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LABOUR AND MACHINERY USE ON THE LARGER, MAINLY ARABLE FARM

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School of Rural Economics

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FOREWORD

A lot of criticism has been levelled at farm economists and management advisers to the effect that they concentrate too much upon gross margins and have too little to say with regard to the "fixed costs", notably labour and machinery. Whether or not such criticism is justified, there is no questioning the considerable importance of these two items of cost - forming as they do about half the total costs on arable farms - nor the concern that farmers have about the rate at which these costs have been increasing, at a time when many product prices have been rising only slowly, with even poorer prospects for compensating increases in the future. Nor is there any denying that there has been relatively little survey work on labour and machinery costs in the past decade or so. This report makes some attempt to help redress the balance.

The material in the report is based on a survey of 62 farms, which forms part of a much wider study of labour and machinery requirements and costs on large, mainly arable farms. The author, Nigel Walford, is a research postgraduate in the Farm Business Unit. The content is largely statistical, and while some of it merely verifies what is already well-known it was felt to be worthwhile publishing the results in full, since there is a dearth of published facts about the current position. Furthermore, the farmers who participated in the survey were keen to see the overall results without too long a delay.

In summary the report begins by describing the size and type of labour force employed, together with wage rates, plus the amount, type and age of machinery present on the farms surveyed. It then considers the size of staff required, by looking at rates of work achieved and the total labour requirements of different crops, finally calculating the seasonal requirements of labour throughout the year.

Finally, the author and I wish to convey our sincere thanks to those farmers who co-operated in the survey so helpfully and generously. We also wish to thank the Ministry of Agriculture, Fisheries and Food for financing this research.

John Nix,
Head, Farm Business Unit
November, 1979.

1. INTRODUCTION

Over the years, many farm management economists, both in the U.K. and abroad have investigated the levels of labour and machinery inputs, either separately or in combination. Some of these studies, particularly in the U.S.A., have attempted to calculate optimum combinations of labour and machinery (Billingsley et al, 1973; Casler and Morris, 1967; McHardy, 1967) through the application of farm planning models, such as linear programming and simulation studies. Others have preferred a simpler approach using budgeting (Eidsvig and Olson, 1969; Schwart, 1972; Krenz and Micheel, 1974). These researchers have sought to calculate the various elements of labour and machinery costs involved in operating different-sized machines on different areas of crops, with a view to providing information to assist farmers in their machinery selection decisions.

Others have attempted a more interpretive analytical approach, endeavouring to discern the relationships between levels of labour and machinery inputs. In these studies reference has been made to the effects of differing size, either with respect to particular crops (Kerr, 1977) or overall farm size (Sturrock, 1966). These investigations have generally acknowledged a tendency towards increased mechanization, a reduction in labour inputs and increased farm size. Economies of scale, seen essentially as a spreading of fixed costs over a greater production area, have been examined in relation to increased specialization and concentration into large-scale units (Sturrock, 1968).

In this report, the relationships between labour and machinery are examined on farms with a total area in excess of 300 ha (approx. 750 acres). In 1974 farms in this category represented approximately 1.75% of agricultural holdings and 18% of the crops and grass area in England (Agricultural Statistics, MAFF, 1974). The decision to concentrate on larger farms was made partly because few studies in this country have considered such farms as the basis for study, despite the continuing tendency towards increasing farm size. Furthermore, and perhaps more important, if evidence of economies and diseconomies in labour and machinery use associated with increased size were to be uncovered, it seemed sensible to regard this upper end of the size range as the most appropriate for study.

One possible effect of size that will be considered is whether farms lying towards the highest end of the size spectrum exhibit features of 'overcapacity' in labour and machinery. If so, this may be interpreted as an attempt by farmers to reduce the risk of untimeliness in operations and possible worries concerning the unreliability of machinery. Some aspects of this question are investigated through an examination of the size and structure of the labour force and machinery complement, having regard to farm size and cropping characteristics. The work rates being achieved on these farms for the main field operations, which are clearly related to machine capacity, are used for comparison with previously published data and as a basis for looking at a farm's labour and machinery requirements.

2. THE SURVEY

As already mentioned, the lower limit of total farm size was set at 300 ha, since this was felt to provide a convenient 'cut off' point enabling some comparison with farms in MAFF's upper two size categories, namely 285 - 405 ha (700 - 1000 acres) and over 405 ha (over 1000 acres). Table 1 shows the number and geographical distribution of the farms selected for inclusion in the survey. As will be seen, the proportion of farms in

TABLE 1. COMPARISON OF DISTRIBUTION OF FARMS OVER 300 ha IN SOUTH-EAST ENGLAND AND IN SURVEY (1974 figures).

	Farms per county.	Farms over 300 ha per county.	% farms over 300 ha per county.	Farms over 300 ha in survey.	% farms over 300 ha in survey.	% farms over 300 ha in region per county.	% farms over 300 ha in survey per county.
Kent	5284	113	2.2	29	25.7	47.9	46.8
Surrey	1841	19	1.0	5	26.3	8.0	8.0
Sussex (East & West)	4657	104	2.2	28	26.8	44.1	45.2
	11782	236	1.8	62	26.3	100.0	100.0

each county accords with the proportion of those surveyed in each county. Just over 25% of the larger farms were visited in each county. Specialist dairy and pigs/poultry farms were excluded, together with those containing a high proportion of fruit or horticultural enterprises. The intention was to achieve a sample representative of the South-Eastern counties while maintaining an emphasis on farming systems based on cropping or cropping with livestock.

The size structure of the sample is shown in Table 2. The most common size of farm was in the range 300.1 - 450 ha (741 - 1112 acres), the numbers fairly steadily decreasing with increasing size.

Cropping details for the survey farms are given in Table 3 and Appendix A, Table (i), the latter indicating in more detail the areas under each crop. As will be seen, 50 percent of the land was in cereals (72% of this area being winter-sown) and 38 percent under grass. Areas and percentage areas are shown for each crop relating to the farms where each is grown as well as to the total area represented.

Although livestock-dominated farms were specifically excluded from the sample, a considerable number of the farms possessed livestock enterprises to differing extents (Table 4). The percentage figures for farms with up to

TABLE 2. SIZE OF SURVEY FARMS: FREQUENCY DISTRIBUTION.

Size range (ha)	Number of farms		% of farms	
	Total area	Farmed area	Total area	Farmed area
Under 300	-	3	-	4.8
300.1 - 450	24	25	38.7	40.3
450.1 - 600	14	14	22.6	22.6
600.1 - 750	11	12	17.7	19.5
750.1 - 900	4	3	6.5	4.8
900.1 - 1050	4	2	6.5	3.2
1050.1 - 1200	3	3	4.8	4.8
1200.1 - 1350	2	-	3.2	-
	62	62	100.0	100.0

200 head of beef animals are generally indicative of a single suckler herd, there being relatively few instances of intensive or large-scale beef production. More than half the farms had a dairy herd, with a large number in both the 101 - 200 and 201 - 300 head size ranges. These dairy herds, therefore, are more than simply 'complementary enterprises' enabling a grass break in an arable

TABLE 3. CROPPING STATISTICS - AVERAGE AREA AND PROPORTION BY CROP TYPE.

	Whole farmed area		Where individual crop present		
	Av. area	% area	% farms	Av. area	% farmed
Winter Cereals	194.3	36.3	100.0	194.3	36.3
Spring Cereals	75.7	14.1	87.1	86.9	15.6
Maincrop Potatoes	7.5	1.4	37.1	20.2	3.7
2nd Early Potatoes	2.0	0.4	17.7	11.3	2.2
Early Potatoes	2.2	0.4	12.9	17.1	3.9
Sugar Beet	0.4	0.1	1.6	24.3	4.8
Oil Seed Crops	8.9	1.7	25.8	31.4	6.8
Vining Peas	1.8	0.3	4.8	37.2	4.3
Seed Peas	5.1	1.0	20.9	24.5	5.5
Other Legumes	4.2	0.8	16.1	25.7	4.9
Root Vegetables	0.4	0.1	8.1	4.4	1.3
Brassicas	0.7	0.1	6.5	10.8	3.5
Top Fruit/Hops	0.9	0.2	8.1	10.5	2.2
Herbage Seeds	10.4	1.9	35.5	29.4	5.6
Grass Leys	110.3	20.6	93.6	117.9	22.5
Other Fodder	17.2	3.2	56.5	30.4	4.7
Permanent Pasture	93.0	17.2	95.2	97.7	17.0
Fallow	1.2	0.2	4.8	25.3	5.9
	536.2	100.0			

production system. 9% of the farmers with dairy enterprises had started them within the previous two years. Sheep were kept on nearly half the farms, most commonly in the traditional areas such as Romney Marsh and the Kentish downland. Pigs and poultry were relatively unimportant overall, with either or both present on only four farms.

TABLE 4. FREQUENCY DISTRIBUTION OF LIVESTOCK ENTERPRISES BY HERD SIZE (% of farms).

