed used where the beet was grown on the flat was approximately 14½ lb. per acre, and on the ridge 2 lb. less were sown. In spite of the fact that a minimum of 15 lb. per acre has, again and again, been shown to be necessary if a reasonable opportunity of obtaining the best results is to be afforded, no less than 40 per cent. of the fields were sown with a smaller quantity, while 29 per cent. received exactly 15 lb. and 31 per cent. more than 15 lb. per acre. As would be anticipated, on those fields in which the rows were more than 20 inches apart the average seeding amounted to only 13½ lb. per acre, while an average of 15½ lb. was put on where the drills were less than 20 inches. Where the rows were exactly 20 inches apart, the seeding averaged just under 15 lb. per acre. Only those fields which were grown on the flat were included in this analysis. The question of the rate of seeding is referred to again on page 50.

Stimulated by the numerous variety trials carried out under the auspices of the Ministry of Agriculture, encouraged by the factories, and assisted by the National Farmers Union, interest in the suitability of different varieties of seed to different conditions has spread considerably during the last year. Evidence

of this was found in the fact that, whereas in 1927 no less than 70 per cent. of the growers were unable to give the name of the seed they used, in 1928 over 50 per cent. could do so. As was the case last year, however, it is impossible to make any deductions from this information (which is given for all fields in Appendix B) on account of the numerous other factors which influence the results. It was hoped, for example, to form some opinion of the comparative propensity to run to seed of the more common varieties. But, apart from the type of seed, the tendency to "bolt" may be influenced, among other things, by the date of drilling, the weather conditions during growth, the manuring, the depth of cultivation and the type of soil. In addition to this many growers used two or more varieties of seed. Obviously it would be impossible to eliminate all these influencing factors and still retain a sample of sufficient size to give a reliable result. But in any case, the grower's choice of seed is, in the great majority of cases, limited to those types with which the factory is able to supply him, and so long as this is the case the onus of providing reliable seed of the most suitable variety must remain with the factory.

As far as information was obtained, drilling extended from the last days of March until almost the middle of June. Just one-third of the fields were drilled during April, but more than half of these fell into the last week of that month. In the previous year approximately one-quarter of the seeding was done in April. Rather under half (46 per cent.) of the drilling was distributed equally over the first two weeks in May, 1928, and half of the remainder had not been started by the end of the next week. Altogether, the seeding period, under the influence of more favourable weather conditions, seems to have been almost a week earlier in 1928 than in 1927. Whereas in 1927 only 5 per cent. of the fields were drilled before 20th April, in the year under review just 13 per cent. had been completed by that date; while, at the other end, 10 per cent. (as compared with 15 per cent. in 1927) had not been completed by 20th May. That this was a not unimportant factor among the several which contributed to the production of a greater yield per acre in the latter year is suggested by the analysis given on page 48.

Only 15 of the 173 fields were grown on the ridge, and six of these were on one of the two sewage farms included in the investigation. The average yield of the whole 15 fields was just over $8\frac{1}{2}$ tons, and the average sugar content 17·3 per cent., but as these figures are largely influenced by the results on the sewage farm, they cannot be used for comparison. Undoubtedly more advantage was derived from this method of production in 1927 than during the season under consideration, and it is noteworthy that in the majority of cases where beet was grown on the ridge in 1927 this system was again adopted.

The distance between the rows varied from 15 to 36 inches. Field No. 107 was, however, the only example of the latter unusually wide drilling, and the next widest was the not uncommon 24 inch drill. The average and the "model" distance between the drills was 20 inches. There has been a definite tendency towards the 20 inch drill since last year, especially from the narrower sowings.

Whereas 43 per cent. of the fields in 1927 were less than 20 inches apart in the drill, in the present year 36 per cent. only were under that width. The number of times 20 inches occurred has risen from 17 per cent. to 26 per cent., and that distance was exceeded in 38 per cent. of the cases as against 40 per cent. last year. This subject is referred to again on page 49.

In Appendix B is given the distance to which each grower intended to chop out his beet. In 1927 the average of these distances was 8·7 inches, and this year it is 9·2 inches. It was suggested in the 1927 *Report* that the actual distance attained was some 3 to 6 inches greater than these figures indicate. With the object of substantiating this suggestion and in order to impress this point, just 246 chain lengths were measured along the row in 40 fields under widely differing soil conditions in September, 1928. The results of this work are considered on page 51; here it is sufficient to mention that the average distance between the plants over all the measured fields works out at 14 inches.

2. MANURING

As a result, probably, of the reduced price offered by the factories, there have been several interesting and suggestive changes in the manuring of the sugar beet crop. A discussion of their full significance is deferred to page 32, and here only a bare analysis of the figures for comparison with the previous year is given.

The more extensive use of farmyard manure is very apparent, the proportion of fields receiving dung in 1927 and 1928 being 44 per cent. and 53 per cent. respectively. Again, on several of the fields the dressing was incomplete, and 50 per cent. (as compared with 40 per cent. in the previous year) had a full dressing. Besides being more extensively used, however, the average rate of application has increased. On no less than 25 of the 84 fields (or 30 per cent.) which received a full dressing did the amount applied exceed 12 loads per acre. In addition to the 88 fields which received some dung, 7 fields were treated with sewage. Fish manure also was rather more popular, being used on 14½ per cent. of the fields, as against 12 per cent. in 1927. More than half the fields which received this manure, as well as the only field to which guano was applied, also received a dressing of dung. Shoddy was only used on one field, where it replaced dung. Altogether 64 per cent. of the fields received one or more of the above manures, against 54 per cent. in 1927. To this might be added one field which was dressed with meat meal, and two on which soot was applied; one of the latter two fields also received dung. If the manuring of the previous crop is considered in conjunction with the above, it will be found that no less than 81 per cent. of the fields were dressed with dung or treated with sewage *either* directly for the sugar beet or for the preceding crop.

Sulphate of ammonia was applied to 36½ per cent. of the fields, a figure which represents an insignificant increase of 2 per cent. on last year. On half

of the fields it was the only artificial nitrogenous manure, on 23 it was used in conjunction with nitrate of soda, with nitrate of lime in 5 cases, and with both these manures in the remaining 2 examples. Nitrate of soda was applied to a further 30 fields (three of which also received nitrate of lime), and consequently appeared on approximately the same proportion of fields as last year—i.e. 33½ per cent. Nitrate of lime used alone was put on to 10 fields, and was therefore used in a total of 20 cases (or 12 per cent.). Altogether, an artificial nitrogenous manure of some kind was used on 61 per cent. of the fields. This represents an advance of 5 per cent. on last year, which is due mostly to an increase in the number of growers who used nitrate of lime.

Superphosphate was the most frequently used individual artificial manure, being applied to 44 per cent. of the fields. This is an increase of 10 per cent. on last year. North African or rock phosphate was put on 8 fields, but only one of these did not also receive superphosphate. A bone manure was applied to 5 fields, in three cases with superphosphate, and basic slag was used by one grower. The falling off in the use of these latter manures has been more than counter-balanced by the increase in the use of superphosphate, so that actually the proportion of fields receiving an artificial phosphatic manure has increased by 2 per cent. to 45½ per cent.

The potash manuring is as remarkable for the falling off in the use of kainit as it is for the increase in the use of muriate of potash. The proportion of fields which received the former has decreased from 36 per cent. to 23 per cent., while the latter has more than doubled at 19 per cent. This change can be attributed, at least partly, to the increase in the price of kainit being greater in proportion than the increase in the price of muriate of potash. Whereas the unit cost of muriate rose from 3*s.* 6*d.* to 3*s.* 8*d.*, kainit increased from 3*s.* 11*d.* to 4*s.* 3*d.* per unit ; but, in addition to this, muriate is more convenient for mixing purposes, and it can be used for potatoes as well as for sugar beet. In one case muriate has been used with kainit and in another with other potash salts. These latter were applied to 11 fields, as against 14 last year, so that the percentage of fields to receive some form of artificial potassic manure has fallen from 53 per cent. in 1927 to 48 per cent. in 1928.

Perhaps on account of a better understanding of the manurial requirements of the beet crop, and influenced by the reduced price of beet, which suggested economy, growers have relied less on the use of "patent" sugar beet manures. In fact, the number of fields receiving such mixtures fell from 43½ per cent. in 1927 to 31½ per cent. in 1928. In the place of these proprietary mixtures many growers have made up their own "complete" manures. There can be no doubt that this represents an advance, for as often as it is claimed that the manufacturer has a better understanding of the qualities of his product than has the farmer, it can be answered that the farmer alone knows the circumstances of the field for which the manure is intended. In 12 cases, however, a "patent" mixture was the only manure applied, but in the majority of cases a nitrogenous artificial, usually as a top-dressing, was also put on.

Another tendency which can be regarded with approval is the definitely wider application of lime. Less than 4½ per cent. of the fields reviewed in the 1927 *Report* was treated with lime, but nearly 11 per cent. has been so dressed this year. This, doubtless, is largely due to the facilities offered by the factories for the disposal of their waste lime; an opportunity which should be acceptable to those growers situated within a radius which does not make transport charges prohibitive.

On only 4 of the 167 fields for which the costs were completed was the sugar beet grown without any manure. One of these was after potatoes which had been heavily manured, another was following sugar beet which had been treated with sewage, and a third was on that class of fen which alone can grow a 15 ton crop of beet without the stimulus of manuring. The remaining unmanured field was also a good fen.

Actually, the total proportion of fields to receive a dressing of one or more of the artificial manures, exclusive of "patent" mixtures, is almost identical with the corresponding figure for 1927, but the rate of application has not remained the same. The "average" dressing of sulphate of ammonia has fallen from 1½ cwt. to just over 1 cwt. per acre. The same figures apply to muriate of potash, and the "average" application of kainit is down from 4½ cwt. to just under 4 cwt. per acre. Nitrate of soda and superphosphate have just maintained their 1927 "averages" of 1¼ cwt. and 3 cwt. per acre respectively, and nitrate of lime is the only one to show an increase, rising from 1 cwt. to 1⅓ cwt. per acre. It is in the case of "patent" mixtures, however, that the greatest economy has been effected. The number of fields which have been dressed with these manures has decreased by some 12 per cent., and, in addition, the reduced contract price has lessened the temptation for growers to experiment with the more highly priced proprietary mixtures. Thus, although the "average" dressing has increased from 4½ cwt. to 5 cwt. per acre, its cost has decreased.

3. YIELD, TARE AND SUGAR CONTENT

(a) *Yield.*

The washed yield over the 167 fields for which the factory advice notes were analysed averaged 9·03 tons per acre. This represents an advance of 1·3 tons on the average of the 172 fields considered in 1927. This increase is exactly the same as the increase in the average yield for the whole country appearing in Part I of *Agricultural Statistics*, where the yields for the two years are given as 6·5 and 7·8 washed tons for 1927 and 1928 respectively. Again, therefore, the average yield of the costed fields is 1·2 tons above that for the whole country, and, as was the case last year, this is due in the main to the weight given to the average by the heavy yielding fens, which contribute a larger proportion to the costed sample than they do to the total acreage of beet grown in the country. This discrepancy, however, is not so large as was

the case last year, and, consequently, while the 1928 yield for the whole country represented an increase of 20 per cent. on the previous year, the same increase in the costed sample amounts to an advance of less than 17 per cent.

The individual field yields varied from 3·7 to 15·4 washed tons, but only 3 per cent. of the fields gave yields of less than 5 tons to the acre, compared with 15 per cent. in the previous year. At the other extreme, whereas in 1927 less than 2 per cent. of the fields reached 12 tons per acre, during 1928 over 10 per cent. exceeded that yield, and no less than 36 per cent. (as compared with 11 per cent. in 1927) gave a yield of 10 tons or more. There is an interesting change in the distribution of the field yields which can only be accounted for by the suggestion that the unfavourable weather conditions of the 1927 season exaggerated the effect of the suitability or otherwise of different soils to the crop. Thus, in 1927 approximately 44 per cent. of the fields gave yields of over seven but under nine tons per acre, and on either side of this peak the number of examples fell away rapidly, but in 1928 the distribution of the fields yielding between six and twelve tons was very even, and does not exhibit such a pronounced peak at any one point.

In connection with the question of yield it may not be redundant to draw attention once more to the fact that so long as a subsidy makes profitable the cultivation of sugar beet on soils on which it would not otherwise be grown, it is unreasonable to compare the average yield of this country with others in which the fiscal advantage is not so great. A reduction in price will weed out first of all those soils least suitable to the crop, and consequently, under normal conditions, will increase the average yield for the country.

(b) *Tare.*

"In general, harvesting was accomplished under satisfactory conditions, although the hard, dry soil made lifting difficult in some places. The absence of the continuously wet weather experienced in the previous year made carting easier, while the beets were received at the factories in a decidedly cleaner condition, the average tare being 14·5 lb. per cwt., as against 20 lb. in 1927 . . ."* Expressed as a percentage, these figures, which apply to the whole crop in England and Wales, represent 13·0 per cent. and 17·9 per cent., and compare with 11·3 per cent. and 17·3 per cent. respectively for the tare on the costed beet. These latter figures suggest a saving of approximately 11 cwt. per acre on the haulage and transport of tare in 1928; an economy which, on the average, has added perhaps five shillings an acre to the profits.

The actual range in the field average percentage tare was from 3·81 per cent. to 27·38 per cent. This former figure was achieved over eight truck loads (one of which gave less than 1·5 per cent. tare), and the latter figure compares with one example of 48·23 per cent. in the previous year. During the 1928 season 45 per cent. of the fields gave an average of less than 10 per cent. tare, while 90 per cent. were below the 1927 average of 17·31 per cent., and

* *Agricultural Statistics*, Part I, 1928.

whereas more than a quarter of the fields gave an average tare of over 20 per cent. in 1927, during the year under consideration only 4 per cent. reached that figure.

(c) *Sugar Content.*

The sugar content of all the fields in 1928 averaged 17·9 per cent., as compared with 16·1 per cent. in the previous year. These figures compare with 17·3 per cent. and 16·1 per cent. for the country as a whole during the same two seasons. Two principal factors combined to give this improved analysis; in the first place the climatic conditions ruling during the latter part of the growing season were such as to encourage the formation of sugar in the plant; and secondly, the 1928 lifting season was completed earlier than in the previous year, and consequently frost and rain had not such an opportunity to play havoc with the sugar content. Of the costed consignments, for instance, less than 1 per cent. was still undelivered on the 1st January, 1929, while in the previous season 7 per cent. was outstanding at the beginning of the new year; and although the production of sugar by the factories during the 1928 campaign exceeded that of the previous season, the output during January, 1929, amounted to only 40 per cent. of the total during January, 1928.

The range in field average sugar content was from 14·8 per cent. to 20·5 per cent., but the range of individual consignments was from 13·5 per cent. to no less than 22·2 per cent. Actually, five fields gave an average of 20·0 per cent. or more and only eight fell below the 16·0 per cent. average. Consignments from 41 per cent. of all the growers, and 50 per cent. of the upland (as opposed to fen) growers contained at least 20·0 per cent. of sugar at some time during lifting. Further, it is probable that, but for the late October and November rains, which encouraged the commencement of secondary growth and consequently reduced the sugar content (although perhaps increasing the weight of the beet), the high average of the earlier consignments would have been maintained. Sugar content fluctuations are again referred to on page 17.

4. SOIL CLASSES

In the 1927 *Report* it was found convenient, for purposes of comparison, to group the costed fields into classes based on the nature of the soil. The same classification has again been adopted, and the same five soil groups have been retained; viz. light to medium soils; medium to heavy soils; fen, warp and silt soils; very light soils, and lastly, the two sewage farms have been kept in a class by themselves. It must again be emphasised that this classification can only be arbitrary and comparative. No definite line exists between the light to medium and the medium to heavy soils, and fields which the North-West Norfolk farmer would deliberately place in the latter class, would be transferred unhesitatingly by the Essex farmer into the former group. The classification, however, has been done entirely by the Department's Out-door Representative, who is familiar with each particular field, so that, comparatively at least, the grouping can be accepted.

There has been a not unexpected change in the distribution of the fields over the various soil classes. The proportion of the costed acreage falling into the medium to heavy group, which accounted for 18·5 per cent. of the total area in 1927, was, in 1928, only just over 11 per cent. In view of the experience of 1927 and on account of the fact that sugar beet is undoubtedly more suited, at least so far as profits are concerned, to the less heavy soils, it seems reasonable that this decrease is only the reflection of a general movement throughout the whole country. Such a suggestion is strongly supported by the fact that the area under sugar beet in Essex decreased, in the same year, by no less than 47 per cent. while the acreage in Norfolk decreased by only 20 per cent. Consequently, also, the factory at Felsted, which had to rely largely on heavy-land beet, worked only 60 per cent. of the tonnage it handled last year, and this in spite of the increased yield per acre grown.

Fen and sewage soils together (they are not entirely dissimilar from the beet point of view) contributed approximately 25·3 per cent. and 26·7 per cent. of the costed sample in 1927 and 1928 respectively. This, again, appears to be representative of the general trend, for the official statistics suggest that the acreage under beet in the fens *as a whole* appears to have been maintained at its former proportion of the total area, although on the better class of fen, noticeably in Lincolnshire, there have been considerable reductions.

The dividing line between the very light and the light to medium soil classes is, perhaps, the least satisfactory of the several divisions. These two soil classes together accounted for approximately 56 per cent. of the acreage dealt with in the 1927 *Report* and represent nearly 62 per cent. of the present sample. It should be remembered that that particular type of the sandiest breck-land which made up most of the very light class in 1927 is not again represented.

There are exactly 90 fields in the light to medium soil class, 25 in the medium to heavy, 31 in the fen, 15 in the very light, and 12 in the sewage groups. The corresponding figures for last year were 86, 41, 38, 12 and 5. The average size of the fields in each soil class falls, with the exception of the sewage farms, into the same order as previously. That is to say that, as would be anticipated, the 15 fields in the very light soil class are the largest, with an average of 23 acres; followed by the fen with an average of 14 acres, the light to medium averaging just over 10 acres and the medium to heavy with approximately 9 acres per field. The average of the 12 sewage fields was nearly 9 acres, and the average of all fields together just under 12 acres. The following figures show the actual acreage concerned in each soil class for both years.

TABLE 4

SOIL GROUPING OF COSTED AREA

Year.	Light to medium.	Medium to heavy.	Fen, warp or silt.	Very light.	Sewage.	Altogether.
1927 ..	1076 acres	424 acres	516 acres	221 acres	66 acres	2303 acres
1928 ..	915¼ ,,	231 ,,	438¼ ,,	347 ,,	105 ,,	2036½ ,,
Difference ..	(−)160¾ ,,	(−)193 ,,	(−)77¾ ,,	(+)126 ,,	(+)39 ,,	(−)266½ ,,

The variations in washed yield between the soil groups fall into much the same order as in 1927, the principal difference being that the 1928 season was more advantageous, as compared with the previous season, to the heavier than to the lighter soils. Consequently, whereas the light to medium soil class returned a yield of nearly 12 cwt. per acre more than the medium to heavy class in 1927, in the 1928 season the difference in their favour was only 1 cwt. In other words, while the light to medium soils increased their yield by nearly 21 cwt., the medium to heavy soils improved their position by more than 31 cwt., and the average of both groups only falls short of 9 tons per acre by approximately 2 cwt. On the fen soils the very satisfactory yield of over 11 tons per acre represents an increase of 48 cwt. per acre on the 1927 figure, and the very light soil class shows an advance from under 4½ tons to nearly 7 tons per acre. As has already been mentioned, it is possible that the latter group is not, as a whole, so light as was the case in the previous year when it included a class of blown sand which, in one case at least, has not since been cultivated, and which was only brought under the plough in response to the 1924–27 contract prices for beet. This fact may account for part of the increase in yield evidenced by this class. There can be no doubt, however, that the light to medium soils suffered least on account of the abnormalities of the 1927 season. The light soils never recovered from the unusual conditions during the germinating period (it will be recalled that the rainfall in May, 1927, was only one-third of normal), and the heavier types suffered more from the excessive rains later in the season. Hence the improvement in yield in 1928 is least on the medium soils.

The sewage group actually records a decrease in yield, but it must be remembered that only two farms are represented in this class, and the reduction is entirely due to the unsatisfactory results on one of them. A comparison of the soil group results for the two years is made in the table below:—

TABLE 5

YIELD, SUGAR CONTENT, TARE AND POUNDS SUGAR PER ACRE IN DIFFERENT SOIL CLASSES IN 1927 AND 1928

Soil class.	Light to medium.			Medium to heavy.			Fen, warp, etc.		
Year	1927	1928	Diff.	1927	1928	Diff.	1927	1928	Diff.
Unwashed yield (tons)	9·430	9·988	0·558	9·261	10·132	0·871	10·411	12·432	2·021
Washed yield (tons)	7·862	8·904	1·042	7·282	8·853	1·571	8·670	11·077	2·407
Sugar content (%)	16·5	18·3	1·8	16·5	18·5	2·0	14·8	16·9	2·1
Tare (%)	16·3	10·9	5·4	21·5	12·2	9·3	16·4	11·0	5·4
Sugar per acre (lb.)	2914	3645	731	2719	3682	963	2895	4219	1324

Soil class.	Very light.			Sewage.			All together.		
Year	1927	1928	Diff.	1927	1928	Diff.	1927	1928	Diff.
Unwashed yield (tons)	5·171	8·115	2·944	10·855	9·489	1·366	9·352	10·185	0·833
Washed yield (tons)	4·439	6·931	2·492	8·959	8·581	0·378	7·711	9·035	1·324
Sugar content (%)	16·5	17·8	1·3	14·1	16·4	2·3	16·1	17·9	1·8
Tare (%)	14·6	14·1	0·5	17·2	9·7	7·5	17·3	11·4	5·9
Sugar per acre (lb.)	1654	2759	1105	2832	3145	313	2780	3624	844

The variations in the average sugar content which appear in the above Table follow closely the diversity which would be expected. Whereas in 1927 the very light, light to medium, and medium to heavy groups all gave the same result in this respect, during the last season there was a definite tendency for the heavier soils to yield the higher sugar content. Thus there is a difference of 0·7 per cent. between the medium to heavy and the very light groups, with the light to medium falling between the two. Although the sugar content of the fen soil beet averaged 16·9 per cent., or 1·4 per cent. below that of all the upland soils, this figure represents a considerable advance of no less than 2·1 per cent. on the previous year. The sewage farms, too, which again have the worst record in this respect, have improved by no less than 2·3 per cent. on the 1927 figure, and now show an average of 16·4 per cent.

It will be seen above that there was an over-all reduction from 17·3 per cent. to 11·4 per cent. in the tare, and, as would be expected, this reduction was greatest in the medium to heavy soil class, where the proportion of tare to total weight delivered, which in 1927 amounted to more than one-fifth, has fallen to less than one-eighth. With the exception of the very light group, the percentage tare is distributed over the various classes in the same order as last year, and as the nature of the soil would suggest. The fact that the tare in the very light soil class represents only a small reduction on last year and that it does not, as might be anticipated, amount to less than in any other group, is due to the inclusion of five fields on one farm which gave an average of 20 per cent., and can only be attributed to inefficient knocking and topping.

The combined result of the improved yield and the increased sugar content is strikingly reflected in the greater output of sugar per acre. Perhaps this is, under normal conditions, the acid test of production, and, when it is applied, the superiority of the fen soils, with an average yield of 4219 lb. per acre in 1928, is immediately apparent. It will be seen from Table 5 that this figure represents an increase of no less than 1324 lb. per acre on last year. The figures given in the same Table again illustrate that in the 1928 season the medium to heavy soil class was not at such a disadvantage as in the previous year. In fact, the difference in favour of the lighter soils, which amounted to 200 lb. per acre in 1927, has been rather more than cancelled on account of the improved sugar content obtained on the heavier soils. Here, also, the inferiority of the very light soils is again very marked, for although the 1928 yield of sugar represents an advance of 1105 lb. per acre on that of the year before, the average figure of 2759 lbs. per acre is only three-quarters of that for all other upland fields and less than two-thirds of the production in the fens.

Opinion as to the suitability of certain manures to certain types of soil is most strikingly illustrated by the case of artificial nitrogenous manures. No less than 70 per cent. of the upland fields were manured in this way while under 12 per cent. of the fen lands were similarly treated. Again, of the upland soils, it is noticeable that potassic manures have not been extensively used on the heavier land, for whereas 63 per cent. of the light to medium class

received this artificial in some form, only 25 per cent. of the medium to heavy was so dressed. Phosphates were more generally applied to the fen than to upland soils, and of the latter the very light group show a marked drop in the use of this type of artificial. Farmyard manure appears to have been used most commonly in the heavier soil class and least in the very light, but this latter fact is due largely to the extensive nature of sugar beet cultivation on the very light soils (one grower alone having 210 acres) which obviously makes it impossible to give a reasonable proportion of the crop a normal dressing of dung.

CHAPTER III.

