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Department of Agricultural Economics

THE USE OF LABOUR ON FRUIT FARMS AND GLASSHOUSE HOLDINGS

MISCELLANEOUS STUDIES No. 10

PRICE 3/6

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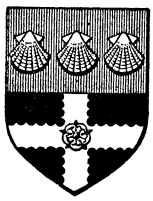

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FOREWORD

This report is the result of an enquiry into the use of labour on fruit farms and glasshouse holdings. The study was carried out by Mr. T. C. Haddow who also prepared a draft report. As Mr. Haddow had left the Department before a final draft could be agreed the present report has been written by Dr. L. G. Bennett with the aid of material prepared by Mr. Haddow.

The Department wishes to record its appreciation of the financial assistance, made available under the Conditional Aid Scheme with funds derived from United States Economic Aid, which made the study possible and its thanks to the growers concerned for their valuable help in providing the records on which the enquiry was based.

Department of Agricultural Economics,
University of Reading.

January, 1957.

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I. INTRODUCTION

In recent years attention has been focussed increasingly on the economic importance of labour to horticultural producers. This increased attention has been due to two facts, the first of which is that labour is the factor of production which figures most prominently in the costs of any business and the second that there has been a marked rise in wage rates. This rise emphasises just how necessary it is that there should be some countervailing increase in labour productivity.

The study of which this report is the result was based on the assumption that any increase in labour productivity, because it could come about only by an increased efficiency in the use of the most important resource, would result in increased profits. In practice, such an assumption is almost certainly correct even though, in theory, a high level of labour productivity on a particular holding is not always synonymous with high profits. In other words, high labour productivity can be dearly bought if it entails the extravagant use of other resources.

In view of the scarcity of detailed information about the use of labour on horticultural holdings one of the first tasks undertaken was to obtain from fruit growers and glasshouse growers as detailed a picture as possible of the volume of labour used throughout a year. But the task which was implicit in this study was to find ways of increasing the productivity of horticultural labour. This task made it highly desirable that some measure of labour productivity should be devised because until labour productivity can be measured it is not possible to assess the effects of attempts to increase it. Moreover, a measure of labour productivity would be very useful in diagnosing management problems.

Having, by the use of the measure or yardstick, established that there are differences in the productivity of labour as between holdings, then what course of action would be most likely to promote an improvement on those holdings with the least satisfactory performance? In this connection, it was decided to examine the use of work simplification as a means of explaining some of the shortcomings in the organisation of labour.

Such, then, was the plan laid down for the study and it was, in fact, closely followed. This report, therefore, is in three parts. The first part illustrates the labour organisation for different types of holding and for different crops in hours of labour per 4-week period over one season. The second part is a discussion of labour productivity measures for use in horticulture. The third part is a description of the results of the application of elementary work simplification to horticultural tasks.

II. LABOUR USE ON FRUIT FARMS AND GLASSHOUSE HOLDINGS

In order to obtain data for this study, a number of fruit growers and glasshouse growers in Hampshire, Warwickshire, Berkshire and the Lea Valley were invited to co-operate with the Department. In all, 12 top

fruit growers and 6 glasshouse growers agreed to provide the necessary information which consisted in the main of a detailed weekly worksheet for each person engaged on manual tasks on each holding for a period of 12 months roughly coinciding with the calendar year 1954. The holdings concerned varied widely in size but hired labour was employed on all of them. The very large scale holdings were avoided, however, because of the sheer physical difficulties of handling with the limited resources available a mass of detailed records for a large number of workers.

As might be expected, the staff on each holding consisted of a somewhat heterogeneous collection of workers, men and women of all ages working full time, part time and on a casual basis. The total number of workers for whom detailed records were obtained was as follows:—

	Fruit holdings	*Glasshouse holdings*
Men—Over 21	52	43
Under 21	2	8
Women and Girls	30	15
	84	66

It was clearly necessary to standardise the hours actually worked on each holding so as to minimise differences between the holdings due to their having staffs of different composition. The actual time spent on each holding by each worker was therefore adjusted to the theoretical equivalent of that which would have been spent by a full-time adult man by using the following conversion rates:—

	Value in terms[1] *of adult man*
Regular workers	
Men 21 and over	1·00
Men under 21	0·75
Women and girls	0·60
Casual workers	
Men 21 and over	0·75
Men under 21	0·60
Women and girls	0·50

Any conversion rate is bound to be arbitrary as it is impossible to calculate the work done by the average woman as compared to the average man. Moreover, the performance of individual workers is seldom average and the relative capability of men and women varies with the nature of the tasks on which they are engaged. Some conversion and standardisation, however, is clearly necessary.

As a result of this process data are available for each of the holdings to show the number of standard hours worked in each week on each holding as a unit, and in each week on the more important groups of jobs. For convenience, however, it was thought wise to show these results as the number of standard hours per four-week period.

[1] Britton and Hunt, Journal of the Royal Statistical Society, Vol. CXIV, 1951.

Top-fruit Holdings

The table below shows the seasonal labour distribution for the group of top-fruit holdings and how it is taken up with the performance of the main kinds of job.

TABLE 1

Seasonal distribution of labour on top-fruit holdings

4-week period	*Standard hours per acre spent on* Spraying	Pruning	Cultivating and mowing	Grubbing, grafting, etc.	Non-productive tasks	Picking and packing	TOTAL
1	0·4	9·0	1·2	1·9	2·5	3·2	19·2
2	0·4	9·0	1·7	2·2	5·8	0·1	19·2
3	0·3	9·0	2·2	1·4	4·5	0·7	18·1
4	2·7	12·0	4·7	0·8	2·6	—	22·8
5	3·5	3·0	9·3	1·6	1·5	—	18·9
6	3·8	1·0	11·6	0·3	1·8	—	18·5
7	5·6	1·6	7·3	0·2	1·7	—	16·4
8	2·6	2·3	7·7	0·2	1·8	—	14·6
9	1·1	2·4	5·3	0·4	2·6	0·9	12·7
10	0·5	1·0	3·4	0·4	3·6	20·9	29·8
11	0·2	—	0·1	—	1·0	46·1	47·4
12	—	0·5	2·0	0·2	1·6	36·4	40·7
13	—	5·5	2·0	2·0	2·9	14·0	26·4
TOTAL	21·1	56·3	58·5	11·6	33·9	122·3	303·7

Table 1 shows how the labour required to perform the various tasks increases as the season advances, spraying times rise to a peak, for instance, in the seventh period, pruning in the fourth, cultivating and mowing in the sixth. Picking and packing are concentrated into the tenth to thirteenth periods, while tasks like grubbing and the non-productive work tend to be carried out when other jobs are of less immediate importance. The table also shows the relative importance of the main tasks as consumers of labour. Picking and packing take up 40 per cent of the total time, pruning 18 per cent, cultivating and mowing 16 per cent, and spraying 7 per cent. Of the remaining 16 per cent of the time consumed, no less than 11 per cent is taken up with so-called non-productive work such as hedging and maintenance.

The time spent on picking and packing depends, of course, to a great extent on the yield but also on the amount of grading, wrapping and general finish given to the market pack. It is not possible to evaluate the quality of the finish but it may be stated that the yield of fruit from these holdings averaged 219 bushels an acre. This means that something over half an hour was spent to pick and pack each bushel of fruit.

The seasonal distribution of labour for three holdings is shown graphically in Figures 1, 2 and 3. The standard hours worked on these holdings have been divided into two categories only, (a) time spent on picking and packing and (b) time spent on all other work. The importance of the peak demand for labour for harvesting is clearly shown, the height

of the peak depends on the yield but also, of course, on the date at which different varieties mature. Holding No. 10 had a yield of 376 bushels per acre, No. 2 a yield of 178 bushels per acre but spread the labour demand by a longer harvesting season, while No. 6 had a yield of 150 bushels an acre. The diagrams clearly show how the times spent on harvesting reflect differences in yield.

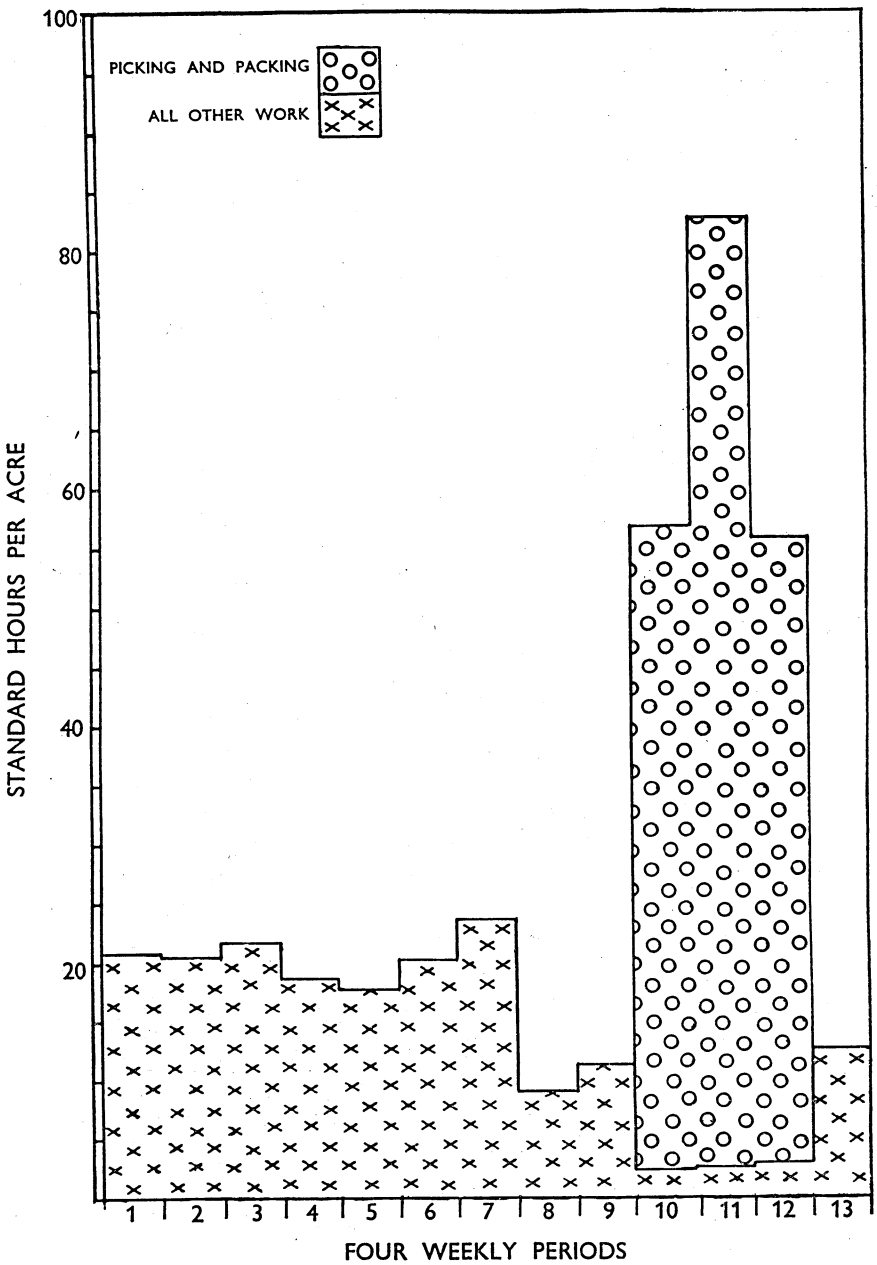

FIGURE 1. Seasonal distribution of labour in top-fruit growing. Holding No. 10.