No. of head:	Less than 100	101 - 200	201 - 300	301 and over	Total %
Dairy Cows	8	23	18	8	57
Beef Cattle	24	24	10	14	72

No. of ewes:	Less than 750	751 and over	
Sheep	31	18	49

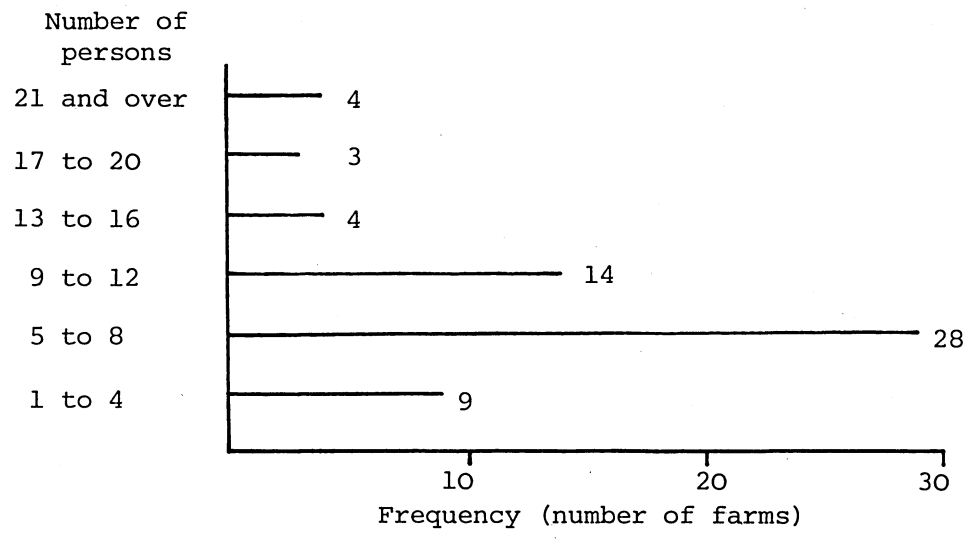
Thus the 'typical' large farm in the survey is to a considerable extent based on cereal cropping frequently accompanied by a livestock enterprise. The individual farm variations in cropping and stocking must obviously be taken into account when considering and applying the conclusions reached regarding the levels of labour and machinery.

3. THE LABOUR FORCE

3.1. Number of Workers

The number of full-time workers obviously varies according to the size, cropping and stocking, and machinery complement of the farm. The number ranged from 2 to 32, Figure 1 showing that the 5 to 8 size group was the most common, with the modal (most typical) size being 6 persons. It is interesting to note the number of farms still with quite a considerable full-time labour force. When considering the relationship

FIGURE 1: SIZE OF FULL-TIME LABOUR FORCE.



between the full-time labour force and farm size, it is necessary to include students present on a farm for a whole year; such students - generally one or two only - were present on 18 of the farms. Table 5 compares the farmed areas with the number of full-time workers including students. Despite 'distortions' attributed to differences in cropping pattern and livestock numbers, the expected relationship between the number of workers and farm area is clearly demonstrated.

Seasonal or casual workers were employed on 84% of the farms, though the numbers involved obviously depended upon the task for which they were employed. For baling and grain harvesting 1 or 2 students may be all that are required, while potato harvesting may involve a large number of casuals, in one case 70. Part-time workers employed on the farm throughout the year were also a significant feature, being present on 51.5% of the farms. Usually 1 or 2 such persons were employed, often old-age pensioners performing general duties around the farm buildings, such as attending to youngstock and grain stores.

A further supplement to the labour force is in the form of manual work performed by 'management' or the farm family. Table 6 shows that 52% (32) of the farms had just the one such person available and that on average 1.5 people in this category were available per farm. The number of hours contributed by such labour per person was mainly under 1500 per annum, but in 25% of cases 'management' worked manually more than 2000 hours a year. There appeared to be two main types: one of a relief and

TABLE 5: COMPARISON OF FULL-TIME LABOUR FORCE WITH FARMED AREA (number of farms).

Farmed area	Size of full-time labour force 1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	Over 21	Total
0.1 - 300 ha	1	1	1	-	-	-	3
300.1 - 450 ha	8	12	5	-	-	-	25
450.1 - 600 ha	-	9	5	-	-	-	14
600.1 - 750 ha	-	5	2	2	2	1	12
750.1 - 900 ha	-	1	1	1	-	-	3
900.1 -1050 ha	-	-	-	1	1	-	2
1050.1 -1200 ha	-	-	-	-	-	3	3
Total	9	28	14	4	3	4	62

supervisory nature, such as at drilling and harvest, and the other virtually full-time manual.

3.2 Categories of Workers

Apart from looking at the employment status characteristics of the labour forces, employees were also classified according to their type of work. Four categories were used:

A Tractor Drivers	mainly engaged in fieldwork, including that on forage crops, but no regular livestock work.
B Livestock Workers	livestock work on cattle and sheep.
C Maintenance	estate, workshop and building maintenance.
D General Farm Workers	including full-time and part-time workers doing general duties.

N.B. Persons spending distinct proportions of their time on more than one type of work were classified accordingly, e.g., 0.5 Tractor Driver and 0.5 Maintenance. Pig and Poultry workers were included in the total labour force, but excluded from type-of-work classification.

The numbers of farms with tractor drivers and livestock workers and the numbers of these workers clearly reflect the cropping and livestock basis of these farms (Figure 2). It is also interesting to note the number of farms with maintenance workers, which demonstrates the ability of large farms to afford and justify maintenance workers rather than using outside concerns. The farms with 3 or 4 maintenance workers all had over 700 ha (1730 acres) of farmed area and those with 1 such worker or one employed half-time were in most cases below 600 ha (1483 acres).

TABLE 6: MANUAL WORK BY MANAGEMENT (number of farms)

Hours of manual labour	Number of management workers 0	1	2	3	4	5	Total
Less than 500	-	23	6	2	1	-	32
501 - 1000	-	9	1	2	1	-	13
1001 - 1500	-	11	5	3	1	-	20
1501 - 2000	-	1	4	-	-	-	5
2001 - 2500	-	5	3	1	2	2	13
Over 2500	-	6	4	1	-	-	11
Number of farms	7	32	14	4	3	2	62
Number of persons	-	32	28	12	12	10	94

The percentage proportions of each type of worker in the full- and part-time labour force were calculated as a fairly crude measure to indicate whether there was some degree of consistency in the ratio between the different types of labour despite changes in the overall size of the labour force.

FIGURE 2: NUMBER OF WORKERS BY JOB CLASSIFICATION

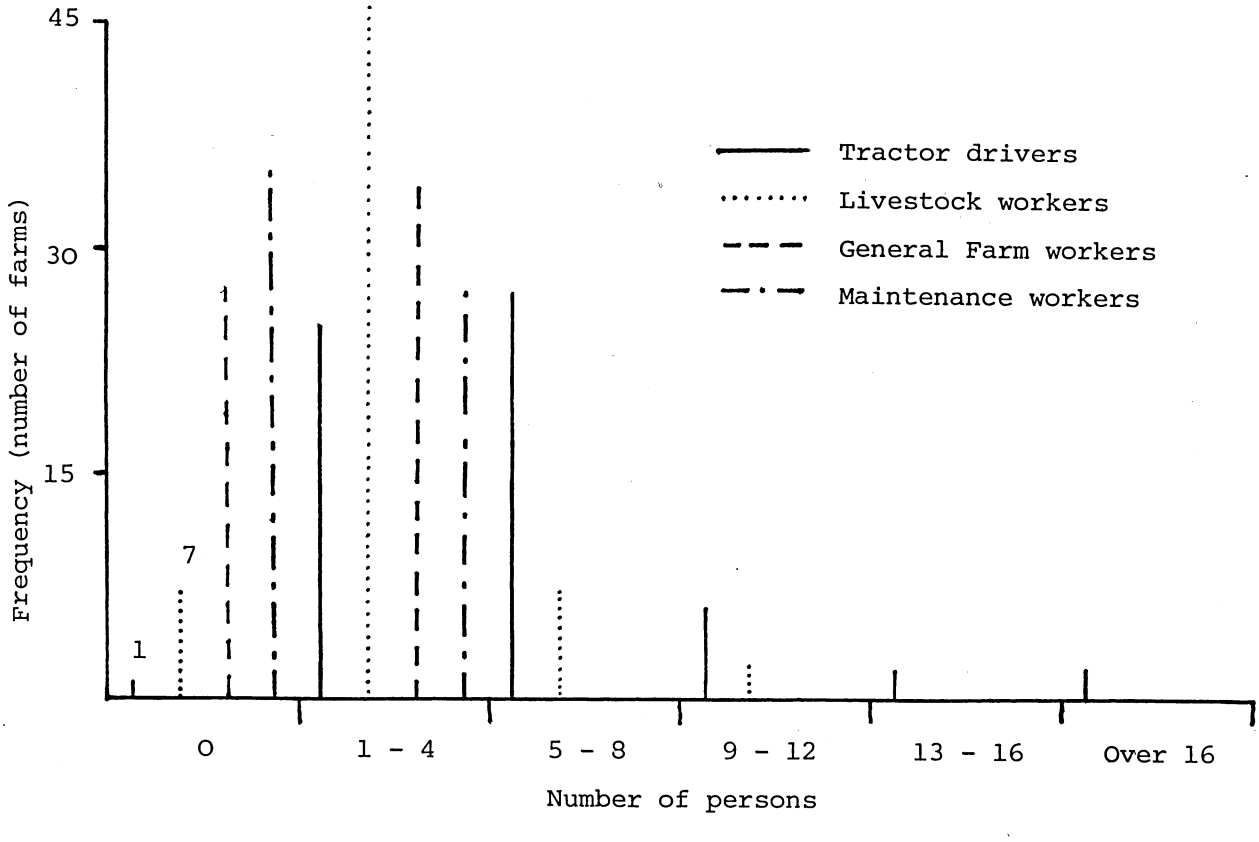


Table 7 summarizes these proportions, showing that tractor drivers consistently accounted for over 50% of a farm's regular labour force (70% of farms were in this category) and livestock workers represented less than 50% on 80% of farms. The small proportions associated with general farm workers demonstrates the high levels of specialization of farm labour, especially

TABLE 7: COMPARISON OF PERCENTAGE PROPORTION OF LABOUR FORCE FROM DIFFERENT TYPES OF LABOUR.

