LABOUR IN RELATION TO ECONOMIC EFFICIENCY ON DAIRY FARMS

by

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1952.

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INTRODUCTION.

In 1948-49 labour represented 43.6 per cent of the primary cost structure of milk production(1), made up of 26 per cent direct labour on cows and 17.6 per cent indirect labour connected with milk production. The direct labour is that labour used in caring for cows and includes all time spent on milking, feeding, cleaning, fetching cows, and dairy work.

Indirect labour represents the labour spent in rearing replacement stock, caring for the bull and growing food for the cows. This study will be mainly concerned with the use of direct labour although the inter-relationship of direct and indirect labour will be considered to some extent.

Food is the main item in the direct costs of milk production but the importance of labour has increased considerably since pre-war.

In 1938-39 food made up 58 per cent of the direct costs of milk production(2) whilst labour represented 21 per cent. By 1948-49 food represented 52 per cent whilst labour represented 26 per cent(3). During this time food costs rose to 206 per cent of the 1938-39 figures but cost of labour rose to 275 per cent.

Maunder(4) estimates that for 1947-48 to 1948-49 the direct labour hours per cow for the national herd averaged 164 hours per year. Reliable figures are not available for 1938-39, but the position in the early war years compared with recent years can be deduced from other figures. In 1947-48 the index of labour cost per cow stood at 246 compared with 1939-40 = 100(5) and the index of cowmen's total weekly wages stood at 255(6). If the total hours worked per week by cowmen had remained unchanged during the period, the comparison of the above two indices suggests that labour hours per cow were lower in 1947-48 than in 1939-40.

(6) Calculated from data supplied by The Ministry of Agriculture and Fisheries.
Table 1 shows that basic hours per week went down in the years from 1939-40 to 1949-50 and that, from 1945-46, total hours worked by cowmen also went down. As this latter figure is not available for years previous to 1945-46 it cannot be stated with certainty whether it was higher, lower or the same in 1939-40 as in 1947-48, but Table 1 indicates that it was unlikely to have gone up. The evidence available suggests that labour hours per cow were probably lower in 1947-48 than in 1939-40. Can national statistics explain this decrease or explain the big variations which occur from farm to farm. One possible approach would be to see how dairy cow numbers have changed in relation to the number of cowmen. This approach is useless, however, on two counts.

(a) Figures are not available prior to 1945-46 for numbers of cowmen.

(b) The figures that are available from 1945-46 onwards do not show the total number of men working with cows, they merely show the number of men, over 21, whose main duties are looking after cows. Thus part time cowmen, males under 21, females, partners, non-hired family workers and farmers themselves are not included. This fact becomes very clear if the total number of dairy cattle in England and Wales is divided by the number of male workers over 21 reported as cowmen in 1950\(^{(2)}\) (32,700). This gives a figure of 111.

If these figures are to be taken at their face value it means that one cowman in this country can look after 111 dairy cattle apart from attending to bulls and young stock. This is obviously impossible and rules out the use of the ‘number of cowmen’ figure in an examination of reasons behind changes and variation in labour cost per cow.

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(1) Calculated from data supplied by the Ministry of Agriculture and Fisheries.
(2) Calculated from data supplied by the Ministry of Agriculture and Fisheries.
Assuming that all men working full time with cows work the same number of hours as the class of worker reported as cowmen in 1948-49, the number of dairy cattle looked after by one ‘cowman equivalent’ would equal:

\[
\frac{\text{hours worked by cowman per week} \times 52}{\text{average labour hours per cow for National herd}}.
\]

Using the 1948-49 figure from Table 1 on the top line and Maunder’s estimate on the bottom this fraction becomes:

\[
\frac{55.6 \times 52}{164} = 18 \text{ cows per ‘cowman equivalent’}.
\]

If we divide the number of dairy cattle in England and Wales by this figure we arrive at the number of ‘cowman equivalents’ needed to look after the national herd and this equals 194,600, or over a third of the total regular agricultural labour force in this country in 1948-49, and nearly six times the number of cowmen reported in that year. The above calculation suggests that the 32,700 male, adult hired workers whose main duties were looking after cows represent only 17 per cent of the dairy labour force, leaving 83 per cent of the force to be made up from part time cowmen, males under 21, females, partners, non-hired family workers and farmers. Statistics are not available giving the numbers of workers in these categories who work with cows, but farmer and family labour probably account for a large proportion. In England and Wales 76 per cent of the herds have been estimated to be under 20 cows in size\(^{(1)}\), and in 1948-49\(^{(2)}\) 71 per cent of the labour cost in herds under 20 cows was due to farmer and family labour.

The preponderance of family labour and small herds affects both the scope and method of studying the use of labour in dairying. For labour may not be a limiting factor on small family farms and hence the inter-relationship of labour with other factors of efficiency in dairying, such as yield and feeding efficiency, will need to be studied. Under family farm conditions suggested ways of saving labour and hence reducing costs per cow will only be effective in increasing profits if output can be increased by employing on productive work the labour saved. This can be done by introducing other stock or enterprises, by keeping more cows or by using the ‘saved labour’ to manage the herd more intensively and obtain greater yields or a better feeding

\(^{(2)}\) National Investigation into the Economics of Milk Production. 1948-49. Ministry of Agriculture and Fisheries, London.
efficiency. Any labour saved that is not productively employed should be considered as the cost of the increased leisure obtained by the farm family.

East Midlands milk production figures\(^{(1)}\) show that there is a wide variation in labour costs and labour used. Although on average 167 labour hours per cow per year were used on an identical sample of 45 herds over the three years 1946-47 to 1948-49, the range was from 292 hours per cow in the herd with the highest figure to 99 in the herd with the lowest (Figure 1). Over the same period the labour cost per cow varied from £9.7 to £29.9 and labour cost per 100 gallons from £1.44 to £5.95.

Figures 2, 3 and 4 show the range in labour cost per cow and per 100 gallons and in labour hours per cow around the mean. The coefficients of variation of labour cost per cow and labour hours per cow were almost the same at 32 per cent and 31 per cent respectively, but at 39 per cent the coefficient of variation of labour cost per 100 gallons was higher. This suggests that the other variable contained in this latter measure (i.e. yield) is not closely linked with labour cost per cow, since labour cost per 100 gallons equals:

\[
\frac{\text{labour cost per cow}}{\text{yield per cow}} \times 100
\]

If there were a close relationship between labour cost per cow and yield it could be expected that the coefficient of variation of the distribution of labour cost per 100 gallons would be of the same order as that of the distribution of labour cost per cow.

The extent of, and the reasons for, the wide variation in labour used per cow from farm to farm are studied in subsequent chapters using material obtained from:

(a) Other studies of labour efficiency.

(b) Correlation analysis of East Midlands Milk Production cost figures.

(c) 10 case studies of dairy farms in the East Midlands, involving time and motion studies of work routines and a detailed questionnaire on labour and other factors affecting the efficiency of dairying.

\(^{(1)}\) Figures taken from a sample of farms in Derbyshire, Nottinghamshire, Lincolnshire (Lindsey and Kesteven) and Leicestershire, costed by the University of Nottingham Department of Agricultural Economics, Sutton Bonnington, under the National Scheme for the Investigation of the Economics of Milk Production.
RANGE OF LABOUR HOURS PER COW. 45 FARMS. EAST MIDLANDS. 3 YEAR AVERAGE 1946-47 TO 1948-49.

FIGURE 1.
DISTRIBUTION OF LABOUR COST PER COW. 45 FARMS. EAST MIDLANDS
3 YEAR AVERAGE 1946-47 TO 1948-49.

FIGURE 2.

MEAN £15.9

COEFFICIENT OF VARIATION = 32%
NUMBER OF HERDS

MEAN £2.66

COEFFICIENT OF VARIATION = 39%

LABOUR COST PER 100 GALLONS (£)

1.4 1.8 2.2 2.6 3.0 3.4 3.8 4.2 4.6 5.0 5.4 5.8 6.2

DISTRIBUTION OF LABOUR COST PER 100 GALLONS. 45 FARMS. EAST MIDLANDS.

FIGURE 3.
3 YEAR AVERAGE 1964-66 TO 1966-69.
Figure 4. Distribution of labour hours per cow, 45 farms, East Midlands.

- Mean 167 hours.
- Coefficient of variation = 31%
CHAPTER I.

PREVIOUS WORK DONE IN THIS FIELD.

The bulk of the work done on the efficiency of dairy labour has been of two kinds:

A. The statistical arrangement of correlation of figures about dairy labour obtained in the ordinary course of investigations into the economics of milk production.

B. Studies of dairy labour efficiency involving case studies of work routines, building arrangements and other factors directly affecting the amount of labour used in dairying.

The former have been carried out since a much earlier date than the latter but the latter, by their very nature, have been larger in content and more specific in their recommendations. Considerable work has been done in the U.S.A. and a certain amount in this country on both approaches. The problem has been treated with more urgency in America than here for three main reasons.

Firstly, due to the considerably higher cost of labour per hour there as compared with this country, any saving in hours that has been effected there has resulted in a greater saving in cost than it has here. For example, in Michigan\(^{(1)}\) for the five years 1945 to 1949 the labour cost per hour in looking after cows was 88 cents or about 6s. 2d.\(^{(2)}\) Over the three year period 1946-47 to 1948-49 in the East Midlands the average labour cost per hour in the dairy herds costed was 1s. 10d. or less than a third of the Michigan figures. Over the same periods the average labour hours per cow were 118 in the Michigan sample and 167 in the East Midlands sample. During the period the Michigan dairy farmers reduced their labour hours per cow from 132 in 1945 to 93 in 1949, and the East Midlands farmers reduced their requirements from 173 in 1946-47 to 161 in 1948-49.

Secondly, whereas in this country there are about two hired workers for every farmer, in the U.S.A. there are more farmers and family workers than hired workers. In the East Midlands sample


\(^{(2)}\) Calculated at 2.82 dollars to the pound. If calculated at the rate in force before devaluation of the pound this figure would be 4s. 5d. or still almost two and a half times the East Midlands labour cost per hour.

15
the proportion of the total labour hours represented by hired workers was 70 per cent whilst in the Michigan sample it was only 25 per cent. Where a saving in labour enables a farmer to do without hired help, to have more time for other jobs, or to have more leisure, there is a greater incentive to watch labour efficiency closely than there is when the labour saved is merely that of the hired man. In the Michigan sample, too, the average size of herd at 16.6 cows was only half the average size for the East Midlands sample, a fact which would probably result in more personal supervision by the farmer himself than could occur where herds were larger and more dependant on hired help.

Thirdly, the margin of returns over costs in dairying is very much less in the U.S.A. than it is here and hence there is a greater economic incentive there for the dairy farmer to be efficient. Comparing Michigan and East Midlands figures again we find that the net returns per cow\[^{1}\] and per gallon in the sample of Michigan farms for 1949 were 32 dollars and 3.75 cents respectively, (£11.2 and 3.16d.)\[^{2}\] whilst figures for the East Midlands sample of farms for the same year were £32 and 11.2d., or three times as much per cow and three and a half times as much per gallon.

At first, most of the work done on efficiency in the use of dairy labour in the U.S.A. was based on general investigations into the economics of milk production (Type A) but from 1944 onwards as labour became a more costly item of farm expenditure, more and more studies of work routines, building arrangements and other factors directly affecting the amount of labour used in dairying were undertaken (Type B). About 1943 the Farm Work Simplification Laboratory was set up at Purdue University, Lafayette, Indiana to work in conjunction with the National Farm Work Simplification Project\[^{3}\] and since that time there have been numerous publications issued by the Land Grant Colleges, reporting results of work simplification and time and motion studies.

In England, Dunlop\[^{4}\] first studied labour efficiency by the time and motion approach 24 years ago, but between that time and

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1. Net returns after making allowance for the fact that in the original Michigan cost figures all food is costed at market price. This net return figure includes allowance for difference between farm cost of food and market cost.
2. Calculated at 2.82 dollars to the pound. At the old rate of exchange the figures would be £8 and 2.25d. or one quarter and one fifth respectively of the East Midlands figures.
3. Set up late in 1942 by the United States Department of Agriculture to meet the need for increasing worker productivity essential for the war effort.
the work of Sturrock\(^{(1)}\) and Stubbs\(^{(2)}\) in 1948 all other studies of dairy labour were of Type A.

**Type A. The statistical arrangement of correlation of figures about dairy labour obtained in the ordinary course of investigations into the economics of milk production.**

Numerous milk cost studies in the U.S.A. and this country have demonstrated the effect of size of herd, yield and use of milking machines on labour cost or hours per cow and per gallon. Some studies showed how cows kept per man or daily milk sales per man increased with the size of herd, but others noted that although labour efficiency, as measured by labour hours per cow, increased as size of herd increased, the increase in size of herd was sometimes accompanied by lower average yields per cow. Three factors—size of herd, yield and presence, or absence, of a milking machine—emerge from these early milk cost studies as being the only ones studied, or (and this is more likely) as the only ones this method of approach to labour efficiency was able to study.

Milk cost studies in this country in the Second World War showed the advantage of machine milking over hand milking, the economy in labour which occurred as size of herd increased and the increase in labour cost with increasing yield per cow. Nothing new emerged from these studies. The absolute figures differed from the American ones, but the general trends indicated were the same.

The majority of United States publications studied on this subject tended to emphasise the importance of size—of herd, farm or business. Size may be the predominant factor under conditions where land does not limit the expansion of farm or herd size. But in England where the opportunities for increasing farm size are not so great, the only solution for many small farmers may well be to make the best use of the other factors of efficiency available to them—high yield, correct feed and sound management.

Subsequently publications from the U.S.A. have recognised that many farmers may not be able to do very much to increase the size of their herd or farm, and in the later years of the Second World War this led to the study of the best practices on different types of

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farms to determine how farmers can make the most of the resources available to them.

To summarise the results of this type of study of dairy labour it may be said that:

(a) Herd size stood out as the one factor which was studied more than any other in relation to labour efficiency. All investigators concluded that as herd size increased labour cost or hours per cow decreased due to:

(i) Greater use of milking machines in larger herds.

(ii) Spreading of ‘fixed labour’ needs in doing dairy work, barn work, etc. over a greater number of cows.

(iii) Greater opportunity in larger businesses for productive use of available labour and for the use of labour saving machinery and methods.

(b) There was some evidence that as yield per cow increased the labour cost per cow increased, but usually the increase in yield more than made up for the increase in labour cost and consequently labour cost per 100 gallons decreased as yields increased.

(c) There was no measure of agreement as to the relationship between herd size and yield.

Type B. Studies of dairy labour efficiency involving case studies of work routines, building arrangements and other factors directly affecting the amount of labour used in dairying.

The setting up late in 1942 of the National Farm Work Simplification Project in the United States, together with the publication by R. M. Carter of Vermont of his work on labour saving, marked the beginning of the modern studies on work routines and farm job analysis.

The work of this type, both in England and in the U.S.A. can be classified under three headings:

(i) Descriptive of the prevailing position on case study farms, comparison between these farms and the compiling of average figures for the various jobs done in looking after cows.

(1) R. M. CARTER. *Labour Saving through Farm Job Analysis: I. Dairy Farm Chores.* University of Vermont Agricultural Experiment Station, Burlington. Bulletin 503. 1943.
(ii) **Suggested improvements** for case studied farms and/or description of results attained after improvements.

(iii) **Synthesis of ‘ideal’ methods and routines** to suit different farm conditions. Whilst work under class (i) can stand alone, class (ii) work depends on class (i) for its data, and class (iii) on both (i) and (ii).

It is not proposed here to discuss the details of the works which fall into the above three categories\(^{(1)}\) but rather to summarise their findings and to comment upon them.

The main conclusions of these studies were that:

1. As a factor affecting labour efficiency, size of herd or farm was not entirely within the control of the farmer. On the other hand, work methods could be regarded as being largely within the control of the individual farmer.

2. Study of work methods showed that the farmers with best labour efficiency were the ones with better work methods and equipment.

3. Of all the jobs making up the dairy operation milking was the biggest single one.

4. Most saving in time spent in looking after cows could be effected by study and rearrangement of the milking routine. In attempts to do this a lot of work has been directed towards reducing machine time per cow. The emphasis placed on the quick milking technique\(^{(2)}\) with its insistence on low machine times per cow has influenced and sometimes confused work directed towards reducing time spent on the whole milking operation. It has often been assumed that the quickest machine time per cow is the best one to adopt.

The argument advanced by some workers that high machine time indicates inefficiency is quite legitimate when the reason for high milking time is poor training resulting in the cowman either waiting or doing non-essential jobs such as repeatedly checking or looking at the units. It is also valid when it criticises hand stripping or excessive machine stripping. But it is on very much more doubtful ground when the reason for high machine time is the cowman doing other jobs including looking after another unit. Work in New

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\(^{(1)}\) Publications studied on this aspect of the work are listed under the appropriate headings in the Bibliography. See pp. 96-100.

\(^{(2)}\) As advocated by Professor Peterson of the University of Minnesota.
Zealand(1) for example, has indicated that high output per labour unit per hour should be the goal and that this was generally achieved by each milker operating many units (actually under their conditions ‘sets of cups’ as most of the milking there is of the parlour type), rather than by fast milking time per cow. It has not been shown conclusively that all cows can be trained to milk out in three to four minutes(2) nor has it been shown that to leave a machine on a cow longer than four minutes is harmful. Therefore, the man who leaves a machine on a cow longer than another man is not necessarily less efficient, indeed he may be more efficient if by doing so he can handle more machines or do more milking jobs and hence finish the whole milking operation in a shorter time.