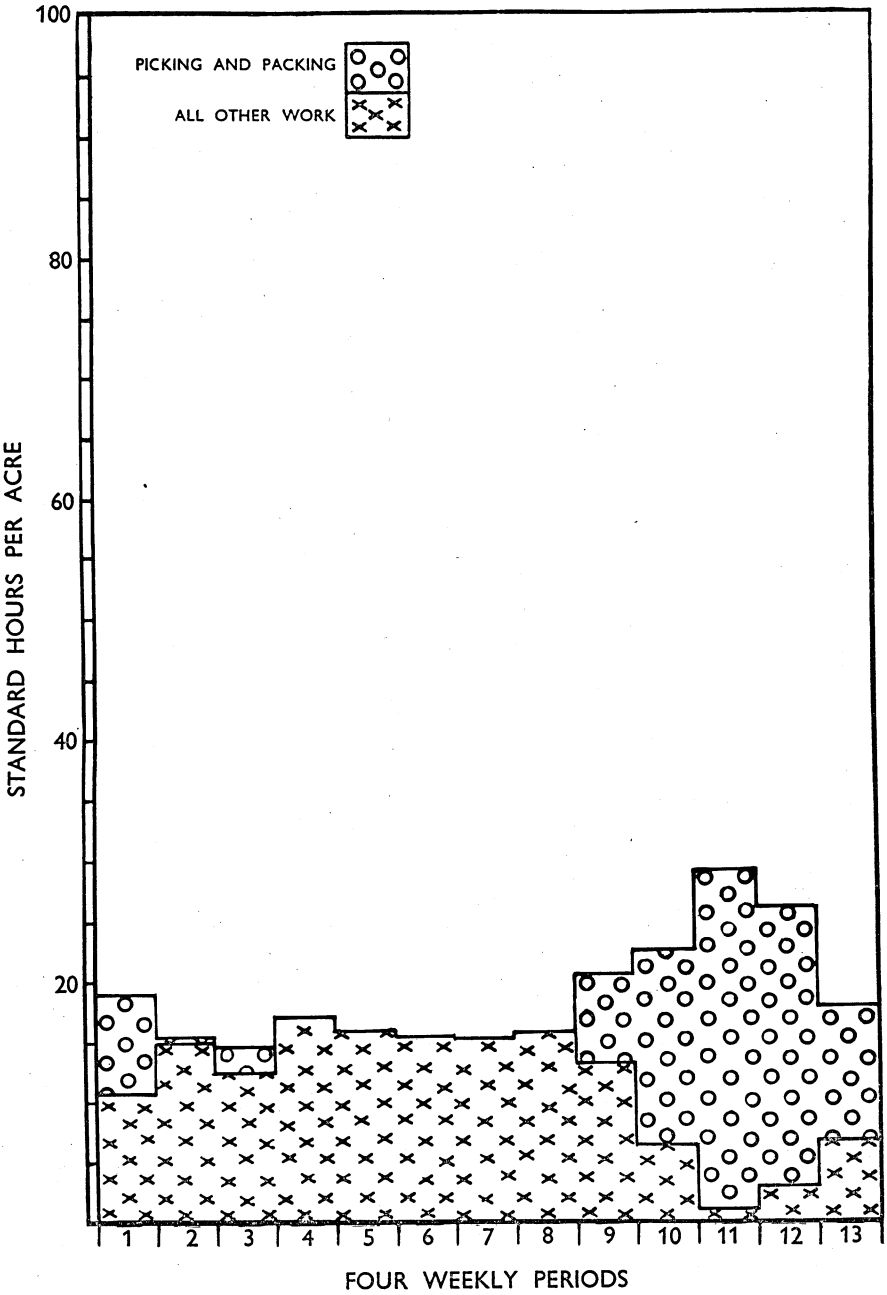

FIGURE 2. Seasonal distribution of labour in top fruit growing. Holding No. 2.

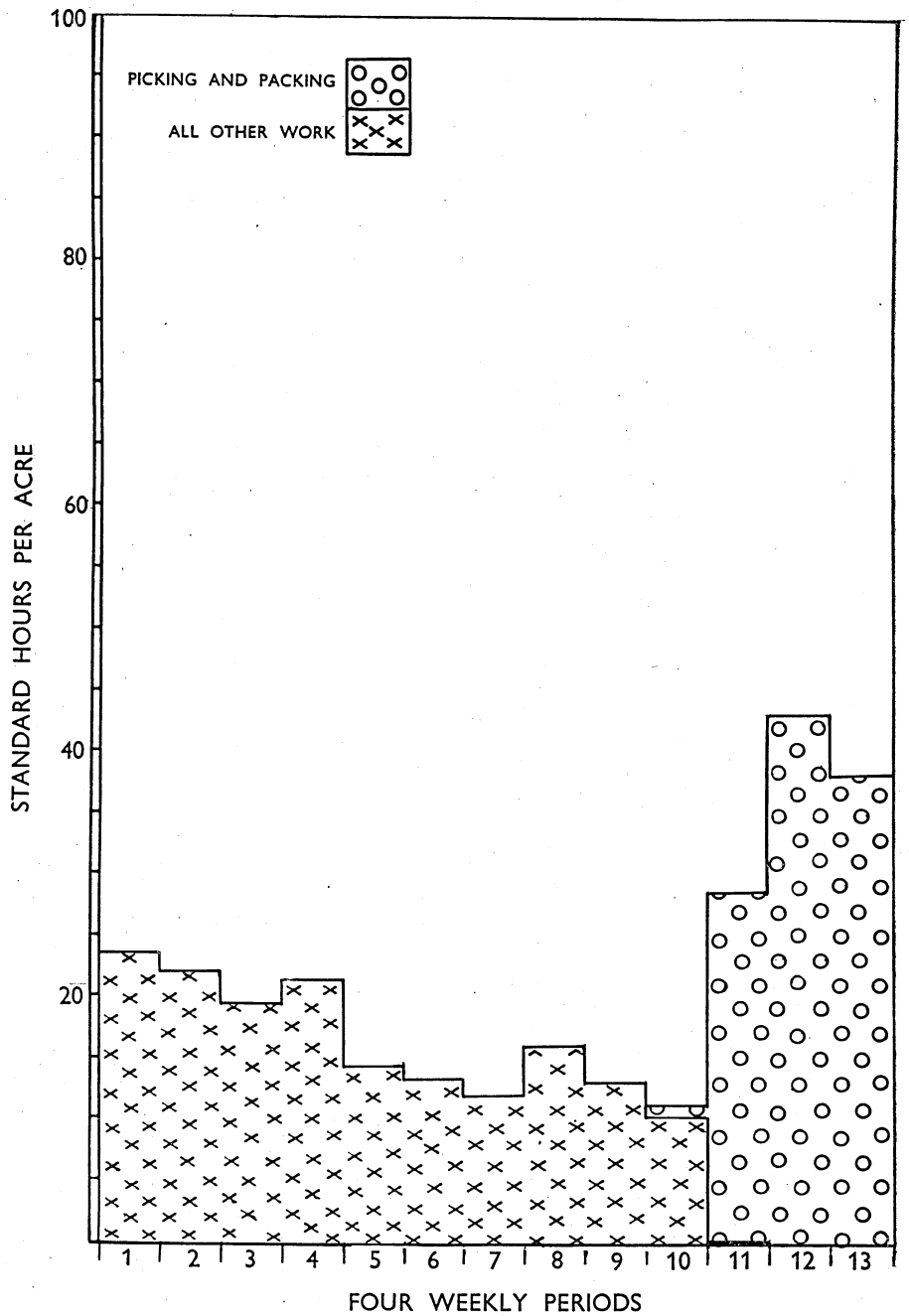

FIGURE 3. Seasonal distribution of labour in top-fruit growing. Holding No. 6.

Glasshouse Holdings

Any general statement on the seasonal distribution of labour on glasshouse holdings would have only limited value because of differences in the crops grown. Thus a holding growing tomatoes only would have a different pattern of labour distribution to the holding growing cucumbers only or to the holding growing tomatoes and winter crops such as chrysanthemums. Instead of giving a general statement in the form of that given for the top-fruit growers it has been thought more instructive to give the seasonal labour distribution in standard hours per acre of glass for each of the six holdings and to show also the kinds of crops grown and their relative importance. This is done in Table 2 below.