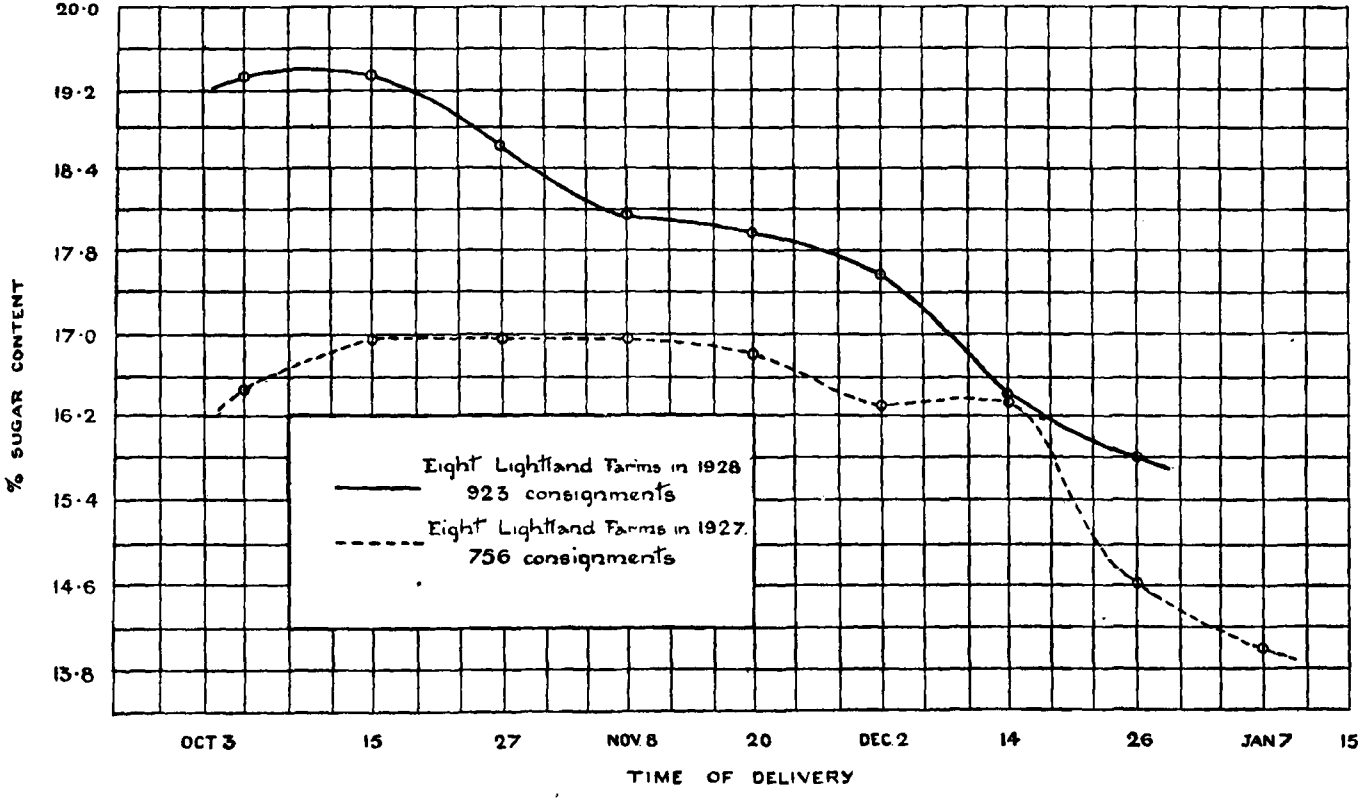
1. INFLUENCE OF TIME OF DELIVERY ON SUGAR CONTENT

THAT the time of delivery affects the sugar content of the roots is well known to every grower, and in the earlier *Report* considerable space was given to a discussion of the movements in sugar analysis observed during the 1927 lifting season. It was then pointed out, however, that as it is impossible to dissociate the effect of the time at which the natural process of ripening is interrupted from that of the weather conditions during harvesting, the rate and direction of fluctuations in sugar content would not be the same in two seasons. Thus it was anticipated that there would not necessarily be any close connection between the curves showing the average sugar content over the delivery period in different years, and this fact is well illustrated in Diagram II, which shows the fluctuations in the percentage of sugar in the costed beet at various dates during the lifting campaigns of 1927 and 1928. A closer analysis of the data for each month (made by considering the variations of each consignment about the weighted average of each field) brings out in detail certain finer movements which are not evident in the Diagram. Thus, in both seasons the sugar content increased rapidly until the first week of October, but whereas in 1927 it continued to rise at a more steady rate until the last week of the month, in 1928 it fell sharply by nearly 1 per cent. during the second week and remained fairly constant for the rest of October. A close connection is apparent between these fluctuations and the prevailing weather conditions during the two seasons. Thus in October, 1927, there was a dry spell lasting from the 3rd until the 20th, and the whole month experienced a below average rainfall, but in 1928 unusually dry weather conditions continued during September and the first seven days of October, while sufficient rain fell during the remaining three weeks of the latter month to bring the average rainfall for the whole actually above normal. These rains in October, 1928, were associated with unusual warmth, a combination of factors which stimulated secondary growth in the beet and brought about a reduction in the sugar content.

During the first half of November, 1927, the percentage of sugar showed a slight tendency to fall, and this movement became more pronounced as the month advanced, a fall of approximately 1 per cent. being recorded in the last fortnight. In 1928 the first ten days of November were rainless, and the detailed analysis shows a distinct rise at this point followed by a rapid fall of 1 per cent. as the sharp frosts in the second week became effective. December of both years showed a considerable fall in the percentage sugar content, but

DIAGRAM II.

Effect of Time of Delivery on Sugar Content in 1927 and 1928.



this came earlier in 1928 than it did in the previous season, on account of the spell of cold weather with frosts at the beginning of the month.

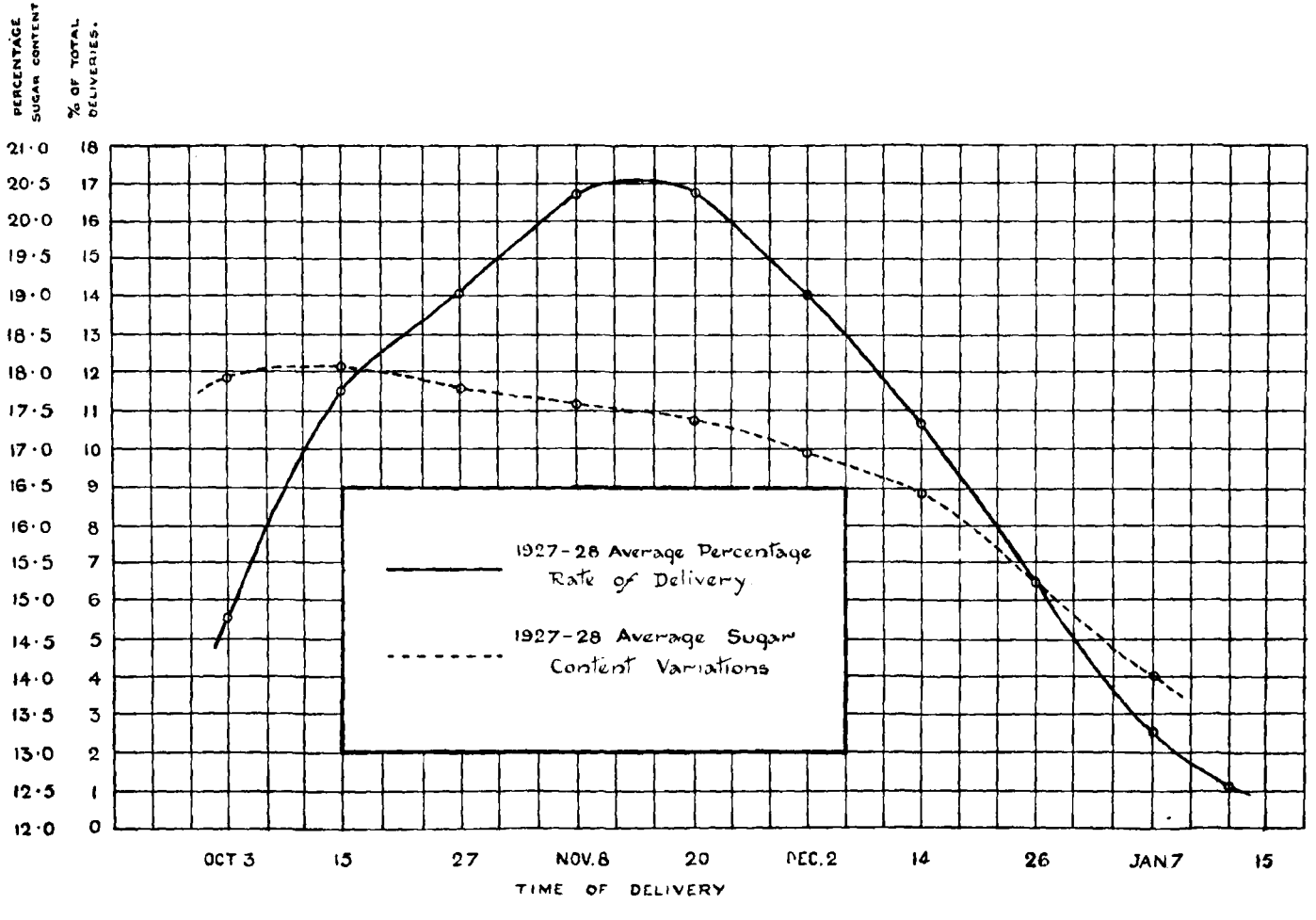
Since the time of the delivery of the beet has such a considerable effect on the sugar content, and consequently on the price per ton received by the grower, this factor is of some practical significance. The limits of the lifting season are determined by the factory operating campaign, and within this period weather conditions and the demands made by other essential autumn operations on the personnel of the farm, curtail considerably the elasticity of the growers' delivery dates. In addition, the factories have found it necessary to organise the despatch of consignments in a way which pre-determines to a great extent the period during which growers may lift their crop. The choice of this period is primarily left to the individual growers, but the factories necessarily reserve the right to make such adjustments as may be required to maintain supplies at a moderately even level.

Having considered the principal factors affecting the time of delivery of the beet and the movements in the sugar content, it may be of value to attempt to make some deduction which is of practical significance. A comparison of the rate at which delivery is proceeding with the movements in the percentage of sugar in the beet is illustrated in Diagram III, the curves being based on the average of the data for all the costed beet, amounting to over 40,000 unwashed tons, in the two seasons 1927 and 1928. It will be observed that the optimum sugar content, and therefore the highest price to the grower as well as the greatest percentage extraction by the factory, was reached by the end of the second week in October, but that delivery does not attain its maximum rate until just one month later. By this time the sugar content has fallen by nearly 1 per cent., and the price, at present rates, by 3*s*. 4*d*. per ton. Normally it would require an increase of quite half-a-ton an acre in weight to compensate for this reduction in the percentage of sugar, and whether such an increase does in fact take place would form an interesting line of inquiry. Doubtless much depends on the season, but it would seem that the greater the amount of autumn growth, the greater is the reduction in the sugar content, and it remains an open question whether it would not pay growers to push forward deliveries to an earlier date. Any change in this direction would seem to be welcomed by the factory authorities, who appear to have some difficulty in obtaining beet in sufficient quantities to enable them to work at full pressure during the early days of the campaign. Hasty judgment must not, however, be passed on the growers on this account, for it must be remembered that sugar beet lifting is only one of many operations which have to be performed at this time of the year. Nevertheless, an examination of the facts does suggest that, where it is possible, earlier lifting is worth serious consideration.

Statisticians occasionally embarrass scientific workers by demonstrating the unsatisfactory nature of the data on which conclusions are frequently based, and illustrating the extreme difficulty of eliminating the human factor. For instance, it is well known that individuals frequently exhibit a distinct

DIAGRAM III.

1927–28 average Sugar Content and Percentage Rate of Delivery during Lifting season.



preference for certain figures and an equal dislike for others.* Thus, it has been shown that even numbers, as well as 0's and 5's are commonly popular, while the figure 7 is usually distasteful to people making a number of observations. The data returned by several of the factories (probably those in which the majority of the percentages are read from the scale by the same observer) illustrate this point. In 1,000 readings it would be expected that, within the usual limits of the probable error of sampling, there would be approximately 100 analyses of whole numbers, 100 observations ending in ·1, 100 ending in ·2, and so on. A typical example is afforded by one factory. In 1,000 observations there is an excess over normal of 23 whole numbers, but the number of analyses ending in ·9 shows a deficiency of 18. There is also a slight shortage of ·1's, but it is evident that the excess of whole numbers is mostly due to this observer having a tendency to err on the lenient side and occasionally read, for example, 17·9 as 18·0. Similarly, the same factory's figures show an excess of 24 in the number of ·8's, but a deficiency of altogether 32 in the number of ·6's and ·7's. A few of these ·6's and ·7's have gone downwards to swell the ·5's, but the majority have, again to the growers' advantage, been read as ·8's. The excess in the number of ·3's, amounting to 12, have all, apparently, been drawn from the ·2's, which show a deficiency of the same amount, while the ·4's occur exactly 100 times.

If the analyses returned by a number of factories are pooled, the personal tastes of individual observers are, to a large extent, obscured, but another factor comes into operation. It is perhaps necessary to explain that in the analysis of the beet, the sugar content of a sample is finally read from a graduated dial. (The dial, which is usually black, the graduations being marked on it in white, is rotated to the appropriate position, when a fixed indicator points to the actual sugar percentage of the sample.) The scale from which the readings are taken is somewhat similar to, though smaller than, the $\frac{1}{10}$ inch graduations on the ordinary foot-rule. That is to say, the graduations at the whole numbers, and to a less extent at the ·5's, are longer than those at the intermediate tenths. It is well known that, in taking readings from such a scale, these longer graduations have an irresistible attraction for the unwary observer, and sugar percentage figures are no exception. In a sample of 6,680 sugar analyses there is an excess over normal of 240 whole numbers. That is to say, instead of 100, in every 1,000 observations there are 136 analyses of whole numbers. The ·1's, ·3's, ·4's and ·5's are all within a single observation per 1,000 of being normal, and the ·2's were only 5 in excess. The ·6's and ·7's, on the other hand, contribute equally to a total deficiency of 22 per 1,000 readings, and the ·8's and ·9's are below normal by 7 and 14 respectively. It is evident from this distribution that the excess of whole numbers has absorbed the entire deficiencies of the ·7's, ·8's and ·9's, while a few have been drawn from as far down the scale as the ·6's. Actually,

* See "On Reading a Scale," by G. Udny Yule, F.R.S., *Journal of the Royal Statistical Society*, 1927–28.

in practice, it is probable that the ·6's and ·7's have often been read as ·8's, but the ·8's and ·9's have still more frequently been read as whole numbers. In any case, the distribution suggests that, more often than not, the analyst has erred, in this respect, to the advantage of the grower.

2. WEATHER CONDITIONS

So great is the influence of weather conditions on the yield and sugar content of beet, as well as on the costs of production, that a short account of the principal features of the 1928 season, from the commencement of drilling until the end of delivery, is here given. This material has been kindly provided by C. S. Leaf, Esq., Meteorological Observer to the Department of Agriculture, and the details refer to the observations made by him at Cambridge.

April. While the temperature of this month was almost exactly normal, there was a deficiency of sunshine amounting to 56·8 hours, and of 0·52 inches of rain. Ground frosts were recorded on twelve nights and this represents average conditions, but the intensity of the frost on the night of the 18th, when 14 degrees were recorded, was unusual.

May. This month was cool, the mean temperature being 2·6° below normal, and there was no hot spell. Rainfall was 0·73 inches above normal owing to a fall of 0·62 inches occurring in a thunderstorm on the night of the 2nd. Sunshine was again below the average to the extent of 38·1 hours. Ground frosts occurred on five nights, this being one above normal.

June. This month was also markedly cool, the mean temperature being 2° below normal. Rainfall and sunshine were almost exactly average, and the distribution of rain was very even over the whole period.

July. This month was hot, the mean temperature being 2·1° above normal. The highest reading of the year, 87°, occurred on the 15th, and altogether maxima of over 80° were recorded on 12 days. The feature of the month as regards rainfall was an absolute drought, lasting 17 days, from the 9th to the 25th inclusive. In spite of this the rainfall was slightly above average on account of heavy falls on the 26th, 27th, 30th, and 31st, which together yielded 1·79 inches. Sunshine was greatly in excess, being above average to the extent of 78·5 hours.

August. The temperature was very slightly below normal, and there was a deficiency of 0·55 inches of rain. No rain fell from the 5th to the 13th inclusive. Sunshine was 14·9 hours above normal.

September. The temperature was 0·9° below normal owing to the nights being in general cloudless and cool. This month was unusually dry, there being a deficiency of rain amounting to 1·02 inches. No rain fell from the 29th of August to the 8th of September, and again none between the 10th and the 24th. Sunshine showed a large excess amounting to 59 hours.

October. This month was warm, the mean temperature being 1·5° above normal. Rainfall was 0·50 inches in excess, although none fell during the

first seven days of the period, but over the rest of the month the fall was very evenly distributed. There was again abundance of sunshine, amounting to 25·7 hours above the average. Ground frosts of slight intensity occurred on four nights.

November. Like October, this month was warm, the mean temperature being 1·8° above normal. Rainfall was, however, 0·24 inches below normal, the first ten days being quite rainless. For the sixth month in succession there was an excess of sunshine amounting to 12·2 hours. The severest ground frost, measuring 11°, occurred on the night of the 10th, and altogether only eight, or four below normal, were recorded.

December. The temperature was 1·3° below normal, and there was a slight excess of rainfall. The feature of the month was the large number of ground frosts, which were recorded on no less than 22 nights; or seven above normal. The severest was on the night of the 21st, when 21° were measured.

January, 1929. This month was unusually cold, the mean temperature being about 5° below normal. There was a slight deficiency of rainfall and ground frosts occurred on 25 nights. This was in fact the beginning of the prolonged cold spell.

TABLE 6

AIR TEMPERATURES RECORDED AT CAMBRIDGE DURING THE GROWING AND HARVESTING PERIOD.

Month.	Actual.			Normal.			Deviation.
	Max.	Min.	Mean.	Max.	Min.	Mean.	
April	54·5	38·7	46·6	56·6	36·8	46·7	−0·1
May	58·8	41·6	50·2	62·9	42·7	52·8	−2·6
June	65·9	47·2	56·6	68·5	48·5	58·5	−1·9
July	75·4	52·6	64·0	71·7	52·0	61·9	+2·1
August ..	69·6	52·2	60·9	70·8	51·4	61·1	−0·2
Sept.	67·6	44·4	56·0	66·3	47·4	56·9	−0·9
Oct.	58·5	43·3	50·9	57·2	41·5	49·4	+1·5
Nov.	52·5	37·2	44·9	49·6	36·5	43·1	+1·8
Dec.	43·4	31·7	37·6	44·6	33·2	38·9	−1·3

TABLE 7

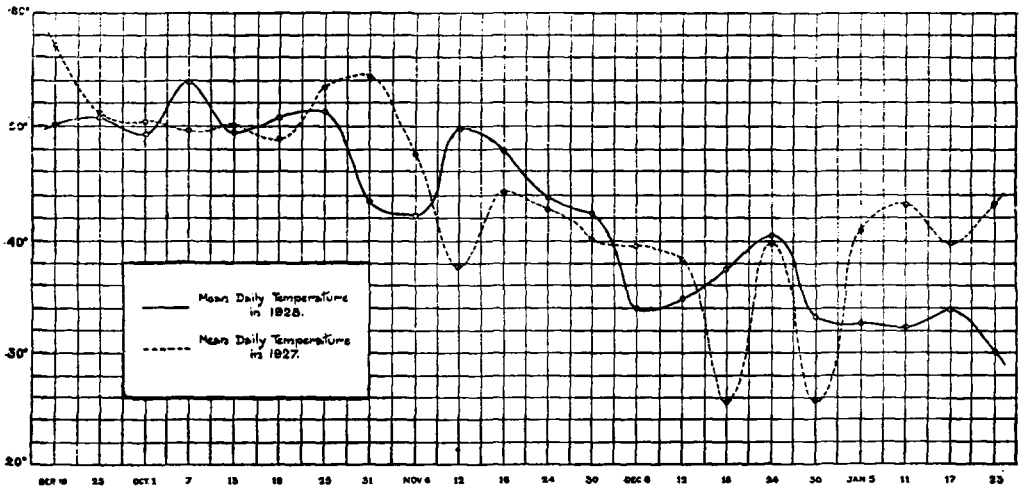
RAINFALL AND SUNSHINE RECORDED AT CAMBRIDGE DURING THE GROWING AND HARVESTING PERIOD

Month.	Rainfall (inches).			Sunshine (hours).		
	Actual.	Normal.	Devn.	Actual.	Normal.	Devn.
April ..	0·84	1·36	−0·52	109·1	165·9	−56·8
May ..	2·49	1·76	+0·73	164·0	202·1	−38·1
June ..	2·26	2·11	+0·15	201·9	201·0	+ 0·9
July ..	2·17	2·16	+0·01	280·6	202·1	+78·5
Aug. ..	1·80	2·35	−0·55	202·8	187·9	+14·9
Sept. ..	0·59	1·61	−1·02	209·9	150·9	+59·0
Oct. ..	2·86	2·36	+0·50	129·6	103·9	+25·7
Nov. ..	1·69	1·93	−0·24	74·3	62·1	+12·2
Dec. ..	2·03	1·93	+0·10	—	—	—

. Diagram IV shows in graph form the mean daily temperatures, grouped in six-day periods, as recorded at Cambridge during the 1927 and 1928 lifting campaigns. A comparison of these with the corresponding curves for the average sugar content (Diagram II) reveals a close relationship between the more marked fluctuations in temperature and the changes in the percentage of sugar in the roots. In 1928, for example, the rapid fall in temperature at the beginning of November, and again in the first week of December, was followed by a corresponding decrease in the sugar content of the roots lifted during these periods. Attention must also be drawn to the continuous above normal amount of sunshine lasting from June until November, and amounting in all to an excess of 191 hours. This is in striking contrast to the previous year, in which, during the same period, there was a deficiency of 104 hours. This difference of nearly 300 hours in the amount of sunshine recorded during the two periods cannot be dissociated from the marked difference in the sugar content of the beet grown during each year.

DIAGRAM IV.

Mean Daily Temperature as recorded at Cambridge during the Harvesting period in 1927 and 1928.



3. HAULAGE AND TRANSPORT

Throughout this investigation the term "Haulage" covers the operations of loading the roots in the field, carting them to the roadside, rail station or wharf as the case may be, and unloading. In "Transport" is included only the cost of carriage of the beet by road, rail or water from the loading station to the factory. Appendix A shows the road distances of each farm from the factories supplied, and the average of these is almost exactly 17 miles. This represents a decrease of nearly 4 miles on the previous year, a decrease which can be attributed mainly to the fact that many growers took advantage of the break in the contracts on the termination of the 1927 season to make new agreements with the nearer factories opened since their first contract was made. Thus, while in 1927, the costed farms were sending their beet to factories approximately $5\frac{1}{2}$ miles more distant than the nearest factory, in 1928 this discrepancy has been reduced to less than $2\frac{1}{2}$ miles.

By classifying the fields according to the means of transport employed (and excluding those which were conveyed to the factory in two or more ways) it is found that, in comparison with the 1927 season, the only significant alteration is a reduction of $8\frac{1}{2}$ miles, to an average of 19 miles, in the distance transported by rail. The average distances transported by road and water show little alteration from the previous year, the former having decreased by half a mile to $11\frac{1}{2}$ miles, and the latter increased by three-quarters of a mile to $12\frac{1}{2}$ miles. Such variations may be entirely due to the change in the sample.

A similar trend is exhibited by the average distance of haulage. Beet transported by road have again been hauled, on an average, rather less than a quarter of a mile, and those conveyed by water were hauled a little further in 1928 than in the previous year, but the only significant difference is the reduction of more than half a mile in the haulage distance of the beet transported by rail, which in 1928 amounted to an average of $1\frac{1}{4}$ miles.

The costs per *unwashed* ton of haulage and transport by road, rail and water are given in Table 8, together with the average haulage and transport distance. Those fields to which more than one method of transport was applied have been excluded from the calculation.

TABLE 8

COST PER UNWASHED TON OF HAULAGE AND TRANSPORT BY ROAD, RAIL AND WATER

	Method of transport.			
	Road.	Rail.	Water.	Over-all.
Haulage (including loading and unloading)	2/8¼	4 3¼	3/6¾	3/5¾
Transport	5/3¼	3 11¾	3/4¾	4/6¼
Total cost from field to factory ..	7/11½	8 3	6/11½	8/-
Average distance hauled (exclusive of return journey) in miles ..	0·23	1·29	0·66	0·72
Average distance to factory in miles	11·46	19·09	12·54	14·76

The cost of haulage per ton of beet transported by road shows a reduction of 3½*d.* on the 1927 figures, which may perhaps be attributed to the drier autumn weather and consequent better going in the 1928 season. Naturally this factor had more influence in the fens where adverse conditions can add so much to the cost of carting, and consequently the reduction under this heading for water-borne beet is nearly 1*s.* per ton. A decrease of the same amount in the cost of haulage of beet transported by rail is due largely to the reduction in the distance hauled. It is interesting to note that the saving in the cost of this last item is not proportional to the reduction in the haulage distance; the decrease in the length of the haul being 30 per cent., and the fall in cost only 20 per cent.

A reduction of 1*s.* per ton in the cost of transport by road must be attributed mainly to keen competition among contractors, while a rather smaller decrease in the cost of rail freight is accounted for by the substantial drop in the distance carried. The cost of water transport has increased slightly with the increased distance carried. The over-all result of these class variations is a decrease of 10*d.* per ton in both the cost of haulage and of transport, giving a total reduction of 1*s.* 8*d.* per ton.

In 1927 the average tare was 18½ per cent. on the beet transported by road and 15½ per cent. on the water-borne beet, while that on the rail-carried beet fell midway between the two. The same order is maintained in the present season, although, as would be expected, the variation is not so great. Thus the road, rail and water-carried beet contained 12 per cent., 11 per cent. and 10½ per cent. tare respectively in 1928. As explained in the 1927 *Report*, these variations may be due to the re-loading necessitated by rail and water transport, and to the tendency for the fen beet to come away cleaner.