(5) Many studies discussed and compared times and distances taken for dairy jobs on different farms and tried to correlate them with practices and building arrangements without considering the effect of size of herd, yield or general conditions on the farms being compared. Also there was a considerable amount of repetition of exactly the same type of work—times taken for milking, feeding, etc.—the only difference being in the location of the centre from which the work was carried out.

(6) Apart from the work of Hardin(3) and Carter(4) few studies have made allowance for individual farm variations. Hardin and Carter showed that the figures obtained and changes suggested for any one farm were only applicable to that farm and that the importance of such studies lay in their demonstration of how other farmers or their advisors could tackle the problem of labour saving under their own conditions.

Despite this lead towards developing methods of approach rather than setting up standards a number of studies attempted the latter. Averages for milking, feeding and other job times per cow were compiled, often from a relatively small number of observations which varied between wide limits. From such averages a few workers attempted to build up standardised routines for general application.

(2) See Appendix, p. 93, for discussion of this in the light of recent work.
Most studies did not attempt, or profess, to integrate the study of dairy labour with the efficiency of the whole farm or to study the inter-relationship of labour efficiency and efficiencies in other factors affecting dairying profits. Hardin(1), however, went beyond the studies of routines and labour saving methods to which most other studies were confined. He recognised that labour savings could be achieved in three ways:

(a) By improving labour methods and organisation, other productive factors remaining the same.

(b) By altering the other productive factors, for example, type of feed or yield level management, so as to effect a decrease in labour use.

(c) By a combination of (a) and (b).

He also recognised that the productivity of labour could be increased by improving, modifying or changing other factors of production without necessarily altering the actual inputs of labour.

Other workers were no doubt aware of these aspects of labour use in dairying, but few of them went beyond the study of routines to consider the wider implications.

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(1) HARDIN. Ibid.
CHAPTER II.

THE INADEQUACY OF STUDYING LABOUR EFFICIENCY IN ISOLATION.

Most of the work summarised in Chapter I cannot be criticised seriously on content but it can be in relation to depth of outlook. Whilst it has a certain usefulness as descriptive work or as the basis for advisory work, it does not go very far towards ascertaining the fundamental reasons behind given labour usages. It assumes that labour efficiency can be measured in isolation without reference to its interaction with other productive factors.

Ashby once said[1] . . . . "There never can be, either in farm management or in the general social economics of agriculture any absolute standards of production or efficiency . . . . the three simplest standards, per acre, per unit of capital, and per man; each is in fact applied, if not in theory in actual practice, according to those conditions in which any one of the chief factors has to be used to the greatest possible advantage. Where land was plentiful as in Western Canada where it cost a dollar an acre, where labour was scarce and capital cost an average of about 12 per cent per annum, the farmer had to think about the standards of production per unit of capital and per man employed. In parts of India where land is scarce and labour is plentiful and little capital is in use, the standard of production per unit of land will be dominant and so one might go on".

Those who say that only by operating larger herds or farms can higher labour efficiency be achieved fail to recognise that under many farming conditions it may be impossible to obtain more land or increase herd size. To achieve greater all round efficiency, i.e. greater profits from the farm as a whole, a farmer under such conditions may well have to improve his feeding methods, or keep higher yielding cows or even add another non-competitive enterprise. By so doing he can improve his profits per cow or per farm without necessarily having changed his labour efficiency in terms of cost per cow or per gallon.

Each farmer achieves his final profit from his farm or enterprise by the use of all the resources (labour, land, capital and managerial ability) at his disposal. How much of each, what quality of each, and in what proportions he combines them depends on the conditions peculiar to him and his farm.

In dairying the resources available to an individual farmer for the production of milk are:—

(a) Labour: This can be that of the farmer himself, of members of his family, of hired workers or of any combination of these three. The labour may be young, old, skilled, unskilled, capable of taking charge of the whole process or needing personal supervision all the time. It may be in plentiful supply and its real cost, in terms of alternative use, may be small as on many family farms, or it may be very scarce and expensive.

(b) Land: This can be plentiful or scarce, highly fertile or very poor, favourably or unfavourably situated in relation to climate and topography and capable or incapable of alternative uses for growing crops for sale or for supporting other types of livestock.

(c) Capital: This can be in the form of high or low quality cows, buildings and equipment and any combination between different grades of these.

(d) Managerial Ability: This can be of all grades and on its capacity will depend the degree of efficiency to which the capacities of the land, labour and capital available are used.

Even if one assumes that all other productive resources do not vary and only labour has an effect on total output, the assumption made in most of the studies reviewed in Chapter I that the least use of labour is the best is incorrect. For the law of variable proportions applies to the use of labour as to any other productive resource and it will pay a farmer to continue using labour to produce milk until the point is reached where the cost of the last input of labour is just met by the increased output of milk obtained. Referring to Figure 5 a farmer would only stop applying labour at the point A, where diminishing returns begin to operate, if the other fixed services were free. At this point, given this assumption, he would maximise his return per unit of his variable service—labour. A farmer would operate at point B if labour were free, for at this point maximum output is achieved and an additional increment of labour has no effect on output. No one would operate beyond the point B, for to do so would reduce the total output. At this point, a farmer maximises his output per unit of fixed factor. The only significant region in practice, therefore, is that bounded by lines AC and BD. For any given price of product the point between A and B where a farmer will stop will depend on the relative cost of the variable factor (labour) and the fixed factors. As the cost of labour decreases relative to the costs of the other (fixed) factors, so the inputs of labour move towards point B.
FIGURE 5. HYPOTHETICAL RELATIONSHIP BETWEEN OUTPUT OF MILK AND INPUTS OF LABOUR (a)

This variation in the optimum input of labour is the point missed, apparently, in many of the studies quoted in Chapter I. Where the cost of labour in terms of opportunities for alternative use or in monetary terms is small, the amount applied will be close to B. Such a case can be envisaged with an owner-operator, having a limited area of land, limited capital resources, and because of low capacity of the land, no opportunities for alternative use of labour. He will have a high labour cost per cow, probably a high labour cost per 100 gallons, low returns per £100 labour and yet, because he is making the best use of what resources he has available, i.e. obtaining high yields from his small number of cows and feeding them efficiently, he will be operating efficiently.

Unless he is a superlative manager and feeder of cows he will probably not obtain profits equal to those obtained under conditions where more and better productive resources are available. But he certainly cannot be accused of ‘inefficiency’ simply because by any measure his labour usage is high(1).

When one goes a stage further and considers the varying use of labour in relation to varying uses of other productive factors, the unreality of an approach which only considers variable labour inputs becomes even more apparent. Where there is more than one productive factor responsible for the output of a commodity substitution of one resource for another may occur. Not only can one factor be partially substituted for another but different grades and quantities of one factor can be combined in varying proportions with different grades and quantities of other factors. Thus a lot of labour can be used on a few cows or a lot of cows looked after by a small amount of labour and also skilled labour, highly paid, can be employed to attend to high yielding cows or relatively unskilled labour can be used to look after cows of low milk capacity.

If a third factor (for example—feed) is brought into the already three-dimensional relationship between labour, cows and output, the optimum substitution combinations can only be determined mathematically. For the purpose of illustrating the complexities of the problem it is sufficient to consider the three-dimensional relationship between labour, cows and milk output, but it should be remembered that the number of variables in most productive processes is much higher than two. Because of this, the example is still far from presenting a complete picture of the situation.

(1) A discussion of this point in relation to an actual farm studied—Farm 14—will be found in Chapter III, p. 38.
HYPOTHETICAL SUBSTITUTION RELATIONSHIP BETWEEN LABOUR AND COWS IN THE PRODUCTION OF MILK. (a)

FIGURE 6.

(a) After BOULDING, K. E. Economic Analysis. Hamish Hamilton, London. p. 679, Figure 88. 1948.

GALLONS OF MILK PRODUCED

UNITS OF LABOUR

NUMBER OF COWS.
Figure 6 is a graphic representation of the substitution relationship between labour and cows in the production of milk.

The solid figure $OYPRQX$ represents the physical production surface giving all the relationships between the resources, labour and cows, and the product, milk. The point $W$ on this surface represents a certain combination of labour, cows and product quantities. The perpendicular $WZ$ represents the quantity of milk produced by an input of labour of amount $O OX$ and an input of cows of amount $O OY$. The perpendicular $wz$ represents the same quantity of milk as $WZ$, but produced as a result of an input of labour of amount $O Ox$ and of an input of cows of amount $O Oy$. Similarly, from any point on the line $PwWQ$ a perpendicular could be dropped, equal to $WZ$ and representing the same amount of milk, produced as a result of varying combinations of labour and cows. Thus, $PwWQ$ can be said to be the product contour for a given amount of milk produced as a result of differing combinations of labour and cows. The product contour $TUV$ represents a greater quantity of milk than $PwWQ$, produced as a result of a greater total input of factors.

If a product contour map is drawn similar to the contour map of a mountain, product contours or iso-product curves can be drawn on a flat surface representing increasing quantities of milk produced as a result of varying combinations of labour and cows. Figure 7 is an example of this. It shows how any given quantity of milk can be obtained from varying quantities of labour and cow inputs. For example, 30,000 gallons per year can be obtained from the use of five units of labour on 15 cows, i.e. managing them very intensively and getting yields of 2,000 gallons. Alternatively, the same production can be obtained from the much less intensive management of 45 cows giving 666 gallons yield and using only one and a half units of labour.

In theory, the least cost combination of cows and labour for any given product contour can be ascertained as also can the most profitable level of production. But in actual practice the input-output data are not available to enable the theoretical concepts to be worked out.

When it is borne in mind that the above argument has only been concerned with the inter-relationship of two factors and a product, the size of the problem of studying quantitatively one productive factor, (£abour) in relation to all the other factors which jointly combine with it to produce the product, (£milk) becomes apparent. Whilst, therefore, in subsequent chapters, the measurements of labour use,
Figure 7: Hypothetical product contour map expressing relationship between milk produced and varying inputs of cows and labour.
feeding ability, land use, yield level, intensity of stocking, etc. will be
in quantitative terms, of necessity much of the reasoning and the
conclusions drawn as to the relationships existing between labour use
on different farms and the other productive factors appertaining to
those farms will be couched in qualitative terms.

With the background of reasoning as expressed in this
Chapter it was felt that any study of the use of labour in dairying in
the East Midlands should not be confined solely to an examination of
work routines and organisation. Such a study was essential in order
to ascertain the variations in practices and times taken for the various
dairy jobs. But the wide variations in labour costs can only be ade-
quately explained by reference to the other factors affecting the
efficiency of milk production. At least three lines of approach are
possible:

(a) To study factors affecting profits from dairying and
the importance of labour in relation to the other factors, or

(b) To study factors affecting labour efficiency and the
relative importance of the different factors, or

(c) To consider both (a) and (b) and attempt to correlate
the two methods.

It has been decided to adopt the third of these.

Chapter III is concerned mainly with the first approach and
is based on material from:

(a) The 1950-51 East Midlands milk cost sample of the
National Investigation into the Economics of Milk Production.

(b) The National Investigation into the Economics of Milk
Production 1949-50.

(c) A sample of 45 identical farms in the East Midlands for
the three years 1946-47 to 1948-49, obtained for the National In-
vestigation into the Economics of Milk Production.

(d) Case studies of the 10 farms used for Chapter IV.

Chapter IV deals with the second approach using material
from case studies of 10 farms drawn by inspection out of the East
Midlands Milk Cost sample as illustrative of the effect under widely
different conditions of the various factors liable to effect labour effi-
ciency. Some reference will be made to relevant details from Chapter III.

In Chapter V an attempt is made to formulate some con-
clusions from the data discussed in previous chapters.
CHAPTER III.

SOME FACTORS AFFECTING PROFITS FROM DAIRYING AND THE IMPORTANCE OF LABOUR IN RELATION TO THE OTHER FACTORS

This chapter will not treat exhaustively all the factors liable to affect profits from dairying. Such a study, involving detailed analysis of factors affecting yields, feeding efficiency and all other factors in addition to labour, would be outside the scope of this work. The chapter will be concerned, therefore, with the relative importance of the main factors affecting profits and labour's relation to these factors. Five factors will be considered:—volume of production; amount of milk produced at different times of the year; grade of milk; food costs; and labour costs.

(a) Volume of production: This is the product of yield per cow and number of cows kept.

The 1950-51 milk production records of 40 farms in the East Midlands on which dairying was the main enterprise were placed in two groups, one with high and one with low total milk production, in such a way as to eliminate differences in size of farm and the figures shown in Table 2 emerged.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>High production herds group</th>
<th>Low production herds group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of farms</td>
<td>Number</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Size of Farm</td>
<td>Acres</td>
<td>116</td>
<td>114</td>
</tr>
<tr>
<td>Total milk produced per herd</td>
<td>Gallons</td>
<td>22,095</td>
<td>16,678</td>
</tr>
<tr>
<td>Average yield per cow</td>
<td>Gallons</td>
<td>734</td>
<td>668</td>
</tr>
<tr>
<td>Size of herd</td>
<td>Number</td>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>Returns per Cow</td>
<td>£</td>
<td>109.0</td>
<td>97.3</td>
</tr>
<tr>
<td>Net costs per cow</td>
<td>£</td>
<td>72.6</td>
<td>71.7</td>
</tr>
<tr>
<td>Profit per cow</td>
<td>£</td>
<td>36.4</td>
<td>35.6</td>
</tr>
<tr>
<td>Profit per herd</td>
<td>£</td>
<td>1,096.0</td>
<td>639.8</td>
</tr>
</tbody>
</table>

The greater profits per cow and per herd achieved by the farms in the high production group were due to them having more cows with better yields than the farms in the low production group, while net costs per cow were still nearly the same as the latter group.

National figures for 1949-50(1) shown in Tables 3 and 4 show the effect of size and yields on profits.

Except between the 5.0 to 9.9 size group and 10.0 to 19.9 size group where size of herd seemed to be affecting labour cost per cow and herd replacements costs, size of herd did not appear to affect profits per cow, although obviously, it would have an influence on profits per herd. The increase of margin with increase in size of herd shown in Table 3 was more probably associated with the slight yield increase which occurred rather than to a direct effect of size of herd. The drop in yield shown in the 60.0 to 134.5 herd size group as compared with the 50.0 to 59.9 size group was accompanied by a drop in margin per cow despite the fact that the former group had lower labour and food costs per cow than the latter group.
Table 4 shows how yield had a marked effect on profits, margin per cow rising steadily as yield increased. Costs per cow increased with yield but costs per gallon decreased.

When for a sample of 50 herds in the East Midlands in 1950-51 herd size was kept constant and the sample was sorted into a high profit and a low profit group the influence of yield on profits was clearly shown as can be seen from Table 5. The greater margin per cow obtained by the high profit group was almost entirely due to the higher yield obtained coupled with a slightly higher percentage of T.T. milk being sold.
### FACTORS AFFECTING PROFIT PER COW—HERD SIZE CONSTANT.

#### TABLE 5. 50 HERDS. EAST MIDLANDS 1950-51.

<table>
<thead>
<tr>
<th>Item</th>
<th>High Profit</th>
<th>Low Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of herds</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>No. of cows per herd</td>
<td>29.2</td>
<td>28.4</td>
</tr>
<tr>
<td>Yield per cow—gallons</td>
<td>756</td>
<td>648</td>
</tr>
<tr>
<td>Per cent of milk sold October—March</td>
<td>49.9</td>
<td>48.4</td>
</tr>
<tr>
<td>No. of T.T. producers</td>
<td>18</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Per Cow</th>
<th>Per Gallon</th>
<th>Per Cow</th>
<th>Per Gallon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchased foods</td>
<td>23.8</td>
<td>7.54</td>
<td>23.0</td>
<td>8.51</td>
</tr>
<tr>
<td>Home grown foods</td>
<td>16.4</td>
<td>5.21</td>
<td>17.3</td>
<td>6.41</td>
</tr>
<tr>
<td>Grazing</td>
<td>3.8</td>
<td>1.22</td>
<td>3.6</td>
<td>1.32</td>
</tr>
<tr>
<td>Total foods</td>
<td>44.0</td>
<td>13.97</td>
<td>43.9</td>
<td>16.24</td>
</tr>
<tr>
<td>Labour</td>
<td>15.8</td>
<td>5.01</td>
<td>15.6</td>
<td>5.79</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>11.7</td>
<td>3.74</td>
<td>9.6</td>
<td>3.56</td>
</tr>
<tr>
<td>Herd replacement</td>
<td>2.2</td>
<td>0.70</td>
<td>5.3</td>
<td>1.96</td>
</tr>
<tr>
<td>Gross farm costs</td>
<td>73.7</td>
<td>23.42</td>
<td>74.4</td>
<td>27.55</td>
</tr>
<tr>
<td>Credits</td>
<td>3.6</td>
<td>1.16</td>
<td>3.4</td>
<td>1.25</td>
</tr>
<tr>
<td>Net farm costs</td>
<td>70.1</td>
<td>22.26</td>
<td>71.0</td>
<td>26.30</td>
</tr>
<tr>
<td>Farm returns</td>
<td>113.7</td>
<td>36.12</td>
<td>92.6</td>
<td>34.31</td>
</tr>
<tr>
<td>Margins</td>
<td>43.6</td>
<td>13.86</td>
<td>21.6</td>
<td>8.01</td>
</tr>
</tbody>
</table>

(b) *Amount of milk produced at different times of the year and grade of milk*: While both these factors increase returns they are not *in themselves* sufficiently important to show their effect if a sample of farms is sorted on the basis of one or the other. The effect of yield, size of herd, or food and labour costs tend to override the effects of seasonality or grade. For example, Table 6 represents an attempt to keep yields constant by paired analysis and to sort the 1950-51 East Midlands sample on the basis of percentage of milk produced in winter. It was found that:

(i) The yield was not kept constant.