% of Labour Force	Tractor drivers	Livestock workers	Main-tenance	General Farm workers	Other (pig/ poultry)
Less than 25%	1	23	33	30	-
25 - 49.9%	16	27	1	4	1
50 - 74.9%	33	5	-	-	1
75% and over	10	-	-	1	-
No. of farms	60	55	34	35	2

as this classification includes regular part-time workers. On one farm maintenance workers accounted for 27% of the total, but in the main the proportion was considerably less, mainly below 15%.

Refining this approach slightly, Table 8 presents comparable figures representing the percentage of total hours contributed by the members of the same work-type categories in the full- and part-time labour force. This improves on the estimates of labour input in the previous table in that it takes account of the number of hours in the basic working week and the amount of overtime worked. However, only slight differences between the two tables can be detected, with perhaps a marginal increase in the importance of livestock workers.

TABLE 8: COMPARISON OF PERCENTAGE PROPORTIONS OF TOTAL HOURS FROM DIFFERENT TYPES OF LABOUR.

% of total hours	Tractor drivers	Livestock workers	Maintenance	General Farm workers
Less than 25%	-	20	33	32
25 - 49.9%	18	31	1	2
50 - 74.9%	32	4	-	-
75% and over	10	-	-	1
No. of farms	60	55	34	35

Table 9 gives a very broad indication of the relationship between tractor driver hours and the area of arable crops. The smaller areas are obviously associated with fewer hours, though one interesting feature is that a number of farms in the higher size range also have comparatively few hours. This suggests either an economy of scale or less intensive cropping.

TABLE 9: COMPARISON OF ARABLE CROPS AREA WITH HOURS FROM TRACTOR DRIVERS.

Tractor driver hours	Arable crops area (ha) 100 - 199.9	200 - 299.9	300 - 399.9	400 - 499.9	500 - 599.9	600 and over
Less than 9000	5	7	3	-	-	-
9000 - 17999	5	11	7	7	1	-
18000 - 26999	-	2	1	3	-	3
27000 - 35999	-	-	1	1	-	1
36000 - 44999	-	-	-	-	1	1
No. of farms	10	20	12	11	2	5

3.3 Wage Rates

Although statutory minimum wage rates for agricultural workers are established at the national level, higher rates are commonly paid. The rates of pay for the different types of workers in 1978 on the farms in the survey were as given in Table 10. The basic rates paid on these farms (standardised to a 40 hour week) exceeded the statutory minimum rates (Craftsman Rate £47.30; Appointment Grade II £51.60; and Appointment Grade I £55.90). Comparing the basic rates paid to the different types of worker, there appear to be clear differences among them, with each category receiving an excess over the basic craftman's rate to differing extents. Livestock and maintenance workers, while having a comparatively high basic rate, were also working considerably longer hours per week for this. The point is brought out in Table 11, which relates the basic wages for the different types of worker over all the farms, taking into account the number of hours for which the basic rate is paid (coded in the boxes a,b,c, and d). Thus one can see that tractor drivers were paid Craftsman's rates, a premium or both, usually for 40 hours a week. On the other hand, 70% of livestock workers were paid over £51.60 generally for a basic week of over 45 hours.

TABLE 10: WAGE RATES AND HOURS FOR AGRICULTURAL WORKERS.

	Tractor drivers	Livestock workers	Maintenance	General farm workers (incl. P/T)
Av. basic rate paid	£49.74	£60.08	£61.65	£34.99
Av. hours for basic	40.2	45.6	47.8	28.9
Hourly basic rate	£1.24	£1.32	£1.29	£1.21
Av. rate for 40 hours	£49.60	£52.80	£51.60	£48.43
Av. overtime hours per annum	451	479	296	356
Av. overtime rate per hour	£1.53	£1.51	£1.51	£1.43½
Av. overtime pay per week	£13.28	£13.91	£8.58	£9.84
Av. total hours	48.9	54.6	53.5	35.2
Av. total pay per week	£63.03	£73.99	£70.23	£44.83

TABLE 11: COMPARISON OF BASIC WAGE RATES WITH BASIC HOURS FOR DIFFERENT TYPES OF WORKER. (Number of farms)

	Basic wage rates.											
	Under £43.00		£43.01 - £47.30		£47.31 - £51.59		£51.60 - £55.89		Over £55.90		Not available	
Tractor drivers	a -	b -	a -	b 23	a -	b 22	a -	b 9	a -	b 5	a -	b 1
	c -	d -	c -	d -	c -	d -	c 1	d -	c -	d -	c -	d -
Livestock workers	a -	b 1	a -	b 9	a -	b 5	a -	b 7	a -	b 7	a -	b -
	c -	d -	c -	d -	c -	d 1	c 1	d -	c 9	d 15	c -	d -
Maintenance workers	a 1	b 3	a -	b 7	a -	b 4	a -	b 6	a 1	b 10	a -	b 1
	c -	d -	c -	d -	c -	d -	c -	d -	c -	d -	c 1	d -
General Farm workers	a 27	b 4	a -	b 3	a -	b 1	a -	b -	a -	b -	a -	b -
	c -	d -	c -	d -	c -	d -	c -	d -	c -	d -	c -	d -

N.B. a Up to 40 hrs./wk.; b 40 - 45 hrs./wk.; c 45 - 50 hrs./wk.; d Over 50 hrs./wk.

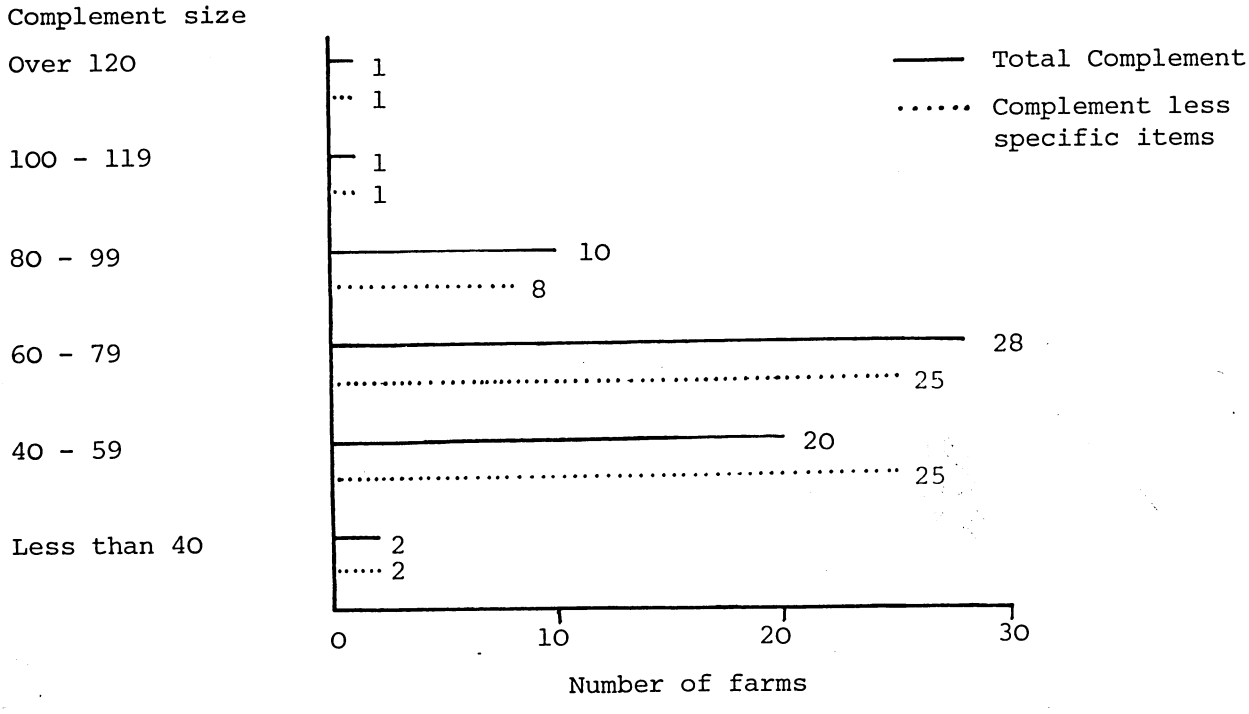
4. MACHINERY USE

The features of farm machinery of principal interest relate to the general disposition towards 'modern', high technology machinery or more standard proven equipment, which can to some extent be exemplified in the age and size structure of the machinery. The items and types of machinery included in the survey were based, with some additions, on those listed in the Farm Management Pocketbook, 8th. edition, (Nix, 1977) and thus excluded all workshop tools and equipment, farm vehicles and most 'fixed' items, such as milking parlours. (A complete list of included items appears as Appendix B). The information collected relating to each item of machinery were its age in 1978, purchase price where obtainable, make and size or power rating where appropriate.