TABLE 2

Seasonal distribution of labour on glasshouse holdings

	Standard hours per acre used by holding					
4-week period	No. 18	No. 17	No. 14	No. 16	No. 13	No. 15
1	334	522	874	749	1339	1529
2	458	765	1041	958	1367	1743
3	479	765	1121	1085	1392	1978
4	484	948	1219	1197	1550	1926
5	499	1096	1315	1186	1623	2296
6	453	1186	1388	1402	1669	2216
7	493	1088	1229	1288	1529	2157
8	536	902	1116	1419	1297	2209
9	420	630	508	1156	1361	1528
10	389	591	848	1217	1220	1122
11	310	669	673	1071	1645	1129
12	424	471	112	1104	1498	1559
13	363	431	461	1195	1264	527
	5642	10064	11905	15027	18754	21919
Percentages of cropped area devoted to	%	%	%	%	%	%
Tomatoes ...	20	81	40	—	84	88
Chrysanthemums	—	14	—	—	16	—
Cucumbers ...	80	5	60	50	—	12
Carnations ...	—	—	—	23	—	—
Mushrooms ...	—	—	—	27	—	—
Cash return per acre of each crop grown	£	£	£	£	£	£
Tomatoes ...	4842	7057	Not available	—	5813	5353
Chrysanthemums	—	5414		—	2672	—
Cucumbers ...	4572	5513		7915	—	4883
Carnations ...	—	—		10158	—	—
Mushrooms ...	—	—		7078	—	—

The labour distribution on three holdings is given graphically in Figures 4, 5 and 6, and shown divided between the three crops which they carried, viz. tomatoes, cucumbers and chrysanthemums.

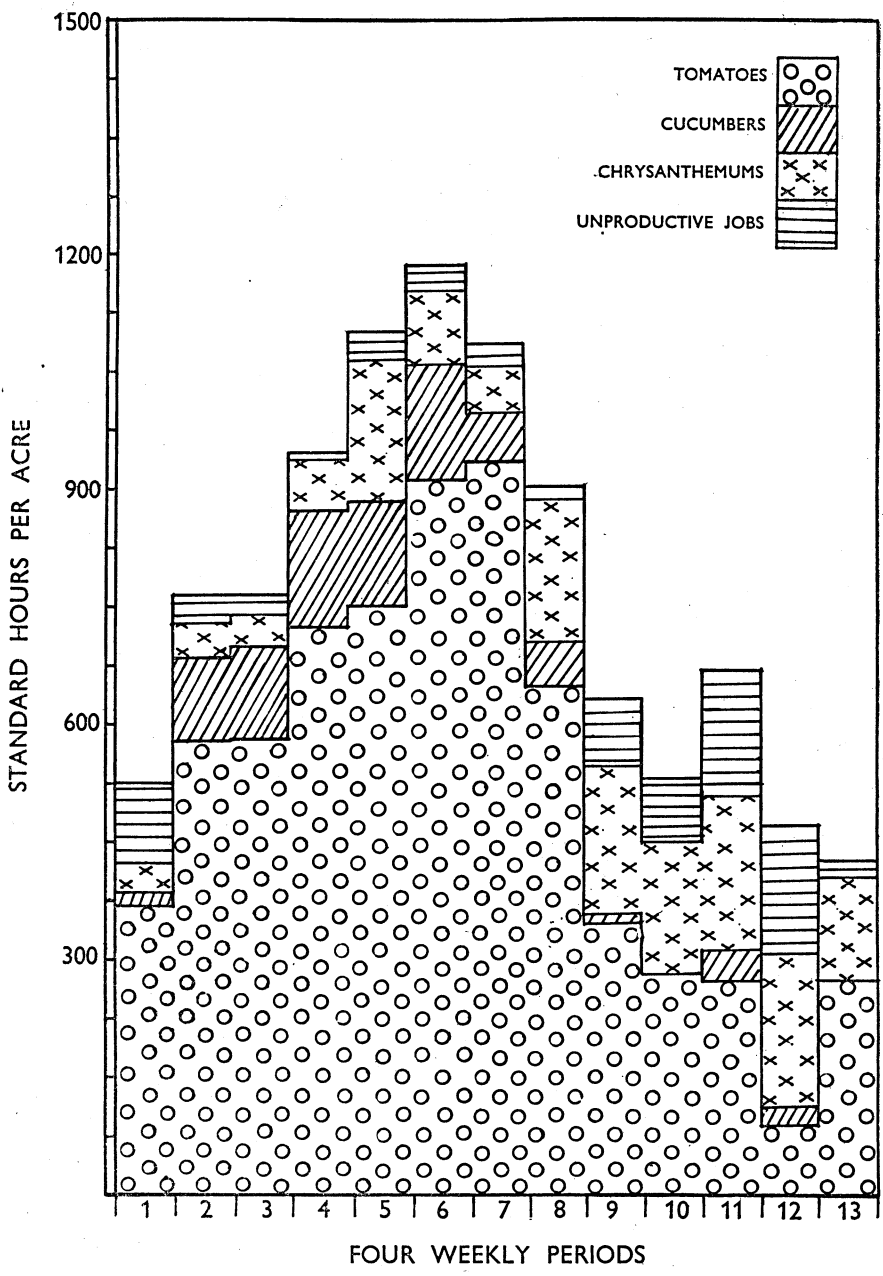

FIGURE 4. Seasonal distribution of labour in glasshouse production. Holding No. 17.

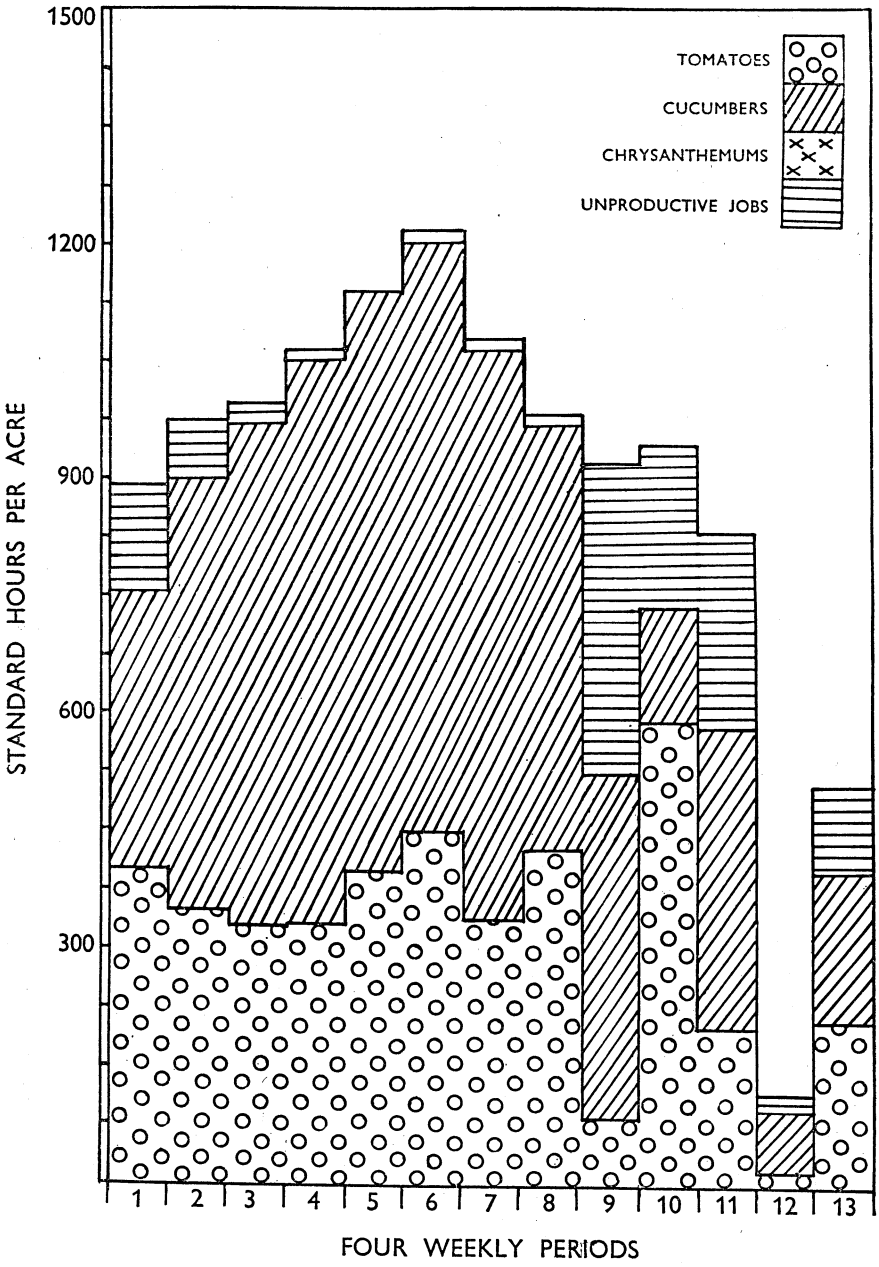

FIGURE 5. Seasonal distribution of labour in glasshouse production. Holding No. 14.