(ii) The sample sorted out with a very different average herd size in the two seasonality groups.

(iii) The difference in margin shown between the high winter milk production group and the low group was due more yield, to labour costs and the proportion of T.T. producers than to the effect of seasonality.

However, reference to Table 5 shows that the high profit group had more T.T. producers and a slightly higher proportion of winter milk, indicating that these factors are of importance when taken in conjunction with other factors.

(c) *Food costs*: For the National sample in 1949-50 food costs represented 52 per cent of the direct costs of milk production. East Midlands figures for 1950-51 showed that the 10 herds with the
HERDS SORTED ON BASIS OF PERCENTAGE WINTER MILK PRODUCTION ATTEMPTING TO HOLD YIELD CONSTANT.
61 HERDS. EAST MIDLANDS 1950-51.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>High winter milk production group</th>
<th>Low winter milk production group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herds</td>
<td>Number</td>
<td>30</td>
<td>31</td>
</tr>
<tr>
<td>Size of herd</td>
<td>Number</td>
<td>38</td>
<td>19</td>
</tr>
<tr>
<td>Yield per cow</td>
<td>Gallons</td>
<td>717</td>
<td>691</td>
</tr>
<tr>
<td>T.T. producers</td>
<td>Number</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>Winter milk production</td>
<td>Per cent</td>
<td>56</td>
<td>48</td>
</tr>
<tr>
<td>Food costs</td>
<td>£ per Cow</td>
<td>44.8</td>
<td>44.6</td>
</tr>
<tr>
<td></td>
<td>Per Gallon</td>
<td>14.98</td>
<td>15.30</td>
</tr>
<tr>
<td>Labour costs</td>
<td>£ per Cow</td>
<td>15.0</td>
<td>15.2</td>
</tr>
<tr>
<td></td>
<td>Per Gallon</td>
<td>5.01</td>
<td>6.67</td>
</tr>
<tr>
<td>Returns</td>
<td>£ per Cow</td>
<td>106.0</td>
<td>100.8</td>
</tr>
<tr>
<td></td>
<td>Per Gallon</td>
<td>35.48</td>
<td>35.04</td>
</tr>
<tr>
<td>Margins</td>
<td>£ per Cow</td>
<td>34.9</td>
<td>36.1</td>
</tr>
<tr>
<td></td>
<td>Per Gallon</td>
<td>11.68</td>
<td>9.08</td>
</tr>
</tbody>
</table>

lowest food costs per gallon made three times as much profit per gallon and four times as much profit per cow as the 10 with the highest food costs per gallon, (see Table 7).

THE EFFECT OF FEED COSTS PER GALLON ON COSTS AND RETURNS.
EAST MIDLANDS 1950-51.

<table>
<thead>
<tr>
<th>Item</th>
<th>10 herds with highest food cost per gallon</th>
<th>10 herds with lowest food cost per gallon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed costs</td>
<td>£ per cow 50.9</td>
<td>£ per cow 22.20</td>
</tr>
<tr>
<td></td>
<td>d. per gallon 21.20</td>
<td>d. per gallon 10.93</td>
</tr>
<tr>
<td>Total net farm costs</td>
<td>£ per cow 72.2</td>
<td>£ per cow 60.4</td>
</tr>
<tr>
<td></td>
<td>d. per gallon 30.07</td>
<td>d. per gallon 20.12</td>
</tr>
<tr>
<td>Returns</td>
<td>£ per cow 84.4</td>
<td>£ per cow 106.3</td>
</tr>
<tr>
<td></td>
<td>d. per gallon 35.15</td>
<td>d. per gallon 35.40</td>
</tr>
<tr>
<td>Margins</td>
<td>£ per cow 12.2</td>
<td>£ per cow 45.9</td>
</tr>
<tr>
<td></td>
<td>d. per gallon 5.08</td>
<td>d. per gallon 15.28</td>
</tr>
<tr>
<td>Size of herd</td>
<td>24.5</td>
<td>38.5</td>
</tr>
<tr>
<td>Yield per cow—gallons</td>
<td>576</td>
<td>720</td>
</tr>
</tbody>
</table>

The greater feeding efficiency of the herds with the lowest food cost per gallon came from lower unit costs of food and much more efficient feeding of it as is shown in Table 8.

QUANTITIES OF FOOD FED PER GALLON AND UNIT COSTS PER TON.
EAST MIDLANDS 1950-51.

<table>
<thead>
<tr>
<th>Item</th>
<th>10 high feed cost per gallon herds</th>
<th>10 low feed cost per gallon herds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average yield—gallons</td>
<td>576</td>
<td>720</td>
</tr>
<tr>
<td>Purchased concentrates</td>
<td>lbs. per gallon 2.68</td>
<td>lbs. per gallon 1.82</td>
</tr>
<tr>
<td></td>
<td>£ per ton 29.2</td>
<td>£ per ton 26.2</td>
</tr>
<tr>
<td>Home grown concentrates</td>
<td>1.63</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td>£ per ton 12.1</td>
<td>£ per ton 10.7</td>
</tr>
<tr>
<td>Total concentrates</td>
<td>4.31</td>
<td>3.05</td>
</tr>
<tr>
<td></td>
<td>£ per ton —</td>
<td>£ per ton —</td>
</tr>
<tr>
<td>Hay and straw</td>
<td>6.16</td>
<td>2.55</td>
</tr>
<tr>
<td></td>
<td>£ per ton 5.6</td>
<td>£ per ton 4.4</td>
</tr>
<tr>
<td>Silage</td>
<td>2.49</td>
<td>2.70</td>
</tr>
<tr>
<td></td>
<td>£ per ton 2.6</td>
<td>£ per ton 2.6</td>
</tr>
<tr>
<td>Roots</td>
<td>15.87</td>
<td>6.19</td>
</tr>
<tr>
<td></td>
<td>£ per ton 2.6</td>
<td>£ per ton 2.2</td>
</tr>
<tr>
<td>Total bulk</td>
<td>24.52</td>
<td>11.52</td>
</tr>
<tr>
<td></td>
<td>£ per ton —</td>
<td>£ per ton —</td>
</tr>
</tbody>
</table>
Labour costs: Labour represented 26 per cent of the direct costs of milk production for the 1949-50 National sample and showed a wide variation in cost per cow and per gallon for the East Midlands sample. But its importance in milk production lies in its use in relation to the other productive factors in dairying rather than in its absolute costs per cow. Table 9 illustrates this point well. It will be seen that there was no significant difference in margin per cow between the first four 'labour hours per cow' groups, any economies due to the saving in labour achieved in the lower 'labour hours per cow' groups were only achieved at the expense of yield. For only one fifth of the total number of herds, i.e. those with over 200 hours per cow did the margin decrease as the hours per cow increased. Even in these groups increases in other costs associated with lower returns per gallon were partly responsible for the decrease in margins shown.

When the combined effect of labour and yield was studied, however, there was a steady increase in margins per cow and yields per cow as the gallons produced per labour hour increased.

From this preliminary analysis it would appear that yield and feeding policy in themselves are important in determining dairying profits and that the use of labour in relation to these other two factors is also of importance.

In order to study further the inter-relationship of the three factors a three year average sample has been used so as to reduce the effect of chance variations which are likely to occur in single year comparisons. If we arrange the 45 herds from the three year average East Midlands sample used in this study in order of profit per cow, and alongside them put their order in yield per cow, returns per £100 food costs and returns per £100 labour, some interesting details emerge. From a study of Table 10 it can be seen that in general, the highest profit per cow herds tend to have high yields and high food and labour efficiency and conversely the lowest profit per cow herds tend to be poor in all these three measures. Between these two extremes, however, the great majority of the herds owe their profit per cow to varying efficiencies in yield, feeding and labour use.

Although a part of this may be explained by variation in the skill and management by the farmer of the different aspects of dairying efficiency some of the differences in efficiency in yields, feeding and labour use on any one farm are due in part to the conditions peculiar

(1) Taken from Economics of Milk Production Tables 1949-50, Table 17. Ministry of Agriculture and Fisheries, Economics Branch, London. (Unpublished data).
### NATIONAL INVESTIGATION INTO THE ECONOMICS OF MILK PRODUCTION.
COSTS, RETURNS AND MARGINS OF MILK PRODUCTION BY LABOUR REQUIREMENT GROUPS.
660 HERDS. ENGLAND AND WALES. YEAR 1949-50.

#### TABLE 9.

<table>
<thead>
<tr>
<th>Item</th>
<th>1.07 to 1.99</th>
<th>2.00 to 2.99</th>
<th>3.00 to 3.99</th>
<th>4.00 to 4.99</th>
<th>5.00 to 5.99</th>
<th>6.00 to 6.99</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of herds</td>
<td>13</td>
<td>62</td>
<td>159</td>
<td>147</td>
<td>120</td>
<td>69</td>
<td>72</td>
</tr>
<tr>
<td>Av. gals. per labour hour</td>
<td>1.7</td>
<td>2.6</td>
<td>3.5</td>
<td>4.5</td>
<td>5.5</td>
<td>6.5</td>
<td>7.8</td>
</tr>
<tr>
<td>Av. labour hours per cow</td>
<td>297</td>
<td>235</td>
<td>189</td>
<td>159</td>
<td>133</td>
<td>114</td>
<td>98</td>
</tr>
<tr>
<td>Av. % paid labour hours</td>
<td>44</td>
<td>57</td>
<td>71</td>
<td>76</td>
<td>79</td>
<td>76</td>
<td>82</td>
</tr>
<tr>
<td>Av. cost d. per labour hour</td>
<td>24.3</td>
<td>24.8</td>
<td>26.3</td>
<td>27.0</td>
<td>27.1</td>
<td>26.6</td>
<td>26.8</td>
</tr>
<tr>
<td>Av. % farms with milking machines</td>
<td>15</td>
<td>39</td>
<td>53</td>
<td>83</td>
<td>88</td>
<td>99</td>
<td>86</td>
</tr>
<tr>
<td>Av. No. of cows per herd</td>
<td>12.7</td>
<td>13.7</td>
<td>12.8</td>
<td>23.7</td>
<td>29.6</td>
<td>36.1</td>
<td>43.1</td>
</tr>
<tr>
<td>Av. seasonality Winter gals. % year</td>
<td>46.5</td>
<td>47.7</td>
<td>48.9</td>
<td>49.5</td>
<td>49.1</td>
<td>49.9</td>
<td>50.1</td>
</tr>
<tr>
<td>Av. yield gals. per cow</td>
<td>501</td>
<td>608</td>
<td>659</td>
<td>719</td>
<td>734</td>
<td>754</td>
<td>772</td>
</tr>
</tbody>
</table>

#### TABLE 9.

<table>
<thead>
<tr>
<th>Item</th>
<th>7.00 to 11.04</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of herds</td>
<td>72</td>
<td>88</td>
</tr>
<tr>
<td>Av. gals. per labour hour</td>
<td>6.0</td>
<td>6.6</td>
</tr>
<tr>
<td>Av. labour hours per cow</td>
<td>114</td>
<td>114</td>
</tr>
<tr>
<td>Av. % paid labour hours</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>Av. cost d. per labour hour</td>
<td>27.5</td>
<td>27.5</td>
</tr>
<tr>
<td>Av. % farms with milking machines</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td>Av. No. of cows per herd</td>
<td>36.1</td>
<td>36.1</td>
</tr>
<tr>
<td>Av. seasonality Winter gals. % year</td>
<td>51.0</td>
<td>51.0</td>
</tr>
<tr>
<td>Av. yield gals. per cow</td>
<td>772</td>
<td>772</td>
</tr>
</tbody>
</table>

---

to that farm. For example, take Farms 17, 14 and 10. Farms 17 and 14 are close together in the order of profit but for different reasons. Farm 17 is a relatively large hill dairy farm of about 200 acres having mostly family labour. Tying space for fifty cows is a limiting factor

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36
AB is regression line of profit per cow and labour cost per cow.

Figure 6. Profit per cow and labour cost per cow, 45 farms, East Midlands, 3-year average 1964-66 to 1966-68.
closely linked. Each of them is a very much better indication of labour use in relation to general efficiency (as measured by column 2) than 'labour cost per cow' and 'labour hours per cow'. Comparison of columns 5 and 6 also shows that the yield is of much greater importance in determining returns than seasonality of production and grade of milk. If seasonality and grade had a big effect on returns there would not be the close relationship between returns per £100 labour and labour cost per 100 gallons as measures of labour efficiency.

In order to study the individual relations between labour cost, feed cost, and yield and profit per cow, dot graphs were drawn and the regression lines fitted. Figure 8 shows the scatter diagram expressing the relationships between labour cost per cow and profit per cow. It confirms the impression already conveyed by Table 10 that there is little relationship between the two. There is a wide scatter around the fitted line AB and the slope of the line is not great.

When food costs per cow were plotted against profit per cow the scatter around the regression line, shown in Figure 9, was not as wide as in Figure 8 and the slope of the line was more definite, the indication being that as food costs per cow rose, profits rose.

The close relationship between yield and profits, already suggested from a perusal of Table 10 is also indicated in Figure 10. The regression line AB closely fits the scatter diagram and the upward slope is very definite.

The relationships indicated in the previous paragraphs suggested that interesting relationships might occur if labour and food costs per gallon were plotted against yield and profit per cow. It was not felt that anything further would be added to the study of labour in relation to other productive factors by plotting food costs per gallon against yield or profit. But the labour relationships were pursued.

Figure 11 shows that there is a reasonably close relationship between labour cost per 100 gallons and profit per cow, profit per cow increasing as labour cost per 100 gallons decreases. This confirms the general impression gained from a study of Table 10 and it

---

(1) Using three year averages for an identical sample of 45 East Midlands farms.
(2) Equation to line: \( Y = 17.02 - 0.05x \).
(3) Equation to line: \( Y = 26.29 + 0.194x \).
(4) Equation to line: \( Y = 451.21 + 7.45x \).
(5) Equation to line: \( Y = 3.71 - 0.046x \).
AB is regression line of profit per cow and food costs per cow.
AB IS REGRESSION LINE OF PROFIT PER COW AND YIELD PER COW.
Figure 11.

Profit per cow and labour cost per 100 gallons, 45 farms: East Midlands.

3 year average 1946-47 to 1948-49.

AB is regression line of profit per cow and labour cost per 100 gallons.
AB is regression line of labour cost per 100 gallons and yield per cow.

3-year average 1946-47 to 1948-49.
AB IS REGRESSION LINE OF YIELD AND LABOUR COST PER COW.
CD IS REGRESSION LINE OF YIELD AND LABOUR COST PER COW.
WHEN NUMBER OF COWS IS CONSTANT AT 30.
also agrees with the tabular analysis of National figures quoted in Table 9(1) where margin per cow was shown to increase as gallons produced per labour hour increased.

As profit per cow was shown in Figure 10 to be closely related to yield per cow it would be expected, in view of the relationship shown in Figure 11, that there would be a close relationship between labour cost per 100 gallons and yield. Figure 12 shows that this is so, the slope of the regression line(2) being very much the same as that on Figure 11. Again this agrees with the trends indicated by Table 10 and Table 9.

Plotting labour cost per cow against yield there is an upward trend(3) (line AB on Figure 13) labour cost increasing as yield increases but there is a wide scatter around the regression line. When corrected for the effect of herd size on labour cost per cow the steepness of the regression line CD when herd size is kept constant(4) is very much less. It will be shown in the next chapter(5) that herd size has a much greater effect on labour cost per cow than has yield.

The indications throughout this chapter have been that the absolute amount of labour used per cow is not in itself a very great factor affecting profits per cow, other factors, particularly yield, having a greater effect than labour cost. It is the combination of labour with these other factors of production which affects profits. Where the same amount of labour is used in combination with varying yield and food efficiencies, high or low profits can be obtained by having good or bad efficiencies in the latter two factors as was shown in Table 5. p. 33. On the other hand it is possible to have the same profits per cow despite widely varying amounts of labour used per cow as Table 9 demonstrated.

---

(1) p. 36.
(2) Equation to line: \( Y = 4.53 - 0.003x \).
(3) Equation to line: \( AB: Y = 9.68 + 0.01x \).
(4) Equation to line CD: \( Y = 14.621 - 0.130S + 0.008x \) where \( S \) = size of herd, \( Y \) = labour cost and \( x \) = yield.
(5) p 49.
FACTORS AFFECTING THE EFFICIENCY OF USE OF LABOUR IN DAIRYING.