4.1. Machinery Complements

An individual farm's machinery complement is likely to include certain items, such as tractors, combine harvesters, cultivation equipment and, given the presence of dairy or beef cattle, forage machinery, which are common to all farms. The amount of such equipment will clearly depend upon the farm size and cropping area. The presence of other, specific, types of machinery, such as potato and sugar beet harvesters, will depend upon the particular cropping pattern. The machinery complements on the farms ranged from 38 to 133 items. The most common size range was between 60 and 80 items, (Figure 3). Most farms had between 40 and 80 non-specific items; the number was less variable than the total complement. The numerical importance of the different types of machinery is indicated by the overall proportions across the sample of farms. Table 12 presents these figures as percentages: self-powered

FIGURE 3: FREQUENCY DISTRIBUTION OF SIZE OF MACHINERY COMPLEMENT



machinery accounted for just over 19% of the items and cultivation equipment for about 25%. Other features to note are the fairly similar values for fertiliser, spraying and drilling machinery, and the moderately high figures for baling and forage machinery, possibly attributed to a sizeable number of bale trailers and amount of grass-turning equipment respectively.

TABLE 12: PROPORTIONS OF DIFFERENT TYPES OF MACHINERY.

	% of items		% of items
2-wheel drive tractors	13.4	Sugar Beet	0.1
		Fertiliser Spreading	2.6
4-wheel drive tractors	1.1	Drilling	3.4
Caterpillar/ crawler	0.7	Spraying	2.3
		Ploughs	4.9
Other powered	1.3		
		Cultivation	19.8
Combine Harvesters	2.8	Forage	8.6
Baling	11.1	Feeding	1.0
Grain/Food Handling	4.1	General	19.2
		Specific non-	
Potato	2.9	allocated	0.7
			100.0

4.2. Age Structure of the Machinery

The overall age structure of all the machinery items, depicted in Table 13 and Figure 4, suggests that there was a peak for purchasing machinery in 1974/75. In the subsequent years there appears to have been a slight fall in the numbers of machines purchased. It should however be borne in mind that, while the majority of the survey interviews were carried out in the latter half of 1978, some farms will have purchased items in that year which were not present when the visit was made. Machinery purchased prior to 1972 obviously include 'long life' items which have not yet become obsolete.

The percentages of the different types of machines first purchased in the different years are presented in Table 14, which enables a more detailed examination as to which types of machinery tend to be relatively older or younger. The age of machinery has in some cases an upper limit, in that the particular type of machine was not available x number of years ago, e.g. 'big baling' equipment. The figures in this table can be compared with those for the total number of items given in Table 13. Thus 42% of two-wheel tractors, 72% of four-wheel drive tractors and 50% of combine harvesters were bought in 1975 or more recently, whereas overall 36% of items were in this category. On the other hand, some of the relatively older types of machines were grain/food handling equipment, cultivation machinery

FIGURE 4: AGE DISTRIBUTION OF MACHINERY ITEMS PRESENT IN 1978.

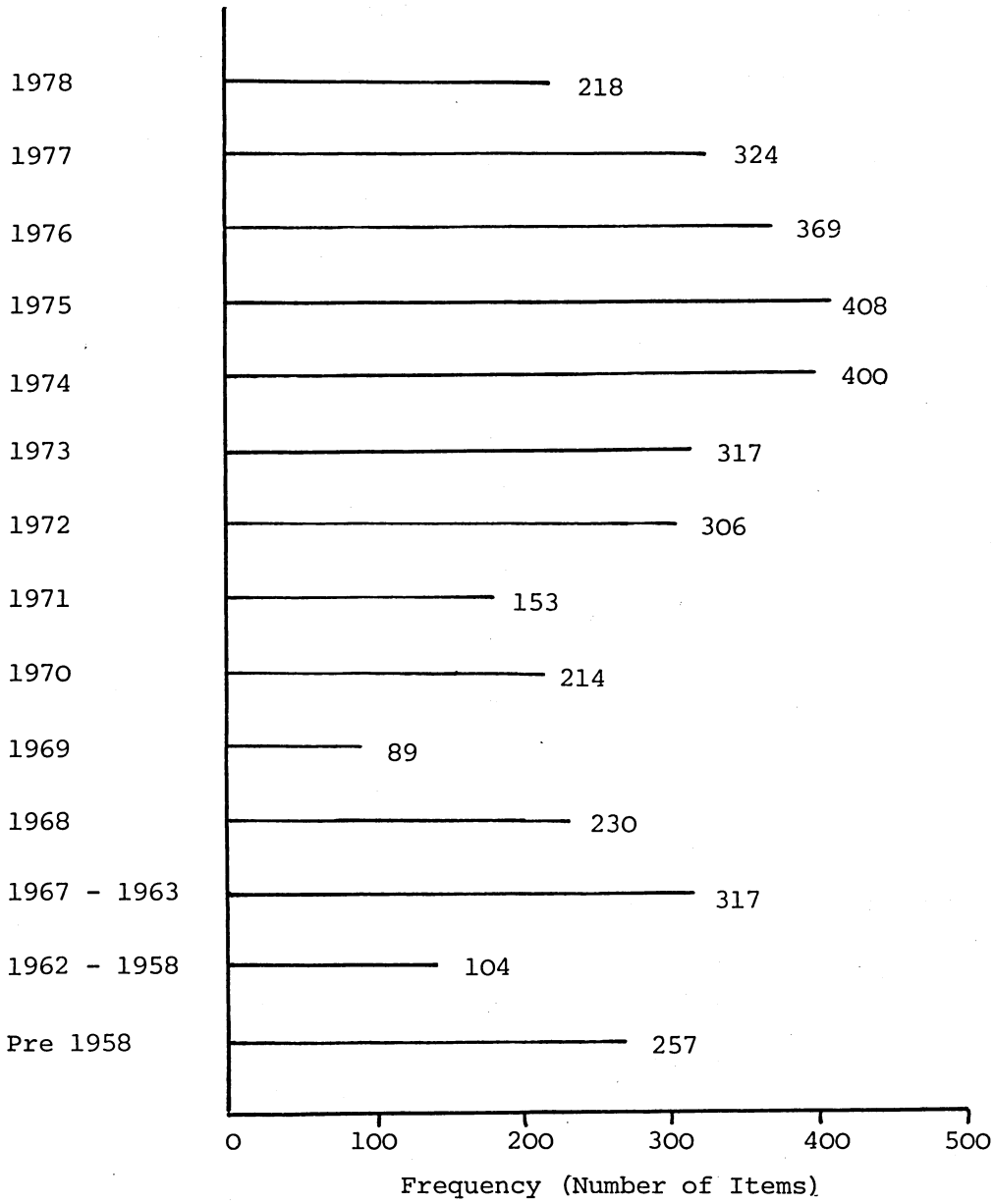


TABLE 13: PERCENTAGE AGE DISTRIBUTION OF MACHINERY IN 1978

	Year of 1st Purchase												
	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968	1967 -'63	Pre 1963
% of items	5.9	8.7	10.0	11.0	10.8	8.6	8.3	4.1	5.8	2.4	6.2	8.6	9.7

TABLE 14: AGE OF DIFFERENT TYPES OF MACHINES (% PER YEAR)