In Table 9 are given the costs *per ton-mile* of haulage and transport by the different means. This calculation is again made on the *un-washed* yield.

TABLE 9

COSTS PER UNWASHED TON-MILE OF HAULAGE AND TRANSPORT BY ROAD, RAIL AND WATER

	Means of transport.			
	Road.	Rail.	Water.	Over-all.
Haulage (including loading and unloading)	11/8	3/3½	5/4¾	4/10¼
Transport	5½*d.*	2½*d.*	3½*d.*	3½*d.*
Total cost per ton-mile from field to factory	8¼*d.*	4¾*d.*	6¼*d.*	6¼*d.*

The very rapid decrease in the cost of haulage per ton-mile as the distance hauled increases is to be expected on account of the large proportion of the cost which represents loading and unloading. The cost per ton-mile of haulage on beet transported by rail is the only item exhibiting an increase on the 1927 figures, and this is entirely due to the reduced distance hauled. This has had the effect of increasing the over-all cost per ton-mile. As anticipated, the

cost of road transport has been slightly reduced, and is now at 5½d. per ton-mile, but this is more than off-set in the over-all average by an increase of a half-penny per ton-mile in rail transport. This latter change is again due to the decreased distance carried. It will be readily appreciated that the per ton-mile costs given in Table 9 are applicable only to the distances to which they refer, and that, for instance, water transport might appear cheaper than rail if the distance carried were the same.

Faced, as they thought, with a repetition of the shortage of supplies of beet which they experienced in 1928, a shortage which was largely responsible for the decreased profits many of them returned for that year, the sugar beet factories launched a scheme which is to apply to the 1929 crop, and by which they undertake to pay the rail freight over and above 8*s*. per ton on beet grown within certain scheduled areas. By this means it is hoped to widen the area from which supplies of beet may be forthcoming. It is doubtful, however, whether such a policy can be described as sound economics, and it is fortunate that the 1929 acreage has increased sufficiently to render unnecessary its extensive application. It was advertised that the motive behind the scheme was to give the farmers situated at a greater distance from a factory an opportunity to obtain immediate benefit from the sugar beet subsidy. But in this connection it must be remembered that the object of the subsidy was to establish a *permanent* industry in this country for the lasting benefit of the farming community in particular, and that this object is not advanced by the encouragement of sugar beet growing in areas beyond the economic limit of transportation. Even for the present, the benefit of this scheme to the more distant growers is doubtful, for in the majority of cases a transport cost of 8*s*. per ton is prohibitive to economic beet production. For example, if all the beet covered by the present enquiry had had to bear a freight charge of that amount, the cash profit would have been reduced by 35*s*. 6*d*. per acre, and a similar calculation for 1927 converts the cash profit for that year of 5*s*. 6*d*. into a cash loss of 25*s*. per acre. Further, there is a natural tendency for beet growing to become concentrated about the factories, for the more distant growers are the first to feel the effects of a reduced price. To illustrate this point attention may be drawn to the fact that, while in the 1927 investigation 23 per cent. of the fields bore a freight rate of 8*s*. per ton or more, in 1928 only 7 per cent. of the examples reached this figure. Also, in both years the proportion of cash losses recorded by the fields on which the freight reached 8*s*. per ton of beet was double that on the fields where this item was less costly.

The available figures suggest a distinct falling off in the proportion of beet transported by rail, with a corresponding increase in road transport. Thus rail transport was used on 54 per cent. of the farms reviewed in the 1927 *Report*, but only 44 per cent. of the present sample utilised this means of conveyance. Correspondingly, 48 per cent. of the growers, as against 38 per cent. in the previous year, delivered their beet by road. This suggestion is supported by the fact that the number of rail trucks unloaded by the Ipswich

and Cantley factories in 1928 represented a decrease of 30 per cent. on the 1927 figures, although the total tonnage of beet delivered to these factories fell by less than 20 per cent.* This decline in rail transport must be attributed to the, often heavy, expense of haulage from field to station. Road transport, on the other hand, does not entail such costly haulage to the loading station, which is usually adjacent to the field on which the beet are grown, and in many cases the re-loading which is necessary at the railway station is avoided. Thus many growers who are near enough to their factory to be able to take advantage of road transport have found it possible to continue to grow beet at a profit, while more distant growers, who are necessarily dependent upon rail transport, have been forced to give up on account of the high cost of haulage. It seems that, for those growers who make use of the railways to convey their beet to the factories, the cost of haulage is a more important item than the cost of transport itself, and, in fact, Table 8 shows the former to be the more expensive item.

Nevertheless, a very large proportion of growers find rail transport the most economical means of getting their beet to the factory, and no efforts should be spared in attempting to reduce the cost of haulage to the station. In this object the growers should find the Railway Companies willing co-operators, and, if a practical suggestion may be made, it is that elevated platforms should be erected in order to facilitate loading at those stations where they are not already in existence. The provision of more convenient loading facilities would make a substantial reduction in many haulage costs, and would add considerably to the attractiveness of rail transport. The prospect of transferring beet from the farm wagon to a rail truck which stands at an inconvenient elevation, must, in many cases, have been the cause of a decision to utilise road transport where it would not otherwise have been economical.

* At the recent Annual General Meeting of the Ely Factory the following figures were given as indicating the increase in road, and decrease in rail transport.

	1927		1928	
	Tons.	% of total deliveries.	Tons.	% of total deliveries.
Beet delivered by road ..	41,247	22·9	67,180	33·9
Beet delivered by rail ..	102,156	56·7	90,323	45·6
Beet delivered by water ..	36,742	20·4	40,622	20·5
Total beet delivered ..	180,145	100·0	198,125	100·0

The figures for the Lynn Factory are even more suggestive, for the proportion of beet delivered by road increased from 14·4 per cent. in 1927 to 44·2 per cent. in 1928.

CHAPTER IV.

1. OVER-ALL COSTS PER ACRE AND PER TON

IT is convenient to group the cost items together under certain broad headings, and the classification used in the 1927 *Report* has again been adopted. At the risk of redundancy the following explanation of the grouping is reproduced from the earlier publication :

"*Preliminary Cultivations*" includes all work done from the harvesting of the previous crop up to the time of, but not including, drilling the beet seed.

"*Seed, drilling and after cultivations*" includes the cost of seed, drilling, chopping-out, singling, hand hoeing, horse hoeing and odd work.

"*Manures*" includes the cost of all manures applied direct to the crop, *plus* the cost of carriage, carting, mixing and applying.

"*Harvesting*" includes lifting by machine, pulling, topping, lumping and haulage by farm wagon to road-side, railway station or wharf.

"*Overheads*" includes rent, rates and establishment charges. It should be noted that no allowance has been made for interest on capital or remuneration for the farmer's time as manager.

Further, it is perhaps advisable again to warn readers that on account of the different number of costs concerned, it must not be expected that the five items which together make up the farm cash cost will add up exactly to the figure given under that heading. Thus, in 1928 the information in respect of six of the costed fields is incomplete, but the over-all cost of each of the headings given above is based on the average of all those for which data are available. The discrepancy amounted, in 1927, to *plus* 9½*d.* per acre, and in 1928 to *minus* 9¼ per acre, so that the disparities almost cancel one another when the two years are amalgamated, but in the column showing the difference between the two years there appears to be an error of 1*s.* 6¾*d.*

Table 10 shows the component items in the cash and net costs per acre for both years, as well as the difference between the two years and the percentage of the total cash cost represented by each item. An examination of this table shows how small is the variation in the component items as well as in the total cost of growing sugar beet even in two such divergent seasons as 1927 and 1928. It is evident that the average cost of preparing land for sugar beet does not vary much from £2 15*s.* 0*d.* per acre. A still more extraordinary similarity is exhibited by the item "seed, drilling and after cultivations," where the variation between 1927 and 1928 only amounted to 2¼*d.* per acre. It is in "manures" that the greatest difference, just 10*s.* per acre, occurs, and this is due, as is shown on page 8, to the more extensive use of dung as a substitute for artificial manures. It seems probable that the first economy the

grower has made to meet the reduced contract price, has been to cut down his artificial manures bill, and this has been accompanied by a still further transference of farmyard manure from other crops to the sugar beet. The result has been a reduction in the *cash* outlay, but an actual increase in the cost of

TABLE 10

AVERAGE COSTS PER ACRE IN 1927 AND 1928

Year	1927		1928		Difference	
Number of costs	182		173		(−) 9	
Acreage	2303 acres		2036·5 acres		(−)266·5 acres	
Average washed yield ..	7·711 tons		9·035 tons		(+) 1·324 tons	
Sugar content	16·1%		17·9%		(+) 1·8%	
Costs	Per acre. £ s. d.	As a % of total cash cost.	Per acre. £ s. d.	As a % of total cash cost.	Per acre. s. d.	As a % of total cash cost.
Preliminary cultivations ..	2 13 5	12·6	2 15 9¼	13·1	(+) 2 4¼	(+)0·5
Seed, drilling and after cultivations	3 15 6	17·9	3 15 8½	17·7	(+) 2½	(−)0·2
Manures	4 13 8	22·2	5 3 8½	24·2	(+)10 0½	(+)2·0
Harvesting	4 19 9¾	23·7	4 12 0½	21·6	(−) 7 9¼	(−)2·1
Overheads	2 14 7	12·9	2 13 7	12·5	(−) 1 0	(−)0·4
Farm cash cost	18 16 2¼	89·3	19 1 6¾	89·1	(+) 5 4½	(−)0·2
Transport and Growers' Representative	2 5 2	10·7	2 6 10	10·9	(+) 1 8	(+)0·2
Total cash cost	21 1 4½	100·0	21 8 4¾	100·0	(+) 7 0½	
Residual values of manures and cultivations brought forward	17 2½		16 9¾		(−) 4¾	
Gross cost	21 18 6¾		22 5 2½		(+) 6 7¾	
Credit for tops and for residual values of manures and cultivations carried forward ..	4 15 10		5 0 3		(+) 4 5	
Net cost	17 2 8¾		17 4 11½		(+) 2 2¾	

the sugar beet crop, because the dung has cost more than the artificial manures it has replaced. The economy has therefore been made, not in the cost of the sugar beet crop, but in the production of those crops which would otherwise have received the dung.

An analysis of the manuring under the headings of "artificials" and "dung" reveals the fact that the "average" cost per acre of the former has fallen from £2 9*s.* 0*d.* to £2 5*s.* 3*d.*, while the latter has risen from an average cost of £1 10*s.* 10*d.* to £2 3*s.* 0½*d.*, and, of course, the cost of applying manures has risen from 13*s.* 10*d.* to 15*s.* 5*d.* per acre. This change is perhaps more clearly illustrated by the following table.

TABLE 11

ANALYSIS OF MANURING COSTS IN 1927 AND 1928

Year.	1927. £	s.	d.	1928. £	s.	d.	Difference. s.	d.
Cost of mixing, carting and applying manures		13	10		15	5	(+) 1	7
Cost of artificials	2	9	0	2	5	3	(−) 3	9
Cost of dung at 7/6 per load*	1	10	10	2	3	0½	(+)12	2½
Total	4	13	8	5	3	8½	(+)10	0½

The increased cost of manuring has been partly offset by a decrease of 7*s.* 9*d.* per acre in the cost of harvesting. This decrease is due mostly to a reduction of some 6*s.* in the cost of pulling and topping which for the 1928 season averages approximately £2 7*s.* 0*d.* per acre, and to a reduction of 2*s.* 6*d.* in the cost of carting which averages £1 15*s.* 8*d.* per acre. The cost of ploughing out the beet, where this was done, approximated 11*s.* 3*d.* per acre, or 9*d.* more than in 1927.

A somewhat unexpected result emerges when the cost of pulling and topping on those fields on which ploughing out was practised, is compared with the cost of the same item where the beet were not first loosened. Ploughing out does not appear to have reduced the cost of pulling and topping. This may be partly accounted for by the fact that it was mostly on the lighter and sewage soils that the beet were not ploughed out. The more extensive employment of beet raising implements in the 1928 season, in spite of a decrease in the proportion of heavy land, suggests that these are used more to facilitate pulling, rather than to economise in the cost of harvesting. In fact, up to the present, there has been little adjustment in lifting rates where ploughing out has been practised, and the cost of harvesting has, therefore, been increased by the full cost of this operation. It must be remembered that the reduction in the harvesting costs has been obtained in spite of a heavier crop, and therefore does not reflect fully the effect of the more favourable climatic conditions associated with the 1928 lifting season. On the other hand, it is probable that harvesting costs do not increase in proportion to an increase in the yield. The difference of 1*s.* per acre in the overhead charges is due, probably, to the reduction, already mentioned, in the proportion of fen costs.

The total result of these small variations between the 1927 and 1928 costs is an increase of 5*s.* 4½*d.*, to £19 1*s.* 7*d.* per acre, in the farm cash cost. The item "transport and growers' representative," which appears in the majority of cases as a deduction from receipts, has increased by 1*s.* 8*d.* per acre. This increase may not, at first sight, appear reasonable in view of the considerably increased yield, which, calculated on the basis of the 1927 figures would suggest a rise of 7*s.* 9*d.* per acre; but, as will be seen on page 27, the increase in the average tonnage carried is offset by a reduction in the average distance transported.

The increase in the total cash cost consequently amounts to only 7*s.* per acre, and a small reduction in the residual values leaves the gross cost with

* See *Report* No. 12, page 68.

an increase of nearly 6*s.* 8*d.* per acre. The credit allowances show an increase of 4*s.* 5*d.* per acre. This figure is the result of several complex changes. The allowance for the residual value of cultivations has increased only from 13*s.* to 13*s.* 10½*d.* per acre, but this is nearly offset by a reduction of 8½*d.* to 13*s.* 9*d.* per acre in the credit given for the after effect of artificial manures. On account, however, of the more extensive use of dung, the total residual values of all manures together has risen by approximately 5*s.* 5*d.* per acre. The total credit allowances also include the value of tops, and this item has decreased by approximately 1*s.* 10*d.* per acre, and now stands at an average of £2 11*s.* 2*d.* It may be asked why, when the yield of tops has decreased by nearly a ton an acre,* the value put on them has fallen only by 1*s.* 10*d.* It will be recalled, however, that a higher value is put on tops which are fed to stock than on tops which are ploughed in, and there has been a considerable increase in the proportion of tops used for fodder, and consequently an increase in the "average" value per ton.

The net result of all the above slight variations is an increase of only 2*s.* 3*d.* per acre in the net cost of growing the crop in 1928. Concisely, the only significant change is the increase in the cost of farmyard manure, due to heavier application; an increase which is largely offset by the decreased cost of harvesting.

TABLE 12

AVERAGE COSTS PER WASHED TON IN 1927 AND 1928

Year.	1927.	1928.	Difference.
Number of costs	182	173	(−) 9
Acreage	2303 acres	2036·5 acres	(−)266·5 acres
Washed yield	7·711 tons	9·035 tons	(+) 1·324 tons
Sugar content	16·1%	17·9%	(+) 1·8%
Costs.	Per ton. £ *s.* *d.*	Per ton. £ *s.* *d.*	Per ton. *s.* *d.*
Preliminary cultivations	6 11	6 2¼	(−) 8¾
Seed, drilling and after cultivations	9 9½	8 4½	(−) 1 4¾
Manures	12 1¾	11 5¾	(−) 8
Harvesting	12 11¼	10 2¼	(−) 2 9
Overheads	7 1	5 11	(−) 1 2
Farm cash cost	2 8 9½	2 2 3	(−) 6 6½
Transport and Growers' Representative	5 10¼	5 2	(−) 8¼
Total cash cost	2 14 7¾	2 7 5	(−) 7 2¾
Residual values of manures and cultivations brought forward	2 2¾	1 10¼	(−) 4½
Gross cost	2 16 10½	2 9 3¼	(−) 7 7¼
Credit for tops and for residual values of manures and cultivations carried forward	12 5	11 1	(−) 1 4
Net cost	2 4 5½	1 18 2¼	(−) 6 3¼

* See page 54.

In contrast to the component costs *per acre*, the costs *per ton* of beet produced in 1928 shown in Table 12 reveal an all-round reduction on the 1927 figures. This reduction amounts over all to a decrease of approximately 14 per cent., and is due chiefly to an increase of 17 per cent. in the yield. The largest reduction, amounting to 2*s.* 9*d.* per ton, is, of course, in the cost of harvesting, and represents a saving of 21 per cent. in this particular item. Manuring, on the other hand, which showed a substantial increase in the cost per acre, represented 8*d.* per ton less than in the previous year. The total *cash* cost per ton is reduced by nearly 7*s.* 3*d.* and the *net* cost by 6*s.* 3*d.*

It will be readily appreciated that the cost per unit of produce bears a closer relationship to profit than does the cost per acre grown, and, therefore, in comparing the costs of the two years Table 12 gives a more complete picture of the results obtained than does Table 10.

2. OVER-ALL RECEIPTS AND PROFITS PER ACRE AND PER TON IN 1927 AND 1928

The greatly increased yield and sugar content obtained in the 1928, as compared with the 1927, season resulted in an increase in the *gross* cash receipts,* amounting to £2 17*s.* 11*d.* per acre, or 13·6 per cent., and raises the contract price value of the crop to £24 4*s.* 9*d.* per acre in 1928 (Table 13). This has had the result of increasing the *cash* profit from 5*s.* 5½*d.* to the more satisfactory, but by no means excessive, figure of £2 16*s.* 4*d.* per acre. A small increase in the credits has raised the *net* profit from £4 4*s.* 1*d.* in 1927 to only threepence short of £7 per acre in 1928. Such a result suggests that, in 1928, sugar beet growing was not unsuccessful from a cash point of view, and, when full advantage could be taken of the by-products and consideration given to the residual values, the net result was very satisfactory. This position is in striking contrast to that of the previous year, and when the results of the two years are amalgamated the return can only be considered remunerative when compared with the profits accruing from other farm products at the present time.

The satisfactory result in 1928 was obtained in spite of a considerable reduction in the contract price. It is interesting to note, however, that the increased yield alone was rather more than sufficient (by 5*s.* per acre) to maintain the average gross cash receipts per acre at their 1927 level; consequently the improvement in profits is almost equivalent to that proportion of the increase in receipts which is due to the better sugar content of the roots. It is also interesting to note that the cash profit per acre would have been rather more than doubled if the 1924-27 contract prices had not been revised.

* i.e. the actual cash value of the crop before any deductions have been made for transport charges or growers' representative, or for any manures or seed which may have been obtained on credit from the factory, or any cash advances which may have been made.

TABLE 13

OVER-ALL RECEIPTS AND PROFITS PER ACRE IN 1927 AND 1928

Year.	1927.	1928.	Difference.
Number of fields	172	167	(−) 5
Average washed yield	7·711 tons	9·035 tons	(+) 1·324 tons
Average sugar content	16·1%	17·9%	(+) 1·8%
Costs and receipts per acre.	£ s. d.	£ s. d.	£ s. d.
Total cash cost	21 1 4½	21 8 4¾	(+) 7 0½
Gross cash receipts	21 6 9¾	24 4 8¾	(+) 2 17 11
Cash profit	5 5½	2 16 4	(+) 2 10 10½
Credit for tops and net residual values of cultivations and manures	3 18 7½	4 3 5¼	(+) 4 9¾
Net profit	4 4 1	6 19 9¼	(+) 2 15 8¼

Table 14 presents the information contained in Table 13 in a different form; that is, the results are shown per ton of beet produced instead of per acre grown.

In considering the profits as represented in this form, it must be remembered, however, that the full extent of the improved result is not illustrated; for the profit per ton tends, within the limits of usual farm practices, to increase more slowly as the yield per acre improves. Thus, the cash profit *per acre* in 1928 represents a greater percentage increase on the 1927 figure than does the cash profit *per ton*. It is interesting to notice that the system of averaging adopted has distorted the final figures so little that the average gross cash receipts per ton in 1928 differ by only one farthing from the contract price of a ton of beet at the average sugar content. A similar comparison cannot be made with the 1927 figures, as a uniform contract price was not then prevalent throughout every contract.

TABLE 14

OVER-ALL RECEIPTS AND PROFITS PER TON IN 1927 AND 1928

Year.	1927.	1928.	Difference.
Number of fields	172	167	(−) 5
Average washed yield	7·711 tons	9·035 tons	(+) 1·324 tons
Average sugar content	16·1%	17·9%	(+) 1·8%
Costs and receipts per ton.	£ s. d.	£ s. d.	s. d.
Total cash cost	2 14 7¾	2 7 5	(−) 7 2¾
Gross cash receipts	2 15 4¼	2 13 7¾	(−) 1 8½
Cash profit	8½	6 2¾	(+) 5 6¼
Credit for tops and net residual values of cultivations and manures	10 2¼	9 2¾	(−) 11½
Net profit	10 10¾	15 5½	(+) 4 6¾

But for the improvement in the sugar content of the roots, the cash profit per ton would have been reduced to almost half the very unsatisfactory 1927 figure; for the price of beet with a sugar content of 16·1 per cent. would have only exceeded the total cash cost of £2 7*s*. 5*d*. recorded in 1928 by 4½*d*. per ton. It will be noticed that the total net credits for tops and all residual values shows a reduction of 1*s*. per ton of beet from the former year; this is due entirely to the increased yield per acre of beet.

3. RESULTS GROUPED ACCORDING TO SOIL TYPE

Following the practice adopted in the earlier *Report*, the costs and returns given in the present volume have been grouped according to soil type, and the comparable analyses for both seasons are given in Tables 15 and 16. A consideration of the data contained in these two tables reveals many interesting facts, but it is only intended here to draw attention to the salient points.

It is, at first sight, surprising to find that in 1928 the cost of preliminary cultivations is less on the medium to heavy than on the light to medium soils, but a closer analysis reveals the fact that, while one quarter of all the fields were either subsoiled or broken up with steam tackle, the proportion of the heavier soil class on which this additional operation was performed amounts to only one in eight. Evidently, in an attempt to cut down their cultivational expenses, the heavier soil growers have given up deep cultivation, and by doing so have reduced their preliminary expenses below those of the lighter soil growers. That this has been a false economy is suggested by the results discussed on page 47. In the other soil classes the outlay on preliminary cultivational expenses falls into the anticipated order.

Although the average cost of the "seed, drilling and after cultivations" varies little during the two seasons, an analysis of the components of this item shows that a small economy has been made in the cost of hand hoeing in 1928, which, over the two years, averages £2 11*s*. 0*d*. per acre. An increase in the cost of drilling, due to several growers drilling both ways and other similar experiments, and a rise from 11*s*. 9*d*. to 12*s*. 9*d*. in the average cost of horse hoeing counterbalances this economy.

The increase in the cost of manuring is most apparent on the heavier soils on account of the fact that the increase in manuring with dung was heaviest in this group. Whereas 41 per cent. of the medium to heavy fields received farmyard manure in 1927, no less than 75 per cent. were so treated in 1928.

Harvesting costs show an all-round reduction, but while the light to medium group is less by nearly 5*s*. 6*d*. per acre, the medium to heavy soils show a reduction in this item of exactly 14*s*. The latter are still, however, nearly 9*s*. 6*d*. per acre more expensive to harvest than the former, in spite of the slightly lower yield. The very light class actually shows an advance of over 4*s*. under this heading, but this is not surprising when considered in conjunction with the 56 per cent. increase in yield in this soil group. On a per ton basis,

TABLE 15

AVERAGE COSTS AND RETURNS PER ACRE IN 1927 ARRANGED IN SOIL GROUPS

(As the cost *data* from some fields are incomplete, the number of items concerned with each individual cost average is shown)

Soil Group	Light to medium.		Medium to heavy.		Fen, warp and silt.		Very light.		Sewage farms.		Over-all.	
Costs and returns:—	Per acre.	No.	Per acre.	No.	Per acre.	No.	Per acre.	No.	Per acre.	No.	Per acre.	No.
	£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.	
Preliminary cultivations	2 14 2¼	86	3 1 1½	41	2 6 11	38	2 0 1½	12	2 12 0¾	5	2 13 5	182
Seed, drilling and after cultivations	3 13 9½	84	3 19 0¾	39	3 16 4¾	38	3 14 7¾	12	3 11 10	5	3 15 6	178
Total manures	5 9 11½	86	5 3 4¼	41	2 19 11½	38	3 10 5½	12	2 5 8¾	5	4 13 8	182
Total harvesting	4 17 6	83	5 15 7½	35	5 1 3½	37	3 9 4½	12	4 9 5½	5	4 19 9¾	172
Total overheads	2 10 4½	86	2 9 10¼	41	3 15 2½	38	1 17 0½	12	2 11 4¼	5	2 14 7	182
Farm cash cost	19 4 5½	83	20 10 9½	35	18 1 2¾	37	14 11 7¾	12	15 10 5¼	5	18 16 2¼	172
Transport and growers' representative	2 5 11	83	2 12 0½	35	2 0 9½	37	1 13 5	12	2 5 2¾	5	2 5 2	172
Total cash cost	21 10 4½	83	23 2 10	35	20 2 0¼	37	16 5 0¾	12	17 15 8	5	21 1 4¼	172
Gross cash receipts	22 3 3½	83	20 14 0¾	35	22 15 0	37	12 12 3¼	12	22 12 7	5	21 6 9¾	172
Cash — Profit	12 11	83	—	—	2 12 11¾	37	—	—	4 16 11	5	5 5½	172
Cash — Loss	—	—	2 8 9¼	35	—	—	3 12 9½	12	—	—	—	—
Residual values brought forward	16 0½	83	13 6¼	35	1 0 4	37	1 6 3	12	18 0	5	17 2½	172
Gross cost	22 6 5	83	23 16 4¼	35	21 2 4¼	37	17 11 3¾	12	18 13 8	5	21 18 6¾	172
Total credits	5 4 4	83	4 19 5	35	4 8 6	37	2 15 3½	12	4 1 2	5	4 15 10	172
Net cost	17 2 1	83	18 16 11¼	35	16 13 10¼	37	14 16 0¼	12	14 12 6	5	17 2 8¾	172
Net — Profit	5 1 2½	83	1 17 1½	35	6 1 1¾	37	—	—	8 0 1	5	4 4 1	172
Net — Loss	—	—	—	—	—	—	2 3 9	12	—	—	—	—
Distribution of *cash* profits (+) and *cash* losses (−)	+48 −35		+12 −23		+28 − 9		+ 2 −10		+4 −1		+ 94 − 78	
Distribution of *net* profits (+) and *net* losses (−)	+72 −11		+23 −12		+36 − 1		+ 3 − 9		+4 −1		+139 − 33	
Net cost — Standard deviation	3 10 10		3 7 1		3 6 7		3 13 6		2 12 2		3 12 4	
Net cost — Standard error of mean	7 9		11 4		10 11		1 1 2		1 3 3		5 6	

TABLE 16

AVERAGE COSTS AND RETURNS PER ACRE IN 1928 ARRANGED IN SOIL GROUPS

(As the cost *data* from some fields are incomplete, the number of items concerned with each individual cost average is shown).