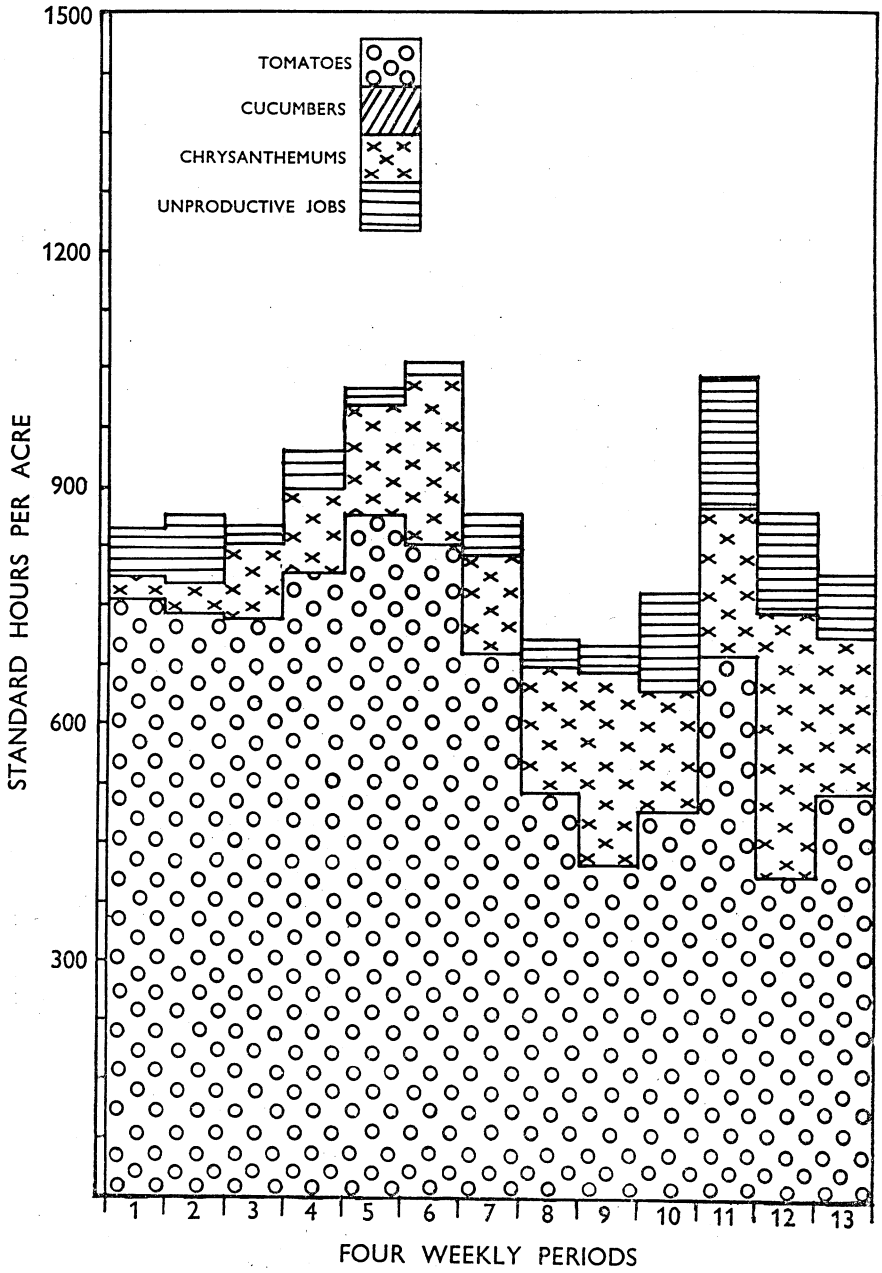

FIGURE 6. Seasonal distribution of labour in glasshouse production. Holding No. 13.

Holdings No. 17 and No. 14 are in the Lea Valley and are able to draw upon supplies of casual labour as necessary. Holding No. 13, on the other hand, has to maintain a relatively constant labour force throughout the year. Fluctuations in the labour used on Holdings No. 17 and No. 14 therefore represent differing numbers of casual workers employed, fluctuations in the labour used on Holding No. 13 mainly represents more or less overtime worked by the regular staff.

Examination of the distribution of labour on the tomato crop on Holdings No. 17 and No. 13 will show that on the former there was a much greater seasonal difference than on the latter. This is accounted for by the fact that Holding No. 17 grew an early crop in all houses while Holding No. 13 spread the season more widely with houses coming into production successively over several months. Both holdings show a falling off in labour demand in the autumn and both have utilised this lull to give attention to the chrysanthemum crop. It would seem that a crop of chrysanthemums, then, could well be regarded as complementary to a crop of tomatoes. It will be noticed, however, that the presence of the chrysanthemum crop materially increases the demand for labour in the summer when labour demands are at their highest. If such peak demands can be met by the employment of casual labour there could be no conflict between the needs of the two crops. If, however, there is a limit to the labour available, then almost inevitably such a conflict must occur.

Glasshouse Crops

The remaining Figures 7 to 12 show the labour distribution for the three main crops grown on these holdings divided for each crop into the various tasks involved in growing them.

These diagrams are self-explanatory but attention might perhaps be drawn to the different circumstances in which the tomatoes are grown on Holdings No. 17 and No. 13, No. 17 using casual labour to a considerable extent and No. 13 depending mainly on a regular staff. The spreading of the season on Holding No. 13 is also evident from the distribution of time spent on picking and packing.

The diagrams of seasonal labour distribution for chrysanthemums clearly show the two peaks, the second of which fits the crop so well with a tomato crop and the first of which is the cause of conflict.

The diagrams of seasonal labour distribution for cucumbers show how different methods of production affect the labour requirements. Holding No. 14, for instance, concentrates on an early crop with little replanting for a second crop. Holding No. 18, on the other hand, clears the early crop and entirely replants, with the consequence that labour requirements are much more uniform over the season.

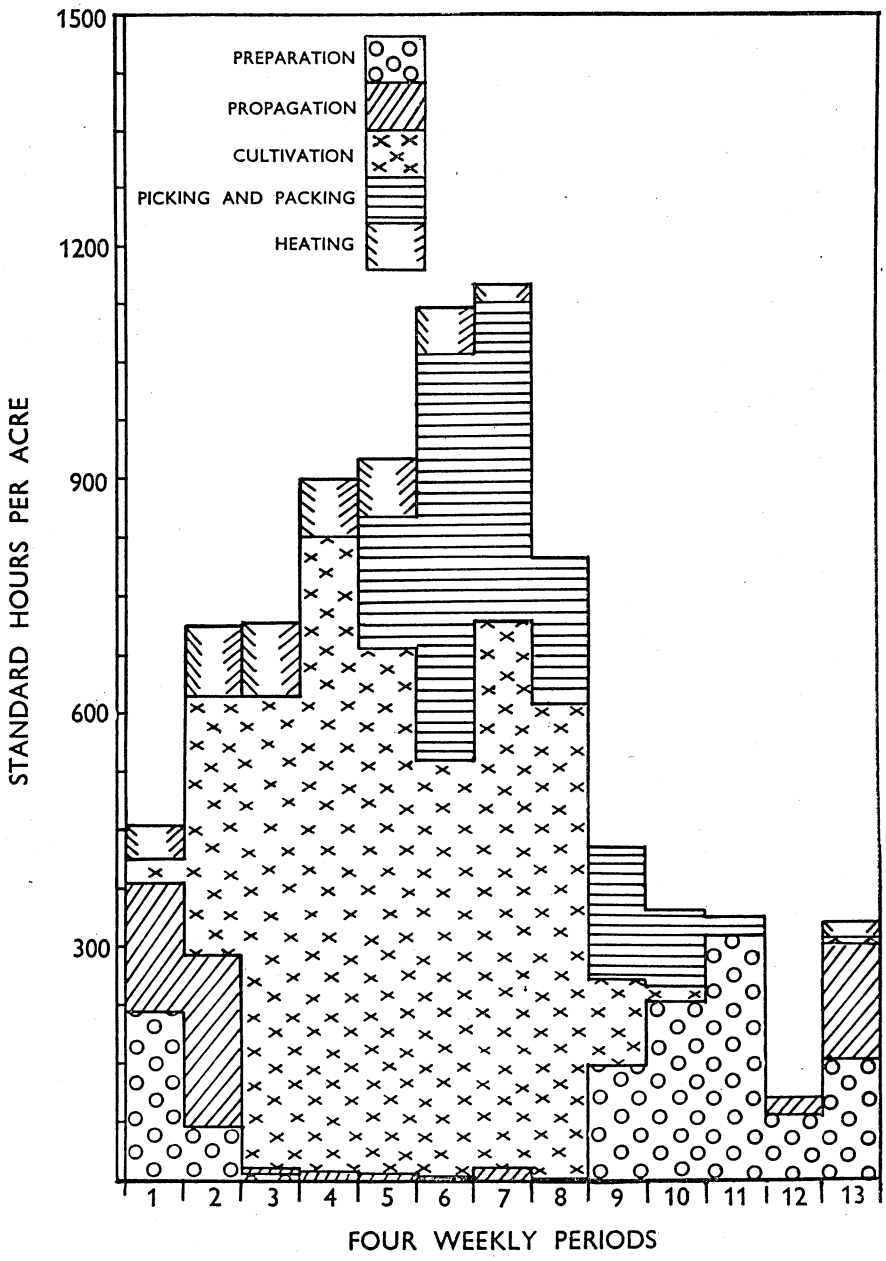

FIGURE 7. Seasonal distribution of labour in glasshouse tomato production. Holding No. 17.

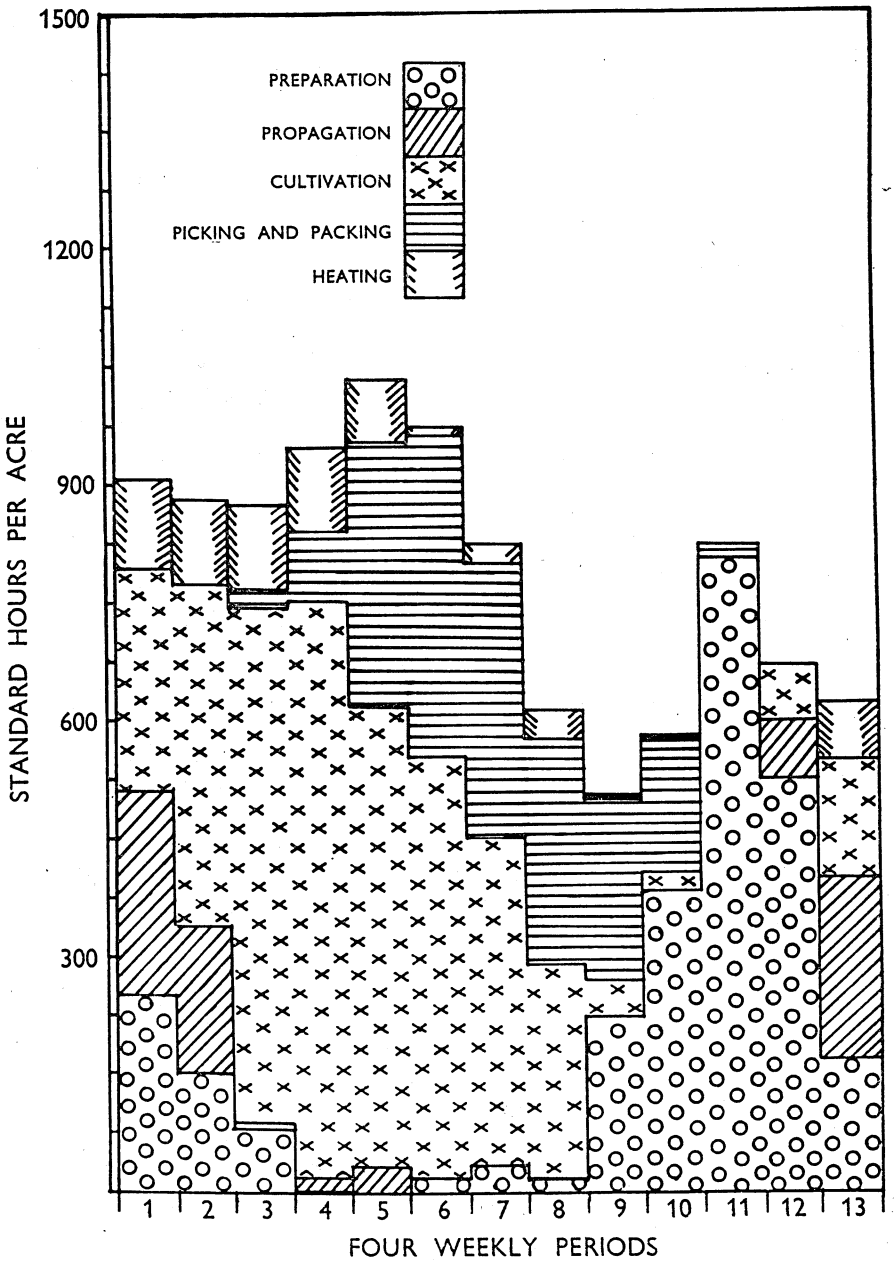

FIGURE 8. Seasonal distribution of labour in glasshouse tomato production. Holding No. 13.