There are two groups of factors which affect the efficiency of use of labour in dairying. On the one hand is the group of manifest factors, mostly capable of quantitative measurements and comprising the practices, organisation and physical arrangements which together result in a certain quantity of labour being used. On the other hand is the group of underlying factors which can only be related qualitatively to the use of labour.

The first part of this chapter will be concerned with the manifest factors and in the second part the underlying factors will be considered.

PART 1. Manifest factors affecting the use of labour in dairying.

These factors can be listed as:

(a) Size of herd.
(b) Yield level of the herd.
(c) Presence or absence of a milking machine.
(d) Efficiency and composition of work routines.
(e) Type and layout of buildings.
(f) Type and amount of equipment used.
(g) Types and quantities of food fed.
(h) Proportion of the year taken up by summer and winter routines.
(i) Skill, speed, intellect and interest of the worker.

In subsequent paragraphs these factors will be treated under separate headings, but, because of their inter-relationship, some aspects of each may be discussed under more than one heading.

(a) Size of herd: Chapter I showed that in most of the studies done elsewhere size of herd was considered an important factor affecting the amount of labour used per cow. The indivisibility of the labour unit, the spreading of ‘overhead’ labour over a greater number of cows in large herds, and the possibility of there being optimum herd sizes—one-man, two-man units, etc.—being some of the reasons for the decrease in labour hours per cow usually shown to occur as size of herd increased.
AB IS REGRESSION LINE OF HERD SIZE AND LABOUR COST PER COW.
CD IS REGRESSION LINE OF HERD SIZE AND LABOUR COST PER COW, WHEN YIELD IS KEPT CONSTANT AT 600 GALLONS.
When labour cost per cow was plotted against herd size for the three year average of the identical sample of 45 East Midlands herds the scatter diagram shown in Figure 14 was the result. AB was the fitted regression curve\(^{(1)}\).

It will be seen from the figure that the curve dropped steeply where the herd size was small and gradually levelled off as size of herd increased. Table 11 shows the reduction in labour cost per cow that accompanied each increase of five cows in size of herd.

**Table 11.**

<table>
<thead>
<tr>
<th>Increase in herd size</th>
<th>Reduction in labour cost per cow</th>
<th>Reduction %</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 10 cows to 15 cows</td>
<td>2.7</td>
<td>14</td>
</tr>
<tr>
<td>From 15 to 20</td>
<td>1.7</td>
<td>10</td>
</tr>
<tr>
<td>From 20 to 25</td>
<td>1.2</td>
<td>8</td>
</tr>
<tr>
<td>From 25 to 30</td>
<td>0.9</td>
<td>7</td>
</tr>
<tr>
<td>From 30 to 35</td>
<td>0.8</td>
<td>6</td>
</tr>
<tr>
<td>From 35 to 40</td>
<td>0.6</td>
<td>5</td>
</tr>
<tr>
<td>From 40 to 45</td>
<td>0.6</td>
<td>5</td>
</tr>
<tr>
<td>From 45 to 50</td>
<td>0.4</td>
<td>4</td>
</tr>
<tr>
<td>From 50 to 55</td>
<td>0.4</td>
<td>3(\frac{1}{2})</td>
</tr>
<tr>
<td>From 55 to 60</td>
<td>0.3</td>
<td>3</td>
</tr>
</tbody>
</table>

It has been suggested that there are probably optimum sizes of herds that can be managed by one man, two men, etc., but it would be almost impossible to determine these by statistical analysis even if the sample was very much larger than the one used for this study. The interplay of all the other factors discussed in this chapter with size of herd would tend to cancel out any trend that may otherwise show if it were possible to keep the effect of everything except herd size constant. Because of the number of factors liable to affect labour cost per cow only the very broad trends caused by any one factor can be deduced from correlation analysis. Corrections can, of course, be made for the effect of other factors where the relationships between these other factors and labour cost per cow are known. It has already been shown in Chapter III\(^{(2)}\) that yield was a factor affecting labour cost per cow so that we can correct the regression line AB in Figure 14 for the effect of yield. When this was done the resultant regression line was CD\(^{(3)}\).

\[ \text{Equation to curve: } \log Y = 1.6697 - 0.3535 \log X. \]

\[ \text{Equation to line: } Y = 14.62 - 0.135 + 0.008X. \]

Where \(Y\) = labour cost per cow, \(S\) = herd size and \(X\) = yield per cow.

---

\(1\) Equation to curve: \( \log Y = 1.6697 - 0.3535 \log X. \)

\(2\) p. 46.

\(3\) Equation to line: \( Y = 14.62 - 0.135 + 0.008X. \) Where \(Y\) = labour cost per cow, \(S\) = herd size and \(X\) = yield per cow.
and herd size\(^{(1)}\). A comparison of Figure 14 and Figure 13. p. 45 in Chapter III suggests that herd size had greater effect on labour cost per cow than yield and was influencing the relationship between yield and labour cost per cow more than yield was influencing the relationship between herd size and labour cost per cow.

Plotting herd size and yield showed that there was very little relationship between the two (see Figure 15), there being a very wide scatter around the regression line AB and only a slight slope to the line\(^{(2)}\). A multiple correlation between labour cost per cow, herd size and yield would tend, therefore, to show the combined effect of herd size and yield on labour cost per cow, the inter-relationship of herd size and yield on each other not being important. Such a correlation in fact indicated that 32% of the variations in labour cost per cow could be accounted for by the combined effect of variations in herd size and yield\(^{(3)}\). A simple correlation between labour cost per cow and herd size showed that 37 per cent of the variation in labour cost per cow could be accounted for by variation in herd size\(^{(4)}\). Herd size and yield had opposite effects on labour cost per cow, which decreased with increase in herd size but increased with increase in yield. It was expected, therefore, that this correlation would be greater than the previous multiple one. The simple correlation between labour cost per cow and yield showed that seven per cent of the variation in the former could be accounted for by variation in the latter\(^{(5)}\).

Table 12 setting out the relationship, between size of herd and labour used on the 10 case study farms brings out some interesting details. It shows that when farms selected because of their differences in practices, organisation and labour use in relation to other productive factors are compared on a basis of size of herd very little connection can be seen between herd size and labour use. Farm 2, for example, had only about a quarter of the number of cows in its herd as compared with Farm 17 and yet their labour hours per cow were almost the same. Although their size and con-

\(^{(1)}\) It would have been possible to make a curvilinear correction but it was not considered that it justified the greater amount of calculation that would have been involved.

\(^{(2)}\) Equation to line: \(Y = 645.56 - 0.84X\).

\(^{(3)}\) Coefficient of multiple correlation: \(R_{123} = 0.5639\); \(R_{123}^2 = 0.318\).

\(^{(4)}\) Coefficient of correlation: \(r_{yx} = 0.6107\); \(r_{yx}^2 = 0.373\).

\(^{(5)}\) Coefficient of correlation: \(r_{yx} = 0.275\); \(r_{yx}^2 = 0.075\).
AB is the regression line of herd size and yield per cow.
SIZE OF HERD AND AMOUNT OF LABOUR USED. 10 CASE STUDY FARMS.
EAST MIDLANDS. 3 YEAR AVERAGE 1946-47 TO 1948-49.

TABLE 12.

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Size of herd (includes dry cows)</th>
<th>Labour cost per cow</th>
<th>Labour hours per cow</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>8</td>
<td>£</td>
<td>260</td>
</tr>
<tr>
<td>14</td>
<td>9</td>
<td>20.3</td>
<td>191</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>9.9</td>
<td>121</td>
</tr>
<tr>
<td>13A</td>
<td>13(b)</td>
<td>18.8(e)</td>
<td>144(b)</td>
</tr>
<tr>
<td>37</td>
<td>15</td>
<td>10.4</td>
<td>99</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>10.9</td>
<td>108</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>17.9</td>
<td>231</td>
</tr>
<tr>
<td>19</td>
<td>19</td>
<td>17.5</td>
<td>210</td>
</tr>
<tr>
<td>30</td>
<td>47</td>
<td>14.8</td>
<td>166</td>
</tr>
<tr>
<td>17</td>
<td>63</td>
<td>9.9</td>
<td>107</td>
</tr>
</tbody>
</table>

(a) 1948-49 only. (b) 3 year average 1948-49 to 1950-51.

ditions were very different (Farm 2 being an arable dairy farm with high yielding cows whilst Farm 17 was a hill dairy farm with relatively low yielding cows) some of the factors affecting their labour use were the same. They both had good routines well adapted to their building conditions and operated by skilful, speedy, hard working, conscientious workers. It will be shown in (d), p. 56, that they both spent about the same time per milking cow in total although their per cow time for the separate jobs making up the dairy routine differed quite markedly.

Farm 13A was not included in the same three year average as the other nine farms because 1948-49 was the first year in which it was costed. For the purposes of this table, in order to make the labour hours per cow on this farm comparable with the others, the three year average 1948-49 to 1950-51 was worked out. In doing this the effect on the labour hours per cow figure of increasing herd size without changing the total hours expended per herd, was demonstrated. Table 13 sets out this comparison.

TABLE 13.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total hours expended per herd</th>
<th>Average No. of cows in herd</th>
<th>Labour hours per cow</th>
<th>Change in labour hours per cow compared with 1948-49 figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948-49</td>
<td>1,885</td>
<td>10.1</td>
<td>187</td>
<td>%</td>
</tr>
<tr>
<td>1949-50</td>
<td>1,876</td>
<td>12.9</td>
<td>145</td>
<td>-33</td>
</tr>
<tr>
<td>1950-51</td>
<td>1,876</td>
<td>16.2</td>
<td>116</td>
<td>-38</td>
</tr>
</tbody>
</table>

Merely by continuing his policy of gradually building up a pedigree herd from small beginnings this farmer was able to decrease, in two years, his labour required per cow by 38 per cent. But it is important to note that knowledge of the farm conditions and the
farmer indicates that this was done without any conscious effort on the farmer's part to save labour. His aim was to increase the volume of his business by keeping more cows rather than to keep more cows because he could increase his labour efficiency thereby. Between 1948-49 and 1950-51 his profits increased to double the amount per cow and four times the total per herd. This was due to:

(i) Increasing yields per cow by 200 gallons. (ii) Increasing size of herd by six cows. (iii) Keeping food costs per cow almost the same and total hours expended per herd constant. The improvement in labour efficiency has been the result of an improvement in all round efficiency and not due to a deliberate labour saving policy.

(b) **Yield level of the herd**: The relationship between labour cost per cow and yield has already been discussed under (a) above and also in Chapter III. The same Chapter has shown that although the labour costs per cow increased as yield increased, labour cost per 100 gallons decreased because the rise in yield level more than compensated for the rise in labour cost.

A comparison of yield per cow and labour hours per cow on the 10 case study farms did not reveal any very definite relationship (see Table 14). Even when Farms 44 and 19 were excluded which had no milking machine, there was only a slight tendency for labour hours per cow to increase as yields increased. As with herd size, trends shown from the whole East Midlands sample and National figures were not borne out when individual farms chosen for the wide variation in their conditions were studied.

Table 15 shows that on the 10 case study farms there was a wide variation in man and machine times per cow and feeding times per cow, and these variations were not due to yield differences. Machine time per lb. of milk produced decreased as yield increased,
higher yielding herds not taking so long proportionately to milk as the lower yielding ones. The farms with the best combination of

YIELD PER COW AND MILKING AND FEEDING TIMES. 10 CASE STUDY FARMS. EAST MIDLANDS.

TABLE 15.

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Yield per cow on day of timing (lbs.)</th>
<th>Machine time per cow per milking (a)</th>
<th>Machine time per lb. of milk</th>
<th>Man time per cow per milking for milking</th>
<th>No. of units operated per man working on milking operation</th>
<th>Man time per cow per day for feeding and food preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>15.0</td>
<td>Min. Secs.</td>
<td>5. 56</td>
<td>0. 40</td>
<td>3. 26</td>
<td>2</td>
</tr>
<tr>
<td>37</td>
<td>15.4</td>
<td>Min. Secs.</td>
<td>5. 16</td>
<td>0. 41</td>
<td>5. 55</td>
<td>1.5</td>
</tr>
<tr>
<td>44</td>
<td>18.6</td>
<td>Min. Secs.</td>
<td>10. 47(b)</td>
<td>2</td>
<td>10. 34</td>
<td>9. 35</td>
</tr>
<tr>
<td>19</td>
<td>20.0</td>
<td>Min. Secs.</td>
<td>9. 34(b)</td>
<td>2</td>
<td>9. 35</td>
<td>9. 35</td>
</tr>
<tr>
<td>30</td>
<td>24.0</td>
<td>Min. Secs.</td>
<td>6. 44</td>
<td>2</td>
<td>7. 36</td>
<td>10. 39</td>
</tr>
<tr>
<td>14</td>
<td>28.8</td>
<td>Min. Secs.</td>
<td>6. 17</td>
<td>2</td>
<td>6. 02</td>
<td>13. 02</td>
</tr>
<tr>
<td>3</td>
<td>29.0</td>
<td>Min. Secs.</td>
<td>5. 58</td>
<td>1.5</td>
<td>6. 06</td>
<td>5. 45</td>
</tr>
<tr>
<td>2</td>
<td>31.2</td>
<td>Min. Secs.</td>
<td>5. 26</td>
<td>2</td>
<td>5. 45</td>
<td>5. 45</td>
</tr>
<tr>
<td>10</td>
<td>35.2</td>
<td>Min. Secs.</td>
<td>7. 52</td>
<td>1.3</td>
<td>7. 26</td>
<td>7. 26</td>
</tr>
<tr>
<td>13A</td>
<td>44.4</td>
<td>Min. Secs.</td>
<td>3. 28</td>
<td>3</td>
<td>5. 59</td>
<td>5. 59</td>
</tr>
</tbody>
</table>

(a) Includes hand stripping where practised. (b) Hand milked.

number of units operated per man and machine time were the ones with the lowest milking times per man. Thus Farm 13A, where three units were operated per man, and Farms 2 and 17 which had two units per man with low machine times, had low man times per milking. The other farms, where the number of units and the machine times were not as well balanced, had higher man times per milking.

It might be thought that where yield levels were higher the time spent in feeding and food preparation would be higher. What evidence there is from Table 15 does not bear out this supposition, however. If anything, in fact the tendency is the other way and this is probably linked with the simpler feeding systems adopted in the higher yielding herds. This point will be discussed further in (d) below when work routines and their efficiency are discussed.

(c) Presence or absence of a milking machine: National figures\(^{(1)}\) showing labour requirements per cow for milking by hand or by machine are set out in Table 16.

The slightly higher yields obtained by the hand milked herds in four out of the seven size groups did not compensate them for their increased labour expenditure incurred and consequently the gallonage of milk produced per labour hour was less than that of the machine milked herds in all size groups.

\(^{(1)}\) Adapted from Table 7 Economics of Milk Production Tables 1949-50. Ministry of Agriculture and Fisheries, Economics Branch, London (Unpublished data).
NATIONAL INVESTIGATION INTO THE ECONOMICS OF MILK PRODUCTION.
METHOD OF MILKING AND LABOUR REQUIREMENTS. 660 HERDS.
ENGLAND AND WALES 1949-50.

TABLE 16.

<table>
<thead>
<tr>
<th>Item</th>
<th>Herd Size Groups</th>
<th>5.0—9.9</th>
<th>10.0—19.9</th>
<th>20.0—29.9</th>
<th>30.0—39.9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M/M</td>
<td>Hand</td>
<td>M/M</td>
<td>Hand</td>
<td>M/M</td>
</tr>
<tr>
<td>No. of herds</td>
<td>21</td>
<td>64</td>
<td>118</td>
<td>64</td>
<td>127</td>
</tr>
<tr>
<td>No. of cows per herd</td>
<td>5.2</td>
<td>7.5</td>
<td>15.8</td>
<td>13.9</td>
<td>24.6</td>
</tr>
<tr>
<td>Labour hours per cow</td>
<td>183</td>
<td>227</td>
<td>155</td>
<td>202</td>
<td>147</td>
</tr>
<tr>
<td>Yield per cow</td>
<td>693</td>
<td>704</td>
<td>721</td>
<td>672</td>
<td>695</td>
</tr>
<tr>
<td>Gallons per labour hour</td>
<td>3.8</td>
<td>3.1</td>
<td>4.7</td>
<td>3.3</td>
<td>4.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Herd Size Groups</th>
<th>40.0—49.9</th>
<th>50.0—59.9</th>
<th>60.0—134,5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M/M</td>
<td>Hand</td>
<td>M/M</td>
<td>Hand</td>
<td>M/M</td>
</tr>
<tr>
<td>No. of herds</td>
<td>65</td>
<td>3</td>
<td>39</td>
<td>2</td>
<td>33</td>
</tr>
<tr>
<td>No. of cows per herd</td>
<td>43.9</td>
<td>41.6</td>
<td>54.1</td>
<td>54.8</td>
<td>81.0</td>
</tr>
<tr>
<td>Labour hours per cow</td>
<td>138</td>
<td>187</td>
<td>132</td>
<td>196</td>
<td>119</td>
</tr>
<tr>
<td>Yield per cow</td>
<td>725</td>
<td>731</td>
<td>767</td>
<td>703</td>
<td>719</td>
</tr>
<tr>
<td>Gallons per labour hour</td>
<td>5.3</td>
<td>3.9</td>
<td>5.8</td>
<td>3.6</td>
<td>6.1</td>
</tr>
</tbody>
</table>

M/M = Milking Machine.