Soil group:—	Light to medium.		Medium to heavy.		Fen, warp and silt.		Very light.		Sewage farms.		Over-all.	
Costs and returns:—	Per acre.	No.	Per acre.	No.	Per acre.	No.	Per acre.	No.	Per acre.	No.	Per acre.	No.
	£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.		£ s. d.	
Preliminary cultivations	2 18 2¾	90	2 15 5¼	25	2 10 3¼	31	2 11 5¼	15	2 17 8¼	12	2 15 9½	173
Seed, drilling and after cultivations	3 16 6	90	3 17 5¼	24	3 16 0¼	31	3 10 4½	15	3 11 7	12	3 15 8½	172
Total manures	5 12 8¾	90	7 6 4	24	3 9 5¼	26	3 13 9½	15	3 2 4¾	12	5 3 8½	167
Total harvesting	4 12 0¾	90	5 1 7½	24	4 18 11½	26	3 13 9	15	4 0 6¼	12	4 12 0½	167
Total overheads	2 10 5	90	2 10 4¼	24	3 15 10¾	26	2 1 10¾	15	2 9 11½	12	2 13 7	167
Farm cash cost	19 9 11¼	90	21 11 5¾	24	18 14 5¾	26	15 11 3	15	16 2 1¾	12	19 1 6¾	167
Transport and growers' representative	2 7 11¾	90	2 4 9¾	24	2 10 0¼	26	2 2 11¼	15	2 0 2¾	12	2 6 10	167
Total cash cost	21 17 11	90	23 16 3½	24	21 4 6	26	17 14 2½	15	18 2 4½	12	21 8 4¾	167
Gross cash receipts	24 8 8¾	90	24 16 7¾	24	27 17 6¾	26	18 9 1½	15	20 17 7	12	24 4 8¾	167
Cash — Profit	2 10 9¾	90	1 0 4¼	24	6 13 0¾	26	14 11¼	15	2 15 2½	12	2 16 4	167
Cash — Loss	—	—	—	—	—	—	—	—	—	—	—	—
Residual values brought forward	16 9	90	16 0½	24	17 3½	26	1 2 3¼	15	11 0	12	16 9¾	167
Gross cost	22 14 8	90	24 12 4	24	22 1 9½	26	18 16 5½	15	18 13 4½	12	22 5 2½	167
Total credits	5 1 5	90	6 1 5¼	24	4 12 11¾	26	4 3 11½	15	4 5 0¼	12	5 0 3	167
Net cost	17 13 3	90	18 10 10¾	24	17 8 9¾	26	14 12 6	15	14 8 4¼	12	17 4 11½	167
Net — Profit	6 15 5¾	90	6 5 9	24	10 8 9	26	3 16 7½	15	6 9 2¾	12	6 19 9¼	167
Net — Loss	—	—	—	—	—	—	—	—	—	—	—	—
Distribution of *cash* profits (+) and *cash* losses (−)	+62 −28		+14 −10		+25 − 1		+ 8 − 7		+ 9 − 3		+118 − 49	
Distribution of *net* profits (+) and *net* losses (−)	+76 −14		+21 − 3		+25 − 1		+13 − 2		+11 − 1		+146 − 21	
Net cost — Standard deviation	3 14 4		3 5 4		3 10 5		2 1 2		2 9 3		3 13 2	
Net cost — Standard error of mean	7 10		13 4		13 10		10 8		14 3		5 8	

therefore, it will be seen (Tables 17 and 18) that a substantial reduction has been achieved.

The overhead expenses are very similar in comparable soil groups for the two years. The only significant variation is an increase of nearly 5*s*. per acre in the very light group, which is a reflection of the already mentioned absence in the latter year of a type of soil which can only be described as heath land.

TABLE 17

AVERAGE COSTS AND RETURNS PER WASHED TON IN 1927 ARRANGED IN SOIL GROUPS

(As the cost *data* from some fields are incomplete, the number of items concerned with each individual cost average is shown)

Soil class:—	Light to medium.		Medium to heavy.		Fen, warp and silt.		Very light.		Sewage farms.		Over-all.	
Costs and returns:—	Per ton.	No.	Per ton.	No.	Per ton.	No.	Per ton.	No.	Per ton.	No.	Per ton.	No.
Preliminary cultivations	6/10¾	86	8/3¾	41	5/5	38	9/0½	12	5/9¾	5	6/11	182
Seed, drilling, etc.	9/4½	84	10/10¼	39	8/9¾	38	16/9¾	12	8/0¼	5	9/9¼	178
Total manures	13/11¾	86	14/2½	41	6/11	38	15/10½	12	5/1¼	5	12/1¾	182
Total harvesting	12/4¾	83	15/10½	35	11/8¼	37	15/7½	12	9/11¾	5	12/11¼	172
Total overheads	6/5	86	6/10	41	8/8	38	8/4	12	5/8¾	5	7/1	182
Farm cash cost	48/10¾	83	56/5	35	41/8	37	65/8¼	12	34/7¾	5	48/9½	172
Transport and G.R.	5/10	83	7/1¾	35	4/8½	37	7/6¼	12	5/0½	5	5/10¼	172
Total cash cost	54/8¾	83	63/6¾	35	46/4½	37	73/2½	12	39/8¼	5	54/7¾	172
Gross cash receipts	56/4½	83	56/10¼	35	52/5¾	37	56/10	12	50/6	5	55/4¼	172
Cash Profit	1/7¾	83	—	—	6/1¼	37	—	—	10/9¾	5	-/8½	172
Cash Loss	—	—	6/8½	35	—	—	16/4½	12	—	—	—	—
Residual values bt. fwd.	2/0½	83	1/10¼	35	2/4	37	5/11	12	2/-	5	2/2¾	172
Gross cost	56/9¼	83	65/5	35	48/8½	37	79/1½	12	41/8¼	5	56/10½	172
Total credits	13/3¼	83	13/7¾	35	10/2½	37	12/5½	12	9/0½	5	12/5	172
Net cost	43/6	83	51/9¼	35	38/6	37	66/8	12	32/7¾	5	44/5½	172
Net Profit	12/10½	83	5/1	35	13/11¾	37	—	—	17/10¼	5	10/10¾	172
Net Loss	—	—	—	—	—	—	9/10	12	—	—	—	—

The net result of these soil group variations is an increase in 1928 in the farm cash cost ranging from rather over £1 per acre on the very heavy, to 5*s*. 6*d*. per acre on the light to medium soils, but the totals fall into the same relative order of magnitude as in 1927. The cost of "transport and growers' representative" naturally follows closely the yield per acre, with the exception that the fen and sewage groups are inclined to be low on account of the utilisation of water conveyances. Thus, again, the total cash costs in the soil groups assume the same order as in the previous season.

The gross cash receipts in each soil class attest the combined results of the improved yield and sugar content with the reduced contract price. The most noticeable features are the improved position of the heavier soils and the very satisfactory result in the fen group. The results are reflected in the cash profits of the respective classes, and in the fact that in no class did the number

of cash losses exceed the number of cash profits. Actually, only one field in the fen group showed a loss and, over all the soils, more than 70 per cent., as compared with 55 per cent. in 1927, gave cash profits.

After adjustment has been made for the residual values of manures and cultivations, both brought forward and carried forward, and for the value of "tops," the net costs in the various soil groups show very little variation from those of 1927 and, consequently, the increase in the net profits in each class

TABLE 18

AVERAGE COSTS AND RETURNS PER WASHED TON IN 1928 ARRANGED IN SOIL GROUPS

(As the cost *data* from some fields are incomplete, the number of items concerned with each individual cost average is shown)

Soil class:—	Light to medium.		Medium to heavy.		Fen, warp and silt.		Very light.		Sewage. farms		Over-all.	
Costs and returns:	Per ton.	No.	Per ton.	No.	Per ton.	No.	Per ton.	No.	Per ton.	No.	Per ton.	No.
Preliminary cultivations	6/6½	90	6/3	25	4/6½	31	7/5	15	6/8¾	12	6/2¼	173
Seed, drilling, etc. ..	8/7¼	90	8/9	24	6/10¼	31	10/2	15	8/4¼	12	8/4½	172
Total manures	12/8	90	16/6½	24	6/3½	26	10/7¾	15	7/3½	12	11/5¾	167
Total harvesting ..	10/4	90	11/5¾	24	8/11¼	26	10/7¾	15	9/4½	12	10/2½	167
Total overheads ..	5/8	90	5/8¼	24	6/10¼	26	6/0¼	15	5/9¾	12	5/11	167
Farm cash cost ..	43/9¾	90	48/9	24	33/9½	26	44/10¾	15	37/6¾	12	42/3	167
Transport and G.R. ..	5/4½	90	5/0¾	24	4/6¼	26	6/2½	15	4/8¼	12	5/2	167
Total cash cost ..	49/2¼	90	53/9¾	24	38/3¾	26	51/1¼	15	42/3	12	47/5	167
Gross cash receipts ..	54/10½	90	56/1¼	24	50/4	26	53/3¼	15	48/8	12	53/7¾	167
Cash { Profit ..	5/8¼	90	2/3½	24	12/0½	26	2/2	15	6/5	12	6/2¾	167
Cash { Loss ..	—	—	—	—	—	—	—	—	—	—	—	—
Residual values bt. fwd.	1/10½	90	1/9¾	24	1/6¾	26	3/2½	15	1/3¼	12	1/10¼	167
Gross cost	51/0¾	90	55/7½	24	39/10½	26	54/3¾	15	43/6¼	12	49/3¼	167
Total credits	11/4½	90	13/8¾	24	8/4½	26	12/1½	15	9/11	12	11/1	167
Net cost	39/8¼	90	41/10¾	24	31/6	26	42/2¼	15	33/7¼	12	38/2½	167
Net { Profit ..	15/2¼	90	14/2½	24	18/10	26	11/1	15	15/0¾	12	15/5½	167
Net { Loss ..	—	—	—	—	—	—	—	—	—	—	—	—

represents approximately the amount by which the yield has improved. It will be noticed that the total credits in the medium to heavy soil class are £1 per acre above any other group and above the average of all soils together. This, of course, is due to the more extensive use of dung, half the cost of which is carried forward as unexhausted value. An examination of the average net profits in the various soil groups again emphasises the facts that the fen soils are specially suited to profitable beet production, and that, when compared with the previous year, the 1928 season was less severe to the least suitable types of soil.

In Tables 17 and 18 are given the costs and returns per ton of beet grown in 1927 and 1928 respectively. A comparison between the two years reflects largely the difference in yield, but the results are influenced by the changed contract price.

4. LABOUR COSTS

Because labour is by far the largest individual item of cost, and since the amount of labour employed in the production of sugar beet has been made a political question, it is interesting to analyse the figures available with a view to establishing the facts of the case. In the Table below are given the costs per acre of "total labour" during the two years 1927 and 1928.

TABLE 19

TOTAL LABOUR* COSTS PER ACRE

Year.	1927.				1928.				Difference.			
	£	s.	d.	No.	£	s.	d.	No.		£	s.	d.
Light to medium ..	10	17	0¾	83	10	16	10¾	90	(−)			2
Medium to heavy ..	12	11	7¾	35	11	7	6	24	(−)	1	4	1¾
Fen	10	16	8¾	37	11	0	10	26	(+)		4	1¼
Very light	8	17	2¼	12	9	8	6½	15	(+)		11	4¼
Sewage	10	4	11½	5	10	1	9	12	(−)		3	2½
All together	11	0	10¾	172	10	15	4¾	167	(−)		5	6

These figures represent actually the cost of all farm operations except manuring and therefore include, as well as man and horse labour, the cost of tractor and steam work. The average cost of these latter items amounts to approximately 6*s.* per acre, but the cost of applying manures over the two years adds a further 14*s.* 6*d.* per acre. Thus the sum of 8*s.* 6*d.* per acre (14*s.* 6*d.* less 6*s.*) must be added to the over-all average for both years of £10 18*s.* 2*d.*, which gives the cost of man and horse labour as £11 6*s.* 8*d.* per acre, or 53·3 per cent. of the total cash cost. These figures agree, within 2 per cent., with the results of a full cost investigation† carried out over four years and covering 41 separate costs in which the data are so arranged as to enable a more exact division between labour and other costs.

The results of the above-mentioned investigation suggest that, in the case of sugar beet, just 70 per cent. of the total labour costs is accounted for by manual labour. If this proportion is used in connection with the present costs it will be found that the cost of manual labour over the two years averages £7 12*s.* 8½*d.* per acre. This figure represents 36 per cent. of the total cash cost, and differs very little from the comparable figure for mangolds as shown in *Report* No. 12.

In the published results of the 1927 sugar beet crop an analysis was made which illustrated that the size of the field bore a definite relationship to the average labour costs. Table 20 shows that the 1928 results again evince the more economical use of labour on the larger plots of beet.

* These figures include the cost of all operations except manuring. They therefore include, as well as man and horse labour, an average of approximately 6*s.* per acre as the cost of tractor and steam work, but do not include an average of 14*s.* 6*d.* per acre for labour on manures. They are therefore an average of 8*s.* 6*d.* *below* the true total cost of man and horse work.

† See *Report* No. 12, "Four Years' Farming in East Anglia, 1923–7."

TABLE 20

INFLUENCE OF SIZE OF FIELD ON LABOUR COSTS

Year.	Size of field.	No. of costs.	lb. sugar per acre.	Labour costs per acre.	lb. sugar per £ labour.
1927	10 acres and under	50	3019	£11 3 8	270
	Over 10 acres	33	2755	£ 9 15 5	282
1928	10 acres and under	58	3751	£11 5 6	338
	Over 10 acres	32	3454	£10 1 3	359

This Table, which refers only to the light to medium soil class, also indicates that, while the yield per acre in pounds (lb.) of sugar is definitely larger on the smaller fields, the yield of sugar per pound (£) expended on labour is consistently greater on the larger fields. It is not improbable that the nature of the soil puts the larger fields at a disadvantage in this comparison, for there is a tendency for the larger fields to include the lighter soils (see page 13).

The results again show that, from the growers' point of view, the number of pounds (lb.) of sugar produced per pound (£) expended on labour is a more important criterion of production than the yield of sugar per acre since it bears a closer relation to profit. Table 21 shows the relation between the production of sugar per pound (£) labour and the net profit per acre for both years in the light to medium soil group.

TABLE 21

RELATIONSHIP OF LABOUR COSTS TO PROFIT

lb. sugar per £ labour.	1927. No.	1927. Net profit. £ s. d.	1928. No.	1928. Net profit. £ s. d.
Above 500	none	—	4	13 18 4
451 to 500	none	—	6	13 7 5
401 to 450	5	12 1 10	11	12 16 0
351 to 400	8	10 2 2	24	7 10 6
301 to 350	12	8 0 5	18	6 17 11
251 to 300	25	6 12 7	12	4 11 4
201 to 250	20	2 0 9	8	2 9
151 to 200	10	(loss) 1 9 9	6	(loss) 3 8 6
150 and under	3	(loss) 5 15 2	1	(loss) 7 1 2

It will be noticed that, where the sample is sufficiently large to be reliable, the yield of sugar resulting from expenditure on labour was greater in 1928 than in the previous year.

Before leaving the subject of labour costs it is of interest to examine the effect of experience on the incidence of this item. It will be noticed in Table 19 that the 1928 over-all cost of total labour represents a reduction of 5*s.* 6*d.* per acre on the 1927 figure, and this result is obtained in spite of having a much heavier crop.* This figure, however, does not state the whole case, for several

* The fen and very light groups show an increase which is entirely due to the greatly increased yield.

TABLE 22

EFFECT OF EXPERIENCE ON LABOUR COSTS

	Year 1925.			Year 1926.			Year 1927.		
Acreage grown	35½			58¼			85		
Costs per Acre.	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
Manual labour*	10	14	9	9	1	7	8	5	2
Horse, tractor and steam work	4	15	4	4	1	4	3	19	6
Total labour*	15	10	1	13	2	11	12	4	8

This considerable economy, amounting in total to £3 5*s.* 5*d.* per acre, can be attributed to two factors only, namely, accumulated experience in the more economical handling of the crop, and perhaps, to a less extent, more extensive production.†

* Exclusive of labour on manures.

† See page 43 of the 1927 *Report.*

CHAPTER V.

FACTORS AFFECTING COSTS AND RETURNS

IN the *Report* on the 1927 crop, certain analyses were made of the principal factors influencing the cost of production and the return per acre. It was emphasised then that the results could only be considered significant in so far as they applied to that individual season and those particular conditions under which the crop was grown. Similar analyses have been made of the results of the 1928 season in order to substantiate or disprove the conclusions arrived at in the 1927 *Report*. The dissimilarity of the two years cannot fail to add weight to those results which confirm the earlier findings, and should the same effect be apparent in the third, and final, year of investigation, their significance will be still further strengthened.

(a) *The Value of Farm-yard Manure.*

In analysing the results in such a way as to obtain an indication of the return resulting from the application of dung, the light to medium and medium to heavy soils have again been selected. As in the previous year, all fields which were subsoiled have been excluded from the analysis so that the results cannot be influenced by the effect that deep cultivation may have on yield. Table 23 gives the results of this analysis of the 1928 figures:—

TABLE 23

INFLUENCE OF FARM-YARD MANURE

	Average per acre figures.											
	Fields dunged.				Fields not dunged.				Difference.			
	£	s.	d.	No.	£	s.	d.	No.	£	s.	d.	
Cost of Manures	7	15	3¾	43	3	0	9½	36	4	14	6¼	
Gross Cash Receipts ..	23	19	11½	43	23	12	9½	36		7	2	*

It will be recalled that the 1927 analysis showed the increase in yield due to the application of dung to amount to rather less than half the cost of the dung plus the cost of applying it. The 1928 results put a still smaller value on the productive power of farm-yard manure, for the average gross cash receipts of the 36 undunged fields is less by only 7*s.* 2*d.* per acre than the average of the 43 dunged fields. The average cost of the dung has increased by 3*s.* 6*d.* per acre, due to a slightly heavier dressing, but that the increase in yield should be so small and so much less than in the previous year is more difficult to account for. It is not unreasonable to suppose that the great

* Standard error of this difference = £1 7*s.* 7*d.*

dissimilarity of climatic conditions was in part responsible and that, for instance, the heavier rainfall in 1927 resulted in the more immediate utilisation of the manurial ingredients of the dressing, and consequently the results of that year tended to accentuate its effects. On the other hand, the 1928 analysis may not be unaffected by the manures other than dung which were used. While the expenditure on other manures remains the same in both classes, in the undunged group five out of the 36 were limed, whereas only one of the dunged fields was so treated. While liming appears to have had no significant effect on the yield, there is no doubt that this fact would to some extent tend to neutralise the results of the application of farm-yard manure when compared with other fields. Further, investigation reveals that on a larger proportion of the undunged fields the beet were being grown after a fallow crop, and this again would militate against the fields which were dressed with farm-yard manure. While these factors undoubtedly contributed to the unexpectedly small margin in receipts existing between the dunged and undunged fields, they could not possibly account for the whole discrepancy, and the results add weight to the suggestion made in the 1927 *Report*, viz.: that no *apparent* advantage is gained by the use of farm-yard manure.

(b) *The Value of Subsoiling.*

Again only the light to medium and medium to heavy soils have been chosen for analysis, and the fields which received a dressing of dung have been excluded in order to eliminate any possible influence this may exert on the results. The following figures (Table 24) effect comparison between the subsoiled and the unsubsoiled fields in 1928.

TABLE 24

INFLUENCE OF SUBSOILING

	Average per acre figures.											
	Fields subsoiled.				Fields not subsoiled.				Difference.			
	£	s.	d.	No.	£	s.	d.	No.	£	s.	d.	
Cost of Preliminary Cultivations	3	3	2½	9	2	14	3	36		8	11½	
Gross Cash Receipts ..	25	5	6½	9	23	12	9½	36	1	12	9	*

The increase in the cost of preliminary cultivations is considerably less than was the case in the previous year, owing to the more common use of subsoiling attachments to the plough, which only necessitates an extra horse and dispenses with subsoiling as an operation by itself. There is also a smaller increase in the receipts per acre which can be attributed to the effect of subsoiling. The sample is, however, small on account of many of the subsoiled fields having been dunged and thus rendered unsuitable for inclusion in this analysis, but the results obtained in the next section add considerable weight to these findings. The fact that in both years subsoiling has resulted in an

* Standard error of this difference = £2 4*s.* 9*d.*

increase in receipts which is considerably above the additional expenditure incurred appears to suggest that its more widespread practice is desirable.

It is impossible to leave this subject without drawing attention to one particular case which does not fall into the above analysis, and demonstrates that the good effects of subsoiling are not confined to any particular type of soil. On one of the sewage farms six fields of beet were grown and four of them were subsoiled. These four gave washed yields of 9·829, 9·850, 10·809 and 11·229 tons, or an average of nearly 10½ tons per acre. The two unsubsoiled fields gave yields of 6·499 and 7·168 tons, or an average of less than 7 tons per acre. In other words, the gross cash receipts from the fields which were subsoiled exceeded those from the fields which were not subsoiled by almost exactly £9 per acre.

(c) *The Value of Subsoiling and Farm-yard Manure.*

A comparison of those fields which were both dunged and subsoiled with those which received neither of these treatments, again supports the results obtained from an investigation of each of these factors individually. The appropriate figures are given in Table 25, and again they refer to the average of the 1928 figures for the light to medium and medium to heavy soils

TABLE 25

INFLUENCE OF FARM-YARD MANURE AND SUBSOILING

	Average per acre figures.											
	Subsoiled and dunged.				Neither subsoiled nor dunged.				Difference.		
	£	s.	d.	No.	£	s.	d.	No.	£	s.	d.
Cost of Preliminary Cultivations and Manures ..	11	18	8¼	23	5	15	0½	36	6	3	7¾
Gross Cash Receipts ..	26	10	1¼	23	23	12	9½	36	2	17	3¾*

The increase in cost due to the combined use of farm-yard manure and subsoiling differs only by 4*d.* an acre from the comparable figure for the previous year, but, as was the case with the individual analyses of dunging and subsoiling, the increased return consequent upon the introduction of both these factors together was not so great in 1928 as in 1927. In fact, although the fields in the dunged and subsoiled group above do not appear in either of the separate analyses of dunging and subsoiling, the net results of these separate analyses together, agrees very closely with the result obtained in this combined analysis. Thus, in Table 23 the cost of dunging exceeded the immediate return by £4 7*s.* 4*d.*, and in Table 24 the return from subsoiling was greater than its cost by £1 3*s.* 10*d.*, so that, on this basis, the net result of dunging and subsoiling should be an immediate deficit of £3 3*s.* 6*d.* per acre (£4 7*s.* 4*d.* less £1 3*s.* 10*d.*). Actually, in Table 25, this sum appears as £3 6*s.* 4*d.* per acre (£6 3*s.* 7¾*d.* less £2 17*s.* 3¾*d.*), a figure which supports the former analyses.

* Standard error of this difference = £1 11*s.* 0*d.*

It has been suggested elsewhere that the nature of the 1927 season exaggerated the suitability or otherwise of certain soil types to the beet crop, and this also appears to have been the case with regard to the treatment of the crop. It would seem that more immediate benefit resulted from dunging and subsoiling in 1927 than was the case in 1928, and consequently, while in the former year the cost of these two treatments exceeded the immediate return by just £1 15*s.* 0*d.* an acre, in the latter year this deficit amounted to rather less than twice that sum. There can be little doubt, however, that the residual value of the farm-yard manure applied in 1928 was greater than that of the dung used in the previous year.

(d) *Influence of Preceding Crop.*

When, in the 1927 *Report*, the costs and returns of beet grown after a fallow or fallow crop were compared with those after a straw crop, it was found that the reduction in costs plus the increase in receipts demonstrated that the residual values after the fallow or fallow crops averaged £2 18*s.* 6*d.* per acre. An exactly similar analysis of the 1928 figures gives the very concordant result of £2 19*s.* 3*d.* per acre. In Table 26 are given the figures on which this result is based.