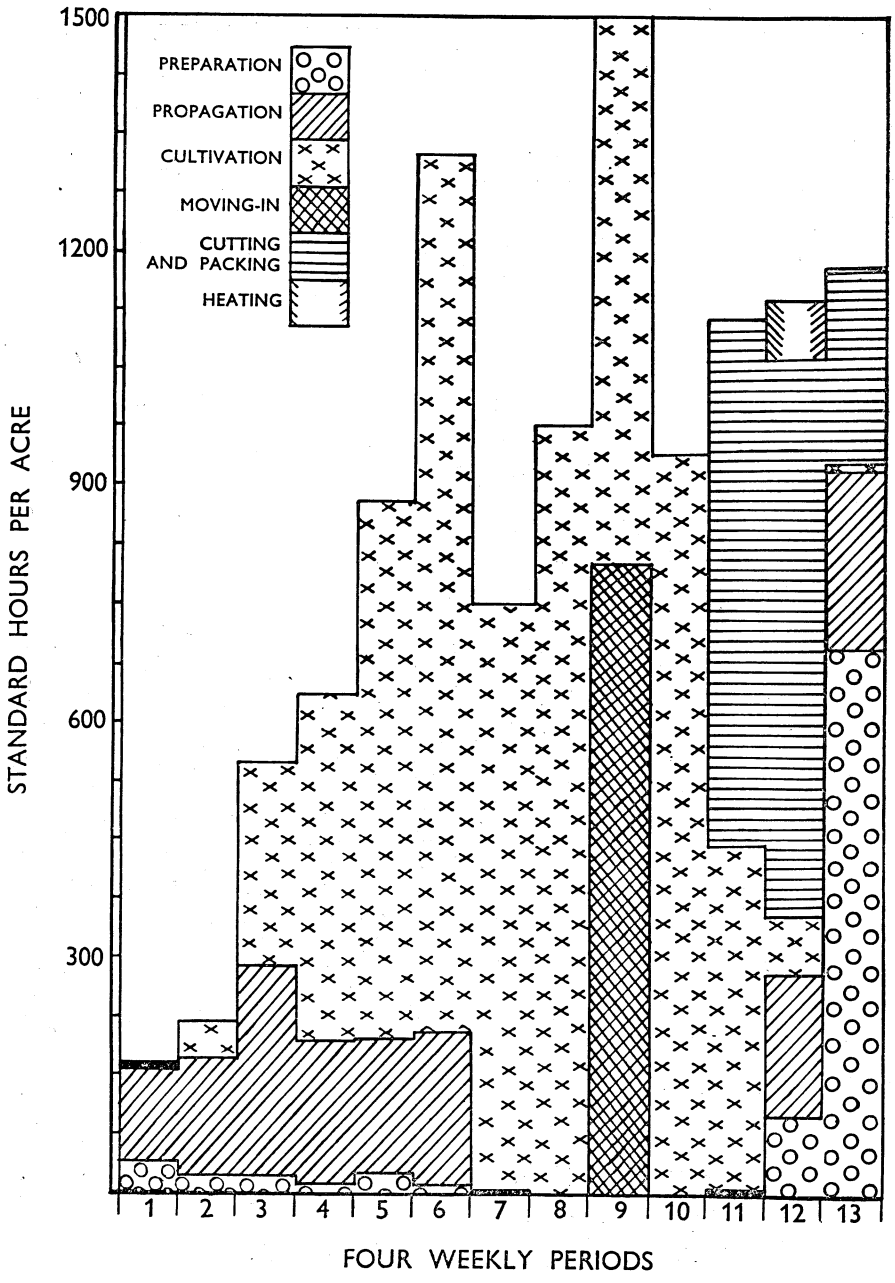

FIGURE 9. Seasonal distribution of labour in glasshouse chrysanthemum production. Holding No. 13.

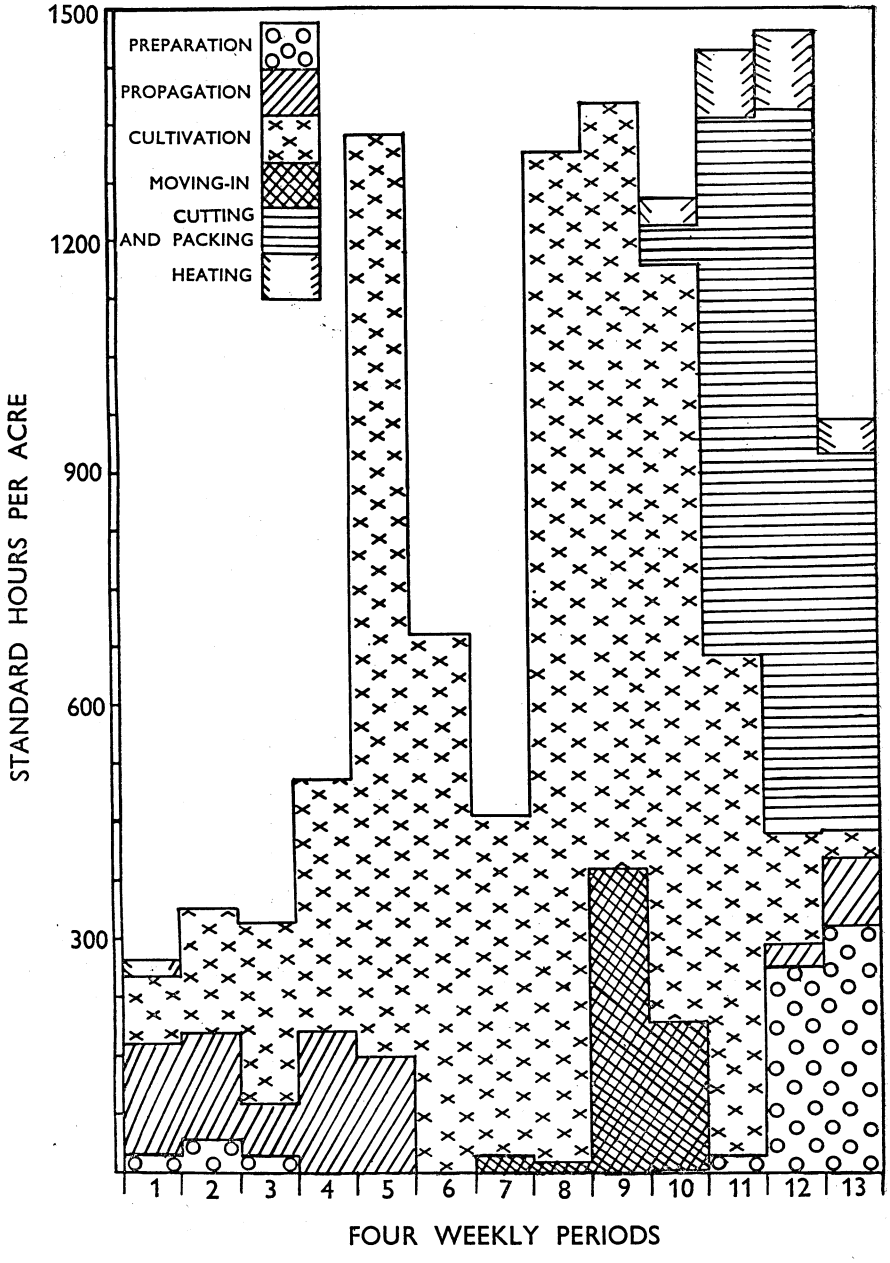

FIGURE 10. Seasonal distribution of labour in glasshouse chrysanthemum production. Holding No. 17.