When the herds in the 1950-51 East Midlands sample were grouped in a similar manner, the labour hours per cow for the hand and machine milked herds were as set out in Table 17.

METHOD OF MILKING AND LABOUR REQUIREMENTS. 60 HERDS. EAST MIDLANDS 1950-51.

TABLE 17.

<table>
<thead>
<tr>
<th>Item</th>
<th>Herd Size Groups</th>
<th>Under 10</th>
<th>10.0—19.9</th>
<th>20.0—29.9</th>
<th>30.0—39.9</th>
<th>Over 40</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M/M</td>
<td>Hand</td>
<td>M/M</td>
<td>Hand</td>
<td>M/M</td>
<td>Hand</td>
<td>M/M</td>
</tr>
<tr>
<td>No. of herds</td>
<td>5</td>
<td>7</td>
<td>10</td>
<td>6</td>
<td>8</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Labour hours per cow</td>
<td>214</td>
<td>262</td>
<td>245</td>
<td>201</td>
<td>174</td>
<td>180</td>
<td>195</td>
</tr>
</tbody>
</table>

M/M = Milking Machine.

In the three groups containing both hand and machine milked herds the labour hours per cow figure was considerably less for the machine milked herds than for the hand milked herds.

Of the 10 case study farms, Farms 44 and 19 were milked by hand. Apart from Farm 3, these two had the highest labour hours per cow—260 and 210 respectively (see Table 14. p. 53). In these two hand milked herds milking represented a greater proportion of the time spent on the cows(1) than on the other eight machine milked herds (see Table 18).

(1) Time for all jobs on cows but not including work on young stock.

55
MILKING TIMES AS PERCENTAGE OF TOTAL TIME SPENT ON COWS. 10 CASE STUDY FARMS.

TABLE 18.

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Milking times as percentage of total time spent on cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>58</td>
</tr>
<tr>
<td>44</td>
<td>48</td>
</tr>
<tr>
<td>2</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>43</td>
</tr>
<tr>
<td>30</td>
<td>41</td>
</tr>
<tr>
<td>10</td>
<td>37</td>
</tr>
<tr>
<td>37</td>
<td>35</td>
</tr>
<tr>
<td>13A</td>
<td>34</td>
</tr>
<tr>
<td>14</td>
<td>33</td>
</tr>
</tbody>
</table>

(d) Efficiency and composition of work routines and
(e) Type and layout of buildings:

Apart from the work of Sturrock(1) very little data is available on work routines in dairying in this country. The labour item in the National Investigation into the Economics of Milk Production is not split up to show the time spent on the various jobs—being merely recorded as total hours spent on cows. In order, therefore, to get some idea of the variations in times and distances taken for the different jobs and also to see whether there was any variation in the types of jobs done and the ways of doing them, 'time and motion' studies were carried out on the 10 case study farms for the winter routine. Table 19 sets out the times and distances required for the different dairying jobs on these farms. In order to facilitate inter-farm comparisons and to minimise the effect of variations in size of herd and in the proportion of dry cows, all the figures quoted are 'per cow in milk'.

The Table shows that it took $2\frac{1}{2}$ times as long to do all the dairying work on Farm 14 as on Farm 2 and that the distance travelled in doing the work was $2\frac{2}{3}$ times as great on the former as on the latter.

There were wide variations from farm to farm in the time taken for the different jobs, the general tendency being for the time taken for individual jobs to increase as total time increased. Distances travelled fluctuated considerably from farm to farm and only for work done on other stock was the increase in time taken closely associated with increase in distance travelled. This was due to the other stock being in other sets of buildings or out in fields on most of the farms: the further removed they were from the main buildings


56
TIME SPENT AND DISTANCE TRAVELLED PER COW ON DAIRY JOBS. (WINTER ROUTINE).

10 CASE STUDY FARMS.

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Time</th>
<th>Distance</th>
<th>Time</th>
<th>Distance</th>
<th>Time</th>
<th>Distance</th>
<th>Time</th>
<th>Distance</th>
<th>Time</th>
<th>Distance</th>
<th>Time</th>
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<th>Distance</th>
<th>Time</th>
<th>Distance</th>
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<th>Distance</th>
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<tbody>
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<td>7</td>
<td>112</td>
<td>5</td>
<td>115(c)</td>
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<td>4</td>
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<td>40</td>
<td>2</td>
<td>11</td>
<td>1</td>
<td>42</td>
<td>1</td>
<td>47</td>
<td>21</td>
<td>34</td>
<td>371</td>
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<td></td>
</tr>
<tr>
<td>13A</td>
<td>6</td>
<td>101</td>
<td>5</td>
<td>67(c)</td>
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<td>1</td>
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<td>44</td>
<td>10</td>
<td>62</td>
<td>35</td>
<td></td>
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<td>6</td>
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<td>19</td>
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<td>35</td>
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<td>117</td>
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<td>29</td>
<td>8</td>
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<td>56</td>
<td>854</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) Includes time taken to cart and spread sugar beet tops in field but does not include the distance for this operation.
(b) Distance travelled in attention to other stock could not be measured as most of them were in another set of buildings away from main ones.
(c) Not tying and releasing but composed of waiting 1 min. 15 secs. per cow and breeding 1 min. 2 secs., and 10 yards per cow.
the longer it took to travel to and fro. Where routines were well adapted to the buildings in and around which they were carried out the times taken and distances travelled were low. Figures 16 to 25 (see pp. 72 to 81) show that the layout and area covered by the buildings varied very significantly. For example, the area covered by the buildings on Farm 17 was large and the layout was not convenient (see Figure 20). Although 47 cows were kept, of which 42 were in milk, never more than six could be kept in each of the sheds, which were built in two single rows at opposite sides of a large yard. Despite this big structural disadvantage, the good routines adopted for the different jobs, carried out by speedy and skilful workers, resulted in low time and travel figures being attained. Conversely, where routines were poor, high time and distance figures resulted even though the building arrangements were reasonably satisfactory. Such a case was Farm 14 (Figure 17. p. 73).

Another significant factor was the number of workers employed on the different jobs. On some farms more workers were employed on some jobs than on others. Some measure of the balance between labour and cows kept can be obtained by setting out for each of the farms the labour used per 20 cows(1) for each job. This is done in Table 20, the farms being arranged in order of total time taken per cow, as in Table 19. The last column showing the weighted average for all jobs suggests that, even under the widely different conditions typified by the 10 case study farms, the number of cows kept per worker employed was a significant factor affecting the time spent per cow on all jobs.

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Milking</th>
<th>Feeding</th>
<th>Food preparation</th>
<th>Cleaning</th>
<th>Dairy work</th>
<th>Tying and realising</th>
<th>Work on other stock</th>
<th>Weighted(a) av. all jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
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<td>0.42</td>
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<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
</tbody>
</table>

(a) Weighted by percentage of total time taken on each job.

The percentage of total time taken up by the different jobs varied widely, although in all cases more time was spent on milking

(1) In milking herd, i.e. including dry cows kept in the same buildings as milking cows, but not including dry cows and other stock kept in other buildings.
than on any other single job. On the two hand milked herds (Farms 19 and 44), milking was by far the most time consuming job. With the exception of Farm 14, 50 per cent or over of the time spent on all jobs was spent on milking, feeding and food preparation. (see Table 21).

**PERCENTAGE OF TOTAL TIME TAKEN UP BY DIFFERENT JOBS. 10 CASE STUDY FARMS.**

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Milking</th>
<th>Feeding</th>
<th>Food preparation</th>
<th>Cleaning</th>
<th>Dairy work</th>
<th>Tying and releasing</th>
<th>Work on other stock</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>36.8</td>
<td>25.0</td>
<td>1.7</td>
<td>11.9</td>
<td>11.5</td>
<td>6.2</td>
<td>6.9</td>
<td>100</td>
</tr>
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<td>28.7</td>
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<td>5.9</td>
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<td>17.3</td>
<td>100</td>
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<td>18.0</td>
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<td>16.7</td>
<td>7.7</td>
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<td>100</td>
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<tr>
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<td>13.5</td>
<td>11.0</td>
<td>9.3</td>
<td>10.7</td>
<td>4.5</td>
<td>21.7</td>
<td>100</td>
</tr>
<tr>
<td>10</td>
<td>36.2</td>
<td>13.1</td>
<td>4.1</td>
<td>10.8</td>
<td>20.3</td>
<td>4.6</td>
<td>10.9</td>
<td>100</td>
</tr>
<tr>
<td>44</td>
<td>40.2</td>
<td>15.7</td>
<td>2.2</td>
<td>6.6</td>
<td>18.7</td>
<td>—</td>
<td>16.6</td>
<td>100</td>
</tr>
<tr>
<td>14</td>
<td>22.4</td>
<td>15.3</td>
<td>7.9</td>
<td>7.6</td>
<td>10.4</td>
<td>1.7</td>
<td>34.7</td>
<td>100</td>
</tr>
</tbody>
</table>

**Milking**: Man time and machine time per cow in milking depend on three main things:—

(i) Number of units handled per man.

(ii) Capacity of the cows to milk out quickly.

(iii) Other jobs done during milking in addition to putting units on and taking them off.

It has been shown under (b) p. 54 that, where there was a good balance between machine time and units per man, low man times per cow resulted.

The New Zealand publication\(^1\) showed that number of units handled per man was more important in determining man time per cow than was machine time per cow. If an operator did no other jobs apart from putting on the units and taking them off, and changing them, the man time per cow would be a direct function of (i) and (ii). In actual practice, however, most milkers do some or all of the following jobs whilst milking is in progress: Washing udders, fore stripping, feeding concentrates, carrying milk, hand stripping and occasionally dairy work and cleaning.

If some or all of these jobs could be eliminated, the cows trained to milk quickly, and the number of units handled per worker increased, machine time and man time per cow could be speeded up. Assuming that all the incidental jobs could be eliminated during

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actual milking, they would still have to be done either before or after. A re-organisation would only be worthwhile if, by altering the routine, the total time for milking plus doing these jobs was reduced. Table 22 sets out the man and machine times for the five machine milked herds for which information on the times taken to do other jobs during milking was obtained.

Farm 13A and Farm 2, both with almost the same number of cows in milk (19 and 17 respectively) had almost the same man time per cow; spent as much time on productive other jobs and yet had widely different machine times per cow. By leaving the units on longer Farmer 13A had no need to spend time machine stripping. Also his cows gave 7½ lbs. of milk more per cow on the average and appeared to need some extra time to milk out compared with those of Farm 2. By operating three units, he achieved a man time per cow of 30 seconds less than Farm 2 despite a difference in machine times of 2 minutes 20 seconds in favour of Farm 2. The farmer and the worker on Farm 2 could achieve faster machine times but it is very doubtful if they could achieve faster overall man times. Assume for example that all the cows in the herd on Farm 13A could be milked out in four minutes, (and, in view of the evidence quoted in Chapter I, Appendix I and later paragraphs of the present section, this is a doubtful assumption), and also assume that one minute would be sufficient to put the units on, take them off and change buckets(1), machine handling time alone with three units would amount to three minutes. To this must be added twice 51 seconds (i.e. 1 minute

(1) This assumption based on figures from work routine sheets of Farm 13A.

<table>
<thead>
<tr>
<th>Item</th>
<th>Farm 13A</th>
<th>Farm 2</th>
<th>Farm 37</th>
<th>Farm 14</th>
<th>Farm 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man time per cow per milking</td>
<td>3. 28</td>
<td>3. 38</td>
<td>5. 55</td>
<td>6. 17</td>
<td>6. 49</td>
</tr>
<tr>
<td>Machine time per cow per milking</td>
<td>9. 09</td>
<td>6. 49</td>
<td>4. 09</td>
<td>8. 16</td>
<td>9. 53</td>
</tr>
<tr>
<td>Hand stripping time</td>
<td>2. 00</td>
<td>1. 07</td>
<td>1. 39</td>
<td>2. 00</td>
<td>1. 20</td>
</tr>
<tr>
<td><strong>Other jobs done during milking</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrying milk</td>
<td>0. 51</td>
<td>0. 41</td>
<td>0. 28</td>
<td>0. 23</td>
<td>0. 06</td>
</tr>
<tr>
<td>Washing udders</td>
<td>0. 32</td>
<td>0. 14</td>
<td>—</td>
<td>0. 43</td>
<td>0. 52</td>
</tr>
<tr>
<td>Feeding</td>
<td>0. 15</td>
<td>0. 18</td>
<td>—</td>
<td>0. 03</td>
<td>0. 48</td>
</tr>
<tr>
<td>Cleaning</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0. 12</td>
<td>—</td>
</tr>
<tr>
<td>Dairy work</td>
<td>0. 06</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0. 41</td>
</tr>
<tr>
<td>Tying and releasing cows</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Fore stripping</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0. 08</td>
<td>0. 07</td>
</tr>
<tr>
<td>Attention to other stock</td>
<td>0. 03</td>
<td>0. 34</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total (i) to (viii)</strong></td>
<td>1. 47</td>
<td>1. 47</td>
<td>0. 28</td>
<td>1. 29</td>
<td>3. 34</td>
</tr>
<tr>
<td>(productive jobs)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0. 58</td>
<td>0. 17</td>
</tr>
<tr>
<td>Attention to machines</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0. 45</td>
<td>0. 35</td>
</tr>
<tr>
<td>Waiting during milking</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0. 35</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total (ix) and (x) (unproductive jobs)</strong></td>
<td>—</td>
<td>—</td>
<td>1. 45</td>
<td>1. 33</td>
<td>0. 52</td>
</tr>
<tr>
<td><strong>Total (i) to (x)</strong></td>
<td>1. 47</td>
<td>1. 47</td>
<td>2. 13</td>
<td>3. 02</td>
<td>4. 26</td>
</tr>
</tbody>
</table>

Table 22.
42 seconds) for carrying of milk, which would have to be done during milking. Thus there would not be time in the four minutes available between putting a unit on one cow and taking it off, to do the absolutely essential jobs.

Such a synthetic routine does not allow for time which must be spent in travelling from one shed to another and also for all those little incidentals such as teat cups slipping, a cow kicking the units off, a cow being awkward or taking longer to milk because she is on heat, or the occasional attention to cans in the dairy or having to wait for the cooler pan to empty, all of which are part of a normal routine but cannot be standardised.

On top of all this, add the complete disturbance to a cow’s routine which would result from feeding and washing before milking commenced, and there is sufficient evidence to convince the farmers and others with whom the problem was discussed that, except where gross inefficiency is obvious, reducing machine time per cow is a much less sure method of reducing man time per cow than is increasing the number of units operated per man.

Farm 10 is a case where increasing the number of units (assuming the increased capital cost and increased time that would be required for washing up justified the expense for a herd of only 11 milking cows—again a doubtful assumption) would reduce man time per cow. Without increasing the number of units some time could be saved if only one worker did everything connected with the milking operation, instead of having another worker to carry milk. The time spent in unproductive jobs should, in this case, be sufficient to enable the milker to carry milk instead of, as at present, another worker breaking off his other jobs to carry milk.

Both Farm 37 and Farm 14 illustrate hand milking routines applied to machine milking. On Farm 37, apart from carrying milk and hand stripping, no other jobs were done during milking, with the result that nearly a third of the milking man time per cow was spent in waiting for units to finish milking. This time amounted to nearly 20 minutes per milking, or approximately the time taken to wash udders and prepare and feed concentrates, both of which operations were done before actual milking commenced. Fitting these two jobs into the milking routine could make a difference of 40 minutes per day to the time taken for the whole dairying jobs. Eliminating the hand stripping and leaving the machines on longer would have made available another 12 minutes per milking for other jobs. Simil-
ary, the 1 minute 33 seconds per cow or 13 minutes 57 seconds per milking wasted during milking on Farm 14 could be spent in preparing and feeding concentrates which was done before milking commenced and which took 13 minutes 47 seconds.

Other work\(^{(1)}\) has indicated that machine time per cow increases with yield per cow. Fluctuations occur in machine times per cow from day to day due to slight differences in routine and also to cow variation. It was not found possible to take observations on machine times for more than one day, but morning and evening times were taken on the same day, or one evening and the following morning. Table 23 sets out the average machine times and yields per cow for the morning and evening milkings on each of the eight machine milked herds. In all cases the interval between evening and morning was longer than that between morning and evening milking. Except for herd 37, which had low yields and long hand

**MORNING AND EVENING MACHINE TIMES AND YIELDS PER COW. EIGHT CASE STUDY FARMS.**

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Morning</th>
<th>Evening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Av. machine time per cow</td>
<td>Av. yield per cow</td>
</tr>
<tr>
<td>2</td>
<td>7. 16</td>
<td>18.5</td>
</tr>
<tr>
<td>3</td>
<td>7. 55</td>
<td>16.6</td>
</tr>
<tr>
<td>10</td>
<td>10. 56</td>
<td>21.5</td>
</tr>
<tr>
<td>13A</td>
<td>9. 27</td>
<td>22.6</td>
</tr>
<tr>
<td>14</td>
<td>8. 27</td>
<td>13.9</td>
</tr>
<tr>
<td>17</td>
<td>6. 25</td>
<td>Not recorded</td>
</tr>
<tr>
<td>30</td>
<td>9. 51</td>
<td>Not recorded</td>
</tr>
<tr>
<td>37</td>
<td>3. 39</td>
<td>Not recorded</td>
</tr>
</tbody>
</table>

(a) Actually machine and hand stripping time per lb. Hand stripping was 1 minute 7 seconds per cow for morning milking and 1 minute 11 seconds per cow for evening milking.

stripping times, all the morning machine times per cow were greater than the evening times. The only common factor which varied between morning and evening on the seven farms was yield. (Farm 17 produced four cans of milk in the morning and three at night and Farm 30 five in the morning and four at night). It would seem from these figures that machine time per cow was longer when yield, under the same routine conditions, was greater.