TABLE 26

INFLUENCE OF PRECEDING CROP

	Average per acre figures.											
	Beet after bare fallow or fallow crop.				Beet after a straw crop.				Difference.			
	£	s.	d.	No.	£	s.	d.	No.		£	s.	d.
Cost of Preliminary Cultivations	1	19	6½	22	3	5	7¾	60	(−)	1	6	1¼
Manures	5	9	3	22	5	16	2½	60	(−)		6	11½
Seed, Drilling, etc. ..	3	13	11¾	22	3	17	6½	60	(−)		3	6¾
Gross Cash Receipts ..	25	3	3¼	22	24	0	8	60	(+)	1	2	7¼*

The difference which exists between the results of the 1927 and 1928 analyses is that the latter show a greater saving in costs but a smaller increase in receipts. Thus, while in 1927 there was no saving in the cost of manures, or in the cost of intercultivations, in 1928 these amounted to 10*s.* 6*d.* an acre. This was anticipated in the 1927 *Report*, where it was suggested that in that year, in many cases where beet followed a straw crop, it was in the middle of the rotation, taking the place of a second straw crop. Consequently the cost of manuring and keeping clean was not so great as in those cases (which were more numerous in 1928), in which "beet after a straw crop" can be understood to imply beet grown after a complete rotation. This suggestion is supported by the analysis of the cropping data given on page 5, where it is shown that, with the lowering of the contract price the inducement to break rotations has

* Standard error of this difference ± £2 3*s.* 7*d.*

been lessened and sugar beet has assumed, since the 1927 season, a more normal position in the sequence of crops. How far this position will be maintained in 1929, when the results of the 1928 season seem to have re-awakened some of the enthusiasm which received such a setback by the experience of 1927, it will be interesting to follow.

That the results of two successive but very dissimilar years should show a difference of approximately £3 per acre in favour of beet after a fallow or fallow crop adds considerable weight to the system of assessing residual values which has been followed.

(e) *Influence of Rate of Seeding.*

The analysis of the yields on the light to medium and medium to heavy soils according to the quantity of seed drilled (which appears in Table 27) makes better comparison than was the case in 1927, because the date of drilling does not appear as a disturbing factor. This table does not include the cases in which a spacing drill was used.

TABLE 27

INFLUENCE OF RATE OF SEEDING

Rate of Seeding.	Less than 12 lb.	12 to 12·9 lb.	13 to 14·9 lb.	Exactly 15 lb.	More than 15 lb.
Number of Costs ..	7	17	20	35	29
Average date of Drilling ..	May 6	May 7	May 8	May 3	May 5
Tons Washed Yield* ..	6·220	7·687	8·196	9·519	10·052

It will be seen that the continuous increase in the yield as the rate of seeding is raised results in a difference of $3\frac{3}{4}$ tons per acre between the lowest and the highest groups. This variation is greater than that shown by the 1927 results, because in that year the heavier seedings included all the very late drillings, a fact which, as is shown below, tended to counteract the increased seeding rate.

It seems improbable, however, that the variation in the rate of seeding alone could be responsible for the difference of nearly 40 per cent. in the yield which is shown between the best and worst groups in the Table. Closer analysis reveals, as might be anticipated, that the heavier seeding rates are more common on those fields with narrower drill widths, and Table 29 in Section (g) of the present chapter illustrates that there is again a definite relationship between yield and the distance between the drill rows. This factor appears to be responsible for a difference of a ton in the yield between the extreme groups of "22 inches and over" and "19 inches and under." The average distance between the drills in each class in Table 27 varies from just over 19 inches on those fields which received more than 15 lb. of seed per acre, to rather more than 21 inches on the fields drilled with less than 12 lb. of seed per acre. This variation is not so great as that illustrated in Table 29 and would not, therefore, account for the ton difference in yield which is there

* Standard deviation of all 108 yields = 2·166 tons.

shown. There still remains, accordingly, a difference of some 3 tons per acre in the yield between the highest and the lowest seeding rate groups which can be attributed to no other cause.

The evidence in favour of an increased seeding rate, which is produced above for the second year in succession, supports strongly the demands of the factories that at least 15 lb. an acre should be used, and makes it difficult to understand why some growers are still little more liberal with their sugar beet seed than they are accustomed to be when sowing mangolds. This subject is again referred to on page 52.

(f) *Influence of Date of Drilling.*

In arranging the yields of fields on the light to medium and medium to heavy soil classes according to the date of sowing, the same divisions of the drilling period have been observed as in the previous year. Although this arrangement gives a somewhat uneven distribution of the sample (on account of the drilling period being almost a week earlier in 1928 than in 1927), it is necessary if comparison of the results of the two seasons is to be made.

TABLE 28

INFLUENCE OF DATE OF DRILLING

Date of Drilling.	Before 1st May.	1st to 10th May.	11th to 19th May.	After 19th May.
Number of Costs	27	34	18	6
Average Seeding Rate ..	15·1 lb.	14·5 lb.	14·2 lb.	13·8 lb.
Tons Washed Yield* ..	9·828	9·448	8·634	7·416

The difference of almost 2 tons per acre in the yield between those fields drilled before the 1st May and those drilled after the 19th of that month in 1927 has increased to nearly 2½ tons in 1928. It will be noticed that, contrary to the practice in 1927, the rate of seeding did not increase with the later drillings, but actually diminished. This probably accounts for the more rapid falling off in yield. On account of the uneven distribution of the fields over the various date groups, the whole sample was, with the object of verifying the above table, divided into two larger classes. Those 42 examples which were drilled on or before the 4th May gave an average yield of 9·6 tons per acre, and the remaining 43 fields on which sowing did not take place until after that date yielded 8·7 tons per acre.

It will be remembered that in 1927 there was practically no rain between the last week in April and the middle of May and that the earlier sowings consequently suffered from drought, while the later drillings experienced more normal circumstances. Somewhat similar, though less severe, conditions were experienced during the drilling period in 1928, and, in addition, the earlier sowings suffered considerably from the unusual intensity of the ground frosts at night. It is significant that, in spite of these adverse conditions,

* Standard deviation of all 85 yields = 2·262 tons.

during both years the earlier sowings gave considerably heavier crops than those fields in which drilling was delayed.

(g) *Influence of Distance between Drills.*

Attention is drawn elsewhere to the tendency for the drill width to be concentrated in the neighbourhood of 20 inches. The number of examples of this particular width in 1928 has increased at the expense of both the wider and the narrower sowings. The effect that this change is likely to have on yield is illustrated in the following table:—

TABLE 29

INFLUENCE OF DISTANCE BETWEEN DRILLS

Distance between Drills ..	19 inches and under	19½ to 21 inches	22 inches and over
Number of Costs	48	33	29
Sugar Content	18·5	18·2	18·2
Washed Yield per Acre* ..	9·374	8·806	8·403

The striking similarity between these and the corresponding figures for for 1927 can leave little doubt as to the reliability of the result. In both years there is a difference of approximately half-a-ton between the successive groups, the only diversity being that each of the yields in the present year are some 1¼ tons above the 1927 figures. It is hardly necessary to add that the slightly higher sugar content in the narrower drillings is not significant and was not apparent in the previous year.

In 1927, the difference in yield was equivalent, at the price then in force, to £3 6*s.* 3*d.* an acre, and during the year under review the comparable figure, at the present price, is shown to be £3 2*s.* 5*d.* This, of course, does not suggest an increase in profits to that extent, since lifting and transport charges will be increased, and it is reasonable to suppose that cleaning will be more difficult and consequently more costly in the case of the narrower drill widths. Examination of this latter point reveals this to be the case, for in 1927 horse and hand hoeing in the "22 inches and over" group cost some 8*s.* 6*d.* per acre less than the same operations in the "19 inches and under" class. In 1928 this difference amounted to 6*s.* There can be little doubt, however, that the increased yield outweighs, considerably, the higher cost and, in fact, the narrow sowings show an average cash and net profit of approximately £2 an acre greater than the wider drilled group.

(h) *Ridge and Flat Work.*

Out of the 15 fields in which the beet were grown on the ridge, 6 were in the light to medium soil class, and in Table 30 the costs and returns of these fields are compared with those for the remaining 84 of the same soil type.

* Standard deviation of all 110 yields = 2·177 tons.

TABLE 30

COMPARISON OF RIDGE WITH FLAT WORK

	Average per acre figures.		
	6 Ridged fields.	84 Flat fields.	Difference.
	£ s. d.	£ s. d.	s. d.
Preliminary Cultivations	3 1 5	2 18 0	(+) 3 5
Seed, Drilling and after Cultivations ..	3 12 6½	3 16 9½	(−) 4 3
Harvesting	3 18 4¼	4 13 0½	(−) 14 8¼
Total Labour and Seed	10 12 3¾	11 7 10	(−) 15 6¼
Washed Yield (Tons)	9·089	8·891	(+) 0·198
Tare	9·57 %	11·08 %	(−) 1·51 %
Sugar Content	17·8 %	18·3 %	(−) 0·5 %
Gross Cash Receipts	£24 4 11¼	£24 9 0	(−) 4/0¾

As in the previous year, the increased cost of preliminary cultivations was rather more than balanced by the savings in "seed, drilling and after cultivations." Both these items, however, show differences of approximately only half that which was apparent in 1927. The cost of harvesting again shows a substantial saving on the ridged fields, and all together the cost of total labour and seeds is 15*s.* 6*d.* cheaper than in the flat work group; a figure which compares with 12*s.* 1*d.* in 1927.

No significant difference is apparent in the yield of the two groups, for, in 1927, the fields on flat work gave the better result by rather more than the advantage which the ridged fields now appear to have. In the above table the average sugar content of the ridged fields is shown to be a half per cent. below that in the flat work group. It must be remembered, however, that the sample of ridged fields is small and examination indicates that they were, with one exception, lifted late in the season after the sugar content had commenced to decline. It is probable, therefore, that this factor influenced the result more than the fact that the beet were grown on the ridge. The net result of the increased yield and decreased sugar content is a drop of 4*s.* 0¾*d.* per acre in the gross cash receipts from ridged fields, and this reduces the cash advantage of this method of cultivation to 11*s.* 5½*d.* per acre. It will be recalled that the 1927 figures showed the advantage (6*s.* 3*d.* per acre) to be with the flat work and this result confirms the conclusion that, so far as costs and returns are concerned, there is nothing to choose between the two systems.

The average tare on the ridged fields was 9·57 per cent., as compared with 11·08 per cent. where beet were grown on the flat. This represents a saving in transport costs of proportionally the same amount as was the case in 1927.

CHAPTER VI.

1. PLANT POPULATION

A SECTION in the previous chapter examines the effect on yield of variations in the distance apart of the drill rows, and illustrates that the narrower sowings appear to have given the better results. From this it would seem that any increase in the size of the beet which may result from wider drilling is not sufficient to compensate for the reduction in plant population, and there are indications that, to some extent, the same suggestion may apply to the distance between plants in the row. With the object of obtaining data on this question, a number of fields were visited just before the 1928 lifting season commenced, and a census of their plant population was taken by counting the number of plants per chain. The sample consisted of 246 chain lengths, and was drawn from 40 separate fields under widely differing soil conditions.

It must be admitted at once that none of the figures obtained have any statistical significance.* Indeed, when it is realised that a single acre of beet with a distance between rows of 20 inches contains nearly five miles of drill length, and that altogether only just over three miles were measured and counted, the smallness of the sample will be realised. In addition there was often considerable variation in the number of plants per chain in the same field, and the figures in this section must therefore be studied only with a full appreciation of their statistical shortcomings. On the other hand, there is no reason to believe that the fields in which measurements were made were in any way exceptional, and, so far as observation can be relied upon, the separate chain lengths measured in each field were in no way abnormal.

The average number of plants per chain over the whole measured distance was 56·3, and this figure gives an average distance between plants of almost exactly 14 inches. On the same 40 fields the growers had aimed at obtaining an average plant to plant distance of 9 inches, so that the distance actually attained was more than half as much again as that which was intended. In other words, the figures suggest that these growers had approximately 12,500 fewer beet per acre than they designed. Ten of the 40 fields in which counts were made were on a fen or sewage soil, and, somewhat surprisingly, the number of beet per acre was only 350 less than on the upland fields. Such a difference is insignificant, and when it is considered in conjunction with the fact that the yield on these fields was approximately one ton greater than that on the upland fields, it would appear that the plant to plant distance is not the primary limiting factor in the size of the root.

* Mean number of plants per chain of all counts = 56·34 $\pm$ 0·407. Standard Deviation of all counts = 9·43 $\pm$ 0·288. Root Mean Square Deviation about field means = 6·28 $\pm$ 0·191

The figures obtained suggest that the number of beet per acre over the whole 40 fields averaged 22,402, but the field average varied from 13,607 to 30,288 plants per acre. Altogether, 11 fields gave a count of less than 20,000, while 13 exceeded 25,000 beet per acre. Independent investigators appear to have formed the opinion that 30,000 plants should be the aim of each grower. This figure must, of course, only be considered with a full appreciation of the numerous factors which influence it, but it provides a suitable basis for a comparison with the results actually achieved. To realise this ideal of 30,000 plants an acre the following approximate distances between the rows and the plants in the row must prevail, viz.: 22 in. by 9½ in., 20 in. by 10½ in., or 18 in. by 11½ in. Only two of the counted fields (both, it is of interest to note, situated on the same farm) attained even the widest of these plant to plant distances. It seems, therefore, that under present conditions a plant population of 30,000 per acre is a practical impossibility if the rows are 24 in. apart, for such a width demands a distance between the plants of 8·7 in.

It may be claimed that any increase in the present plant population might be accompanied by a reduction in the size of the roots, and consequently, that the yield would not be increased; although the operations of hoeing and harvesting would be rendered more difficult and costly. The data obtained do not, however, bear this out, for those 13 fields in the light to medium and medium to heavy soil classes which gave an above average plant population yielded 9·0 tons, while the 12 fields of similar soil texture, but with less than the average number of plants per acre gave an average yield of only 8·3 tons per acre. In addition, it has been established that there is a tendency for the larger roots, which might result from wider spacing, to give a lower sugar content. It is of interest to note that the average weight of the roots grown on the ten fen fields in which counts were made was approximately 1 lb., while the upland soil roots averaged only 10 ozs. each.

The question then arises as to how the plant population can be increased. The first suggestion is indicated by the result of the analysis made in section (*g*) of Chapter V, p. 49, where it appears that the narrower drillings gave a yield of approximately one ton more than the wider sowings. Had the distance between the rows on the 40 counted fields averaged 18 in. instead of 20 in., and the plant to plant distance remained the same, there would have been some 2,500 plants per acre more (say, approximately, a ton of beet). That increases of this nature do, in fact, take place is suggested by the figures given in section (*g*) referred to above. Any further increase in the number of plants per acre will probably have to be effected by a reduction of the distance between plants in the row. For example, a spacing of 18 in. by 12 in. will give over 4,000 more beet per acre than distances of 18 in. by 14 in.

The question then arises as to how far plant mortality after singling is responsible for the unsatisfactory plant to plant distance revealed by the figures given above. The counts on which this section is based were made in the month of September, and therefore represent the population at maturity.

A recent investigation by Mr. Engledow and his colleagues* has thrown some light on this question. Their enquiry covered six fields, and took the form of counts to ascertain the plant population before and after singling, and at intervals during the remainder of the growing season. The results ". . . clearly show that from singling in June to mid-August, loss of plants was negligible, while the count at lifting makes it clear that constancy of plant population was maintained to maturity." Attention may be directed, in passing, to the fact that the plant mortality was least in that field in which the rows were 18 in. apart, as compared with the wider drillings. Actually, the plant to plant distance increased by an average of $1\frac{1}{3}$ in. between singling and lifting. This suggests that the distance between plants in the row on the 40 costed fields in which measurements were made averaged more than 12 in. at singling.

Other conclusions based by Mr. Engledow on the results of his investigation are of interest here, and express succinctly the position. Speaking of the plant distribution *before* chopping out, he says: "It will be seen that on fields A, D and E at least 10 per cent. of row was entirely devoid of seedling plants, while the proportion of the field with 0 or 1 plant per foot was about 20 per cent. . . . It is important to bear in mind that within any one foot the plants were very irregularly distributed. Thus in a field such as E, with over 50 per cent. of the area having only from 0 to 4 plants per foot of row, the prospect of a reasonable approach to full plant at maturity was already wrecked before singling." The author supports the opinion that the unexpectedly wide average plant to plant spacing is due as much to the complete failure of the seedling plants at intervals along the row as it is to wide singling, and he traces this gappy distribution to the irregular deliveries of the drill. This, combined with the comparatively low percentage germination of sugar beet seed, often results in the seedling plant being unsatisfactory, even before chopping out is commenced. These investigators are of the opinion that a minimum of 17 lb. of seed per acre is necessary to overcome this primary defect, and such an interpretation of the results is the only explanation which can be given of the enormous influence on yield which the rate of seeding appears to have had in the costed fields (see Section (*e*), Chapter V, p. 47).

Doubtless a thick plant may result in singling being more troublesome and expensive, but it appears that any slight additional outlay in this direction is returned many times over by the increased yield obtained. It is sometimes suggested also that the difficulty of chopping out a thick plant results in the final distance apart being greater than where a thinner plant has made the work easier. Possibly this may be so in extreme cases, but these seldom arise, and the results obtained in the investigation already quoted do not bear it out. Table 31 is reproduced in a slightly modified form from Mr. Engledow's report. The figures refer to four separate rows, singled by the

* "Yield and Plant Population in Sugar Beet," by F. L. Engledow, M.A., and his collaborators. *Journal of Agricultural Science*, Vol. XVIII.

same workman, and suggest that satisfactory results of chopping out can only be obtained if the plant is reasonably thick. "But," the author remarks, "these average values are silent as to length-to-length irregularities of seedling population along one and the same row."

TABLE 31

PLANT POPULATION BEFORE AND AFTER SINGLING

Row number.	1.	2.	3.	4.
Average number of plants per foot before singling	8·6	6·0	5·9	4·3
Average plant to plant distance after singling	10·0 in.	9·6 in.	10·9 in.	11·7 in.

2. BY-PRODUCTS

It is obvious that the influence exerted on the farm supply of fodder for stock by the introduction of the sugar beet crop will depend on (*a*) the proportion of sugar beet grown, and (*b*) the position it occupies in the rotation. The former of these two factors itself depends largely upon the proximity of a factory, the convenience of transportation and the type of soil, but it also appears to be affected by the size of the farm. Those 52 costed holdings which were less than 250 acres in extent had an average of nearly 20 per cent. of their arable land under sugar beet in 1928, while the corresponding figure for the remaining 48 larger farms is comparatively low at 11 per cent. In all probability, therefore, the organisation of the farm has been affected most on the smaller holdings, and, in fact, enquiry supports this suggestion. Replies to a circular letter on this subject were received from 80 costed growers, only nine of whom complained of a shortage of "keep" as a result of growing sugar beet, and seven of these fall into the smaller holding group.

The evidence examined in Chapter II suggests that the 1928 sugar beet crop occupied a more normal position in the rotation than did its predecessor. There is no reason to doubt that conclusion, and it follows that, in all probability, sugar beet replaced other roots or fallow crops more often in the year under review than it did in 1927. The circular letter referred to above obtained information on this point, and the average of all the replies shows that the introduction of sugar beet on these farms has resulted in a reduction of exactly one-third in the acreage under other roots and fallow crops. The average, however, does not give a true picture of the position, for in one quarter of the examples sugar beet was grown *in addition to* the usual acreage of roots, while, at the other extreme, in an even larger proportion of cases the customary root or fallow area was at least half occupied by this crop. The extent to which sugar beet has replaced other roots or fallow crops appears to depend largely on the amount of beet grown. Thus, on the 20 farms on which sugar beet represented a complete addition to the root shift, it occupied less than 9 per cent. of the arable land; but where it was substituted for half or more of the usual acreage of other roots it occupied over one-fifth of the total arable land.

The area of sugar beet grown exceeds the reduction indicated above in the acreage of other roots and fallow crops, and it is interesting to enquire the extent of the consequential increase in the total fallow shift. It seems that, on the 80 farms under consideration, approximately half the sugar beet acreage fell into the usual root or fallow course in 1928. This figure was obtained in answer to the question: "To what extent, if any, has sugar beet taken the place of other roots or fallow crops on your farm?" and it is supported by the other particulars given. Thus, sugar beet alone occupied 12·7 per cent. and other roots and fallow crops 18·7 per cent. of the arable land. Hence the normal proportion of the root shift on these farms before the introduction of sugar beet appears to have been 25 per cent. of the arable land (18·7 per cent. plus half 12·7 per cent.), and this is not an unreasonable figure in view of the fact that a number of them are situated in potato growing districts. Again, however, the average is misleading, for, as previously stated, half the farms are divided equally between the practices of growing sugar beet completely within or completely in addition to the usual root shift.

It would appear from the above that there has been an average reduction of approximately one-third in the acreage of roots, or fodder crops of a similar nature, on account of the introduction of sugar beet; but for each acre which has been replaced, there are now grown two acres of sugar beet. Where sugar beet has replaced a straw, rather than a root, crop several of the smaller farmers, who grow a comparatively high proportion of beet, complain of a shortage of straw; but it is more often the supply of succulent fodder which has been affected, and the amount of compensation derived from beet growing depends on the extent to which "tops" and pulp are used. These two by-products must be considered separately.

(a) *"Tops"* (in which are included the "crown" and the leaves).

In spite of the heavier yield per acre of roots in 1928, the average estimated yield of "tops" is nearly one ton per acre less than in 1927. This reduction is principally due to the decreased weight of "top" produced on the light to medium soils. The medium to heavy class shows a small reduction and the sewage farms a substantial increase. The increase in the very light group is largely due to the modified nature of the soils it includes (see p. 13). The estimated yields for each soil class are given in Table 32.

TABLE 32

WASHED YIELD OF ROOTS AND ESTIMATED YIELD OF "TOPS" IN EACH SOIL CLASS IN 1927 AND 1928.

	1927.		1928.	
	Tops.	Washed roots.	Tops.	Washed roots.
Light to medium	9·0 tons	7·9 tons	7·4 tons	8·9 tons
Medium to heavy	8·3 tons	7·3 tons	8·0 tons	8·9 tons
Fen, warp and silt ..	10·9 tons	8·7 tons	10·0 tons	11·1 tons
Very light	4·4 tons	4·4 tons	7·2 tons	6·9 tons
Sewage	9·0 tons	9·0 tons	10·0 tons	8·6 tons
Over-all	8·9 tons	7·7 tons	8·1 tons	9·0 tons

This table suggests that, in 1927, the average yield of "tops" substantially exceeded the average yield of washed roots; but in 1928 the position was reversed, and, taking the two years together, the weight of "tops" and roots appears to have been approximately the same, except on the fen and sewage soils, where the "tops" are rather heavier than the roots. The use to which "tops" are put is, therefore, a subject which is worth considerable attention.

It must be admitted at once that in many cases sugar beet tops can be of little or no value for feeding, as they are not required, and they cannot be marketed.* To a less extent the same is sometimes true of their manurial value, and in such cases sugar beet must be judged solely on its cash return compared with other cleaning crops. The majority of growers, however, are in a position to make use of the "tops," and each year a larger proportion are beginning to rely upon them to fill in a gap in the supply of fodder. Evidence of this is provided by the costed fields, for the proportion on which the "tops" were ploughed in was reduced from nearly 60 per cent. in 1927 to exactly one-third in 1928. Consideration was given to the manurial value of this by-product in the 1927 *Report*, and it is not now intended to enlarge upon that subject, but to supplement the section (p. 9 of the earlier *Report*) which dealt with "tops" from a feeding point of view. It must not be forgotten, however, that in whatever way "tops" are fed to stock, a considerable proportion of them is trampled in or left on the field, while part is rendered unpalatable by the large amount of earth which adheres to the leaves. In the 1927 *Report* it was suggested that perhaps one-third of the "tops" is unconsumed on this account, and, therefore, can only be considered to have a manurial value.

Up to the present, those farmers who have fitted sugar beet "tops" into their general scheme of feeding have, in most cases, found them useful as autumn fodder, coming in before their mangolds have matured. On the costed fields, in both years, the greater part of the feeding took the form of sheep folding. Some growers make a practice of buying in sheep at the summer lamb sales, to be run on grass and finished off on "tops," with a little cake, for winter mutton. Where sugar beet does not represent a complete addition to the fallow shift, it has often taken the place of turnips or kale; where the acreage under fallow crops has been substantially increased a few farmers have experienced a shortage of labour. In the latter case, one or two growers have substituted ensilage crops for mangolds "in order not to disorganise labour," and recently one or two have gone a step further and made the ensilage from sugar beet "tops." This has made possible the partial substitution of mangolds by sugar beet. A visit to the Continent, where the ensilage of "tops" is a common practice, encouraged the adoption of this system among those who saw it in practice; and because it might

* This statement is not true in every district, for at least two cases were recorded during 1928 where the "tops" were sold. On one farm a considerable acreage was sold for folding at £2 per acre, subject to a discount of 5*s*. if cake was fed. On the other the price, also for folding, was £1 per acre, with a condition that cake should be fed.

profitably be extended, there are given here the experiences which two growers have kindly contributed.

"In 1927 I had more 'tops' than I could conveniently use green, and therefore made ensilage of about seven acres. The method employed was the same as that used in making a manure hill: a bottom was made of the 'tops' and the remainder were carted on to it. Eventually, when the heap became too high for carting, the ends were cut down and thrown up, shaping it like a mangold clamp. Subsequently, the hill was ploughed round and banked up with earth and a covering about one foot deep thrown on the top.

"When the clamp was opened there was a wastage of about eight inches at the sides and on top, and for this reason it would not be worth while making silage in this way from less than five acres of 'tops.' Some of the silage was used in the spring, and the remainder in July, when there was a shortage of keep. At the later date it had not apparently deteriorated, and proved a most valuable stand-by, allowing the maximum amount of stock to be kept without danger of a shortage of keep. The silage was thrown out to dairy cattle on grass, and, although I never exceeded 20 lb. per head per diem, I believe it could be fed without ill effects in much larger quantities if it could be made free from dirt. For this purpose I intend in future to heap the 'tops' as the beet are pulled, and to scrape the cart wheels as each load goes on the hill.