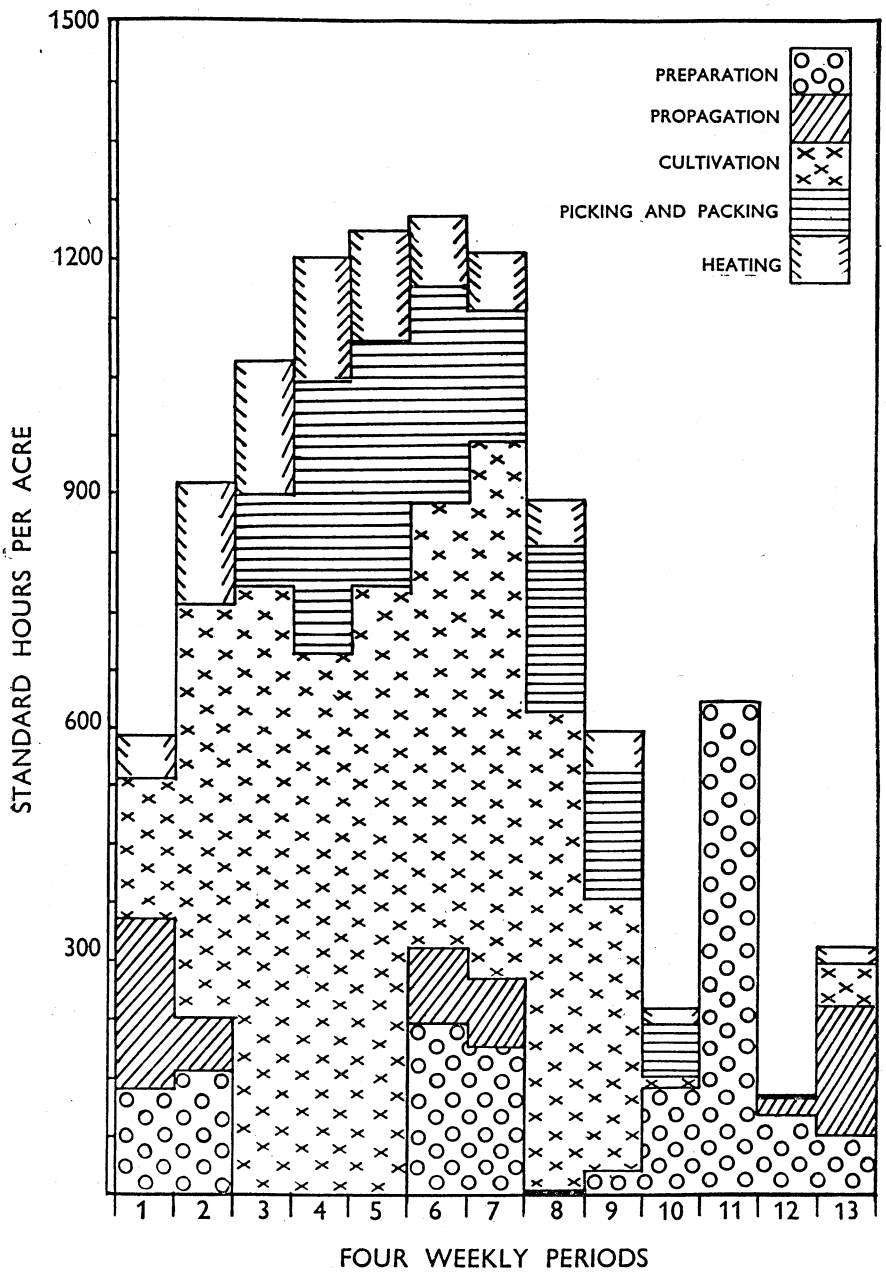

FIGURE 11. Seasonal distribution of labour in glasshouse cucumber production. Holding No. 14.

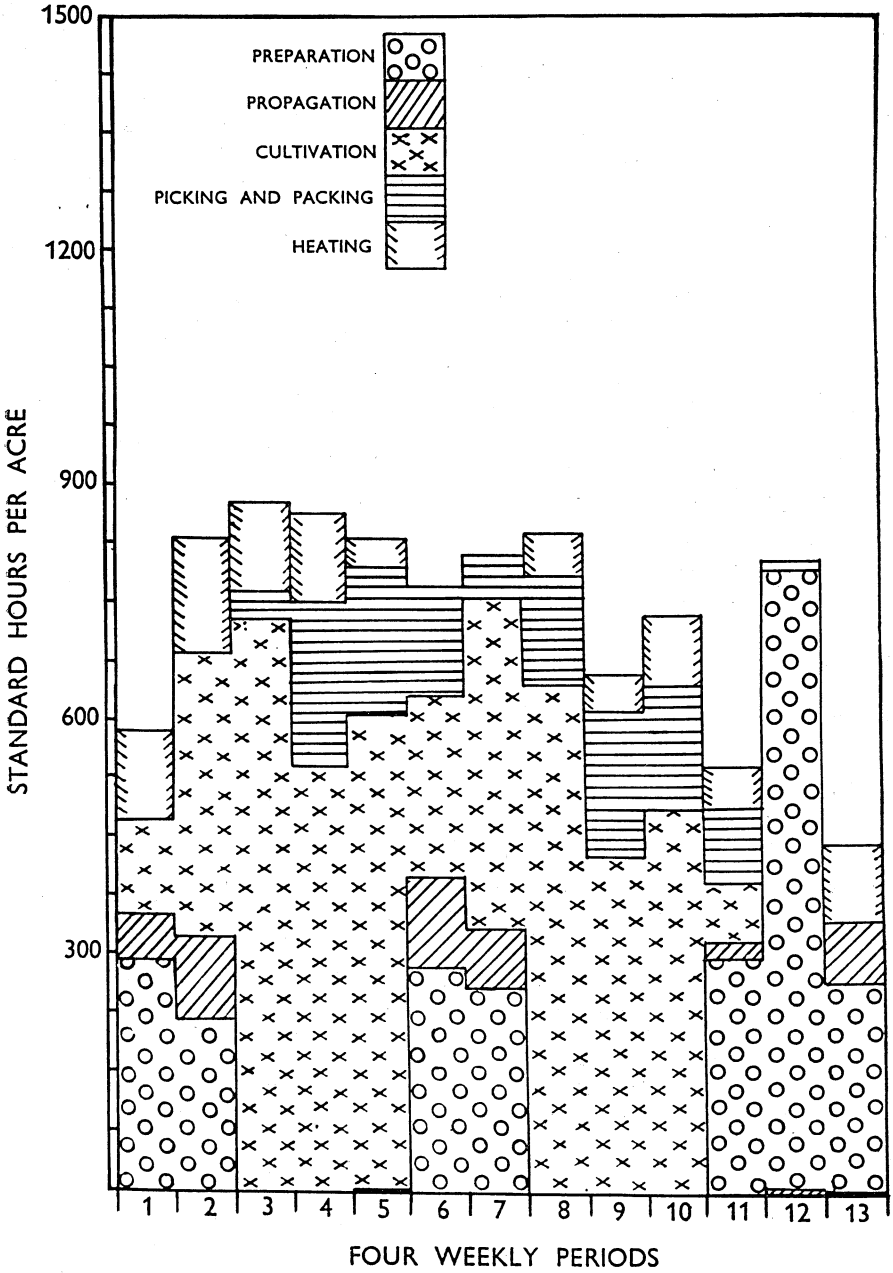

FIGURE 12. Seasonal distribution of labour in glasshouse cucumber production. Holding No. 18.

III. A MEASURE OF LABOUR PRODUCTIVITY

Having given in general and particular terms some examples of labour distribution for two kinds of holding and for three of the more important glasshouse crops the next task is to examine the possibility of measuring the productivity or efficiency of labour either on the holdings concerned or in more general circumstances. Two indices have been in general use in agriculture for some time and appear to have given satisfactory measures of labour productivity. It would be unwise to attempt to devise any fresh index for use in horticulture without first examining the suitability of these existing measures.

The first measure is based on the comparison between the number of so-called 'work units' employed and the theoretical number required. A work unit is the volume of work which an adult man can perform in an eight-hour day and the theoretical number of work units required for different classes of crops and stock has been determined from various studies. A measure of the relative efficiency of labour is obtained by converting into theoretical work units the crops and stock on the holding in question—if the number of work units actually employed exceeds the theoretical requirement then the labour organisation on the holding is in some way defective.

In horticulture, few studies have been made which would provide data on which to calculate a work unit requirement for different crops and so no standard of comparison is available. But even if there were some standard there are factors which invalidate any conclusions from its use. Thus, an early crop of glasshouse tomatoes takes more labour than a later crop of the same weight and consequently the early holding might appear to have a low labour efficiency when, in fact, the value of the product more than compensates for the extra labour used. Again, on fruit holdings the number of work units used would depend upon the yield so that an apparently low labour efficiency might in reality, be no more than the effect of extra heavy yield.

If the work unit method is unsuitable because it fails to take the volume or value of the product into account then it would seem that some measure which does so would have much to commend it. The second kind of index is one which is expressed as a ratio between labour input and the output of the product. As a general guide to labour efficiency this is a very useful measure because an examination of the data available shows that horticultural businesses tend to be less and less profitable the higher is the cost of labour per £100 output.[1] As a relatively refined measure, however, the input-output ratio has a number of shortcomings. It is used, for instance, in farm management advisory work but only alongside appropriate standards which show whether or not the output itself is at a satisfactory level. Again, differences in the age and variety composition of orchards cause greater differences in output than in labour inputs. Short-term price changes may also affect the ratio. A particularly

[1] Bennett, L. G., Labour Productivity in Horticulture, Agriculture, February, 1955.

favourable level of prices would give a relatively high output which in no way reflected the effort put into producing it. Even if the input-output ratio were expressed wholly or partly in physical terms there would still remain the problem of reconciling differing yields of different kinds of fruit, differences which owe nothing to the volume of labour used.

The conclusion drawn is that a general overall index of labour productivity could be constructed for each main branch of horticulture given sufficient financial data and that such an index would be satisfactory in use provided suitable checks were also employed with it and its limitations borne in mind. In view of the complications, however, it would be less than feasible to attempt to construct work unit indices for individual crops.

The limited amount of data available precluded any attempt to devise other forms of index but it was ample to form the basis of an attempt at comparisons between holdings. In view of the severe limitations of the work unit method all the attention has been directed at comparisons on an input-output basis using both a physical and a monetary measure of both input and output. Before this could be done, however, certain adjustments had to be made in the output to take account of those factors other than labour affecting both weight and value of the output, as well as one further adjustment to take account of different wage rates in different areas.

The first adjustment was to obtain standard labour costs for each holding by multiplying the actual hours worked by each class of worker by one of the following wage rates:—

Regular men 21 and over	2s. 9d. per hour
Regular women and girls	2s. 0d. per hour
Casual women and girls	
Regular men under 21 and casual men	

for all jobs except fruit harvesting. For fruit packing and other harvesting work the regular men were reckoned at 2/10½d and the regular women and girls at 2/1d per hour.