**Feeding and Food Preparation:** As mentioned on p. 54 under (b) the higher yielding herds had simpler feeding systems, feeding more concentrated food and fewer varieties of bulky food. Contrast, for example, the feeding and food preparation time tables for Farm 2 and Farm 30 set out below.

---

## FARM 2 FEEDING TIMETABLE.

<table>
<thead>
<tr>
<th>Time of day</th>
<th>Operation</th>
<th>Time taken per cow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before morning milking</td>
<td>(i) Feed dry sugar beet pulp,—two trips with skep from mixing shed.</td>
<td>0 11</td>
</tr>
<tr>
<td>During morning milking</td>
<td>(ii) Feed concentrates before milking each cow—from feed barrow by cowshed door.</td>
<td>0 16</td>
</tr>
<tr>
<td>Immediately after morning milking</td>
<td>(iii) Feed baled hay from store by Cowshed 1—one forklful per pair of cows.</td>
<td>0 8</td>
</tr>
<tr>
<td>10.0 a.m.</td>
<td>(iv) Get five bales hay into store and three of straw to behind cows (see Figure 16).</td>
<td>0 44</td>
</tr>
<tr>
<td>10.30 a.m.—3.0 p.m.</td>
<td>(v) Cows eat beet tops in field—put out each morning by another worker with tractor and trailer.</td>
<td>2 39</td>
</tr>
<tr>
<td>11.0 a.m.</td>
<td>(vi) Put chaff and beet pulp into cow troughs—from barn one bagful chaff, two skeps of pulp.</td>
<td>0 41</td>
</tr>
<tr>
<td>11.15. a.m.</td>
<td>(vii) Mixing concentrates.</td>
<td>0 22</td>
</tr>
<tr>
<td>3.30 p.m.—5.0 p.m.</td>
<td>(viii) Feed concentrates during milking.</td>
<td>0 19</td>
</tr>
<tr>
<td>5.0. p.m.</td>
<td>(ix) Feed hay and straw from store.</td>
<td>0 28</td>
</tr>
<tr>
<td></td>
<td>(x) Feed sugar beet tops from heaps outside.</td>
<td>0 20</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>6 6</strong></td>
</tr>
</tbody>
</table>

## FARM 30 FEEDING TIMETABLE.

<table>
<thead>
<tr>
<th>Time of day</th>
<th>Operation</th>
<th>Time taken per cow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before morning milking</td>
<td>(i) Feed wet beet pulp—with barrow from mixing shed.</td>
<td>0 35 not measured</td>
</tr>
<tr>
<td>During milking</td>
<td>(ii) Feed concentrates before milking each cow.</td>
<td>0 29</td>
</tr>
<tr>
<td>Towards end of morning milking</td>
<td>(iii) Feed hay—from hay places (see Figure 21) one forklful per pair.</td>
<td>0 44</td>
</tr>
<tr>
<td>After breakfast</td>
<td>(iv) Two workers with cart to field taking cabbages out and spreading—cows turned out to these.</td>
<td>1 52</td>
</tr>
<tr>
<td>Mid-morning</td>
<td>(v) Feeding mangolds (whole) from store places, one forklful per cow, also with barrow for longer trips.</td>
<td>0 33</td>
</tr>
<tr>
<td>Later</td>
<td>(vi) One worker fetching baled straw, feeding and bedding with it.</td>
<td>0 34</td>
</tr>
<tr>
<td></td>
<td>(vii) Another worker fetching brewers' grains from pit, breaking up in mixing shed and feeding to heavy milking cows—one barrow load.</td>
<td>1 24</td>
</tr>
<tr>
<td>Before dinner</td>
<td>(viii) One worker for load of cabbage from field 350 yards away and tipping near feeding place doors.</td>
<td>1 24</td>
</tr>
<tr>
<td></td>
<td>(ix) Ditto for load of kale for morning.</td>
<td>0 39</td>
</tr>
<tr>
<td></td>
<td>(x) Grinding oats.</td>
<td>0 52</td>
</tr>
<tr>
<td></td>
<td>(xi) Mixing concentrates.</td>
<td>0 55 not measured</td>
</tr>
<tr>
<td>After dinner</td>
<td>(xii) Cutting and carrying hay from dutch barn to feeding places—seven trusses.</td>
<td>0 40</td>
</tr>
<tr>
<td>During afternoon milking</td>
<td>(xiii) Feeding concentrates.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(xiv) Feeding cabbage from feed places.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>10 41</strong></td>
</tr>
</tbody>
</table>
The more bulky wet pulp and brewers grains fed on Farm 30 increased feeding times as did feeding two lots of roots—cabbage and mangolds—in addition to one lot in the field. The loose hay took longer to feed and also needed cutting and more carrying than the baled hay used on Farm 2. Farm 2 did not use home grown concentrates and so made a further saving over Farm 30 as no time was required for grinding.

Farms 2, 13A, and 3 all used baled hay and straw. The bales were easily handled and quickly moved from the permanent store to the temporary store near the cows (see Figures 16, 18 and 24). Due to the labour involved in cutting and carrying the bulkier material to the temporary stores, the food preparation times were greater on the other seven farms where loose hay was used, than on these three farms. Where baled material was used it was possible to store it temporarily very close to the cows—Farms 2 and 13A immediately behind them and on Farm 3 right above them. Thus the time taken to feed it was shorter than for the other herds where it had to be temporarily stored in a less convenient spot. On Farm 17 the farmer was able to feed loose hay quickly because the temporary stores were immediately in front of the cows for most of the cowsheds. This farmer hopes to purchase a hay baler so that he can stack hay in the field, bale it in slack periods of the year and then cart a good supply direct to convenient temporary stores.

Farm 3, with its baled hay stored above the cows, had a remarkably short feeding time for hay. It took one man only five minutes in the morning and five minutes at night to feed 22 cows, by pushing the hay through holes immediately above the heads of each pair of cows. The practice of storing above cowsheds, very common in the past and still common abroad, has been discouraged in recent years by Clean Milk Regulations. In view of the evidence quoted in the Appendix there seems no sound bacteriological reason why the practice should be discouraged, and it certainly leads to economies of labour. With baled hay becoming more common the complaint of constant dustiness would no longer apply and with machine milking the danger of contamination of the milk by dust is very small.

An incidental point in favour of baled hay is the ease with which it can be rationed. All three farmers who used it knew exactly how many bales, of what weight, were being fed per day and could thus strictly control the bulk food being fed to their high yielding cows.
Circular travel, where practised, enabled feeding to be done efficiently. On Farm 17, for example, wet pulp was stored in one end of Cowshed 10 (see Figure 20). The operation of feeding this commenced in Cowshed 10—the cows there being fed straight from the heap. A barrow was then filled and this did all the other sheds in the same row as Cowshed 10 and Cowsheds 1 and 2, a further barrowful being used for Cowsheds 3 to 6. On returning the barrow to Cowshed 10 the worker commenced bedding up from there, using baled straw also stored there. At other times in the day, when feeding concentrates, chaff and hay, the same routine was adopted. The work commenced at the mixing shed with concentrates and chaff and finished there. Then starting at Cowshed 10 and moving progressively round the yard with hay.

Circular travel was a feature of all the other jobs on Farm 17 and was an important contributory factor to the amazing efficiency achieved with such an adverse building layout.

Farm 19 (see Figure 23) had very much more compact buildings than Farm 17 but did not have low feeding times because the feeding centres were scattered, kale in one part of the yard, grains in another, chaff in the opposite direction, hay and straw elsewhere, etc. The routine associated with these scattered feeding centres took much longer in time and distance per cow. Although the area covered by the buildings on Farm 19 was less than one third of the area of those on Farm 17 the 'back-tracking' resulting from badly sited food stores meant that the worker walked 119 yards to feed each cow compared with only six yards on Farm 17.

Farm 14 was another example of a haphazard feeding routine associated with scattered feed stores (see Figure 17) resulting in high feeding time and distances per cow.

Cleaning: Cleaning of muck was done by barrow on Farms 2, 13A, 30, 3, 19 and 37. On these farms the time taken tended to vary with the distances travelled, which depended on the siting of the manure heap. Where it was very close, as on Farm 30—within two yards of the middle cowshed door—the time and distance taken was low. Even on this farm, however, the time spent per day on mucking out was one and half hours and a much greater time than this was spent in re-handling the muck from the farm heap to the field. One casual worker was employed chiefly to do the jobs associated with manure handling—mucking out, carting and spreading. The installation of a gutter cleaner, filling directly into the muck spreader,
which the farm already possesses, would probably mean that this man’s wages could be saved—there being sufficient labour on the farm to do any other work on which he might be occasionally employed.

On Farms 10 and 44 the mucking out was done direct from the cowshed to a nearby heap. The time spent in travelling backwards and forwards with single shovelfuls of muck was considerable, however, and resulted in a high time and distance per cow. Farm 14, on which mucking out was done both by barrow and direct on the fork to the heap, had a high time and distance.

Farm 17 mucked out direct into a spreader which was moved from door to door of the small cowsheds. This system was ideal for conditions on this farm as not much walking was involved in going from the spreader to any part of a six stall cowshed. The operation was completed very much quicker than it would have been if all the muck had been barrowed out and emptied at some central point.

The farms producing T.T. milk spent time in swilling out but those not producing graded milk did not do so. The rigidity of the clean milk regulations would seem to be limiting labour saving. Swilling out is not commonly practised in the States or in Denmark; the ‘dry-floor’ technique is almost universal in these countries but they still produce clean milk. There would seem to be no sound reason against adopting the ‘dry floor’ technique here.

Dairy Work: Size of herd, method of heating water, simplicity of routine and number of workers employed seemed to be the main factors affecting the time spent on dairy work.

Where the herd was large the time spent in washing up and attention to cows was spread over a large number of cows—for example, it did not take twice as long to wash up the utensils from a 40 cow herd as compared with a 20 cow herd as there was not double the number of utensils—there being only one cooler and pan to wash in each case, only one set of carrying buckets and only four units in the 40 cow herd as compared with three in the 20 cow herd.

Those farms which had not a ready source of hot water wasted a lot of time. For example, in lighting coal boiler fires on Farm 44 and Farm 10, or in waiting for a primus stove to heat the water as on Farm 37.

On some farms the units were washed thoroughly twice each day in hot water and detergent and this increased the daily time
compared with those farms which rinsed thoroughly at night with cold water and then washed in hot only once per day, in the morning.

On Farm 3 two workers washed up in the morning and this increased the washing up time considerably as there was insufficient work to employ two men fully on this job.

Carrying milk was included under milking and jobs associated with it but it could have been included under the heading of dairy work. The practice of bulk cooling adopted on Farms 30 and 3 saved time in carrying milk. On both these farms the milk was poured through sieves into the churns in the cowshed and then the churns were moved to the dairy. On Farm 30 an ‘in churn’ cooler was used, the churns being transported from cowshed to dairy as they were filled. Any other method of cooling or carrying on this farm would have involved more time as the distance across the yard from cowshed to dairy was very long (see Figure 21) and much travel backwards and forwards would have resulted if hand cans had been used.

There appears to be no sensible reason why the practice of pouring into churns in the cowshed should be discouraged under clean milk regulations as long as it is done through a sieve which covers the churn and the lid is replaced when the churn is full. This would seem to be quite as hygienic as pouring from milking units into open buckets or leaving the spare unit bucket with the top open—the usual practice resulting from conforming to the regulations. Certainly transporting and cooling in bulk saves time compared with other methods and with very elementary precautions should not result in any lowering of the standard of milk cleanliness.

Tying and releasing: This was not very important as far as time was concerned. Where it had to be done twice, as on Farm 17, so as to allow the cows out for water, time could have been saved if water bowls were installed. This was realised by the farmer, but a seasonal shortage of fresh water and lack of water pressure prevented this being carried out.

Work on other stock\(^{(1)}\): As mentioned previously the time spent on this item varied with the distance travelled. On Farm 14 with the highest time and distance the reasons were:

(i) Most of the young stock were tied up in stalls and so needed much more attention for feeding and cleaning than if they had been loose.

\(^{(1)}\) See Table 19, p. 57.
(ii) The rest of the young stock were at a distance from the buildings and food had to be carried to them.

The high time and distance on Farm 44 was chiefly due to the young stock being in buildings 250 yards away from the main buildings.

The very low time and distance on Farm 2 was due to the good work routine under which the calves were fed with milk concentrates and bulky foods whilst milking was in progress. Other stock out in the field were fed with concentrates while the worker was taking the cows to pasture. Young stock in yards 100 yards away from the buildings were attended to by a worker on his way back from breakfast and lunch in the village.

The times on the other farms were influenced by factors that have been mentioned previously in relation to other work routines—size of herd, number of workers employed, and type and location of food.

(f) Type of equipment used: This varied considerably from farm to farm and in itself did not appear to be an important factor affecting labour efficiency. The use to which the available equipment was put was what really affected efficiency. A good example of this was the use of a muck spreader on Farms 17 and 30. On Farm 17 mucking out was done into the spreader which when full was taken to the field. On the route the dry and young stock in a second set of buildings were given attention. The spreading then occupied a quarter of an hour. On Farm 30 mucking out was by barrow onto a yard heap. Then later in the day three workers were employed filling the spreader from the heap. One worker took a full load and spread it, the other two being idle until he returned. There was no obvious reason why the mucking out could not have been done direct by barrow into the spreader.

Farmer 14 has not benefited from his milking machine. Milking and dairy work occupied 2 hours 45 minutes of his time per day, but if he could milk all his cows at the rate of 28 seconds per lb. which was his rate of hand milking the one cow which he did not milk by machine, he could do the milking, by hand, in two hours. Even allowing him two and a quarter hours, or about 10 minutes per cow per milking, he should be able to wash up two buckets and the cooler in 15 minutes each milking. Naturally if he could improve his machine milking and feeding routines his times for these jobs could
be reduced. It is questionable, however, whether he could make productive use of any time saved\(^{(1)}\) so that he would probably have been better off without his limited capital locked up in a machine. As he does not appear to be ‘machine-minded’ he would also most likely be happier.

The ‘in churn’ cooler has already been mentioned under (d) and (e) above as a labour saving item of equipment. This in conjunction with a churn carrier could save time on Farm 17 where carrying distances are long.

\(\text{(g) Types and quantities of food fed:} \) For the 45 herds in the three year East Midlands sample labour hours per cow were plotted against weight of foods fed. There was found to be a complete scatter—no trend at all being shown. It appears, therefore, that the weight of the food fed had no noticeable effect on the total quantity of labour used per cow. The time taken for feeding and food preparation on the 45 farms in the sample was not recorded but these figures were obtained (see Table 19) for the 10 case study farms. On these farms particulars of weights of food fed were also available. When these were tabulated and compared with the feeding and food preparation times there was no obvious trend (see Table 24). Apparently the other factors discussed in previous sections of this chapter exerted more influence on the amount of labour used than did the quantities of food fed. The simple feeding systems\(^{(2)}\) on the four highest yielding herds and the use of baled hay and straw on Farms 2, 13A and 3, seemed to affect the amount of labour used in feeding and food preparation more than did the actual weights of food fed.

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Man time per cow per day for feeding and food preparation (c)</th>
<th>Total weight of bulky Food (a) fed (b)</th>
<th>Daily yield per cow (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5. 45</td>
<td>75.7</td>
<td>31.2</td>
</tr>
<tr>
<td>13A</td>
<td>5. 59</td>
<td>96.5(e)</td>
<td>44.4</td>
</tr>
<tr>
<td>3</td>
<td>6. 06</td>
<td>68.0</td>
<td>29.9</td>
</tr>
<tr>
<td>10</td>
<td>7. 26</td>
<td>108.1</td>
<td>35.2</td>
</tr>
<tr>
<td>17</td>
<td>7. 34</td>
<td>121.1</td>
<td>24.0</td>
</tr>
<tr>
<td>30</td>
<td>7. 30</td>
<td>49.0</td>
<td>15.0</td>
</tr>
<tr>
<td>44</td>
<td>9. 35</td>
<td>113.2</td>
<td>18.6</td>
</tr>
<tr>
<td>37</td>
<td>9. 55</td>
<td>59.3</td>
<td>15.4</td>
</tr>
<tr>
<td>19</td>
<td>10. 39</td>
<td>132.7</td>
<td>20.0</td>
</tr>
<tr>
<td>14</td>
<td>13. 02</td>
<td>75.6</td>
<td>28.8</td>
</tr>
</tbody>
</table>

\(\text{(a) All food excluding purchased and home grown concentrates.} \)
\(\text{(b) In winter for the three year average 1946-47 to 1948-49.} \)
\(\text{(c) For winter routine.} \)
\(\text{(d) On the day timings were taken.} \)
\(\text{(e) Three year average 1946-49 to 1950-51.} \)

\(\text{(1) For further discussion of this see Part II of this Chapter, pp. 83 and 84.} \)
\(\text{(2) Referred to under (d) see p. 62.} \)
(h) **Proportion of the year taken up by summer and winter routines**: Where it was possible, because of favourable land and weather conditions, to let cows go out for part or all of the day in winter some saving on labour was effected. Not as much cleaning out of manure was necessary and the feeding of bulky foods—sugar beet tops, cabbage, etc.—was simplified. Where the cows were turned out but all the feeding was still done inside, no saving of feeding time was made. By itself this factor was not of sufficient importance to affect noticeably the total labour hours per cow figures.