"The silage was fed after kale in the first place, and later after tares, but the cattle relished it. In fact, when tares and silage were being fed together most of the cows left the tares (admittedly rather old) for the silage. At both periods when it was tried there was no falling off in the milk yield, or in the condition of the cows. I tried putting layers of wet pulp on part of the hill, but the cattle did not take to it so well, and next time I propose putting in layers of oat straw. This should still further decrease the proportion of grit and consequently remove the danger which is attached to feeding large quantities of dirty 'tops.'"

Another grower writes: "The silage was made at the end of December, 1928, after sugar beet loading had finished, in a pit measuring 15 yards by 3 yards, and being about 3 feet deep. A drain was provided into a near-by ditch. Six or seven acres of 'tops,' which had, until then, been used to cover the beet, were carted in, being stamped down in the process, as in making a manure hill. The middle of the heap was left high by throwing up the last few loads, and the whole was earthed up, on the following day, like a mangold clamp, but without straw. More soil was added later as the clamp settled.

"I started to use the silage in the middle of February when frost affected the kale I was then feeding. It was cut up with an old stack knife and thrown out on to the meadows. My cows and store cattle took to it at once, in spite of a somewhat unsavoury smell, and although they were offered good hay at the same time. The cows cleared up about half a hundredweight a day each, and gave rather more milk than while they were on the marrow-stem

kale. They appeared to prefer this to clamp-silage of tares, clover etc., which had been fed in the previous years.

"There was really no waste at the pit, and beyond being compressed the 'tops' had altered little in appearance. On exposure to the air, however, they soon turned dark in colour, but the stock did not object to this, even although the silage for Sunday was thrown out on Saturday. The clamp was finished about the middle of April, no ill-effects being noted at any time, and my impression was that the silage would remain good for some considerable time, if not required for immediate use. This, undoubtedly, is a very useful feed, especially in frosty weather, and quite takes the place of anything which is usually thrown out for stock to pick up. In my opinion this is the most profitable use to which 'tops' can be put when not fed or carted off the field during lifting."

If the experiences of these two growers are to be summarised, the following points may be picked out: sugar beet "tops" make very good clamp silage, and, as such, will keep for a considerable period; stock relish them, and they may be fed in reasonable quantities without ill-effects; every endeavour should be made to free them from dirt, and there appears to have been less wastage in the pit than in the built-up clamp. It should be noted, however, that both growers make silage of the "tops" *which cannot be fed at lifting time.* To include all the evidence as to their feeding value while fresh is, perhaps, unnecessary, as their worth appears to be generally accepted.

(b) *Pulp.*

It has been previously emphasised that, in the opinion of the investigators, if the sugar beet industry is to withstand the reduction in, and ultimate withdrawal of the temporary support given by the Subsidy Act of 1924, the growers, on the one hand, should cease to demand a *cash* profit on the crop, and the factory shareholders, on the other, must learn to regard it as a steady investment rather than a speculative adventure. It is too much to hope that such a view of the industry will spread more than slowly, but, in the absence of further fiscal support or a considerable alteration in the position of the sugar trade, the future of the crop in this country would seem to depend largely on the adoption of some such attitude. There is ample evidence that the growers are beginning to contribute their share to this psychological atmosphere. The following is part of a letter received from a small farmer. Space permits only one instance being quoted here, but a similar view is now very prevalent among growers. When forwarding the factory advice notes he says: "You will see that I did not have a very heavy crop, but, as this field was in a poor condition . . . I think that, if the beet will pay expenses, I shall be much better off than if I had fallowed it, as I consider the field to be in about the same condition as if fallowed. . . ."

In addition to the "tops," it is open to sugar beet growers to make good any loss of "keep," which may result from a reduction in the acreage of other

root or fallow crops, by the purchase of pulp. Their contract allows growers to buy back at a pre-arranged price pulp to the amount of 5 per cent. of the total weight of washed beet delivered to the factory, and a larger proportion of them are exercising this privilege each year. Of the costed growers, 82 per cent., as against 53 per cent. in the previous year, used pulp in 1928. That this is the general trend is supported by the official figures which show that, of the total dried pulp produced, 60 per cent. was sold for export in 1926, 24 per cent. in 1927, and less than 10 per cent. in 1928. But the increase in the *proportion* retained in this country does not give a complete picture of the greater *amount* consumed at home on account of the largely increased production.

It is suggested that the grower should regard the crop, not as yielding so much *cash* profit or loss, but as a means of producing so much fodder at such and such a cost and at the same time improving the condition of the land; in other words, that he should look at it from the same point of view as he has learned, for example, to look at mangolds. If full use is to be made of the by-products produced, the allowed proportion of pulp must be purchased, and its price added to the other costs of production. (For this purpose the grower's quota of pulp is regarded as the yield of his crop, while purchases in excess of the allowed 5 per cent. are looked upon as ordinary bought foods. Actually, however, the yield of pulp normally exceeds 5 per cent. of the washed weight of the roots.) This adjustment is not necessary on the Continent, where pulp is regarded, in the majority of cases, as the growers' perquisite, and no charge is made for it.* But in this country one hundredweight of pulp for every ton of washed roots delivered to the factory can be bought back at an average price of 5*s.* per cwt. Adding this sum to the over-all cash cost of 47*s.* 5*d.* per ton (see Table 18) gives a "total" cash cost of 52*s.* 5*d.* The over-all gross cash receipts were 53*s.* 8*d.* per ton, which leaves an average cash balance of 1*s.* 3*d.* per ton, or 11*s.* 2*d.* per acre, to be added to the real profit of 8 tons of "tops," 9 cwt. of pulp and an acre of land brought into good condition. A similar calculation for 1927 shows that 9 tons of "tops," 8 cwt. of pulp and the fallowing of an acre of land cost, over-all, £1 13*s.* 1*d.* The following tables show the 1927 and 1928 results re-calculated on this basis for each soil class. It must be remembered that, in addition to the returns shown in these tables, an acre of land was fallowed.

TABLE 33

COST OF BY-PRODUCTS IN 1928

	Soil class.	Light to medium.	Medium to heavy.	Fen.	Very light.	Sewage.	Over-all.
Return	In tops (tons) ..	7·4	8·0	10·0	7·2	10·0	8·1
	In pulp (cwt.) ..	8·9	8·9	11·1	6·9	8·6	9·0
	In cash	6/2	Nil	77/8	Nil	12/4	11/2
Cost	.. .. ..	Nil	23/11	Nil	19/9	Nil	Nil

* It is not suggested that this represents a hardship on the British grower, as, in all probability, the price of the beet is adjusted accordingly.

TABLE 34

COST OF BY-PRODUCTS IN 1927

	Soil class.	Light to medium.	Medium to heavy.	Fen.	Very light.	Sewage.	Over-all.
Return	In tops (tons) ..	9·0	8·3	10·9	4·4	9·0	8·9
	In pulp (cwt.) ..	7·9	7·3	8·7	4·4	9·0	7·7
	In cash	Nil	Nil	9/8	Nil	52/1	Nil
Cost	.. .. ..	26/4	85/2	Nil	95/-	Nil	33/1

It may be objected that some growers want neither "tops" nor pulp; that, in other words, sugar beet is not replacing a fodder crop. Such may be the case on a small minority of farms, but it is only reasonable to suppose that those who are unable to utilise these by-products will be among the first to give up beet growing if the declining subsidy makes necessary a further reduction in the contract price.

To return to pulp in particular, it will be seen in Table 33 that if the whole of the cost in the worst soil class (the very light) in 1928 is regarded as the cost of the pulp alone, then 6·9 cwt. were obtained at a cost of 19*s.* 9*d.*, or £2 17*s.* 3*d.* per ton; but if the "tops" are valued at 7*s.* 6*d.* per ton, then the cost of the pulp is reduced to only 3*s.* 3*d.* per ton. A similar calculation for 1927, and making the same allowance for "tops," suggests that the cost of pulp was, over-all, rather less than £1 per ton. But in this earlier year the cost of pulp was not reasonable in all the soil groups. Thus, in the very light soil class the loss on the beet was sufficient to make the cost of the pulp nearly £20 per ton, while a similar figure for the medium to heavy soils was £8 11*s.* 0*d.* per ton. On the other hand, in the light to medium group the cost was only 3*s.* 8*d.* per ton, while on the fen and sewage soils there was actually a cash balance.

The question then arises, at what point does pulp become more expensive than the fodder which it most often replaces, that is, mangolds. The *Report* No. 12 referred to on page 4 shows the cost of a ton of mangolds over an average of four years to have been 17*s.* 9*d.* If this figure is considered in conjunction with the generally accepted view that one pound of dried pulp is equivalent to approximately seven or eight pounds of mangolds, the value thus put on pulp is between £6 and £7 per ton. It must be remembered, however, that the yield of sugar beet is, on the average, little more than a third of the yield of mangolds, and that, consequently, it requires about 8 acres of beet to produce the "pulp equivalent" of an acre of mangolds. The fodder supply is, however, considerably supplemented by the "tops," which, on an average, appear to yield a weight equal to that of the roots.

Recent work by Dr. H. E. Woodman, however, has shown that to regard pulp solely as a substitute for roots is not justifiable, and that "dried sugar beet pulp must be included with feeding stuffs like maize meal in the class known as carbohydrate concentrates."* It is suggested that 10 lb. of dried

* "The Composition and Nutritive Value of Sugar Beet Pulp," by H. E. Woodman, M.A., Ph.D., D.Sc., and W. E. Calton, B.A., *Journal of Agricultural Science*, Vol. XVIII.

pulp is capable of replacing 8 lb. of maize meal or 9 lb. of barley in the productive part of the ration of ruminant animals. Pursuing this comparison, Dr. Woodman compares the price per ton of pulp with that of maize meal and barley meal in the following table.

TABLE 35

RELATIVE COSTS OF SUGAR BEET PULP, MAIZE MEAL AND BARLEY MEAL

	Dried sugar beet pulp.	Maize meal.*	Barley meal.*
	£ s. d.	£ s. d.	£ s. d.
Price per ton	5 10 0	10 12 0	12 5 0
Manurial value per ton	9 0	11 0	10 0
Cost of food value per ton	5 1 0	10 1 0	11 15 0
Price per unit of starch equivalent ..	1 6	2 6	3 4
Price per lb. of starch equivalent ..	0·8*d.*	1·34*d.*	1·78*d.*

Since the compilation of the above table there has been a considerable reduction in the price of barley meal, although maize meal remains at approximately the same level. Nevertheless, this second method of comparison shows that the value put on pulp when compared with mangolds (between £6 and £7 per ton) is by no means excessive.

Since 1925 there has been a continual and rapid decrease in both the proportion and the amount of wet pulp sold. This may be attributed largely to its incapacity to keep on account of the high percentage of water it contains, and where it is used, fresh supplies have to be received from the factory almost daily. On the other hand, the production of dried pulp, a large proportion of which is now molassed, continues to increase. This appears to be the case, in spite of the reduction in the weight of washed beet handled during the 1928 campaign. The latest official figures† give the production of pulp in 1928 as 97,000 tons dried and 11,000 tons wet; which compare with the corresponding amounts of 88,000 tons and 15,000 tons in 1927. If, for the purposes of a rough calculation, the wet pulp is reduced to a dry pulp basis by assuming 70 per cent. of water to be extracted in the drying process, it would appear that the equivalent of approximately 92,500 tons of dried pulp was produced in 1927 and 100,300 tons in 1928. This increase is in spite of a reduction of an official estimate of 66,750 tons in the quantity of beet delivered at the factories. These figures suggest that the pulp was not dried so efficiently in 1928 as it had been in the previous year, and that the increase in the quantity produced was due to the higher moisture content. In fact, the bare figures indicate that the dried pulp sold during the latter season contained some 12,000 tons of water in excess of the same weight of pulp produced in 1927. The state of affairs cannot, however, have been as bad as this calculation insinuates on account of a larger proportion of the pulp being molassed in 1928. Also, the deterioration of the beet after delivery

* Quoted from the *Journal of the Ministry of Agriculture*, April, 1928.

† *Agricultural Statistics*, Part I, 1928.

at the factory is not allowed for although there is no apparent reason why this latter factor should have had more effect in 1928 than in the previous year. On the other hand, there seems little doubt that the moisture content of dried pulp in 1928 was higher than in 1927, for, in the course of the work already referred to, Dr. Woodman had occasion to analyse numerous samples during both years. In 1927 the analyses usually showed between 10 and 15 per cent. of water, but during 1928 moisture contents of over 20 per cent. were frequently recorded. The practical difficulties in the way of maintaining an even and reasonably low moisture content must be fully appreciated, but many of the complaints, heard during the latter year, that sugar beet pulp tainted cows' milk, are attributed by Dr. Woodman to the pulp going bad on account of the high percentage of water it contained.

3. IMPLEMENTS

It has been shown (on page 45) that experience in the handling of the sugar beet crop has resulted in some considerable economy in the cost of labour. Part of this economy may be due to the more general use of implements designed for this purpose, but, as yet, innovations have been confined to the introduction of such tools as the subsoiling attachment and the lifting plough, and no phenomenal success can be recorded in the reduction of the heavier items of cost. It is only natural that this should be the case where small-scale production is so predominant. In both 1927 and 1928 only 14 per cent. of the sugar beet growers in the whole country held contracts for over ten acres, while in the former year less than 1 per cent. contracted to grow more than 50 acres, and there is no reason to believe that the proportion of large growers exceeded that figure in 1928. It is evident that a very small percentage of the growers in this country could justifiably incur any considerable capital outlay on special implements. On the other hand, quite a substantial proportion of beet is produced by large growers, and the success of the industry as a whole depends to a corresponding extent on the economies which they may be able to make.

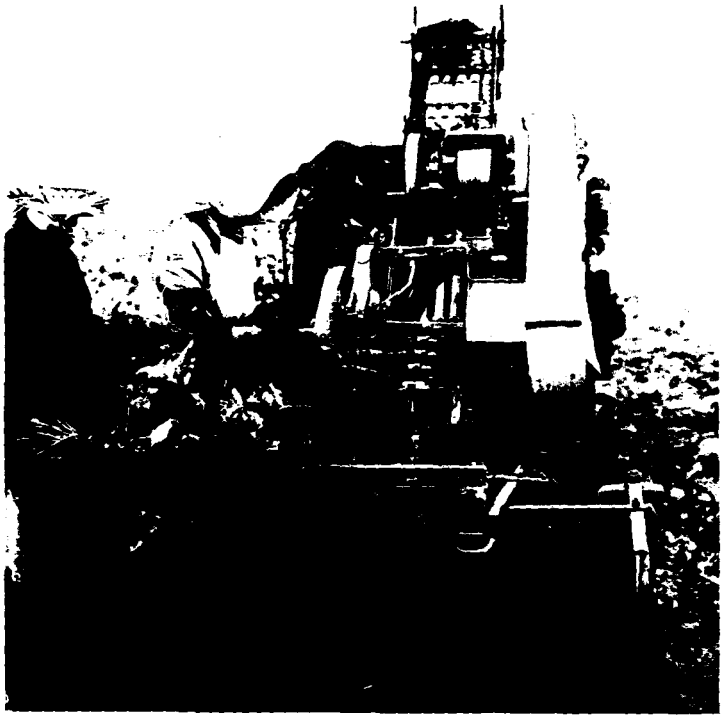
The greatest possibilities of reducing the cost of production are, perhaps, afforded by the operations of lifting, cleaning and topping the roots. Little success has, up to the present, been achieved in this connection, but attempts are continually being made to produce a tool which will perform one or all of these tasks without sacrificing serviceability. During the 1928 season experiments were being made with the most promising implement which has yet come before the notice of the investigators. Seen at work under extremely uncongenial conditions it appeared to give very satisfactory results, and was sufficiently impressive to warrant the following short account which has been kindly supplied by the inventors, Messrs. Morton and Standen. The description is supplemented by two very illustrative photographs, showing the implement at work, which are reproduced by courtesy of Messrs. Photopress.

The Morton and Standen Beet Harvester was designed with three main objects: (1) to top, clean and load beet cheaper and more expeditiously than

THE MORTON AND STANDEN SUGAR BEET HARVESTER

ABOVE

Placing beet in position for topping.



BELOW

General view showing beet being topped.

Reproduced by kind permission of Messrs. Photopress.

can be done by hand; (2) to reduce the number of hands and horses that are necessary if lifting, topping and carting are to be carried out at the same time, and (3) to render more easily available the valuable "tops," a large proportion of which is, under existing conditions, frequently wasted.

After the beet have been ploughed out, the harvester is attached to the back of a cart and drawn alongside the rows. Two women pull a few yards of the rows beside the machine, placing the beet on to trays and carrying the trays to a platform made to receive them at the back of the harvester (see illustrations). Other women take the beet, one in each hand, from the platform and place them in the conveyor cups, in the correct position for topping. The beet are carried forward to a circular knife, which tops them, and they then drop into a cleaner, from which they are elevated to the cart. The "tops" fall to a heap on the ground, and when a few yards have been cleared, the cart and machine are moved on. A man in charge of the harvester also carts the beet away to the dump, one cart being filled while the other is away. A 2½ h.p. petrol engine is mounted on the harvester and drives the machinery.

The amount of work done depends largely, of course, on the number of beet per acre, and whether the conveyor cups are kept full. Working in its lowest gear the harvester is capable of dealing with 3,600 beet per hour, and it can be speeded up to any extent. On a normal crop a team should clear from 3 roods to 1 acre per day. Where the leaf is heavy (as in the fens) it has been found convenient to run a grass cutter over the beet before ploughing out, leaving about four inches for handling. In this way, ploughing out is facilitated, handling the beet in wet or frosty weather is less unpleasant and, while the leaves are scattered over the field for ploughing in, the crowns are left in heaps and can be gathered up for feeding. The cost of the complete harvester, including the petrol engine, is expected to be approximately £80.

It should be noted that the harvester described above performs three distinct operations: i.e. topping, cleaning and loading. A recent enquiry* investigated the rate at which these tasks are carried out under prevailing conditions, and some of the data obtained make interesting comparison with the rate at which the new machine can be worked. The most striking observation was the very wide variation in the number of beet handled by different men working under similar conditions, but the author accepted, as representing average efficiency, a speed of about 1,200 beet per hour when topping only. (Where the workers are capable of satisfactorily topping beet lying in rows on the ground this figure can be greatly increased.) Pulling and knocking off dirt was observed to proceed at an average rate of 700 beet per hour, but it was estimated that three-quarters of the time is occupied in "knocking," which can be largely dispensed with if the harvester is used. One worker normally loads 3,000 roots per hour. If these average figures are accepted, it would seem that, provided the conveyor cups are kept reasonably full, the harvester described above will top beet at a greater rate than two men,

* *Efficiency Investigations in Connection with Farming*, by W. R. Dunlop.

and will load quite as fast as one man. In addition, by cleaning the beet it should allow the rate of pulling to be at least doubled.

Attempts have been made to reduce the cost of singling and inter-cultivation. Several growers have experimented with spacing drills, but with only moderate success. One grower who has used this implement for two years considers that it saves 20*s.* an acre in the cost of singling and cleaning, but he is giving it up this year because of the havoc wrought by wireworms, which results in a very gappy plant. The continuous row also enables the horse-hoe to get to work several days earlier, and it seems very doubtful whether the economy in singling costs is not a false one. A variation of this was tried by several growers who drilled both ways with the intention of horse-hoeing both ways also; but this, again, was not always successful. Irregular germination either made it impossible to horse-hoe both ways, or necessitated hoeing very wide of the true row in order to avoid cutting out many plants which it was desirable to leave.

4. CONCLUSION

It is possible to conclude on a more cheerful note than would have been justified in the previous *Report*. The disastrous experience of the growers in 1927; the steadily falling price of sugar; the declining subsidy; the decrease in the contract price of the roots, and the substantial reduction in the acreage sown, all contributed to the pessimistic view which was generally taken of the prospects of the industry. But now the improved results in 1928 have convinced the growers that the previous year was exceptionally unfavourable; the fall in the price of sugar appears to have received at least a temporary reverse; the present subsidy rate is assured for another two years; the better sugar content showed the reduction in the contract price of beet to have been more apparent than real, and the 1929 sowings are said to exceed in extent all previous records. So much is visible to the general observer, but there are other, and equally optimistic indications which become apparent only on closer examination. First among these encouraging symptoms is the considerable reduction in the costs of production, which results from experience in the handling of the crop. Next must be placed the more extensive appreciation and use of those valuable by-products, "tops" and pulp, and a growing realisation that sugar beet affords, perhaps, the cheapest means of fallowing land. There is comfort, also, in the tendency exhibited by the 1928 growers to fit sugar beet into the organisation of their farms rather than to disregard established practice in order to produce a new crop. And last, although not least, is the inclination of experienced growers to maintain their acreage. In fact, although the total area under sugar beet in 1928 represented a decrease of 21 per cent. on the previous year, the 65 costed growers who had had four years' experience with the crop actually increased their contribution from 2,124 acres in 1927 to 2,397 acres in the year with which this *Report* is primarily concerned. It cannot be pretended, however, that the future is by any means assured, and if this young industry is to survive the depression in the sugar trade, considerable advances have yet to be made.

APPENDIX A.
GENERAL ECONOMIC DATA.