	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968	'67-'63	'62-58	Pre 1958
2 wheel drive tractors	9.9	12.0	10.7	9.4	9.8	9.4	9.4	4.9	6.0	2.4	4.1	8.6	2.1	1.3
4 wheel drive tractors	17.0	19.1	17.0	19.1	12.8	2.1	-	4.3	6.4	-	2.1	-	-	-
Caterpillar/ crawler	3.6	7.1	7.1	-	3.6	10.7	10.7	3.6	-	7.1	10.7	-	14.3	21.4
Other powered	5.9	3.9	9.8	9.8	9.8	7.8	11.8	3.9	7.8	2.0	3.9	9.8	9.8	3.9
Combine Harvesters	12.2	15.7	10.4	11.3	20.0	7.8	7.0	4.4	4.4	1.7	0.9	2.6	-	1.7
Baling	7.1	8.8	10.5	16.5	12.5	3.4	6.8	4.0	4.8	3.1	2.8	7.1	1.4	11.1
Grain/Food Handling	3.2	4.5	4.5	9.0	7.8	9.0	5.2	3.2	5.8	5.8	11.0	16.1	5.2	9.7
Potato	0.9	14.8	10.4	9.6	12.2	4.4	11.3	2.6	7.0	3.5	3.5	8.7	7.8	3.5
Sugar Beet	-	40.0	40.0	-	-	-	-	-	-	-	20.0	-	-	-
Fert. Spreading	4.7	9.4	10.4	15.1	19.8	13.2	8.5	5.7	2.8	1.0	5.7	2.8	1.0	2.8
Drilling	5.1	14.6	12.4	14.6	12.4	5.8	5.1	2.9	4.4	-	4.4	6.6	4.4	7.3
Spraying	6.7	11.1	18.9	11.1	11.1	10.0	6.7	7.8	3.3	2.2	5.7	2.2	1.1	2.2
Ploughs	6.1	7.2	10.7	10.2	10.7	8.7	11.7	5.1	7.2	2.6	9.7	4.6	1.6	4.1
Cultivation	2.5	5.8	8.6	9.2	7.7	10.8	7.6	3.9	6.5	1.9	8.8	12.3	3.3	11.9
Forage	8.1	7.5	11.3	11.6	12.2	8.1	10.4	2.1	6.0	1.5	7.8	7.2	3.0	3.9
Feeding	10.0	5.0	20.0	10.0	10.0	5.0	10.0	5.0	2.5	-	2.5	15.0	-	5.0
General	4.2	7.5	7.2	10.7	11.0	9.6	8.6	4.6	6.4	2.9	6.2	9.1	2.7	9.1
Specific non-allocated	15.0	5.0	15.0	15.0	10.0	5.0	-	5.0	5.0	-	5.0	10.0	5.0	5.0

and caterpillar/crawler tractors, with 79%, 74% and 82% respectively having been bought prior to 1975.

4.3. Size of Machinery

Another important aspect of farm machinery is clearly its size. Obviously there is little point in looking at this in generality across the whole range of machines in the survey. Therefore certain types of machinery are selected for scrutiny in relation to their size, and in particular to consider the hypothesis that relatively newer machines also tend to be larger.

4.3.1. Tractors

Tractor size can be considered on the basis of power-rating. The age and size relationships of two-wheel drive tractors on these farms is given in Table 15. A fairly steady increase is evident in the number of tractors in the higher size ranges, i.e. over 50 kW (67 hp), since the early 1970s, coupled with a concomitant decrease in the number below this size. This seems reasonable evidence of a trend towards larger machines. Further proof can be seen from the four-wheel drive tractor figures: 78% were over 70 kW (94 hp) and of these 74% had been purchased in or since 1975. The fairly large number of small old tractors (12% of 2-wheel drive tractors were pre-1969 and under 50 kW (67 hp)) is also evident; these are obviously used for relatively simple tasks.

4.3.2. Combine Harvesters

The combine harvester is the most significant and expensive single item of machinery investment for most arable farmers. Furthermore, as Table 14 shows, farmers' investment in combine harvesters in recent years has been above the overall average. The size of a combine harvester can be guaged in a number of ways, of which three were selected for analysis-cutting width (m), engine power-rating (kW) and tank capacity (litres). In Table 16, each of these size measures is separately compared with the age of the machine. The explanation of the variation in the total number of cases for each section is that each size measure could not be obtained for every machine.

Since the peak year for purchases of combine harvesters was 1974, one might reasonably assume that the average age of this type of machine is between four and five years. Therefore one should concentrate on the newer machines, which are more likely to reflect current thinking on the part of farmers, rather than considering machines that have been relegated to a 'back-up' role after their peak years of service. With respect to the cutting width, 44% of the six years old or newer machines were less than 3.93 m (13ft.) wide and only 26% were over 4.54 m (15ft.). Furthermore, the number of purchases in this latter size range was less in 1977 and 1978 than in the previous three years. Looking at engine-power rating, while 65% of the machines bought since 1973 (5 years old) were rated at less than 100 kW (134 hp), 59% of all machines over this size were new in 1977 or 1978. There was a fall in the proportion of lower-powered machines in 1977/78 compared with 1974/75 from 70% to 57% with a concomitant increase in the upper two size bands (30% to 43%). The purchase of small machines with respect to

TABLE 15: COMPARISONS OF POWER SIZE OF 2-WHEEL TRACTORS WITH YEAR OF PURCHASE

kW / hp	Under 40 (Under 54)	40 - 50 (54 - 67)	50 - 60 (67 - 80)	60 - 70 (80 - 94)	70 - 80 (94 - 107)	80 - 100 (107 - 134)	Over 100 (Over 134)	Total
1978	4	6	27	8	5	1	0	51
1977	5	1	32	1	22	0	1	62
1976	9	5	27	5	4	1	1	52
1975	5	16	23	4	0	0	0	48
1974	8	14	18	4	2	0	0	46
1973	11	20	16	0	1	0	0	48
1972	11	15	22	0	0	0	0	48
1971	5	9	8	0	0	1	0	23
1970	7	12	6	0	0	0	0	25
1969	5	3	3	0	0	0	0	11
1968	11	6	3	0	1	0	0	21
1967-'63	27	7	0	0	0	0	0	34
1962-'59	5	0	0	0	0	0	0	5
Pre 1959	0	1	0	0	0	0	0	1
Totals	113	115	185	22	35	3	2	475

N.B. Cases for which either variable was not ascertained are omitted.

tank capacity has been fairly static, while that of relatively larger machines has risen by well over 300% in the same two year periods mentioned above. In attempting to summarise conclusions regarding the individual size measures for combines, it appears that while there has been some shift towards larger machines, this has been principally with respect to tank and power size rather than cutting width.

4.3.3 Ploughs

Ploughs provide some further scope for age and size comparisons, and, since the ploughs were subdivided into semi-mounted, mounted and reversible, it is possible to gain some insight as to whether there has been a move towards the third type. Plough size was measured in terms of the number of furrows and is compared with age in Table 17. There appears to have been a shift towards larger ploughs, with the peak size increasing over the years from 3 furrows in 1971/72, 4 in 1974/76 to 5 or 6 furrows in 1977/78. (The X^2 value for this table is statistically significant at the 0.001 probability level). With respect to changes in the ages of the different types of plough, in 1971/72 the reversible plough dominated purchases, as it did again in 1977/78 (Table 18). On the surveyed farms, 75% of the reversible ploughs had been bought since 1970 compared with 63% of the mounted types, which occupied a consistently smaller proportion of purchases for the periods since that date. However, as with tractors and combine harvesters, in reaching conclusions regarding overall patterns, it should be noted that a number of the older items may represent ploughs kept as 'stand-bys' and not brought into use as a first option.

TABLE 16: A COMPARISON OF THE AGE AND SIZE OF COMBINE HARVESTERS (number of machines)

	Age in years												
	0	1	2	3	4	5	6	7	8	9	10	Over 10	Total
Less than 3.05 m (10')	3	1	2	1	3	1	4	1	1	0	0	2	19
3.05 - 3.92 m (10' - 13')	4	6	5	2	8	3	3	3	3	1	1	4	43
3.93 - 4.53 m (13' - 15')	3	6	4	7	4	1	1	1	1	1	0	0	29
4.54 - 5.10 m (15' - 17')	2	1	1	3	5	1	0	0	0	0	0	0	13
Over 5.10 m (17')	2	4	0	0	3	2	0	0	0	0	0	0	11
													115
Less than 75 kW (100 hp)	1	1	0	1	1	0	0	0	0	0	0	0	4
75 - 100 kW (100 - 134 hp)	7	8	12	7	13	5	2	0	1	0	0	4	59
100 - 125 kW (134 - 168 hp)	4	6	0	4	3	2	0	0	0	0	0	0	19
Over 125 kW (168 hp)	1	2	0	0	2	1	0	0	0	0	0	0	6
													88
Less than 100 li	0	1	0	0	0	0	0	0	0	0	0	0	1
1000 - 2000 li	2	1	2	1	3	0	0	0	0	0	0	1	10
2000 - 3000 li	6	8	7	5	7	4	2	0	1	0	0	3	43
3000 - 4000 li	2	4	3	0	0	0	0	0	0	0	0	0	9
4000 - 5000 li	3	2	0	0	3	1	0	0	0	0	0	0	9
													72

TABLE 17: COMPARISON OF PLOUGH SIZE WITH AGE (No. of ploughs)

Year of Purchase	Number of furrows				
	1 or 2	3	4	5 or 6	7, 8 or 9
1977/78	0	8	6	13	0
1975/76	1	7	21	12	1
1973/74	1	14	15	7	1
1971/72	2	15	10	7	0
1969/70	2	10	2	5	0
Pre 1969	10	14	9	5	1

4.4. Machinery Complements on Individual Farms

The overall proportions of the different types of machinery so far presented indicate the composition of the 'average' complement, but individual farms can deviate from this pattern in a number of ways. Differences between farms can occur either by a farm possessing different items of specialized machinery or by operating a farming system involving

TABLE 18: DIFFERENT TYPES OF PLOUGH (% purchased in each year)

	Pre 1969	1969/70	1971/72	1973/74	1975/76	1977/78
Semi-mounted	7.5	10.5	11.8	0.0	14.3	3.9
Mounted	45.0	47.4	17.7	44.7	38.1	26.9
Reversible	47.5	42.1	70.5	55.3	47.6	69.2

a different combination of 'common' machines. In the latter case a farm may employ a differing number of machines, but they may be of different operating capacities. One way of examining this variability is to calculate a statistical measure of dispersion for the proportions of the different types of machinery across all the farms. The use of proportions, despite certain conceptual difficulties, does facilitate, by standardization, the comparison of different-sized machinery complements. Table 19 presents these standard deviations for the different types of machinery. The conclusion to be drawn is that the smaller this measure for a particular type of machinery the less the variability among the farms in its proportion compared with the average. In other words, consistency in the proportion of any one type of machinery in the complement of the sample farms is denoted by a relatively small standard deviation (indicative of greater clustering around the mean).