(i) **Skill, speed, intellect and interest of the workers**: The skill, intellect and interest of the workers seemed to be more important factors affecting labour efficiency than speed alone. For example, the worker who operated the machines on Farm 37 was very swift but not at all thorough. He removed the machines from the cows very quickly—the morning and evening machine times of 3 mins. 39 secs. and 4 mins. 40 secs. being the fastest of the 10 farms—but failed to operate them with intelligence. The result was that he had to spend a long time hand stripping each cow. Also because he was so anxious about the machines he did not do any other jobs, apart from stripping, (the carrying of milk being done by the farmer) and spent his time between putting machines on and taking them off, waiting for the cows to milk out. On the other hand, where the worker knew his job thoroughly, by maintaining a steady methodical rhythm he got through the work speedily, quietly and easily without apparent speedy movement. The two workers on Farm 17 (one of whom was the farmer’s son and the other a youth trained by the son in his own methods) were very good examples of this. Both knew their jobs and did them quietly and efficiently. Whenever a cow had finished milking the machine was removed by whichever of the two workers was in the shed at the time. If each had kept to his ‘own’ cows much more walking backwards and forwards with consequent increase in the time taken would have resulted.

The worker on Farm 2 also knew his job thoroughly. His movements were steady and deliberate and always with a definite purpose. In milking, a bucket would be brought back from the dairy, placed immediately behind the cow from which the machine was to be removed next, the next cow was fed from the feeding barrow, the unit taken off its neighbour, changed and put on the next cow, and so on.

Where the farmer himself also acted as head cowman and knew his job, the ability to do a routine job well under direction was a
sufficient requirement in the workers under him. On Farms 3, 13A and 17 the other workers were youths who worked well under direction but would not have done a good job if left to use their own initiative. Contrasted with these cases was Farm 2 where the worker, on the farmer's own admission, was more competent to manage the cows than the farmer.

Part I of this chapter, therefore, has shown that the different factors varied in importance from farm to farm. On some farms the effect of one factor was sufficiently large to mask the effect of other factors. Generalising, however, it can be stated that farms with good labour efficiency had:

(i) More cows per worker employed in dairying.
(ii) Good routines well adapted to their building layouts.
(iii) Simple feeding systems.
(iv) Used equipment well.
(v) Had skilled workers and/or good supervision of other workers.

The small family farms had difficulty in utilising their labour efficiently due to the smallness of the dairy unit in relation to the number of workers available.

The Figures in Pages 72—81 should be regarded as rough sketch plans only. They are not fully accurate, but are inserted to give a general impression of Building layout on the 10 Case Study Farms. An attempt has been made to show the positions of the main machines, etc. The position of feeding stuffs is also indicated but no doubt such position may be changed from time to time. Each set of buildings is drawn on a scale of \( \frac{1}{4} \)" to one yard and then photographically reduced to page size. This should be borne in mind when considering these figures. A few minor doors and entrances have been omitted as on the reduced scale they would appear minute, if no entrance is shown it can be assumed one exists.
KEY TO NUMBERS.

1. Cowshed No. 1.
2. Straw (baled) kept here.
3. Chute.
5. Gutters run here.
7. Milking machine rack and table.
9. Washing up trough.
10. Canes.
11. Cupboard.
12. Cooler.
13. Tap.
14. Tap.
15. Storage for hay (baled).
16. Sugar beet tops.
17. Cake and ground meal store.
18. Beet pulp stored.
19. Chute.
20. Feed cart stands here.
22. Manure barrow stands here.
23. Concrete apron.
24. Corn store below: Beet pulp above.
25. Milking machine pump and engines.
27. Steps up.
28. Cowshed No. 2.
29. Bull kept in this section.
30. Gutter.
31. Hay and Straw (Baled) storage.
32. Beet pulp and chaff storage.
33. Manure heap.
34. Sugar beet tops.
35. Potatoes store.
36. Hay and Straw (Baled) storage.
37. Calf boxes.
38. Feeding troughs.
39. Hay racks.

SCALE: 1 2 3 4 5 6 YARDS
KEY TO NUMBERS.

1. Calf boxes.
2. Copper.
3. Sink.
4. Sterilisers.
5. Cooler.
7. Water trough.
8. Manure heap.
10. Manure heap.
11. Dutch Barn No. 1—Hay (Baled).
12. Dutch Barn No. 1—mangolds.
13. Bin.
15. Water tank.
16. Meal store.
17. Root chopper.
18. Loft over building—Hay and corn.
19. Cow stalls.
20. Two more stalls.
22. Young stock.
23. Dutch Barn No. 2—implement shed.
24. Calf box.
25. Dutch barn No 3—hay (loose).
26. Dutch barn No 3—straw (baled).
27. Dutch barn No. 3—Wagon stands here.
FIGURE 18. FARM 13A

KEY TO NUMBERS.
1. House.
3. Cowshed No. 3.
4. Straw (baled) stacked here.
5. Cowshed No. 2.
7. Washing troughs.
8. Cooler.
10. Double gates.
11. Manure barrow kept here.
12. Beet tops here
14. Straw (baled), also hay slabs kept here.
15. Cowshed No. 4.
17. Manure heap.
18. Calf pen.
19. Feeding trough.
20. Hay rack.
22. Bags of dairy cake.
23. Skelp for cake.
25. Calf pens.
26. Two cow stalls.
27. Weighing machine.
28. Skelp.
29. Skelp.
30. Mixed concentrates.
32. Work bench.
33. Feed truck stands here.
34. Hammer mill.
35. Implement shed.
36. Tractor stands here.
37. Bull yard.
38. Service stall.
40. Hay and straw stacks 15 yards from here.

SCALE: 
0 1 2 3 4 5 6 YARDS.

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KEY TO NUMBERS.

1. Hay stack.
2. Crew yard (empty).
4. Pig yard.
5. Pig sty.
8. Implement shed.
9. Box No. 2.
10. Box No. 1.
11. Cowshed.
15. Steps up.
16. Gate.
17. Gate.
18. Ashes.
20. Cooler.
21. Copper.
22. Coal.
23. Milk stand.
24. House and porch.
KEY TO NUMBERS.

1. Dutch barn.
2. Cowshed No. 7.
3. Milled oats kept here.
4. Store for concentrates.
5. Gate.
7. Manure spreader kept here.
8. Dutch barn.
10. Hay store.
11. Cowshed No. 2.
15. Cowshed No. 3.
16. Cowshed No. 4.
17. Hay store.
18. Implement shed.
19. Young stock.
23. Cowshed No. 5.
24. Water trough.
27. T.V.O. shed.
28. Water trough.
29. Garage.
30. Implement shed.
FIGURE 21. FARM 30.

KEY TO NUMBERS:
1. Silo (unused) stands here.
2. Young stock.
3. Pigs.
4. Implements shed.
5. Bought concentrates (in bags).
7. Mill.
8. Milking machine and grinding.
10. Steps up.
11. Mixed concentrates.
13. Cabbages.
15. Calves.
16. Loose stanchions (not used).
17. Workshop.
18. Fertilisers kept here.
20. Young stock.
22. Ramp.
23. Turnips.
25. Hay.
27. Gate.
29. Tractor shed.
31. Building with water tank, immersion cooler and milking machine racks.
32. Empty box.
33. Feeding passage.
34. Young stock.
35. Empty positions.
KEY TO NUMBERS.

1. Mangold clamp.
2. Gate.
3. Implement shed.
5. Dutch barn—Straw (baled).
7. Young stock kept here—feeding troughs near walls.
8. Gate.
9. Young stock and feeding trough.
10. Gate.
11. Stalls.
12. Stalls.
13. Water tank.
15. Corn bin.
17. Milking machine engine.
18. Cow box.
20. Manure heap.
21. Storage space.
22. Root chopper.
23. Cow stall.
24. Calves box.
25. Two more stalls.
27. Milking machine racks.
28. Cooler.
29. Cans stand here.
30. Steriliser.
31. Boiler.
FIGURE 23. FARM 19.

KEY TO NUMBERS.

1. House.
2. Dairy.
3. Implement shed.
4. Store.
5. Gate.
7. Two stalls.
9. Grain store.
10. Implement shed.
11. Young bulls yard.
12. Cowshed No. 2.
13. Feeding stuffs kept here.
15. Straw.
16. Mixing store.
17. Cowshed No. 1.
18. Concentrates kept here.
19. Chaff stored here.
20. Two silos sited here.
21. Gate.
22. Gate.
23. Three stalls.
24. Storage space for wet beet.
25. Tractor shed.
27. Calf box.
29. Gate to field.

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KEY TO NUMBERS.

1. Direction of slope of ground.
2. Dutch barn—Straw (Baled).
3. Dutch barn—Corn.
5. Dutch barn—Hay (baled).
6. Calf box.
7. Calf box.
8. Swedes kept here.
10. Cake in bags kept here.
11. Milking machine switch.
12. Loft over buildings—used to store home grown corn.
13. Loft over these stalls—used to store hay (baled). Holes in floor above each cow.
15. Cow stalls.
16. Boiler sited here.
17. Washing up building.
18. Dairy with cooler.
19. Ladder to loft.
20. Box for four stirs, with feeding trough also hayrack.
21. Box for six calves.
22. Box for two calves.
23. Swedes kept here.
24. Manure heap.
25. Trailer stands here.
26. Trailer stands here.
27. Gate to road.
29. Road.
FIGURE 25.

KEY TO NUMBERS.

1. Hay stack (loose).
2. Straw stack (bundles).
3. Hay stack (loose).
5. Lighting plant.
7. Steriliser.
8. Washing trough.
10. Store room.
12. Cow stalls.
14. Straw store.
15. Hay store.
15A. Gate.
17. Hay.
20. Dutch barn—implement store.
22. Implement shed.
23. Young stock.
24. Gate.
25. Food storage (in bags).
26. Saw bench.
27. Water tank.
28. Steps up.
29. Chaff cutter.
30. Mill.
31. Young stock.
32. Hay.
33. Gate.
34. Barn engine.
35. Further cow stalls.
36. Root chopper.
37. Milking machine engine.
38. Young stock.
40. Gate.
41. Gate.
CHAPTER IV (Continued)

PART II: Underlying factors affecting the use of labour in dairying: It has already been shown in Chapters II and III that labour is only one of a number of productive factors which in varying combinations affect the efficiency of dairying as a whole. The efficiency with which labour is used for dairying on any particular farm depends not only on the manifest factors discussed under Part I of the present chapter, but also very largely on underlying factors associated with the farm and the farmer.

These underlying factors can be stated to be:

(a) The alternative use to which the labour on the farm can be put.

(b) The relative importance and supply of labour and the other productive factors on any particular farm.

(c) The capacity of the farmer for operating dairying and other crop and livestock enterprises, and his relative capacity for labour management, feeding efficiency, and management of high yielding cows.

(d) The capacity of the farm to support cows and other enterprises and the capacity of its buildings for labour efficiency.

(e) Incentives towards labour efficiency on the part of the farmer—associated with his efficiency of management of the other productive factors, his object in farming, and the price cost ratio in dairying.

Because of the wide differences in farms and farmers none of these factors will be important ones affecting labour efficiency on one farm whilst on another others will be of more importance. It is conceivable that two farms could have the same labour efficiency measured in physical or monetary terms, which would be explained by reference to similar superficial factors, but the underlying factors affecting this labour efficiency could be entirely different.

In order to illustrate the effect of underlying factors on labour efficiency under different farm conditions the labour efficiency of the case study farms will be discussed in the light of the underlying factors affecting them.

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Farm 2. This is an example of the effect on labour efficiency of almost all the underlying factors being favourable. The capacity of the farm is good, the soil being fertile and capable of growing good crops and grass, and the climate is favourable towards a mixed farming system. Allied to this the management capacity of the farmer is high for arable and dairy farming and his object in farming is very definitely to obtain maximum continuous profit from his available resources. Because of this he has achieved a balance between his dairying and other enterprises which gives him high returns per unit of inputs. His management is dynamic rather than static so that he is constantly seeking to make improvements and adjustments to meet changing conditions.

His dairying enterprise is of sufficient size to utilise the by-products of his arable cropping—sugar beet tops, beet pulp, straw and rotation hay, without the need for special crops to be grown for the cows. The herd of about 20 milking cows plus followers is a one man unit for four months—mid-December to mid-April and for the rest of the year the same man does arable work in addition to looking after the herd. Thus the alternative use value of the dairy labour is high and consequently there is every incentive to achieve maximum labour efficiency from his dairying as well as high yield and food efficiency.

Reference to Chapter III and to Part I of this chapter\(^{(1)}\) shows that the combination of all these favourable underlying factors resulted in Farm 2 having high labour and general efficiency.

Farm 14. This farm shows a poor labour efficiency by any measure, it being in the third quartile in the order of returns per £100 labour, labour cost per 100 gallons, and labour hours per cow, and in the fourth quartile in the order of labour cost per cow\(^{(2)}\). The time per cow for all dairying jobs was greater on this farm than on any of the other case study farms\(^{(3)}\). But, whilst no doubt some improvements could be made by attention to factors dealt with under Part I above, the effect of the underlying factors is the chief reason for the poor labour efficiency.

The farm is small, 42 acres, on poor upland limestone and subject to adverse weather conditions. The alternative use for labour

\(^{(1)}\) See Table 10, p. 37, Chapter III and Table 19, p. 57, Chapter IV. Reference to these tables needs to be made throughout the rest of this chapter when considering the efficiency of all the case study farms.

\(^{(2)}\) Table 10 op. cit.

\(^{(3)}\) Table 19 op. cit.
is very small, there being very limited possibilities for any increase in cropping (in any case the combination of land and farmer capacity for cropping is low, the crop yield index$^{(1)}$ being only 80), and the farmer’s capacity for management of livestock, other than dairy stock, is also low. Because of the size and low capacity of the farm the number of cows it supports could not be increased in an attempt to provide productive work for the labour (the farmer’s own), without purchase of most of the food, bulky and concentrated, necessary to support the increased number of cows. Purchased bulk—hay, straw and roots—is very expensive in the area due to the isolated situation and the long distance from the source of supply. The farmer’s solution to the production problems he faces is to accept his adverse position as far as labour efficiency is concerned and to make the best use of his other productive resources. He obtains good yields from his cows and feeds them efficiently and consequently his general efficiency is reasonable—14th out of 45 in the order of profit per cow$^{(2)}$ despite his low labour efficiency.

**Farms 44 and 13A.** These two case studies illustrate how two farms can have similar capacities but because the capacities of the farmers themselves and their incentives towards efficiency are very different, the alternative use to which the labour can be put can differ widely and with it the labour efficiency.

Although the farm sizes are different, Farm 13A being of 100 acres, whilst Farm 44 is only of 50 acres, the capacities of the farms as regards soil fertility and climate are similar and the stocking with dairy cattle is proportionately the same on each. Both originally had old buildings but whereas Farmer 13A spent about £800 in improving his for ease of working and to bring them up to T.T. standard, Farmer 44 pays interest on a similar amount for new buildings which are no more labour saving than were his old ones. (Compare Figures 18 and 19, pp. 74 and 75).

In the year 1950-51 Farmer 44 obtained 45 per cent out of his gross returns of £2,700 per 100 acres from dairying, whilst farmer 13A, who had about the same proportionate returns from dairying (49 per cent), obtained double the total returns per 100 acres (£5,400). With his present set-up, which is due to his limited managerial capacity, the alternative use for Farmer 44’s own labour is low and so he spends a lot of time looking after his small number of cows—hand milking

$^{(1)}$ Index based on comparison of Farm 14’s crop yields with those for an average of 38 farms of the mainly dairying type.

$^{(2)}$ See footnote (1), referring to Table 10, on p. 83.
them and giving them a lot of attention but not getting either good yield or a good feeding efficiency to compensate for this high labour use. Consequently, not only is his labour efficiency low\(^1\) but also his general efficiency in all the other productive factors, as measured by profits, is also low\(^2\).