Farm Number.	General Description of Soil.	Total Acreage.	% Arable.	Rent and Rates per Acre.	Density per 100 Ac's*		Number of Tractors.†	Total Beet Grown expressed as a % of Total Arable.				1928 Beet Crop actually Costed.		Factories Supplied.	Approximate Road Distance (Miles) to Factory.
					Labour.	Horses.		1925	1926	1927	1928	Number of Fields.	Acres.		
302	Sandy loam ..	699	86	25/9	3·7	2·7	1	13·8	16·1	18·7	16·4	5	98½	Bury	2.
304	Light loam.. ..	465	86	23/4½	3·9	2·4	1	7·5	16·0	32·5	28·5	3	34	Bury	4½.
305	Light mixed ..	236	58	29/1	2·5	3·4	—	—	3·7	4·4	5·9	1	8	Bury	30.
306	Light over chalk	310	92	27/-	2·9	2·6	1	2·1	7·0	10·6	12·3	1	2	Felsted	23.
307	Very light ..	602	88	12/9¼	4·0	3·3	1	5·3	8·7	11·7	23·3	6	122	Bury, Ely and Ipswich.	4, 40, 23.
308	Strong loam ..	1015	75	33/3½	4·5	3·4	—	2·1	5·2	7·8	10·5	2	44	Bury	11.
310	Gravel loam ..	280	54	24/6½	3·6	2·5	—	5·3	11·3	18·0	18·7	2	28	Bury and Ipswich	23, 23.
313	Mixed on sand ..	760	62	32/9	4·5	2·4	1	2·1	2·1	2·1	2·6	1	12	King's Lynn ..	21.
313A	Clay loam ..	440	91	33/5	3·4	3·0	—	6·0	4·5	7·3	6·0	1	24	King's Lynn ..	23.
314	Light sand ..	1000	95	32/5	4·4	3·0	—	4·5	4·8	4·5	2·6	1	25	King's Lynn ..	18.
317	Sandy loam ..	70	64	33/3½	4·3	4·3	—	6·7	13·3	21·1	22·2	3	10	Bardney	9.
318	Mixed	441	57	28/-	2·0	2·3	1	2·8	2·8	4·0	9·6	1	18	Bardney and Selby.	7, 50.
320	Sand and warp ..	242	66	45/-	3·5	4·1	1	3·8	3·8	3·8	1·4	1	2½	Brigg	12.
321	Sand to strong loam	490	69	38/4½	2·9	2·9	—	—	1·8	4·4	1·2	1	4	Brigg	10.
322	Clay and sand ..	197	63	30/7	2·5	2·5	1	12·9	3·2	14·5	12·9	1	16	Bardney	20.
323	Fen	600	88	34/10	3·3	3·3	3	3·4	3·4	8·8	5·9	1	25	Bardney	4.
324	Medium loam ..	350	80	30/5½	2·9	2·3	—	3·2	3·2	5·0	2·1	1	6	Bardney	6.
326	Mixed loam ..	144	79	37/10	4·2	4·9	—	8·8	10·5	14·0	14·9	2	17	Cantley	14.
329	Light loam.. ..	112	89	21/5½	3·6	3·6	1	5·0	11·0	10·9	5·0	1	5	Ely	22.
336	Strong loam ..	150	87	29/4	5·3	3·3	1	7·5	7·5	9·6	11·5	2	15	Ipswich and Cantley.	25, 35.
339	Gravel loam ..	178	64	76/3½	6·7	2·8	1	—	1·8	2·6	6·1	1	7	Peterborough ..	29.
342	Loam on clay ..	380	68	34/1½	5·8	2·6	1	4·6	6·9	6·9	9·6	2	19	Cantley	21.
343	Fen	1411	96	50/11	5·7	5·0	2	11·8	11·8	12·5	15·4	1	17	Ely	8.
344	Gravel loam ..	500	60	27/6	2·0	2·0	—	2·7	6·0	6·0	6·0	1	18	Peterboro' and Spalding.	13, 15.
351	Sewage farm on sand	300	83	27/8	4·0	3·3	1	6·0	9·2	12·8	18·8	6	47	Kelham, Colwick and Bardney.	11, 25, 30.
353	Very mixed ..	800	75	27/3	2·0	2·1	—	—	2·3	2·3	1·7	3	10	Bardney and Kelham.	6, 20.
354	Gravel	73	96	25/5½	4·1	4·1	—	2·9	5·7	8·6	8·6	1	6	Bardney	6.
356	Gravel loam ..	70	69	35/5	4·0	4·3	—	—	7·3	16·7	31·3	1	4	Kelham	20.
357	Sandy loam and clay	485	75	31/5½	4·1	3·1	1	2·2	4·1	5·5	6·8	1	26	Cantley	15.
360	Black fen	144	100	47/1	4·2	5·6	1	—	3·5	3·8	13·9	2	18	Peterborough ..	4.
362	Medium to heavy..	95	68	46/-	3·2	5·3	1	—	3·1	6·2	3·1	1	2	Peterborough ..	8.
366	Fen	44	77	74/6	4·6	4·6	—	5·9	17·6	26·5	35·3	1	6	Peterborough and Spalding.	8, 11
367	Limestone	1353	33	20/4	0·9	1·0	—	—	2·2	4·4	2·2	1	10	Peterborough ..	8.
368	Medium fen ..	196	87	73/8½	5·1	4·6	1	8·8	8·8	8·8	20·0	1	32	Peterborough, Ely and Colwick.	22, 22, 25.
371	Fen on gravel ..	470	47	65/4	2·6	2·6	1	24·5	24·5	28·4	31·8	1	10	Ely	10.
372	Fen on gravel ..	120	100	55/4	2·5	2·5	—	—	16·6	36·6	75·0	1	25	Ely	11.
373	Fen on gravel ..	200	75	55/4	4·3	6·0	—	—	28·7	28·7	46·7	1	8	Ely	12.
375	Medium loam ..	98	65	27/1½	4·1	4·1	—	6·6	14·1	14·8	11·7	2	7½	Ipswich	21.
377	Clay loam	180	100	34/5½	3·8	1·7	1	—	3·9	12·2	12·2	1	4	Felsted	15.
378	Light loam.. ..	200	80	34/6	4·0	4·0	—	3·1	5·0	6·3	6·3	1	9	Cantley	15.
383	Sewage farm on sand	541	55	32/3½	3·1	2·2	1	5·1	5·1	11·5	19·5	6	58	Cantley	14.
384	Light loam on chalk	750	95	23/6	4·8	5·1	—	2·8	5·6	3·4	5·6	1	23	Bury	3½.
386	Light loam.. ..	1179	21	14/5	1·3	0·7	—	7·3	—	4·9	7·3	1	18	Bury	14.
389	Silt loam	400	90	88/6	6·2	4·0	1	2·8	6·9	8·3	2·8	1	10	King's Lynn ..	17.
390	Skirt	50	76	35/7	4·0	4·0	—	—	5·3	5·3	15·8	1	6	Bury	20.
391	Very light ..	999§	22	6/3	1·0	1·0	1	8·2	13·6	22·7	13·6	1	16	Ipswich	18.
392	Gravel loam ..	137	62	34/1	2·9	2·9	—	9·4	9·4	12·9	5·9	1	5	Ipswich	23.
393	Light to loam ..	1700	50	29/-	4·1	2·0	2	5·9	9·9	11·0	5·6	3	34½	Ipswich	10.
394	Light	230	87	23/3½	4·3	4·3	—	8·0	8·0	11·5	12·0	1	24	Ipswich	6.
396	Light loam.. ..	800	50	29/8½	3·5	1·8	1	6·8	7·5	11·3	25·0	1	10	Ipswich	9.
398	Skirt	54	70	52/5	3·7	5·6	—	7·9	15·8	18·4	15·8	1	6	Ely	13.
400	Clay loam	168	84	35/9	5·4	4·2	1	4·2	7·0	6·5	10·2	1	11½	Ipswich	5.
405	Chalk loam and clay	215	81	35/11½	6·0	3·7	—	9·7	12·0	12·0	14·3	1	20	Ely	18.
406	Fen	260	90	55/-	5·0	6·2	—	17·0	20·0	23·8	13·4	2	31½	Peterborough ..	18.
408	Mixed heavy ..	260	86	23/6	5·4	3·5	1	1·8	4·5	6·4	2·9	1	6	Bury	14.
409	Black fen	760	79	56/7	5·0	5·5	2	4·2	10·0	15·0	41·7	1	8	Ely	15.
411‡	Very mixed ..	426	60	30/4	4·8	3·3	1	1·2	3·1	4·8	5·0	2	11	Ely	17.
412	Light loam.. ..	236	98	33/4½	3·4	2·1	2	1·3	3·0	3·0	3·0	1	7	Bury and Felsted.	25, 25.
414	Light to chalk ..	362	75	15/5¾	3·3	2·2	1	2·1	5·2	6·9	5·2	2	14	Bury, Felsted, Ely and Wissington.	35, 23, 30, 70.
415	Mixed loam ..	84	64	34/4½	3·0	6·0	—	—	22·7	33·0	31·1	3	16½	Bury and Ely ..	15, 12.
416	Heavy	46	93	32/3½	4·4	4·4	—	7·0	11·6	11·6	11·6	1	5	Ipswich	13.
417	Sandy loam ..	18	100	27/8	5·6	11·1	—	—	—	—	77·8	3	10	Bury and Ely ..	16, 12
418	Light to strong ..	72	76	30/6	4·2	5·6	—	—	7·3	8·2	8·2	1	4½	Bury	8.
421	Medium loam ..	105	47	24/2	6·7	4·8	—	6·1	6·1	18·4	15·3	1	7½	Cantley	16.
422	Mixed clay to sandy loam.	120	89	35/6¾	5·8	3·3	—	—	—	3·7	5·6	1	6	Cantley	17.
423	Sandy loam ..	204	74	37/11	3·4	3·9	—	—	—	4·7	1·3	1	2	Cantley	16.
424	Sandy loam to strong	75	82	54/5¾	4·1	5·5	—	—	—	6·7	12·5	2	7½	Brigg and Selby ..	8.

* Excludes casual labour. † Excludes tractors hired. ‡ Experimental farm.
§ Includes 750 acres heath, for which only a nominal rent is paid.

General Economic Data—*continued.*

Farm Number.	General Description of Soil.	Total Acreage.	% Arable.	Rent and Rates per Acre.	Density per 100 Acr's*		Number of Tractors.†	Total Beet grown expressed as a % of Total Arable.				1928 Beet Crop actually Costed.		Factories Supplied.	Approximate Road Distance (Miles) to Factory.
					Labour.	Horses.		1925	1926	1927	1928	Number of Fields.	Acres.		
425	Mixed and fen ..	130	81	28/3½	3·8	4·6	—	47·6	66·7	66·7	51·4	5	54	Ely and Bury ..	14, 17.
426	Light to mixed loam	95	57	23/2	3·2	4·2	—	—	—	11·1	38·9	2	21	Bury	28.
427	Loam	4½	100	53/2½	—	—	—	—	—	—	44·4	1	2	Bury	17.
428	Sandy loam ..	230	74	24/2	4·4	3·0	—	8·8	23·5	35·3	35·3	5	60	Ipswich	20.
429	Sand	1600	88	7/4½	1·9	0·9	2	—	—	7·2	15·0	2	210	King's Lynn ..	20.
430	Fen and skirt ..	312	84	65/8	4·8	6·4	1	4·6	6·1	9·2	9·9	2	26	Ely and Wissington	17, 6.
431	Light fen	275	45	31/6	2·2	1·5	—	24·0	24·0	24·0	58·4	2	30	Wissington ..	1.
432	Heavy fen	450	94	70/6	3·3	1·1	1	13·1	13·1	13·1	11·8	1	50	Spalding	10½.
433	Light loam.. ..	250	79	28/-	3·2	5·5	1	—	6·6	9·1	7·6	2	15	Cantley	5.
433A	Medium loam ..	220	85	33/-	5·5	3·2	—	—	6·6	9·1	8·0	2	15	Cantley	5.
434	Mixed sand ..	720	61	22/2	2·9	2·5	—	4·5	9·1	6·8	6·8	3	30	King's Lynn ..	16.
435	Sandy loam ..	250	40	42/3½	2·0	1·2	1	—	4·0	8·0	8·0	2	8	Cantley	16.
436	Sandy loam ..	390	82	37/4½	3·6	3·3	—	—	—	1·9	3·1	2	10	Cantley	18.
437	Light loam.. ..	420	71	28/7½	3·1	2·9	1	—	2·7	5·7	6·3	1	19	Cantley and Bury	10.
438	Fen	280	91	58/9½	2·5	2·9	—	—	—	4·7	3·9	1	10	Bardney	20.
439	Mixed loam ..	200	75	32/6	4·0	5·0	—	—	20·0	22·0	19·7	3	29½	Cantley	20.
440	Fen	200	61	44/-	5·0	4·5	1	32·5	40·7	48·8	50·4	2	55	Ely and Bury ..	9, 19.
441	Light to strong ..	501	68	21/9½	4·4	3·2	—	1·5	5·9	13·2	13·1	1	20	Bury and Cantley	20, 20.
442	Sand to clay loam ..	300	50	25/4	6·0	3·3	—	8·0	20·0	23·3	18·0	2	27	Ipswich and Bury	13, 35.
443	Clay loam	212	81	24/4	3·3	3·3	—	5·8	11·6	11·6	12·8	3	22	Ipswich and Bury	20, 20.
444	Sandy loam ..	150	75	35/-	6·7	4·0	—	—	—	17·7	16·8	1	9	Ipswich	6.
445	Gravel loam to strong	407	63	25/8	2·0	1·7	—	—	14·1	15·6	14·1	3	36	Bury and Ely	7, 20.
447	Medium loam ..	53	79	44/8½	5·6	5·7	—	—	7·1	11·9	9·5	1	4	Cantley	12.
448	Sand and clay loam	110	66	53/9	4·6	5·5	—	5·5	17·1	24·7	9·6	1	7	Cantley	7.
449	Light mixed loam	164	71	36/-	5·5	4·9	—	5·1	8·5	12·0	12·6	2	7½	Cantley	30.
449A	Light mixed loam	164	71	36/-	5·5	4·9	—	5·1	8·5	12·0	12·6	2	7½	Bury	22.
450	Mixed on chalk ..	50	80	45/8½	6·0	6·0	—	30·0	30·0	12·5	12·5	2	5	Ely	38.
451	Medium loam ..	790	73	21/9½	4·9	3·4	—	—	1·4	2·9	4·5	3	26	Cantley	17.
452	Medium	47	92	44/3	4·3	4·3	—	9·3	18·6	18·6	14·0	1	6	Cantley	15.
453	Heavy loam ..	740	86	33/1½	4·0	2·7	1	—	0·1	1·4	2·3	1	15	Ely	40.
454	Skirt	21	81	70/6¾	6·5	9·5	—	17·7	23·5	47·1	35·3	1	5½	Wissington and Ely	9, 20.
455	Clay silt	30	60	72/-	3·3	3·3	—	—	11·1	11·1	16·7	1	3	King's Lynn ..	7.
456	Loam	220	59	25/-	2·3	2·7	—	9·2	9·2	9·2	9·2	1	12	Felsted	32.
	Totals and averages	36,134½	74·3	36/6	3·9	3·6	47	5·3	9·3	12·8	15·6	173	2036½	—	17·0

* Excludes casual labour. † Excludes tractors hired.

APPENDIX B.
FIELD DATA.

Farm Number.	Field Number.	Soil Class.	Acres.	Preceding Crop.	Variety of Seed.	Seed lb. per acre.	Mean Date of Drilling.	Ridge or Flat.	Distance (ins.) between Drills.	Distance (ins.) between Plants	Succeeding Crop.
302	1	V.L.	11	Barley ..	Kuhn, Dippe ..	16	?	Flat	24	9	Barley.
	2	V.L.	16	Barley ..	Kuhn, Dippe ..	16	?	Flat	24	9	Grass.
	3	V.L.	7½	Oats	Kuhn, Dippe ..	16	?	Flat	24	9	Barley.
	4	L.-M.	51	Sugar Beet, Oats and Barley	Kuhn, Dippe ..	16	?	Flat	24	9	Barley.
	7	L.-M.	13	Barley ..	Kuhn, Dippe ..	16	?	Flat	24	9	Barley.
304	8	V.L.	8	Barley ..	Mixed	12	May 21	Flat	19	6	Oats.
	9	L.-M.	16½	Barley ..	Mixed	12	May 11	Flat	19	6	Barley.
	10	V.L.	9½	Wheat ..	Mixed	12	May 21	Flat	19	6	Barley.
305	11	L.-M.	8	W. Barley ..	Zapotil ..	14	April 28	Flat	21	9	Barley.
306	12	L.-M.	2	Barley ..	K.W., Dippe ..	12	May 6	Flat	22	8	Barley.
307	13	L.-M.	44½	Sugar Beet and Wheat.	K.W., Kuhn ..	15	May 15	Flat	19	9–12	Sugar Beet and Barley.
	14	L.-M.	16	Rye	K.W., Kuhn ..	17	June 12	Flat	19	9–12	Sugar Beet.
	15	L.-M.	22½	Sugar Beet ..	K.W., Kuhn ..	15	May 28	Flat	19	9–12	Sugar Beet.
	16	L.-M.	12	Sugar Beet ..	K.W.	12½	April 23	Flat	19	9–12	Kale.
	17	L.-M.	13½	Seeds	Kuhn	20*	April 8	Flat	19	9–12	Sugar Beet.
	18	L.-M.	13½	Sugar Beet ..	K.W.	15½	May 3	Flat	19	9–12	Sugar Beet.
308	19	M.-H.	24	Wheat ..	Mixed	12	May 2	Flat	22½	9	Barley.
	20	M.-H.	20	Wheat ..	Mixed	12	April 30	Flat	22½	9	Barley.
310	21	L.-M.	20	Barley ..	Mixed	16	May 15	Flat	24	9	Barley.
	22	L.-M.	8	Sugar Beet ..	Mixed	18	April 14	Flat	18	9	Sugar Beet.
313	23	L.-M.	12	Carrots ..	Marsters ..	15	April 30	Flat	18	8	Barley.
313A	24	L.-M.	24	Oats	Kuhn	15	May 8	Flat	18	8	Sugar Beet.
314	25	L.-M.	25	Carrots and Turnips.	Johnsons, Dippe.	15	May 11	Flat	18	8	Barley.
317	26	L.-M.	3	Wheat ..	Kuhn	18	May 9	Flat	19	10	Sugar Beet.
	27	L.-M.	6	Sugar Beet ..	Kuhn	15	May 11	Flat	19	10	Oats.
	28	L.-M.	1	Oats	Horning ..	18	May 15	Flat	19	10	Wheat.
318	29	M.-H.	18	Wheat ..	Kuhn, K.W. "Z."	15	May 13	Flat	18	10	Oats.
320	30	F.	2½	Wheat ..	Kuhn	20	May 13	Ridge	21	10	Potatoes.
321	31	L.-M.	4	Barley ..	Horning, Strube.	15	?	Ridge	22	10	Barley.
322	32	M.H.	16	Wheat ..	Schreiber ..	14	?	Flat	20	10	Barley.
323	33	F.	25	Oats and Wheat	Mixed	17	April 28	Flat	22	?	Oats.
324	34	L.-M.	6	Seeds	Strube ..	16	May 9	Flat	18	10	Barley.
326	35	L.-M.	7	Wheat ..	Mixed	15	?	Flat	20	8	Sugar Beet.
	36	L.-M.	10	Wheat ..	Mixed	15	?	Flat	20	8	Barley.
329	37	L.-M.	5	Wheat ..	Dippe	10	May 18	Flat	19	9	Barley.
336	38	L.-M.	12	Wheat ..	Mixed	12	May 8	Flat	22	9	Barley.
	39	L.-M.	3	Oats	Marsters ..	12	May 1	Flat	22	9	Wheat.
339	40	L.-M.	7	Runner beans	K.W.	11	April 17	Flat	22	10	Peas.
342	41	M.-H.	6	Wheat ..	Mixed	16	April 29	Flat	20	9	Barley.
	42	L.M.	13	Tares	Mixed	16	May 6	Flat	20	9	Barley.
343	43	F.	17	Rye	Mixed	12	?	Flat	20	9	Rye.
344	44	L.-M.	18	Barley ..	K.W. "E.," Horning.	12	April 6	Flat	18	8	Barley.
351	45	S.	9	Oats	Mixed	12	?	Ridge	24	8	Barley and Potatoes.
	46	S.	9	Wheat ..	Mixed	12	?	Ridge	24	8	Sugar Beet.
	47	S.	5	Wheat ..	Mixed	12	?	Ridge	24	8	Rye.
	48	S.	5	Sugar Beet ..	Mixed	12	?	Ridge	24	8	Sugar Beet.
	49	S.	3	Mangolds ..	Mixed	12	?	Ridge	24	8	Mustard.
	50	S.	16	Roots	Mixed	12	?	Ridge	24	8	Barley.
353	51	L.-M.	3	Sugar Beet ..	Kuhn, Horning	10	May 3	Ridge	22	10	Sugar Beet.
	52	V.L.	2	Sugar Beet ..	Kuhn, Horning	10	April 24	Ridge	22	10	Sugar Beet.
	53	V.L.	5	Seed Mustard	Kuhn, Horning	9	April 27	Ridge	22	10	Barley.
354	54	L.-M.	6	Potatoes, Sugar Beet and Mangolds.	K.W. "E.," Strube.	15	May 5	Ridge	20	10	Sugar Beet.
356	56	L.-M.	4	Wheat ..	Kuhn, Marsters	13	June 6	Ridge	24	8	Sugar Beet and Barley.
357	57	L.-M.	26	Barley ..	K.W., Hilleshog.	15	May 7	Flat	19–20	8	Barley.
360	58	F.	12	Wheat ..	K.W. "Z," Kuhn.	14	May 4	Flat	20	10	Wheat.
	59	F.	6	Barley ..	K.W. "Z," Kuhn.	12½	May 8	Flat	20	10	Barley.
362	60	M.-H.	2	Oats	K.W. "E." ..	12	May 19	Flat	22	10	Barley.
366	61	F.	6	Wheat ..	Kuhn, Schreiber "S.S."	15	April 17	Flat	21	9	Potatoes.
367	62	M.-H.	10	Wheat ..	K.W. "E." ..	12	May 1	Flat	22	8	Wheat.
368	63	F.	32	Oats and Wheat	Mixed	10	May 1	Flat	19½	10	Wheat and Potatoes.
371	64	F.	10	Wheat ..	K.W. "Z.," Kuhn "P."	15	?	Flat	21	9	Wheat.
372	65	F.	8	Barley ..	K.W. "Z.," Kuhn "P."	15	?	Flat	21	9	Oats.
373	66	F.	25	Wheat ..	K.W. "Z.," Kuhn "P."	15	?	Flat	21	9	Oats.
37	67	L.-M.	6	Wheat ..	Kuhn	19	April 30	Flat	19	8–10	Barley.
	68	L.-M.	1½	Wheat ..	Kuhn	19	April 21	Flat	19	8–10	Barley.
377	69	M.-H.	4	?	?	?	?	Flat	21	10	?
378	70	L.-M.	9	Oats	Marsters, Hilleshog.	15	?	Flat	15	8	Barley.

* Part failed and was re-drilled.

V.L. = Very light. L.-M. = Light to medium. M.-H. = Medium to heavy. F. = Fen, Silt or Warp. S = Sewage.
"K.W." indicates *Klein Wanzleben*. "Mixed" indicates that more than two varieties were drilled.

Farm Number.	Field Number.	Soil Class.	Acres.	Preceding Crop.	Variety of Seed.	Seed lb. per acre.	Mean Date of Drilling.	Ridge or Flat.	Distance (ins.) between Drills.	Distance (ins.) between Plants	Succeeding Crop.
383	71	S.	11½	Barley ..	Mixed	15½	May 4	Flat	18	8	Sugar Beet.
	72	S.	7	Sugar Beet ..	Mixed	16	April 13	Flat	18	8	Oats.
	73	S.	10	Oats	Mixed	16	April 23	Flat	18	8	Oats.
	74	S.	11	Wheat ..	Mixed	16	May 21	Flat	18	8	Oats.
	75	S.	9½	Sugar Beet ..	Mixed	15	June 3	Flat	18	8	Silage.
	76	S.	9	Oats	Mixed	15	May 16	Flat	18	8	Oats.
384	77	L.-M.	23	Barley and Wheat.	Kuhn, Dippe	15	April 27	Flat	18	9	Barley.
386	78	V.L.	18	Sugar Beet ..	Mixed	12	May 8	Flat	20	6–7	Barley.
389	79	F.	10	Wheat ..	Marsters ..	15	April 24	Flat	19	9	Potatoes.
390	80	F.	6	Mustard ..	Schreiber ..	13	May 7	Flat	21	8	Sugar Beet.
391	81	L.-M.	16	Sugar Beet ..	Johnsons ..	10	?	Flat	22½	8	Barley.
392	82	L.-M.	5	Barley ..	Kuhn	12	May 4	Flat	18	8	Barley.
393	83	L.-M.	9	Oats	Johnsons ..	12	May 21	Flat	22	8	Barley.
	84	L.-M.	14	Oats	Johnsons, Kuhn.	12	May 27	Flat	22	8	Oats.
	85	L.-M.	11½	Barley ..	Kuhn	12	May 15	Flat	22	8	Grass.
394	86	L.-M.	24	Wheat ..	K.W.	16	May 2	Flat	18	8	Wheat and Barley.
396	87	L.-M.	10	Oats	Kuhn "P" ..	15	May 13	Flat	18	8	Barley.
398	88	F.	6	Wheat and Oats	K.W., Hilleshog.	12	April 20	Flat	19½	9	Oats and Barley.
400	89	M.-H.	11½	Wheat ..	K.W., Dippe ..	15	April 25	Flat	22	10	Barley.
405	92	L.-M.	20	Wheat ..	Kuhn	14	April 24	Flat	24	8	Barley.
406	93	F.	19	Mustard ..	Kuhn	16	Mar. 29	Flat	20	10	Sugar Beet.
	94	F.	12½	Carrots ..	Kuhn	16	May 2	Flat	20	10	Sugar Beet.
408	95	M.-H.	6	Oats	Kuhn	15	?	Flat	21	9	Barley.
409	96	F.	8	Potatoes ..	Marsters ..	12	April 16	Flat	20	8	Wheat.
411	96A	L.-M.	4	Kale	Variety trials..	9†	May 3	Flat	18–20	10	Barley.
	96B	L.-M.	7	Wheat ..	Variety trials..	17	May 4	Flat	18	10	Barley.
412	97	L.-M.	7	Oats	Kuhn	16	May 13	Flat	16	10	Barley.
414	98	L.-M.	8	Barley ..	Mixed	11	?	Flat	21	10	Barley.
	99	L.-M.	6	Barley ..	Mixed	11	?	Flat	21	10	Barley.
415	100	L.-M.	6	Barley ..	Dippe	15	?	Flat	20	9	Barley.
	101	L.-M.	3	Wheat ..	Dippe	15	?	Flat	20	9	Wheat.
	102	L.-M.	7½	Sugar Beet ..	Dippe	15	?	Flat	20	9	Barley.
416	103	M.-H.	5	Oats	K.W.	15	May 1	Flat	19	12	Barley.
417	104	L.-M.	4	Barley ..	Kuhn	14	?	Flat	20	9	Barley.
	105	L.-M.	4	Barley ..	Kuhn	14	?	Flat	20	9	Barley.
	106	L.-M.	2	Barley ..	Kuhn	14	?	Flat	20	9	Barley.
418	107	M.-H.	4½	Barley ..	Dobrovice ..	12	May 9	Flat	36	9–10	Barley.
421	108	L.-M.	7½	Oats	K.W.	14	May 10	Flat	19	9	Barley.
422	109	L.-M.	6	Oats	Kuhn, Schreiber.	13	May 10	Flat	21	7	Cabbage.
423	110	L.-M.	2	Oats	Dippe	15	April 26	Flat	20	8	Barley.
424	111	L.-M.	4	Potatoes ..	Kuhn	12	May 6	Ridge	20	9	Wheat.
	112	L.-M.	3½	Oats	Kuhn	12	May 15	Ridge	20	9	Wheat.
425	113	F.	8	Sugar Beet ..	K.W."Z.," Kuhn.	15	?	Flat	20	8	Barley.
	114	F.	10	Sugar Beet ..	K.W."Z.," Kuhn.	15	?	Flat	20	8	Sugar Beet.
	115	F.	6	Sugar Beet ..	K.W."Z.," Kuhn.	15	?	Flat	20	8	Sugar Beet.
	116	F.	18	Grass	K.W."Z.," Kuhn.	15	?	Flat	20	8	Sugar Beet.
	117	F.	12	Grass	K.W."Z.," Kuhn.	15	?	Flat	20	8	Sugar Beet.
426	118	L.-M.	19	Barley, Roots and Clover.	Schreiber ..	14	?	Flat	21	10	Sugar Beet.
	119	L.-M.	2	Wheat ..	Schreiber ..	14	May 14	Flat	21	10	?
427	120	L.-M.	2	Wheat ..	Dobrovice ..	15	April 18	Flat	21	9	Sugar Beet.
428	121	V.L.	14	Sugar Beet and Vegetables.	Kuhn	17*	June 10	Flat	20½	8	Sugar Beet.
	122	V.L.	16	Sugar Beet ..	Kuhn	10	May 29	Flat	20½	8	Barley.
	123	V.L.	10	Sugar Beet	Kuhn	9	May 2	Flat	20½	8	Oats.
	124	V.L.	7	Sugar Beet ..	Kuhn	9	April 26	Flat	20½	8	Sugar Beet.
	125	V.L.	13	Sugar Beet and Vegetables.	Kuhn	10	May 8	Flat	20½	8	Sugar Beet.
429	126	V.L.	88	Oats, Mustard and Sugar Beet.	Kuhn	12	?	Flat	24	8	Sugar Beet and Barley.
	127	V.L.	122	Sugar Beet, Fallow, Barley and Oats.	Marsters, Johnsons.	12	?	Flat	24	8	Barley.
430	128	F.	15	Wheat ..	Mixed ..	18	April 24	Flat	19½	9	Potatoes.
	129	F.	11	Wheat ..	Kuhn, Marsters.	18	April 23	Flat	19½	9	Oats and Mangolds.
431	130	F.	10	Sugar Beet ..	Zapotil ..	16*	May 2	Flat	21	10	Mustard.
	131	F.	20	Sugar Beet ..	Zapotil ..	14	May 8	Flat	21	10	Mustard.
432	132	F.	50	Sugar Beet Seed and Wheat.	Kuhn, Marsters.	10†	April 19	Flat	17	8	Potatoes.
433	133	L.-M.	10	Kale and Cabbage.	Hilleshog ..	16	April 27	Flat	17	8–9	Potatoes.
	134	M.-H.	5	Silage	Hilleshog ..	17	May 8	Flat	17	8–9	Barley.
433A	135	M.-H.	6½	Wheat ..	Dippe	15	April 25	Flat	17	8–9	?
	136	L.-M.	8½	Lucerne ..	Johnsons ..	15	May 7	Flat	17	8–9	?
434	137	L.-M.	7	Wheat ..	Dippe	15	April 19	Flat	22	10	Barley.
	138	L.-M.	12	Oats	Dippe	15	April 29	Flat	22	10	Barley.
	139	L.-M.	11	Barley ..	Dippe	15	May 7	Flat	22	10	Barley.