TABLE 19: VARIABILITY OF MACHINE TYPES

	Std. Devn.	Mean Propn.%		Std. Devn.	Mean Propn.%
2 wheel drive tractors	3.48	13.4	Potato	3.85	2.9
			Fert. Spreading	1.28	2.6
4 wheel drive tractors	1.44	1.1	Drilling	1.27	3.4
			Spraying	1.08	2.3
Caterpillar/ crawler	1.27	0.7	Ploughs	2.02	4.9
Other powered	1.33	1.3	Cultivation	4.85	19.8
Combine Harvesters	1.24	2.8	Forage	3.07	8.6
			Feeding	1.36	1.0
Baling	5.48	11.1	General	4.92	19.2
Grain/Food Handling	3.38	4.1	Specific non-allocated	0.95	0.7

Interestingly, it appears that generally those types of machinery for which the mean proportion is relatively greater, i.e. two-wheel drive tractors, baling, cultivation and general machinery, exhibit greater variability in this proportion among farms. Potato machinery, which was present only on a limited number of farms, clearly demonstrates considerable variability from the 'average' complement, since the latter was calculated in relation to all the farms, whether or not they grow potatoes; thus the mean proportion of the machinery complement comprised of potato machinery where present was 7.7% compared with 2.9% overall. It is felt that the other figures in the table fairly accurately reflect the degree of variability in the composition of the machinery complements.

Some further evidence of deviation from the overall pattern comes from an anlysis of the age structure of the individual machinery complements. The results are given in Table 20, from which one can determine that on a large majority of farms (38) less than 40% of their machinery complement was 3 years old or less, with a correspondingly higher proportion of older machinery. Conversely, the 6 farms with a high proportion of machinery (60% and over) under 4 years old had very low percentages of relatively older machinery. Thus some machinery complement are comparatively older or newer than others, and on 36 farms between 15% and 45% of their machinery was over 10 years old.

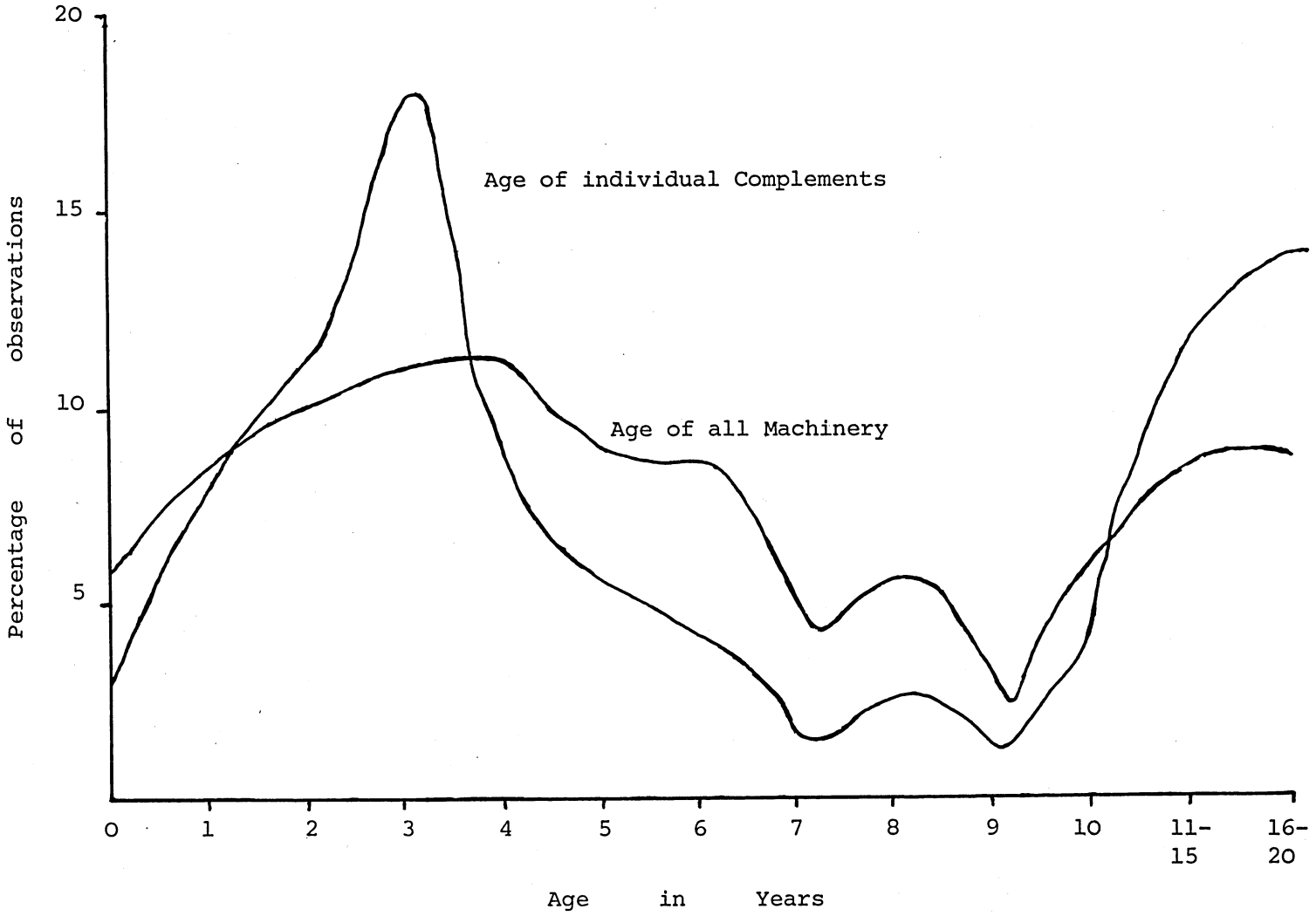
Some indication of the extent to which the ages of individual machinery complements compare with the overall age structure can be gained by considering the modal (i.e. most typical) age of each complement compared with the average age structure of all machinery, given previously. Although the overall trends for each set of figures is fairly similar, as shown in

TABLE 20: AGE STRUCTURE OF MACHINERY COMPLEMENTS ACCORDING TO THE PROPORTION UNDER 4 YEARS OLD (percentages)

% of Machinery Complement 0-3 years old	Number of farms	0 - 3 years	4 - 7 years	8 - 10 years	Over 10 years
10 - 19.9	6	18.8	35.2	20.0	26.0
20 - 29.9	18	24.6	32.5	14.7	28.2
30 - 39.9	14	33.6	34.9	15.2	16.3
40 - 49.9	14	44.7	30.9	11.8	12.6
50 - 59.9	4	53.6	28.9	11.9	5.6
60 - 69.9	5	64.6	22.3	6.4	6.7
90 - 100	1	92.1	7.9	-	-
All	62	47.5	27.5	11.4	13.6

Figure 5, there appears to be a tendency for the individual machinery complements to polarise into relatively younger or older categories though, significantly, the proportion of farms where the modal age for the machinery complement was 0, 1 or 2 years (i.e. 1978, 1977 or 1976) demonstrates some evidence of a decrease in average age, which might be indicative of a contraction in machinery purchases. It is also interesting to note that the trough for the period 7 to 9 years (1969-1971) is present for both sets of figures - though more pronounced with respect to the individual machinery complements.

FIGURE 5: COMPARISON OF PROPORTIONATE AGE DISTRIBUTION OF MODAL AGE OF MACHINERY COMPLEMENTS WITH ALL MACHINERY.



5. DETERMINATION AND PLANNING OF LABOUR AND MACHINERY REQUIREMENTS.

The above examination of the characteristics of the labour forces and machinery complements has attempted to present a framework from which the prevailing levels of labour and machinery in large-scale farming can be detected, and has therefore concentrated on the determination and comparison of patterns and trends among the farms. However, before one can adequately discuss the details of the contention raised earlier concerning possible overcapacity, one further important linking aspect of the analysis is required: namely the determination of the labour and machinery requirements on these farms. The work rates being achieved for a number of field operations provide the necessary connections between labour and machinery complements which, when used in conjunction with information on the operations performed on each of the different types of crops per farm, enables one to derive some estimate of labour and machinery requirements.