On the other hand Farmer 13A has a high alternative use for his labour on other productive enterprises, as he has 60 acres of cash crops in addition to the grassland and fodder crops area for his cows. As mentioned in Part I pp. 52 and 53 his increased labour efficiency over the three years 1948-49 to 1950-51 has been due to the increase in efficiency of use of his other productive resources rather than to any great effort on his part to save labour. His capacity for managing high yielding cows and feeding them efficiently is good and consequently he obtains very good profits, his three year average profit per cow 1948-49 to 1950-51 being £63 per cow. His objective in farming is not as definitely maximum continuous profit as is that of Farmer 2 for instance, but, because he wants to farm well and have a first class pedigree herd (his herd stood high in the county in the National Milk Records for 1950-51), his incentive towards efficiency is high.

Farmer 44 seems to be well content with just sufficient to live on—his returns for his labour and management being £21 per cow for the three year average 1946-47 to 1948-49. Without monetary or status ambitions there is no drive on his part towards increasing either general or labour efficiency.

Farms 30 and 17: These two farms have different farm capacities, more or less the same farming system and different farmer capacities. As can be seen from reference to Figures 20 and 21, pp. 76 and 77, they have both a legacy of old-type dairy farm buildings which are labour saving in some aspects, principally feeding, but are not well suited for machine milking.

Farm 30 has a better farm capacity than Farm 17, its soil being more fertile (heavy to medium loam), its situation less exposed and not as subject to hard winters as Farm 17, which is on thin hill limestone at an elevation of over 1,000 feet. Farmer 30 has a cash crop acreage of 30 acres but does not stock his remaining 185 acres so intensively with dairy cows as does Farmer 17 on his 193 acres. His managerial capacity for dairying is not as great as that of Farmer 17 nor is his capacity for cropping. Despite the fact that he is in the

\(^{1}\) See Table 19, p. 57.
\(^{2}\) See Table 20, p. 58.
second quartile in the order of yield per cow he is in the third quartile in the order of returns per £100 food costs, returns per £100 labour and labour hours per cow, and the second quartile in the order of labour cost per 100 gallons and labour cost per cow\(^{(1)}\). Farm 17, although in the third quartile on yield, is in the second quartile on returns per £100 food costs and the first quartile in the other measures\(^{(1)}\). On cropping too, despite adverse conditions, Farmer 17 is better than Farmer 30, his crop yield index being 115 as compared with 92 for the latter.

Because of his better capacity Farmer 17 operates an extensive dairy system, 63 cows in the herd with a high labour efficiency, low yields (528 gallons for the three year average) and good feeding efficiency for that yield level. His capacity for management at this yield level is good and consequently he gets a good profit per cow and per herd. It is doubtful, however, whether he would be able to obtain better results, or even as good, from keeping higher yielding cows, as his capacity for managing high yielding cows is not good.

Farmer 30, however, operates an extensive system, 47 cows in the herd, at a slightly higher yield level (625 gallons for the three year average), but does not operate it efficiently enough to get good profits. His farm conditions are such that he could operate a more intensive system by keeping higher yielding cows (his buildings probably would seriously limit any expansion in cow numbers), but his capacity for managing and feeding high yielders is not good. His only way of making profits, therefore, is to aim for a reasonable labour efficiency. He has achieved this but even in this respect he is not as good as Farmer 17.

**Farms 19 and 10:** Differences in farmer capacities and incentives towards efficiency are demonstrated further by a comparison of these two farms. Because of the higher managerial capacity of Farmer 10 compared with Farmer 19 on the same sized farm (Farm 10—43 acres: Farm 19—50 acres), with the same equivalent labour force, farmer and son with pupil help on Farm 10, and farmer and son with help from wife and some casual help on Farm 19, and more or less the same farm capacity as regards soil and climate—any difference in favour of Farm 10 being offset by the slightly higher acreage of Farm 19,—the alternative use for the labour on Farm 10 is very much greater than on Farm 19. Farmer 10 has a smaller herd than Farmer 19 (12 cows as against 19), and for 1950-51 his dairying

\(^{(1)}\) See Table 10, p. 37.
returns of £1,290 represented only 39 per cent of his total returns of £3,360, whereas Farmer 19, out of total returns of £2,385, obtained £1,880, or about 79 per cent from dairying\(^{(1)}\). Because of the greater variety and intensity of his other enterprises, (pigs, poultry and wheat), Farmer 10 has more need for his labour in between milking and so spends much less time on his cows than Farmer 19 who has very little else for his labour to do apart from dairy and associated work. Although Farmer 10's returns and his total profits from dairying are lower, his profits per cow and per herd for the three year average 1946-47 to 1948-49 being £39 and £468 respectively, whilst those for the same period for Farmer 19 were £27 and £513, on the basis of his total returns, Farmer 10's profit per farm can be expected to be considerably higher than that of Farmer 19. Not only is his labour efficiency and general efficiency in dairying higher but also his whole farm efficiency is better and he is making better use of his available resources than is Farmer 19. His labour efficiency in dairying seems much more from his all round farm managerial efficiency than from the affect of manifest factors in which, as can be seen from Table 19, he does not always show up in a good light.

**Farms 27 and 3:** Where capacity in the farmer for managing high yielding cows and obtaining a good feeding efficiency is low the only way to make a profit at all from dairying is to use the minimum of labour. This is the case with Farm 27 where the farmer gets low yields because he:—

(i) Has poor cows.

(ii) Has a large proportion of his cows dry\(^{(2)}\).

(iii) Grows poor food for them.

(iv) Feeds them badly.

Labour saving capacity is probably the easiest of the capacities for dairying efficiency as in its simplest form it is a negative rather than a positive thing. One farmer does not swill out. Another milks as fast as possible, and gives the cows the minimum of attention. As a result a farmer's labour efficiency as measured in physical terms may appear good but it just does not pay dividends if it results in poor feeding and low yields. This is clearly shown if one compares for Farm 37 in Table 19 columns 6, 7 and 8 with columns 2, 3, 4 and 5.

\(^{(1)}\) These returns for both farms are estimates based on milk cost figures and enquiry from the farmers as to returns from other enterprises.

\(^{(2)}\) This is why his per cow figures in table 19 are higher—if the measure had been per cow in the herd his total time per cow would have been 29 minutes 59 seconds, and thus more in line with his yearly labour hours per cow in the herd figure of 99.
Farmer 37's managerial capacity is low, consequently he cannot make the most of his farm's capacities, which are reasonable as far as soil and climate are concerned, and his apparent high labour efficiency cannot provide him with a reasonable income.

Contrasted with Farm 37 is Farm 3. Here is a farm on poor thin hill limestone with adverse weather conditions. Yet, because the farmer is a good manager of high yielding cows, a good feeder and has his farm heavily stocked considering its inherent capacities (18 pedigree cows, three year average yield 896 gallons, with followers, on 130 acres of very poor soil), he obtains high profits per cow and per farm. Because he is efficient in the other productive factors affecting dairying, up to the present time he just has not worried about labour efficiency. He employs two youths where he could manage with one and himself, but this arrangement gives him more leisure, his physical working time in winter being confined to actual milking morning and night. His very high labour hours per cow figure of 231 is certainly not due to poor building arrangements (see Figure 24 p. 80), or to poor work routines (see Part I of this chapter and Table 19 p. 27). It is simply because he has one man extra about the place during winter. In summer the labour force is more fully occupied with arable and grassland cultivations.

The labour he has is young and cheap and works well under direction enabling him to control well the feeding and management of his cows. To do away with one of the youths would involve the farmer in more physical work, would upset daily and week-end routines and would entail the employment of casual labour in the busy periods during the spring and summer. The farmer has obviously weighed up in his mind the advantages and disadvantages of his present set-up compared with one with less labour, and, bearing in mind his profit levels from his present system, his desire for leisure and the freedom which it gives him to devote his time to the pedigree side of his dairying, he has decided in favour of his present system. It may well be that with increased purchased food costs, (he uses large quantities of cake), he may in the future have to consider cutting his labour expenditure or increasing his intensity still further. From tentative plans which he is considering for expansion of his buildings to house more cows it appears likely that in the future he will expand his herd, keeping the same labour force and thus increase both output and labour efficiency.

It is important to realise that any increase in labour efficiency which results from such a policy is incidental to the policy and caused
by increasing or improving the other productive factors likely to affect his general dairying efficiency.

This Farm 3 brings to light the importance of the price cost ratio in dairying. It has already been shown in Chapter I p. 16 that compared with American conditions dairy farmers in this country get a much greater proportionate margin over cost, both per cow and per gallon. As long as this is the case there will be no great incentive to improve those efficiencies, of which labour is one, which have in themselves the lesser effects on dairying profits.

As far as the efficiency of the industry is concerned, reduction of margins over costs and/or income tax reductions may well have a greater incentive effect towards increasing labour, feed, or general all round efficiency in dairying, than exhortations to reduce labour hours per cow, or feed food better, as farmers who are reasonably efficient by present standards can see no material advantages resulting from such increased efforts on their part.
CHAPTER V.

CONCLUSIONS.

A. Practical Implications.

(1) The least input of labour in dairying, or the highest returns per unit of labour, is not necessarily desirable. The implications of the laws of variable proportions and of factor substitution must always be considered.

The best use of labour for any particular dairy farm depends on the capacities of the farm and the farmer, the relative scarcity of labour, and the other productive factors (land, capital and managerial ability), and the degree of substitutability of the factors. Where 'other factors' are scarce labour use will tend to be high as the alternative use to which it can be put, i.e. its opportunity cost, will be low. Where its opportunity cost is high due to the scarcity of it and/or the plentiful supply of some or all of the other factors its alternative use will be high and hence it will be used sparingly.

(2) Yield levels and efficiency of feeding have more effect on final profits than has the use of labour. Where labour is used well in relation to these other factors good profits result. But, where economy in labour results in, or is associated with, poor yields and low feeding efficiency, it cannot by itself compensate for these deficiencies and lower profits result.

(3) Farmer and farm capacities for obtaining good yields, good feeding efficiency and good labour efficiency vary. In the relatively few cases with good capacities in all the factors the highest profits result and conversely where capacities are poor in everything the lowest profits are obtained. In the vast majority of cases, however, capacities are good for some factors and not for others.

(4) Labour use in dairying on any particular farm will largely depend on the capacity of that farm for the efficient use of labour and on the capacity of the farmer for labour efficiency and his incentives towards labour efficiency. These incentives will depend on:

(a) His capacity for using other factors well and hence the relative need he feels to use labour efficiently.

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(b) His sense of urgency towards efficiency in labour and the other factors affecting his dairying enterprise. This urgency will be dependent on (i) the farmer’s object in farming—the importance to him of profit, status and leisure: (ii) the incidence of taxation, and (iii) the price cost ratio in dairying.

Within the limits of the underlying factors considered above the important manifest factors affecting the efficient use of labour in dairying are:

The number of cows kept per worker employed on dairying.
The organisation, efficiency and composition of the work routines.
The adaptation of the work routines to the building layout and where practicable the adaptation of the buildings for ease of working.
The skill, interest and intelligence of the workers engaged on the dairying enterprise.

B. Research Implications.

(1) Labour use alone bears very little relationship to general efficiency in dairying. Mere studies of physical labour use are only of value in so far as they are descriptive of the wide farm to farm variations in the amount of labour used.

(2) In trying to ascertain the reasons for the wide variations which occur in labour use on different farms, all the productive factors affecting dairying need to be considered as the inter-relationship of labour with these other factors is of more importance in determining its use than are the actual physical details concerning the labour itself.

(3) Correlation analyses from a sample of farms reveal general trends associated with the main factors affecting the use of labour in dairying. For any one factor, however, the correlations are not very high. Because of this, correlation analyses are only of limited value in studying the large number of factors involved, factors which vary in importance and effect under different farm conditions. On any particular farm the effect of all the other factors may be such as to nullify or conceal the effect of a factor which from correlation analyses would appear to have a marked effect on the use of labour. For detailed examination of the effects of the different factors it is necessary to carry out case studies of selected farms.
(4) Time and motion studies by themselves are valuable for individual farm advice where there is a need and a desire for change. But when used as part of a study into the reasons for inter-farm variations in labour use they do not reveal anything, apart from the absolute figures of times taken and distances travelled, which is not evident from careful observation of farm conditions and practices. The detailed recording involved and its subsequent analysis is very time consuming and when complete is merely a record of time taken and distances travelled for a particular farm. There may be some justification for a certain amount of timing of the different jobs but, in relation to the use to which they can subsequently be put, there is not much justification for making detailed measurements of distances travelled.

(5) Studies of work organisation and management on a farm are more productive of results that can be applied to other farms than are detailed time and motion studies of the jobs performed on that particular farm.

(6) It has been the experience as a result of this study that the research time spent in collecting, analysing and critically considering the details of individual farms and of all the factors likely to affect labour use on these farms has been more productive of results capable of general application than has the time spent in collecting and analysing ‘time and motion’ details. It is felt that, in future studies, greater benefit will accrue from detailed studies of all the factors on a farm likely to have an influence on labour use, carried out on a large number of farms, than would be obtained from carrying out time and motion studies, in addition to detailed studies on a much smaller number of farms.
APPENDIX.

(a) Rate of Machine Milking of cows and the effect on the udder of keeping the machine on longer than four minutes.

Following up the work and the personal tour of Professor Peterson, who claimed that almost all cows could be trained to milk out in four minutes and that damage to udder tissue was caused by keeping machines on longer than this time, extensive work was done at the National Institute for Research in Dairying at Reading, to test these claims. The work done did not confirm these findings as the following extracts from reports show:


"The rate of milking of a cow is not readily affected by changes in management. Even severe management changes have an almost insignificant effect on rate of milking and cows cannot be trained, or forced, to milk more quickly than their udder structure will allow.

In field experiments with 40 heifers over a lactation period, half on a fixed milking time of four minutes and half on eight minutes, it was found that most of the animals on the four minute treatment did not have sufficient time to milk completely.

The routine of washing and feeding immediately before milking led to more complete milking than if washing and feeding was done 20 minutes before milking. The former routine gave a slightly increased rate of milking".

_N.I.R.D. Paper No. 911 by H. S. Hall._

"Many workers have shown that the criterion as to when to remove machines is not time but the flow of milk, milk should start flowing as soon as teat cups are applied to cow and teat cups should be removed immediately milk flow ceases. This must be the sole criterion and the time involved may vary considerably from cow to cow. Three to eight minutes is not an uncommon range. The time will become less for any cow as the lactation advances".

_'Secretion of Milk' by Espe—Journal of Dairy Science 1944._

"No injury to udder occurs due to machine being left on for prolonged periods if milk is still freely flowing through the teat sinus."
If machine is left on for prolonged periods after milk ceases to flow injury occurs”.

(b) Relative importance of different factors affecting the bacteriological cleanliness of milk.


“The basic and important factors affecting the keeping quality of milk can be stated simply:—

Sterile utensils.
Clean udders and hands.
An adequate water supply.
Efficient cooling.

“... if utensils are sterile, the contamination received from dust or from litter should be comparatively unimportant.”

“... the most powerful and determining factor in the life of milk is the temperature at which it is held during standing, transport, distribution and thereafter”.

“... It will be noticed that I have made no reference to the environment in which milk is produced, nor advocated statutory requirements. It has been abundantly demonstrated that if the main rules are observed clean milk may be produced in unpromising conditions, and it is clear that simplicity, with adequacy, in the matter of buildings and fittings is desirable”.

“... Provided that the reduction in temperature of the milk is adequate there are no hygienic disadvantages to the well managed immersion cooler whether water or mechanically cooled. On the other hand, we have recent evidence that even on well managed farms the keeping quality of milk may be adversely affected by the use of a surface cooler”.

“... the most potent factor (affecting production of clean milk) remains in the end the mentality and personal capacity of those actually engaged in milk production”.

In this the authors review reasons for rejection and also examine the practices of producers sending consistently satisfactory supplies to a large Midland dairy over a six year period. In part of their discussion they state:

“Our observations (Table I) show that milk is returned consistently to a minority of producers. These rejections were apparently not related either to distance from the dairy or time of arrival, and, moreover, a proportion of farms is able consistently to produce milk which is at all times and in every respect satisfactory. From a survey of production conditions at farms of the latter type, there seemed to be no factor common to all which would account for the very high standard maintained. The common factor is probably psychological, vesting in the character of the individual responsible for production rather than in any particular method or routine. From intimate knowledge of some of these farms we suggest that the most important point is careful attention to the initial removal of milk by thoroughly rinsing and scrubbing all utensils after each milking. One producer is particularly worthy of mention, and the case will serve as a demonstration and justification of this suggestion. This farm is 45 miles from the dairy; its milk is collected at 8.45 a.m. and arrives at 12.30 p.m. For 13 samples tested for colony count during 1940-49 the mean was 1,028, the lowest value being 270 and the highest 3,000/ml. Eleven of the 13 samples had no coli-aerogenes bacteria, the other two showed the presence of these organisms in 1.0 and 0.1 ml. respectively. Owing to failure to conform to requirements regarding buildings, this farm is not licensed to produce designated milk. The work is done by the farmer and his young daughter, who milk 16 cows by hand. There is a good supply of well water for cooling, with which an open surface cooler is used. Immediately after the morning milking the utensils are thoroughly rinsed with cold water and are later scrubbed with so-called ‘boiling’ washing soda solution, but after the evening milking they are scrubbed in running cold water only. Whatever the weather all utensils are steam sterilised in a chest once a week only. The milk from this farm has invariably been accepted without question since early 1943.”
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