* Part failed and was re-drilled † Spacing drill used.

V.L. = Very light. L.-M. = Light to medium. M.-H. = Medium to heavy. F. = Fen, Silt or Warp. S. = Sewage.
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Farm Number.	Field Number.	Soil Class.	Acres.	Preceding Crop.	Variety of Seed.	Seed lb. per acre.	Mean Date of Drilling.	Ridge or Flat.	Distance (ins.) between		Succeeding Crop.
									Drills.	Plants	
435	140	L.-M.	4½	Barley ..	Dippe, Kuhn	20	May 3	Flat	18	8	Sugar Beet.
	141	L.-M.	3½	Kale	Dippe, Marsters	20	April 24	Flat	18	8	Barley.
436	142	L.-M.	4	Barley ..	Kuhn	17½	May 9	Flat	20	8	Sugar Beet.
	143	L.-M.	6	Sugar Beet ..	Dippe, Schreiber	16	May 8	Flat	20	8	Wheat.
437	144	L.-M.	19	Sugar Beet and Oats.	Mixed	15	April 25	Flat	20	8	Barley.
438	145	F.	10	Potatoes ..	Marsters, K.W. "E."	18	May 5	Flat	20	10	Barley.
439	146	L.-M.	6½	Wheat ..	Hilleshog ..	15	May 2	Flat	20	9	Barley.
	147	L.-M.	5	Wheat ..	Marsters ..	15	May 4	Flat	20	9	Barley.
	148	L.-M.	18	Wheat and Oats	Dippe, Kuhn ..	14½	May 12	Flat	20	9	Barley.
440	149	F.	40	Sugar Beet ..	Kuhn	17½	April 28	Flat	20	9	Oats and Potatoes.
	150	F.	15	Barley ..	K.W.	16	May 18	Flat	20	9	Barley.
441	151	L.-M.	20	Barley and Oats	K.W., Kuhn ..	14	May 8	Flat	22½	6–10	Barley.
442	152	L.-M.	8	Roots	Kuhn	14	April 19	Flat	22	12	Barley.
	153	L.-M.	19	Barley ..	Dippe ..	14	May 2	Flat	22	12	Barley.
443	154	M.-H.	6	Mustard (folded).	Mixed	15	May 3	Flat	22	?	Barley.
	155	M.-H.	12	Barley ..	Mixed	15	April 18	Flat	18	?	Barley.
	156	M.-H.	4	Wheat ..	Mixed	15	May 18	Flat	16	?	Barley.
444	157	L.-M.	9	Barley and Oats	Marsters ..	14	April 24	Flat	18–19	7	Sugar Beet.
445	158	M.-H.	14	Barley ..	Kuhn	16	May 9	Flat	21	9	Barley.
	159	L.-M.	8	Potatoes ..	Kuhn	16	May 2	Flat	21	9	Barley.
	160	L.-M.	14	Sugar Beet ..	K.W.	16	May 20	Flat	21	9	Barley.
447	161	L.-M.	4	Wheat ..	K.W.	15	April 13	Flat	18	10	Barley.
448	162	M.-H.	7	Wheat ..	Dippe, Kuhn ..	16	?	Flat	18	8	Mangolds.
449	163	L.-M.	3½	Wheat ..	Kuhn	12	April 27	Flat	18	9	Barley.
	164	M.-H.	4	Oats	Kuhn	24	April 25	Flat	18	9	Barley.
449A	165	L.-M.	2¾	Wheat ..	Schreiber ..	17½	April 27	Flat	18	9	Barley.
	166	M.-H.	4¼	Wheat ..	Schreiber ..	26	May 2	Flat	18	9	Barley.
450	167	L.-M.	2	Cabbage ..	K.W. "Z." ..	20	May 5	Flat	22	8	Brussel Sprouts.
	168	L.-M.	3	Potatoes ..	K.W. "Z." ..	16	May 17	Flat	22	8	Brussel Sprouts.
451	169	M.-H.	8	Sugar Beet ..	Dippe	14	May 1	Flat	18	10	?
	170	M.-H.	12	Seeds	Dippe	14	May 10	Flat	18	10	Sugar Beet.
	171	M.-H.	6	Oats	Dippe	14	May 31	Flat	18	10	Sugar Beet.
452	172	L.-M.	6	Wheat ..	Dippe	14	May 9	Flat	21	10	Barley.
453	173	M.-H.	15	Wheat, Oats and Sugar Beet.	Hilleshog ..	16	April 19	Flat	20	10	Wheat.
454	174	F.	5½	Sugar Beet ..	Kuhn, Marsters	14	April 27	Flat	21	9	Wheat and Potatoes.
455	175	F.	3	Cabbage ..	Kuhn	15	?	Flat	20	10	Cabbage.
456	176	L.-M.	12	Oats	K.W. "Z." ..	7½	May 17	Flat	22	10	Barley.

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APPENDIX C.

YIELD DATA.

Field Number	Yield in Tons per Acre. Unwashed.	Yield in Tons per Acre. Washed.	% Tare.	Effective % * Sugar Content.	lb. Sugar (Sucrose) per Acre.	lb. Sugar (Sucrose) per £ labour.	† Haulage. Miles.	‡ Method of Transport.	Tops per Acre. Estimated Tons.	Tops per Acre. Method of Disposal.	Value. £ s. d.
1	7·990	7·026	12·06	18·4	2896	323			8	Carted off	3 0 0
2	7·990	7·026	12·06	18·4	2896	290			8	Folded	3 0 0
3	7·990	7·026	12·06	18·4	2896	277	½	Road	8	Ploughed in	2 4 0
4	6·765	5·949	12·06	18·4	2453	242			8	Ploughed in	2 4 0
7	7·990	7·026	12·06	18·4	2896	306			8	Folded	3 0 0
8	9·322	8·097	13·16	18·4	3338	354			6	Ploughed in	1 13 0
9	10·305	9·222	10·51	19·3	3987	442	⅛	Road	6	Ploughed in	1 13 0
10	5·579	5·236	6·16	19·7	2309	268			6	Ploughed in	1 13 0
11	8·253	6·877	16·68	17·4	2681	185	1	Rail	8	Carted off	3 0 0
12	7·500	7·000	6·67	19·5	3058	349	1¼	Rail	6	Ploughed in	1 13 0
13	8·479	7·234	14·68	18·1	2932	353			3	Part folded and part ploughed in ..	15 6
14	8·156	6·259	23·26	16·4	2299	196			5	Part folded and part ploughed in ..	1 12 6
15	10·547	9·069	14·01	17·3	3515	352			4	Ploughed in	1 2 0
16	9·744	8·444	13·34	18·4	3481	361	1/16	Road	4	Carted off	1 10 0
17	10·005	9·156	8·48	20·1	4122	399	¼	Rail	4	Folded	1 10 0
18	11·995	10·369	13·55	19·3	4482	608	¼	Rail	5	Folded	1 17 6
19	10·347	9·381	9·34	19·3	4057	464			9	Part carted and part ploughed in ..	3 3 0
20	9·135	8·224	9·97	19·3	3555	372	¼	Road	9	Part carted and part ploughed in ..	2 18 6
21	14·341	12·602	12·12	18·6	5251	348			9	Part carted and part ploughed in ..	3 7 6
22	15·234	13·827	9·24	19·2	5947	406	1½	Rail	9	Part carted and part ploughed in ..	3 7 6
23	8·361	7·873	5·84	19·2	3387	542	1½	Rail	10	Ploughed in	2 15 0
24	10·615	9·319	12·21	17·4	3633	411	2½	Rail	10	Folded	3 15 0
25	9·111	8·388	7·94	18·0	3382	579	1	Road	9	Folded	3 7 6
26	12·433	11·498	7·52	18·0	4637	416			7	Ploughed in	1 18 6
27	11·731	11·049	5·82	17·5	4332	407	½	Rail	6	Part folded and part ploughed in ..	1 19 0
28	10·712	9·750	8·98	18·2	3976	318			8	Ploughed in	2 4 0
29	10·272	7·459	27·38	17·8	2975	257	⅛	Road	8	Folded	3 0 0
30	12·295	11·425	7·08	17·1	4377	313	¼	Road	13	Carted off	4 4 6
31	11·162	10·050	9·97	17·9	4030	348	⅛	Road	8	Folded	3 0 0
32	6·006	5·035	16·17	17·8	2008	249	1/16	Road	5	Folded	1 17 6
33	11·286	10·185	9·76	16·9	3856	370	½	Rail / Road	9	Folded	2 18 6
34	12·235	11·208	8·39	16·6	4168	392	1/16	Road	10	Folded	3 15 0
35	9·086	8·211	9·63	19·8	3642	365			8	Part carted and part ploughed in ..	2 16 0
36	11·342	10·389	8·41	18·4	4282	382	2	Rail	8	Part carted and part ploughed in ..	2 16 0
37	4·072	3·725	8·53	17·0	1418	135	1½ / ½	Rail / Road	2½	Ploughed in	13 9
38	10·154	9·465	6·79	19·1	4050	346			8	Part carted and part ploughed in ..	2 12 0
39	7·704	7·079	8·11	18·2	2886	225	3	Rail	8	Ploughed in	2 4 0
40	10·493	9·532	9·16	17·3	3694	360	2	Rail	8	Carted off	3 0 0
41	11·736	10·475	10·75	18·8	4411	401			6	Carted off	2 5 0
42	11·736	10·475	10·75	18·8	4411	362	¾	Rail	9	Carted off	3 7 6
43	10·331	9·306	9·92	15·4	3210	354	2	Water	12	Ploughed in	2 14 0
44	6·667	6·108	8·38	19·0	2600	220	1/16	Rail	5	Folded	1 17 6
45	9·000	8·187	9·03	17·0	3118	382	⅛	Road	10	Folded	3 5 0
46	9·000	8·187	9·03	17·0	3118	320	¼	Rail	10	Carted off	3 5 0
47	9·000	8·187	9·03	17·0	3118	332	¼	Rail	10	Folded	3 5 0
48	9·000	8·187	9·03	17·0	3118	332	¼	Rail	10	Folded	3 5 0
49	9·000	8·187	9·03	17·0	3118	343	¼	Rail	10	Folded	3 5 0
50	7·674	6·652	13·32	17·0	2533	379	⅛	Road	10	Folded	3 5 0
51	8·000	6·850	14·38	17·2	2639	263			7	Ploughed in	1 18 6
52	10·050	8·794	12·50	16·2	3191	283	1	Rail	7	Folded	2 5 6
53	7·085	6·137	13·37	17·1	2351	241			7	Folded	2 5 6
54	8·667	8·263	4·66	19·2	3554	484	⅛	Road	8	Part carted and part ploughed in ..	2 12 0
56	7·869	7·428	5·60	16·7	2779	224	1	Rail	7	Part carted and part ploughed in ..	2 5 6
57	10·386	9·358	9·90	18·3	3836	438	1½	Rail	7	Part folded and part ploughed in ..	2 5 6
58	12·438	11·235	9·67	17·4	4379	443			12	Folded	3 18 0
59	12·438	11·235	9·67	17·4	4379	403	⅛	Road	12	Folded	3 18 0
60	6·731	6·048	10·22	17·4	2357	232	1½	Rail	7	Folded	2 12 6
61	12·152	11·594	4·59	16·5	4285	496	⅛	Road	12	Ploughed in	2 14 0
62	4·446	4·208	5·35	18·3	1414	198	⅛	Road	3	Folded	1 2 6
63	14·697	13·196	10·21	17·1	5055	390	¼	Road	6	Part carted and part ploughed in ..	1 16 0
64	15·792	14·307	9·40	17·0	5448	424	1½	Rail	10	Part folded and part ploughed in ..	2 11 0
65	13·520	12·181	9·90	17·3	4720	422	¼	Road	6	Folded	1 19 0
66	12·056	10·948	9·19	17·5	4292	308	¼	Road	6	Ploughed in	1 7 0
67	12·493	11·438	8·45	19·4	4970	260			8	Part carted and part ploughed in ..	2 12 0
68	11·118	10·131	8·88	19·9	4516	364	¼	Rail	8	Part carted and part ploughed in ..	2 12 0
69	?	?	?	?	?	?	?	?	?	?	?
70	8·161	7·667	6·06	20·3	3486	288	½	Rail	6	Ploughed in	1 13 0
71	12·152	10·809	11·06	15·7	3801	375			10	Ploughed in	2 15 0
72	7·571	7·168	5·33	16·1	2585	283			10	Ploughed in	2 15 0
73	10·512	9·829	6·50	16·1	3545	307			10	Ploughed in	2 15 0
74	11·040	9·850	10·78	16·6	3663	281	½	Water	10	Ploughed in	2 15 0
75	7·707	6·499	15·67	14·8	2155	186			10	Ploughed in	2 15 0
76	12·211	11·229	8·04	15·4	3874	299			10	Ploughed in	2 15 0
77	10·918	9·583	12·23	18·2	3907	461	⅛	Road	8	Ploughed in	2 4 0
78	6·578	5·785	12·07	18·4	2384	260	1/16	Road	6	Ploughed in	1 13 0
79	16·991	14·186	16·51	17·1	5434	409	⅛	Road	9	Ploughed in	2 0 6
80	4·714	3·994	15·29	16·6	1485	163	¼	Rail	7	Ploughed in	1 11 6
81	5·850	4·973	14·98	16·7	1860	237	¼	Road	5	Folded	1 17 6

* Weighted average of individual consignments. † From field to roadside, wharf or rail station.

‡ From roadside, wharf or rail station to factory; where more than one destination *data* are given in same order as factories in Appendix A.

Field Number	Yield in Tons per Acre. Unwashed.	Washed.	% Tare.	Effective % * Sugar Content.	lb. Sugar (Sucrose) per Acre.	lb. Sugar (Sucrose) per £ labour.	† Haulage. Miles.	‡ Method of Transport.	Tops per Acre. Estimated Tons.	Method of Disposal.	Value. £ s. d.
82	5·345	4·707	11·93	19·8	2088	320	¼	Road	5	Ploughed in	1 7 6
83	9·861	8·887	9·87	18·8	3743	361			6	Ploughed in	1 13 0
84	6·012	5·446	9·41	19·0	2318	229	¼	Road	6	Ploughed in	1 13 0
85	7·740	7·079	8·54	19·5	3092	303			6	Ploughed in	1 13 0
86	12·134	10·686	11·93	18·6	4452	428	¼	Road	8	Part folded and part ploughed in ..	2 8 0
87	13·502	11·185	17·31	17·6	4410	363	1½	Rail	7	Ploughed in	1 18 6
88	12·029	11·100	7·72	17·8	4426	360	¼	Rail	8	Ploughed in	1 16 0
89	12·288	10·415	15·24	18·4	4293	342	⅛	Road	8	Ploughed in	2 4 0
92	9·707	8·042	17·16	17·2	3098	171	⅛	Road	8	Part carted and part ploughed in ..	2 5 6
93	10·750	9·747	9·33	18·0	3930	418			10	Folded	3 5 0
94	10·750	9·747	9·33	18·0	3930	328	¼	Water	10	Ploughed in	2 5 0
95	10·489	9·122	13·04	19·2	3923	379	¼	Road	7	Part carted and part ploughed in ..	2 5 6
96	12·037	11·309	6·05	17·5	4433	473	2	Water	12	Folded	3 18 0
96A	13·948	12·737	8·68	16·9	4822	335	⅛	Road	6	Part carted and part ploughed in ..	2 5 0
96B	14·439	13·005	9·93	16·9	4923	293	2½	Rail	6	Part carted and part ploughed in ..	2 5 0
97	6·920	6·464	12·62	18·0	2606	303	1½	Rail	6	Part carted and part ploughed in ..	1 19 0
98	7·660	5·996	21·73	16·8	2256	182	1½	Rail	6	Ploughed in	1 13 0
99	7·660	5·996	21·73	16·8	2256	197	1½	Rail	6	Ploughed in	1 13 0
100	8·208	7·180	12·52	17·8	2863	394			8	Ploughed in	2 4 0
101	8·208	7·180	12·52	17·8	2863	269	¾	Road	8	Ploughed in	2 4 0
102	8·208	7·180	12·52	17·8	2863	299			8	Ploughed in	2 4 0
103	8·750	7·692	12·09	19·4	3343	277	¼	Road	8	Carted off	3 0 0
104	7·825	6·667	14·79	17·9	2673	364			7	Ploughed in	1 18 6
105	7·825	6·667	14·79	17·9	2673	325	¼	Road	7	Ploughed in	1 18 6
106	7·825	6·667	14·79	17·9	2673	279			7	Ploughed in	1 18 6
107	7·944	7·439	6·36	20·3	3383	265	1½	Rail	8	Ploughed in	2 4 0
108	6·162	5·926	3·81	18·8	2496	196	4	Rail	5	Part carted and part ploughed in ..	1 14 0
109	10·354	9·325	9·94	18·3	3823	327	1	Rail	9	Part carted and part ploughed in ..	2 18 6
110	12·081	11·431	5·38	19·2	4916	334	1	Water	8½	Carted off	3 3 9
111	13·937	12·203	12·44	17·5	4784	433			12	Folded	4 10 0
112	10·864	9·739	10·36	18·2	3970	438	¼	Road	12	Folded	4 10 0
113											
114											
115	?	?	?	?	?	?	¼	Road	?	?	?
116											
117											
118	9·489	8·416	11·31	18·4	3469	354	¼	Road	8	Part folded, part carted and part ploughed in	2 12 0
119	9·489	8·416	11·31	18·4	3469	336			8		2 12 0
120	15·356	13·862	9·73	18·5	5744	494	¼	Road	12	Ploughed in	3 6 0
121	9·197	6·783	26·25	15·8	2401	301			7½	Part carted and part ploughed in ..	2 5 6
122	7·005	5·662	19·16	16·9	2143	257			7½	Part carted and part ploughed in ..	2 5 6
123	8·118	6·867	15·42	19·3	2969	309	¼	Road	7½	Part carted and part ploughed in ..	2 5 6
124	8·118	6·867	15·42	19·3	2969	287			7½	Part carted and part ploughed in ..	2 5 6
125	12·127	9·595	20·88	17·6	3783	416			7½	Part carted and part ploughed in ..	2 12 0
126	7·287	6·535	10·32	16·6	2430	237	¼	Road	7	Folded	2 12 6
127	7·287	6·535	10·32	16·6	2430	299			7	Folded	2 12 6
128	16·492	14·759	10·51	17·2	5686	382	1	Rail	10	Part carted and part ploughed in ..	2 15 0
129	17·415	14·745	15·33	17·2	5681	444			8	Part folded and part ploughed in ..	2 4 0
130	8·925	7·283	18·40	15·6	2545	249	¼	Water	9	Ploughed in	2 0 6
131	8·925	7·283	18·40	15·6	2545	251	¼	Water	9	Ploughed in	2 0 6
132	11·673	10·336	11·45	18·2	4214	294	⅛	Road	10	Ploughed in	2 5 0
133	12·356	10·199	17·46	17·8	4067	317			8	Folded	3 0 0
134	11·942	9·412	21·18	16·5	3479	259	2	Rail	8	Folded	3 0 0
135	11·212	10·348	7·70	17·6	4080	343			8	Folded	3 0 0
136	12·994	11·012	15·26	17·2	4243	296			8	Folded	3 0 0
137	13·398	12·425	7·26	18·1	5038	481			6½	Folded	2 12 6
138	10·061	9·225	8·31	16·7	3451	289	¼	Road	6½	Folded	2 8 9
139	7·092	6·558	7·53	17·6	2585	371			6½	Folded	2 5 0
140	12·358	11·172	9·60	18·2	4555	367	1	Rail	9	Carted off	3 7 6
141	10·600	9·696	8·52	19·7	4279	371			9	Carted off	3 7 6
142	14·597	12·942	11·34	18·7	5421	431	1½	Rail	10	Part folded and part ploughed in ..	3 10 0
143	14·597	12·942	11·34	18·7	5421	478			10	Part folded and part ploughed in ..	3 10 0
144	12·387	11·026	10·98	18·6	4594	546	⅛	Road	9	Part carted and part folded ..	3 1 6
145	12·754	11·659	8·59	17·5	4570	530	⅛	Road	10	Ploughed in	2 5 0
146	8·852	8·094	8·56	18·4	3336	330	¼	Road	7	Part folded and part ploughed in ..	2 8 6
147	11·522	10·297	10·63	18·0	4152	360	6	Rail	7	Part folded and part ploughed in ..	2 8 6
148	9·844	8·479	13·86	17·1	3248	328			7	Part folded and part ploughed in ..	2 8 6
149	12·873	11·471	10·89	16·3	4188	537	¼	Road	14	Part folded and part ploughed in ..	3 15 0
150	11·158	9·386	15·88	15·2	3196	446			14	Part folded and part ploughed in ..	3 15 0
151	11·850	10·732	9·43	19·0	4568	354	1½ Rail, ⅛ Road		9	Part carted and part folded ..	3 7 6
152	10·667	9·361	12·24	18·5	3879	496	¼	Road	6	Carted off	2 5 0
153	10·667	9·361	12·24	18·5	3879	388	3	Rail	8	Part carted and part folded ..	3 0 0
154	13·346	11·481	13·97	18·4	4732	434			9	Folded	3 7 6
155	11·773	10·552	10·36	19·7	4656	382	1	Rail	9	Folded	3 7 6
156	15·562	12·591	19·10	18·3	5161	327			9	Ploughed in	2 9 6
157	11·729	10·206	12·99	18·8	4298	364	⅛	Road	6	Carted off	2 5 0
158	8·060	6·773	15·96	17·8	2701	261	5	Rail	8	Folded	3 0 0
159	8·060	6·773	15·96	17·8	2701	302	¼	Road	8	Folded	3 0 0
160	8·060	6·773	15·96	17·8	2701	290			8	Folded	3 0 0
161	11·037	10·406	5·72	18·9	4405	436	¼	Road	8	Carted off	3 0 0
162	11·048	10·059	8·95	18·9	4259	364	⅛	Road	8	Carted off	3 0 0

* Weighted average of individual consignments. † From field to roadside, wharf or rail station.
‡ From roadside, wharf or rail station to factory: where more than one destination *data* are given in same order as factories in Appendix A.

YIELD DATA—*continued.*

Field Number	Yield in Tons per Acre. Unwashed.	Washed.	% Tare.	Effective % * Sugar Content.	lb. Sugar (Sucrose) per Acre.	lb. Sugar (Sucrose) per £ labour.	† Haulage. Miles.	‡ Method of Transport.	Tops per Acre. Estimated Tons.	Method of Disposal.	Value. £ s. d.
163	8·578	8·086	5·73	19·8	3586	249	1½	Rail	9	Part carted and part ploughed in ..	2 18 6
164	8·578	8·086	5·73	19·8	3586	258			9	Part carted and part ploughed in ..	2 18 6
165	9·755	9·239	5·29	20·5	4243	287			10	Part carted and part ploughed in ..	3 5 0
166	9·755	9·239	5·29	20·5	4243	271			10	Ploughed in	2 15 0
167	10·040	8·967	10·68	17·2	3455	371	1	Rail	8	Ploughed in	2 4 0
168	10·040	8·967	10·68	17·2	3455	382			8	Ploughed in	2 4 0
169	10·139	9·253	8·74	19·4	4021	400	1	Rail	9	Part carted and part folded.. ..	3 7 6
170	13·386	11·610	13·37	18·0	4681	405			9	Part carted and part folded.. ..	3 7 6
171	9·083	7·410	18·42	17·8	2955	291			9	Part carted and part folded.. ..	3 7 6
172	8·900	8·035	9·71	18·9	3402	291	1	Rail	8	Carted off	3 0 0
173	11·134	10·177	8·59	18·0	4103	331	2½	Rail	10	Ploughed in	2 15 0
174	11·545	10·031	13·11	16·1	3618	393	¼	Water	10	Ploughed in	2 5 0
175	17·204	15·375	10·63	16·9	5820	462	1	Rail	12	Ploughed in	2 14 0
176	7·692	6·470	15·89	17·9	2594	232	5	Rail	5	Part carted and part ploughed in ..	1 7 0

* Weighted average of individual consignments. † From field to roadside, wharf or rail station.
‡ From roadside, wharf or rail station to factory: where more than one destination *data* are given in same order as factories in Appendix A.

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