5.1. Rates of Work

Information relating to the rates of work being achieved for 33 field operations, together with the size of machine and gang required, was collected as part of the survey. The figures for these rates of work are therefore estimates of the average number of hectares covered under 'typical' conditions in performing a particular task in an 8-hour day, i.e. they are not observed, recorded rates. Although this procedure will have introduced some bias into the figures obtained, this would also have been the case had the latter method been employed, since one could not have been certain of the extent to which the recorded measurement was particular to the occasion of the observation. It is felt that the figures given by the respondents were the best estimates that could have been obtained and are good enough to stand up to analytical scrutiny. In cases where there was more than one machine of a given type on a farm, for example, several sets of disc harrows, the data collected referred to the implement most frequently used in carrying out the operation, which was generally the largest machine.

The individual estimates of the rates of work for each operation were combined to produce an average figure for the rate of work per 8-hour day, which enables comparisons to be made with similar published standard figures. The results of this analysis are presented in Table 21, together with the average size of machine to which they relate.

The comparison with published 'standard' figures in the table is with those contained in the Farm Management Pocketbook, 9th. edition (Nix 1978). The rates of work taken from this reference represent the 'premium' figures "which will be achieved on most farms with more than 120 hectares of arable land" and as such would be those most applicable to those farms at the lowest end of the size range being considered in this study. These 'premium' standard figures assume that the tractor power available is in the region of 40 - 55 kW (54 - 74 hp), which accords reasonably well with the predominant power size of tractors on the farms in the survey. The average rates of work obtained from the survey are fairly consistently above the standard figures, though the extent of the difference is somewhat variable. The apparent underestimation in the Pocketbook figures are most pronounced in

TABLE 21: AVERAGE RATES OF WORK AND IMPLEMENT SIZE FOR FIELD OPERATIONS.

	Rate (ha) 8 hr day	'Standard' Rate (ha)	Implt. size	Rate (ha) per m
Ploughing	3.89	2.5 - 3.25	4 furrow	
Chisel Ploughing	7.74	5.75	3.11 m	2.49
Heavy Harrowing	13.59	8.0	4.24 m	3.21
Light Harrowing	20.99	11.5	4.94 m	4.25
Heavy Discing	11.56	6.5	12.75 m	0.91
Light Discing	7.18	7.5	3.01 m	2.39
Rotavating	4.60	3.3 - 5.0	1.97 m	2.34
Power Harrowing	6.40	9.0	3.10 m	2.07
Spring-tine Harrowing	14.97	12.0	4.37 m	3.43
Gang Rolling	16.44	20.0	4.97 m	3.31
Combine Drilling	10.91	9.0	15 row	
Drilling	13.05	15.0		
Potato Planting	2.92	1.75	2 row	
Fert. Spreading - Full width	25.33	15.0	10.19 m	2.49
Fert. Spreading - Spinner	20.63	20.0	7.85 m	2.63
Spraying	24.93	16.0	10.76 m	2.32
Tractor Hoeing*	7.09	4.0	6 row	
Wheat Harvesting	8.39	6.0 - 14.0	3.92 m	2.14
Barley Harvesting	8.55	6.0 - 14.0	3.94 m	2.17
Oat Harvesting	8.13	6.0 - 14.0	3.90 m	2.09
Oil Seed Windrowing	13.50		2.67 m	5.06
Oil Seed Harvesting	5.67		4.36 m	1.30
Grass Mowing	8.27	6.5	1.86 m	4.45
Grass Turning	12.45	16.0		
Legume Harvesting	7.47		4.20 m	1.78
Root Harvesting*	1.20		4 row	
Brassica Harvesting				
Grass Seed Harvesting	4.03		4.22 m	0.96
Early Potato Harvest	1.03	1.0 - 1.25	1 row	
2nd Early Pot.Harvest	1.45	1.0 - 1.25	2 row	
Main Potato Harvest	1.38	1.0 - 1.25	2 row	
Sugar Beet Harvest*	1.01	1.0	1 row	
Baling	9.12	8.0	Big + Sq.	
Bale Carting	9.48			

* One farm only, so figure should be treated with caution.

certain of the cultivation operations, together with spraying and full-width fertiliser spreading. These conclusions are supported by the 't' statistic for these pairs of figures, the result of which suggested a statistically significant difference at the 0.0075 probability level.

A further point of interest is the association between rates of work and size of implement involved. In Table 21 the rate of work per metre, assuming a simple 'straight line' relationship and taking all operations, demonstrates a deviation above the mean value (2.59 ha/m) that one would obviously expect. For example, legume, oil and grass seed harvesting are well below this value and also differ, though to a lesser degree, from the figures for the harvesting of cereals, although combine harvesters are used in each case. Part of the explanation for the latter difference is that the harvesting of legumes, oil seed rape and grass seeds was carried out with slightly larger combine harvesters, and part is a genuinely lower rate of work. Slightly greater consistency appears among the cultivation, spraying and fertiliser spreading operations, with the significant exceptions of heavy discing, gang rolling, light and spring-tine harrowing.

The relationships between rate of work and size of implement are examined in somewhat more detail in Table 22. In this table, the implements used in performing selected field operations are classified according to appropriate size groupings. For each size group for each individual operation the average rate of work has been calculated where that particular size of implement was in use. For the majority of operations, the small-sized implements were obviously capable of lower rates of work than those in the middle and upper size brackets. However, for some operations (chisel ploughing, heavy harrowing and wheat harvesting) the rate for the upper size categories is surprisingly lower than in the middle of the size range. Even where the rate of work increases as the size of the machine or implement increases, as one would of course expect, the differences between the rate of work from one size group compared with the preceding one often tends to decrease as one progresses up the size range, although this is not true of every operation..

5.2 Crop Labour Requirements (per hectare)

The foregoing analysis appears to provide sufficient justification for the use of work rates as a means of determining the labour and machinery requirement of the crops on these farms. These requirements can then be compared with the total labour available in order to guage to some extent whether there is evidence of overcapacity, taking due account of the requirements for livestock and maintenance work, which have not been explicitly assessed in the survey.

Table 23 presents figures for the numbers of man hours per hectare required for the production of the different types of crops under both traditional (ploughing-based) and minimal cultivation patterns. The lower section of the table compares the average figures obtained for the different crops in terms of man-hours per hectare with the standard 'premium' figures taken from the Farm Management Pocketbook, 9th Edn., (Nix, 1978). It should

TABLE 22: COMPARISON OF MEAN AVERAGE RATE OF WORK WITH IMPLEMENT SIZE FOR SELECTED FIELD OPERATIONS
(ha per 8-hour day)

Ploughing — Size band	1	2	3	4	5	6	7	8 Furrows
	2.32	3.62	2.90	3.85	4.59	4.92	9.72	6.48

Size band	Under 2.44	2.44 - 3.05	3.05 - 3.66	3.66 - 4.27	4.27 - 4.88	4.88 - 5.49	Over 5.49 Metres
Chisel Ploughing	6.60	7.63	10.97	7.82	8.1	-	-
Heavy Harrowing	12.96	8.78	11.38	12.15*	12.64	20.25	19.88
Light Harrowing	17.56	32.40*	8.10*	20.25	19.00	21.46	29.64
Heavy Discing	6.97	9.68	13.99	12.34	20.25*	-	16.20*
Light Discing	7.92	9.10	8.10	-	-	-	-
Rotavating	4.60	-	-	-	-	-	-
Power Harrowing	-	6.86	7.96	6.48*	2.43*	-	-
Spring-tine Harrowing	13.37*	8.91	14.40	15.95	18.34	21.06*	28.94
Gang Rolling	-	-	17.01*	12.46	16.45	13.64	23.08

Size band	Under 6.10	6.10 - 9.15	9.15 - 12.2	12.2 - 15.25	Over 15.25 Metres
Fert. Distribution Full Width	-	16.96*	28.13	-	-
Fert. Spreading	18.58	19.19	29.16	15.19*	-
Spraying	16.20*	17.82	25.46	36.27	29.50*

Combine Drilling — Size band	13	15	20	23	32 rows
	8.65*	9.49	13.63	13.77*	14.58*

Size band	Under 3.05	3.05 - 3.93	3.93 - 4.54	4.54 - 5.10	Over 5.10 Metres
Wheat Harvesting	7.46	8.87	8.41	9.22	8.94
Barley Harvesting	7.92	9.11	8.39	9.49	10.12
Oat Harvesting	6.07	8.68	8.32	9.78*	13.40*
Oil Seed Rape Harvesting	2.70*	-	6.14	-	5.09
Legume Harvesting	8.00*	7.18	7.50	-	8.90
Grass Seed Harvesting	-	5.47*	3.85	-	5.90*

* Rates where a very small number of cases were recorded.

TABLE 23: COMPARISON OF MAN HOURS PER HECTARE FOR DIFFERENT CROPS AND WITH STANDARD FIGURES.