The second and subsequent adjustments which were needed applied only to the top fruit plantations. Some orchards consisted wholly of fully productive trees while others contained varying proportions of trees in various stages of growth. Three categories of plantation were distinguished, (a) non-productive, (b) partially productive and (c) fully productive. Growers were asked to state the acreage of each type which they cultivated. The adjustment was made in two stages. First, an allowance was made for the non-productive part by imputing to it the capacity to consume such an amount of labour as had been recorded for a young plantation in S.E. England.[1] Secondly, of the remaining time, harvesting times were divided between fully and partially productive orchards according to yields; other work was divided between the plantations acre for acre.

[1] Butler, J. B., Economics of Fruit Growing. Report No. 1.

The third adjustment was made to take account of the effect of chance climatic factors, such as frost, on the output and also of the suitability of the soil or site for fruit growing. This was done in consultation with the growers concerned.

The fourth adjustment was to convert all weights of fruit to dessert equivalent weights because culinary varieties normally yield heavier weights than dessert varieties. This was done on the basis of the difference in the national estimated yields,[1] and was clearly necessary in any physical comparison between holdings with different proportions of dessert and culinary varieties.

The last adjustment was to take account of the fact that some growers had stores and would therefore incur some costs in storing which would, in effect, reduce the value of the product.[2]

The result of all these adjustments is that quite valid comparisons are possible between holdings on three bases:

(1) Standard hours per 100 bushels output.
(2) Standard costs per 100 bushels output.
(3) Standard costs per £100 output.

Ten of the twelve growers had fully productive plantations. The following table shows the number of standard hours used per 100 bushels output for each holding for five categories of job. The holdings are arranged in ascending order of the total time spent on all tasks per 100 bushels output.

TABLE 3

Hours of labour used by top-fruit growers per 100 *bushels output*

Holding	*Standard hours per* 100 *bushels output spent on*					TOTAL
	Spraying	Pruning	Other productive Work	Non-productive Work	Harvesting and packing	
No. 9	6	19	5	12	57	100
No. 2	6	22	10	21	49	100
No. 8	5	14	10	15	61	114
No. 10	4	23	19	14	52	118
No. 5	4	24	8	3*	81	120
No. 7	12	6	36	18	53	142
No. 1	11	23	34	16	86	169
No. 12	10	27	27	20	87	170
No. 6	13	34	38	27	76	205
No. 11	24	31	33	23	132	242

* This holding had a fruit plantation as part of a farm and market garden. It was able to spread its overhead labour over several enterprises.

The time spent on spraying and pruning per 100 bushels of the crop could well be affected by the yield per acre. The time spent on picking and packing, on the other hand, must be directly related to yield. Differences in the time taken for harvesting must therefore reflect differences in the efficiency with which the work was done and this means

[1] Agricultural Statistics.

[2] Storage costs have been taken as 2/6 per bushel. Folley, R. R. W., "Packing and storing fruit on the farm." Wye College.

differences in the productivity of labour. Differences in the time taken may also, of course, reflect varying degrees of care in performing the tasks involved.

In view of the limitations of the comparison given above it would be wise to pursue the comparison on other bases. The same process is followed in Table 4 as in Table 3 but here the comparison is on a basis of standard cost per 100 bushels output.

TABLE 4

Cost of labour used by top-fruit growers per 100 *bushels output*

Holding	*Labour cost per* 100 *bushels output for* Spraying	Pruning	Other productive work	Non-productive work	Picking and packing	TOTAL
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
No. 2	0 17	3 0	1 6	1 14	7 17	14 14
No. 9	0 16	2 16	0 15	1 15	9 11	15 13
No. 8	0 14	2 0	1 7	2 4	9 5	16 13
No. 10	0 12	3 3	2 8	1 16	8 12	17 11
No. 5	0 11	3 13	1 1	0 9	13 4	18 19
No. 7	1 13	0 16	4 15	2 9	8 2	20 7
No. 12	1 15	3 18	3 19	2 14	12 9	24 5
No. 1	1 9	3 4	4 15	2 4	14 12	26 4
No. 6	1 19	5 9	5 14	4 2	13 10	34 2
No. 11	3 5	4 7	4 15	2 16	20 19	36 2

Substantially the same picture is presented by the second comparison as that given in Table 3. Any differences in the relative position of the growers is due mainly to the varying composition of the labour force.

The most realistic comparison, however, must be that made on the basis of labour cost per £100 output because labour can be used so as to directly increase the value of the product by good grading, wrapping and so on and this would not be taken into account on a cost per bushel comparison. Table 5 below sets out for the ten growers the standard labour cost per £100 output for the several classes of job.

TABLE 5

Standard labour costs per £100 *output of top fruit*

Holding	*Labour cost per* £100 *output for* Spraying	Pruning	Other productive work	Non-productive work	Picking and packing	TOTAL
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
No. 2	0 15	2 13	1 3	1 9	6 18	12 18
No. 9	1 0	3 10	0 19	2 3	11 18	19 10
No. 5	0 13	4 3	1 4	0 11	15 0	21 10
No. 8	1 0	2 17	1 19	3 3	14 15	23 13
No. 1	1 10	3 7	5 0	2 6	15 5	27 8
No. 10	1 0	5 5	3 19	3 0	15 15	28 19
No. 12	1 13	5 4	5 6	3 12	16 12	32 7
No. 7	2 15	1 7	7 18	4 2	17 13	33 16
No. 11	3 6	4 8	4 16	2 16	21 4	36 9
No. 6	2 6	6 7	6 14	4 16	19 15	39 18

Differences in the relative positions of growers in Table 5 as compared to Tables 3 and 4 are due to differences in the prices obtained for fruit sold. Fruit from Holding No. 1, for instance, made a high price while that from Holding No. 7 made a relatively low price.

It would seem that the calculation of the standard labour cost per £100 output provides a valid means of comparing labour efficiency as between holdings. What is not so easy is to say just what level of cost constitutes efficient labour use and what does not. In any case such a statement is bound to be made on a purely arbitrary basis. It is clear, however, that where there are differences in labour cost of such a magnitude as that shown in Table 5, i.e. from £13 to £40, then opportunities exist for improving the labour productivity on those holdings at the more expensive end of the range.

If an input-output comparison is possible on top-fruit holdings is it equally feasible with glasshouse holdings? Glasshouse holdings present a less complicated problem because the only adjustment needed is that to obtain standard costs. Unfortunately, a somewhat limited amount of data is available but nevertheless very considerable differences in standard cost per £100 output are shown to exist on the five holdings for which complete data are available.

TABLE 6

Standard labour cost per £100 *output of glasshouse produce*

Holding	*Labour cost per* £100 *output for* All productive jobs	All non-productive jobs	All jobs
	£ s.	£ s.	£ s.
No. 17	19 8	1 15	21 3
No. 16	20 17	4 3	25 0
No. 18	23 9	2 7	25 16
No. 13	29 7	3 13	33 0
No. 15	27 14	9 12	37 6

Even with no more than five holdings for purposes of comparison it is clear that there are very considerable differences in labour productivity in this branch of horticulture. Part of the apparent difference in productivity, however, springs from differences in management and particularly from those aspects of management concerned with the choice of crops and the system under which they are grown. The available evidence is too scanty to demonstrate differences in labour cost under different systems but three crops were grown by at least two of the five growers and the labour costs of growing them are shown in Table 7.

TABLE 7

Standard labour costs per £100 output for tomatoes, cucumbers and chrysanthemums*

	Labour costs per £100 output for					
	Preparation	Propagation and planting	Heating	Attention to crop	Picking or cutting and packing	TOTAL
Tomatoes	£ s.	£ s.	£ s.	£ s.	£ s	£ s.
No. 17	2 17	1 4	1 0	8 17	3 4	17 2
No. 13	6 7	2 1	1 12	7 16	4 15	22 11
No. 18	3 14	2 5	2 3	8 6	6 7	22 15
No. 15	4 18	2 5	1 6	12 16	4 5	25 10
Cucumbers						
No. 16	3 4	0 6†	0 7	10 4	4 4	18 5
No. 18	6 8	1 5	2 5	12 6	3 9	25 13
No. 15	15 12	1 18	1 17	21 7	4 17	45 11
Chrysanthemums						
No. 17	1 18	3 14	0 16	19 13	5 17	31 17
No. 13	4 17	11 13	0 8	33 12	9 3	59 13

* Excluding cost of unproductive labour which cannot be divided between crops.
† Planting only, plants bought-in.

Again, there are very considerable differences in labour cost as between the holdings and these differences must come about mainly because of the varying capacities of the growers concerned to organise their labour effectively. To some extent, however, differences come about because of different circumstances in the areas in which the growers are situated. Holding No. 17, for instance, uses casual labour very largely and employs just that amount needed at different times of the year. Holdings No. 13 and No. 15, on the other hand, are unable to obtain casual labour at all readily and have to maintain a labour force on a regular basis.

On the evidence obtained from a strictly limited number of growers it would be unwise to attempt to lay down any standard of performance. Clearly, however, given sufficient data such standards could readily be set and, equally clearly, valid comparisons between such standards and the performance of individual holdings are possible. It is hardly necessary to state that such comparisons must be made with care and discretion.

IV. THE APPLICATION OF WORK STUDY (a)

Work study is essentially an empirical process and rarely are the results of one study applicable to another situation. The principles of work study are, however, of wide application and in order to encourage such application as a means of increasing the productivity of labour a few results of some very simple and elementary exercises are given here.

The speeding up of work by the application of work study techniques is not only a desirable objective in itself. For some processes such as fruit tree spraying it is desirable that the task be completed in the shortest possible time otherwise it may not be completed at all. Two studies of fruit tree spraying were carried out, one on Holding No. 10 which had a relatively low labour cost for spraying, and one on Holding No. 16 where the labour cost of spraying was high.

Holding No. 10 showed labour costs for spraying of £1 per £100 output. There were 28 acres of fully productive orchards to be sprayed and the operation was carried out by one man with a tractor-drawn machine fitted with fixed booms. It was clear that the grower had already brought the organisation of the process to a fine art because no improvements to the method of working could be suggested as a result of the study. Two defects in the mechanical equipment were, however, noted. First, the filling orifice was rimmed and the lid recessed within the rim. All sorts of debris collected in the space and was deposited into the tank when the lid was removed. This would not have been of any great importance had the machine been fitted with an efficient filter. The holes in the mesh of the strainer must, however, have been larger than the holes in the nozzles because there was a very considerable amount of time lost from nozzle blockages. It is understood from filter manufacturers that suitable equipment is available at moderate cost.

Holding No. 6, on the other hand, showed spraying labour costs of £2 6s. per £100 output with 20 acres of fully productive and 7 acres of partly productive fruit to be sprayed. A detailed description of the situation and the results of the study are given below.

The filling was carried out in a yard some distance from the orchard. In this yard there was a water tank alongside one end of an open-fronted shed and a water tap 35 yards distant from the other end of it. The tank provided the water for spraying, the shed housed the concentrates, water for mixing them was obtained from the tap.

The spraying machine was drawn by a tractor into the yard and stopped alongside the water tank. Of the spraying team of three, one, the tractor driver, remained on his seat, one remained on the platform at the rear of the machine and one stepped off to get the hose from the water tank to the machine. The one remaining on the machine connected the hose and the tractor driver then started the pump to fill the spray tank. The two spraying operators then walked to the concentrates, a distance of no less than 58 feet. The most usual procedure was for one operator to draw off 5 gallons of lime-sulphur from a 40-gallon drum and for the second to walk to the tap, draw a bucket of water, return to the shed, weigh the two insecticides and measure the spreader and mix the whole in the bucket of water. When the spray tank had filled, the tractor driver disconnected the hose and drove the machine to the place where the mixing had been done, i.e. a distance of 58 feet. The measuring and mixing having been completed, all the concentrates were tipped into the

spray tank, the lid was fixed, the operators climbed on to the machine and the team proceeded to the orchard.

The times recorded for these operations were as follows:—

	Average
To fill the spray tank... ...	12 mins. 45 secs.
To fix hose to pump	31 secs.
To measure lime sulphur ...	2 mins. 6 secs.
To measure spreader	35 secs.
To measure insecticides ...	4 mins. 15 secs.
All operations—start to finish	14 mins. 36 secs.[1]

These times could have been reduced in two ways. First, the concentrates should be moved to the end of the shed next to the water tank and a tap fitted to the tank to provide a nearby source of water for mixing. This would save walking a considerable distance. Secondly, a re-allocation of the measuring and weighing of the concentrates between the workers appears necessary and a speeding up of the tank-filling by running the pump at a faster rate. On one occasion the tank was filled in 10 mins. 13 secs. leaving ample time for the measuring and mixing but if this could be still further reduced by faster filling so much the better. The saving even at 10 mins. 13 secs. for filling is of the order of 27 per cent but perhaps even more important is the inculcation of orderly methods of working and the cumulative effect which this must have on the performance of all tasks.

A similar study was made on filling a spraying machine on another holding which formed no part of the wider study. In this case, the tractor-drawn machine was reversed up to the outlet pipe from an overhead water tank. The tractor driver turned on the water while the two sprayers measured out the D.N.C. concentrate. This was done by raising the 40-gallon drum on to orchard boxes and drawing off 4 buckets-full plus one jug-full. The times taken were as follows:—

	Average
To set machine into position...	1 min. 26 secs.
To fill tank	4 mins. 52 secs.
To measure concentrates ...	5 mins. 0 secs.
All operations—start to finish	6 mins. 18 secs.

If debris littering the yard had been removed the machine could have been drawn directly under the water supply and the reversing time of 1 min. 26 secs. saved. It would not be difficult to devise a ramp for the drum of concentrate so as to speed up the withdrawal of the necessary amount in less than 5 minutes. The time taken to fill the tank at 4 mins.

[1] The 'start to finish' time is less than the sum of the times of constituent jobs because the constituent jobs were performed simultaneously.

52 secs. would then be the total time for the job and clearly attention could then be directed to speeding this process by fitting a larger outlet.

It will be clear that the essence of work study is the breaking of the process down into its elements and then examining each with a view to improving the performance of each and then building up the process again, using so to speak, only those bricks which appear to be necessary. It is essentially a system of analysis and synthesis, and while it is, of course, best applied by those skilled in this special technique, it is obvious that growers can themselves do much to speed up work and to generate an orderly attitude to work by developing this technique under their own particular circumstances.

V. THE APPLICATION OF WORK STUDY (b)

Any horticultural technique which improves the quality of the product can be said to increase the productivity of labour if the addition to the value of the product exceeds the addition to cost occasioned by the extra labour, if any, which is involved. The prospects of increasing the productivity of labour engaged in fruit growing by the simple technique of thinning apple fruitlets was examined and this chapter sets out briefly the results of the study.

The thinning of apple fruitlets is carried out so as to produce a mature crop consisting of fewer but larger fruit than in the absence of thinning. It is a process well known to fruit growers though perhaps not widely practised. The question which the study set out to answer was this: "Would there be any net financial advantage from the process in view of the pros and cons which have to be taken into account?" On the one hand, there would be fewer fruits to pick and pack resulting in a saving of time, the fruits would be larger so that less time and fewer fruits would be required to fill a bushel, and because the fruit was larger it would command a better price. On the other hand, an extra operation would be introduced into the productive process and there might be some reduction in the total yield by thinning.

So far as could be ascertained, no evidence of a technical nature is available to show the extent to which the yield is, or might be, reduced by thinning. The data on yield reduction obtained in the course of this exercise cannot be taken as sufficiently reliable for general acceptance under all conditions but it must be pointed out that this is the crucial point which ultimately determines the profitability of the process and its effect on labour productivity.

For most growers thinning can be assumed to cost nothing. It is carried out at a time of the year when the pressure of work is by no means high and in all probability no *extra* labour would be required to carry it out. It is estimated that a skilled worker could thin fruitlets at the rate of 15 to 20 hours per 100 bushels of subsequent yield but the cost of thinning has for the reason given above been neglected in this exercise.

The material on which the study was carried out consisted of a block of 30 bush Cox's Orange Pippins about 50 years old, and as identical one with another as it was possible to find them. All the trees had received identical spraying, manuring and pruning treatment for many years. In June, 1955, alternate trees were selected and the fruitlets on them thinned to one or two on each truss. The remaining trees were allowed to fruit normally. The mature fruit from each tree was picked and weighed separately and the fruit from the thinned and unthinned trees was kept separate throughout the remaining processes.

The yield from 15 unthinned trees was 35½ bushels and from the thinned trees 30 bushels. If the difference were due to thinning then it is a very serious reduction and amounts to about 18 per cent of the yield of the untreated trees. It is possible that with younger and more vigorous trees the difference would have been smaller as such trees might be expected to react to the process more effectively than old trees.

The time taken, however, to pick the fruit from the unthinned trees was the longer. It took 8·84 minutes to pick a bushel of fruit from the normal trees and 8·11 minutes to pick a bushel from the thinned trees. There were, in fact, fewer but larger apples on the latter and the number of hand movements to gather a bushel was reduced in consequence. Calculated on a per 100 bushels basis this resulted in a saving of 4/-d.

There were, then, 30 bushels of one lot and 35½ bushels in another lot and all grading and packing was performed separately on these two samples. Three points of difference were expected to show up: (a) the time taken in sorting for quality and grading for size, (b) the time taken in wrapping and packing and (c) the value of the fruit because of differences in the proportion of different grades.

The sorting for different qualities was carried out as part of the size grading and each bushel of fruit from the normal trees took 6 mins. 53 secs. to sort into two qualities. The fruit from the thinned trees took 5 mins. 30 secs. per bushel or a saving of 2 hrs. 18 mins. per 100 bushels of fruit. There was, however, a considerable difference in the grading-out percentages from the two samples. This is shown below by the percentages falling into different counts.

Count	*Percentage distribution of counts*	
	unthinned	*thinned*
	%	%
66	10	16
78	18	43
83	9	3
90	26	19
Over 90	37	19
	100	100

The removal of the graded fruit from the sizer bins took 6 mins. 0 secs. per bushel for the fruit from the thinned trees and 7 mins. 38 secs. per bushel from the normal trees. This is equivalent to a saving of 1 hr. 4 mins. 37 secs. per 100 bushels throughput. There was a further net saving of 33 mins. 21 secs. on the resorting and sizing of blemished fruit.

One consequence of the better quality and size of the thinned fruit was that wrapping and packing took longer solely because there were more fruits of a standard normally wrapped and fewer of the counts and qualities which are normally sold unwrapped. In fact, 23 mins. per 100 bushels must be set against the saving in time on the other operations because of the extra wrapping.

The position, then, is that there is a net advantage per 100 bushels in favour of the thinned fruit of 3 hrs. 33 mins. 16 secs. made up as follows:—

	hrs.	*mins.*	*secs.*
(a) Sorting and sizing unblemished fruit ...	2	18	20
(b) Removing unblemished fruit from sizer	1	4	37
(c) Resorting and sizing blemished fruit ...		33	21
(d) Wrapping and packing—*extra time* ...		23	2
	3 *hrs.*	33 *mins.*	16 *secs.*

Taking into account the different grades in each sample and the different prices at which they were selling in 1955-56 there would be a difference in cash returns as between 100 bushels of thinned and unthinned fruit of £4 5s. 0d. It is now possible to estimate the financial consequences of thinning. The advantages per 100 bushels are:—

	£	s.	d.
(a) Extra value of crop	4	5	0
(b) Saving on picking costs		4	0
(c) Saving on grading and packing costs ...		10	6
	£4	19	6

This is equivalent to a saving of about £250 on an orchard of approximately 27 acres. If, however, the reduction in yield is of the order of that noted in this exercise then by not thinning there would be an extra 18 bushels on every 100 and at the prices ruling at the time of the study this would have resulted in an additional income of nearly £35. The grower would therefore be approximately £30 out of pocket by every 100 bushels of his crop. In other words, if thinning reduced the yield by $2\frac{1}{2}$ per cent, then thinning or not thinning would be a matter of indifference because the net advantage of following one practice or the other would be nil under 1955 conditions. Any diminution of yield of less than $2\frac{1}{2}$ per cent would make the process profitable and any of

over $2\frac{1}{2}$ per cent would make it unprofitable. Clearly, further evidence must be forthcoming from appropriate experiments before any reliable statement could be made on the effect of thinning on yield but it must be emphasised that the case for or against thinning (or conceivably other techniques also which affect the use of labour) cannot be settled, unless the technique of work study is used to measure the differences in the amount of labour used.

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