Hrs./ha groups	Winter Cereals	Spring Cereals	Field Legumes	Oil Seed Rape	Potatoes	Sugar Beet	Herbage Seeds & Leys	Winter Cereals	Spring Cereals	Oil Seed Rape
Less than 4.99	1	-	1	1	-	-	2	-	-	2
	(2)	-	(6)	(17)	-	-	(8)	-	-	(25)
5.0 - 7.49	12	16	3	-	-	-	9	12	3	3
	(21)	(33)	(19)	-	-	-	(35)	(50)	(75)	(38)
7.5 - 9.99	24	19	9	2	-	-	6	9	-	1
	(43)	(38)	(56)	(33)	-	-	(23)	(38)	-	(12)
10.0 - 14.99	16	14	3	3	2	-	9	3	1	2
	(29)	(28)	(19)	(50)	(9)	-	(35)	(12)	(25)	(25)
15.0 - 19.99	3	-	-	-	1	-	-	-	-	-
	(5)	-	-	-	(5)	-	-	-	-	-
20.0 - 34.99	-	-	-	-	7	1	-	-	-	-
	-	-	-	-	(33)		-	-	-	-
35.0 - 49.99	-	-	-	-	6	-	-	-	-	-
	-	-	-	-	(29)	-	-	-	-	-
Over 50.0	-	-	-	-	5	-	-	-	-	-
	-	-	-		(24)	-	-	-	-	-
Average	9.6	8.6	8.6	9.6	39.2	23.8	8.9	7.8	7.2	7.4
Std. average	15.3	14.6	15.3	12.0	69.8	63.2	18.3			
Std. premium	10.7	10.0	11.5		51.7	39.5				

N.B.
1. Potato figures are the average of Earlies, Second Earlies and Maincrop.
2. Cereal figures exclude baling and later barn work.
3. Only one case for Sugar Beet.
4. Figures in brackets are the column percentages.
5. The standard average for legumes is the average of Field Beans and Dried Peas; the standard premium for legumes is the Dried Peas figure.
6. The Herbage Seeds and Leys figures exclude these that are undersown.

be noted that the standard figures taken from this reference incorporate allowances for certain aspects of an operation which were omitted from the survey, the main instance of this being the carting of materials to the field. If such discrepancies were estimated at 0.5 man hour per hectare, the differences between the sets of figures still remains clear, in particular for the non-cereal crops. In the case of cereal crops, the average survey values were 95% and 91% of the standard premium values for the winter and spring types respectively. In contrast the percentage for potatoes was 76%, for sugar beet 60% and for herbage seeds and grass leys 52%. The distinction between traditional and minimal cultivation techniques is also evident from the table, with the latter averaging about 1½ man-hours per hectare less than the former. Furthermore, the same difference as that between farms also occurred at the intra-farm level only one farm practised solely minimal cultivations. The proportion of farms where the labour requirement per hectare is below the premium is consistently high; for instance, traditionally cultivated spring cereals, where 72% of farms were achieving less than 10 hours per ha (the premium).

5.3. Labour Requirements for Fieldwork, Livestock and Maintenance

The survey figures are likely to be more reliable for assessing the productive labour requirements, though, in the absence of data from the survey on livestock requirements on large farms, the relevant standard premium figures have been taken as appropriate in the estimation of total labour requirements. Table 24 shows the percentages of labour available per farm cumulatively taken up by fieldwork, livestock and maintenance requirements. In compiling the table, labour for arable forage production has been excluded, as data was not collected for this type of crop, though leys and herbage seed labour has been included, except where undersown. Labour available has been taken as the total of ordinary and overtime hours with no allowance for holidays, illness etc. It would appear that on most of the farms (65%) at least 30% of the labour available has not been taken up by these requirements, though it should be noted that no allowance has been made for maintenance where workers were not specifically employed for this purpose. Those farms which appear to be using more labour than is employed (i.e. over 100%) are cases where 'unpaid' management or family labour is essential (assuming the average survey work-rates), since hours available refers to the regular paid labour force only.

5.4. Whole Farm Labour Requirements : Some Examples

However, before it could be argued that large-scale farming in Britain is overmanned, a further major aspect has to be incorporated into the analysis, namely, the seasonal requirements. The time of year required for performing the various operations has to be introduced into the analysis. Tasks must be completed within limited time periods. The most appropriate technique available is the Gang-Work Day Chart (Barnard and Nix, 1973; Culpin, 1975; Sturrock, Cathie and Payne, 1977). Space clearly prohibits the application of this technique to each of the farms in the survey, but to illustrate the method, gang-work day charts are constructed for three selected farms that appear representative of the sample. These will be used as a means of examining the technique and for further considering the question of overcapacity.

TABLE 24: PROPORTION OF LABOUR AVAILABLE ACCOUNTED FOR BY DIFFERENT REQUIREMENTS. (Number of farms)

Requirement as % of labour available (total hours)	Fieldwork (1)	Fieldwork+ Livestock (2)	Fieldwork+ Livestock (3)	Fieldwork+ Livestock+ Maintenance (4)	Fieldwork+ Livestock+ 15% for Maint. (5)
Less than 10	16	-	-	-	-
10 - 19.9	29	1	1	-	-
20 - 29.9	9	6	6	4	1
30 - 39.9	3	12	11	9	2
40 - 49.9	-	10	8	11	11
50 - 59.9	-	6	6	5	10
60 - 69.9	-	6	9	7	11
70 - 79.9	-	4	4	6	7
80 - 89.9	-	4	4	7	5
90 - 99.9	-	2	2	2	3
100 and over	-	4	6	6	7
	57	57	57	57	57

(1) Figures from survey, excludes work on horticultural crops and arable forage.
(2) Excludes Pigs and Poultry.
(3) Includes Pigs and Poultry.
(4) Hours from maintenance workers where present.
(5) Hours from maintenance workers where present and 15% allowance for maintenance where absent.

Four criteria were used in selecting the farms: mixed cropping should be practised; a livestock enterprise should be present; the data relating to the rates of work and machinery complement should be complete; and the number of hours per hectare for the different types of crops should be similar to the average figures for the whole sample. Thumbnail sketches of the significant characteristics of the farms appear in Table 25. These farms are reasonably representative of those in the survey and their sizes cover a large part of the range of sizes. On each of the farms the cropping pattern is clearly dominated by cereals, though the relative emphasis on winter and spring types is variable. The cropping regimes include onr or more arable break crops, potatoes (Farm A), oil seed rape (Farm B) and oilseed rape and seed peas (Farm C). The variations in the areas of grass leys and other sources of forage and fodder clearly reflect the significance of the farms' livestock enterprises. The sections of the machinery complement shown in the table indicate that similar types of machines were present on each farm (apart from potato machinery). However, the size of the machines were variable, note, for instance, the case of combine drills. The labour forces on the three farms demonstrate some variability between the proportions of regular full-time, part-time and casual labour.

TABLE 25: CROPPING, LABOUR AND MACHINERY PROFILES OF GANG-WORK DAY CHART FARMS.

	Farm A	Farm B	Farm C
Cropping (Ha) and Livestock (No.)			
Farmed Area	770	587	339
Winter Wheat	81	237	122
Winter Barley	81	115	25
Winter Oats	-	-	22
Spring Barley	223	15	64
2nd Early Potatoes	12	-	-
Main-crop Potatoes	37	-	-
Oil Seed Rape	-	65	34
Seed Peas	-	-	48
Grass Leys	207	135	-
Arable Fodder	40	-	-
Permanent Pasture Rough Grazing	89	20	24
Dairy Cows	150	270	-
Dairy Followers	250	124	-
Beef Animals	800	-	75
Machinery			
4 wh Drive Tractors	1 x 75 kW(101hp)	1 x 84 kW(112hp)	-
2 wh Drive Tractors under 50kW(67hp)	5	-	-
2 wh Drive Tractors 50-60 kW(67-80hp)	6	6	1
2 wh Drive Tractors over 60kW(80hp)	-	-	3
Combine Harvester	2 x 3.1m(10')	1 x 4m (13') 1 x 4.6m (15')	1 x 4m (13')
Baling	1 x Sq.Baler 1 x Sledge 1 x Loader	1 x Sq. Baler 1 x Accumulator 2 x Loader	1 x Sq. Baler 1 x Accumulator 1 x Loader
Potato Planter	1 x 2 row automatic		
Mounted Fert. Spinner	2 x 9m(30')	2 x 12m (39')	1 x 10m (33')
Mounted Sprayer	2 x 10m (33')	1 x 10m (33')	
Trailed Sprayer		1 x 12m (39')	
Combine Drill	2 x 15 row	2 x 31 row	1 x 20 row
Mounted Plough	2 x 4 furrow 1 x 5 furrow	1 x 10 furrow 2 x 5 furrow	
Reversible Plough	1 x 3 furrow	1 x 3 furrow	3 x 3 furrow
Chisel Plough	2 x 3.1m(10')		
Medium Cultivator		2 x 4 m(13')	
Springtine Harrow	3 x 3.4m(11')		1 x 4.3m(14')
Disc Harrow	2 x 2.6m(8.5')	1 x 3.1m(10')	1 x 3.7m(12')
Light Harrow	3 x 3.7m(12')	1 x 6.7m(22')	1 x 6.1m(20') 1 x 4.6m(15')
Power Harrow	1 x 2.5m(8')	1 x 3.5m(11.5')	
Gang Roll	2 x 6.7m (22')	2 x 4.6m (15')	1 x 4.6m (15')
Labour			
Full-time Tractor Drivers	8	4	3
Livestock	3	3	-
General Farm Workers	2	-	-
Total Full-time Regular	13	7	3
Part-time Regular	-	-	1
Casual and Part-year	20	1	2
Labour requirement as % of Labour available	106.0%	95.8%	45.1%

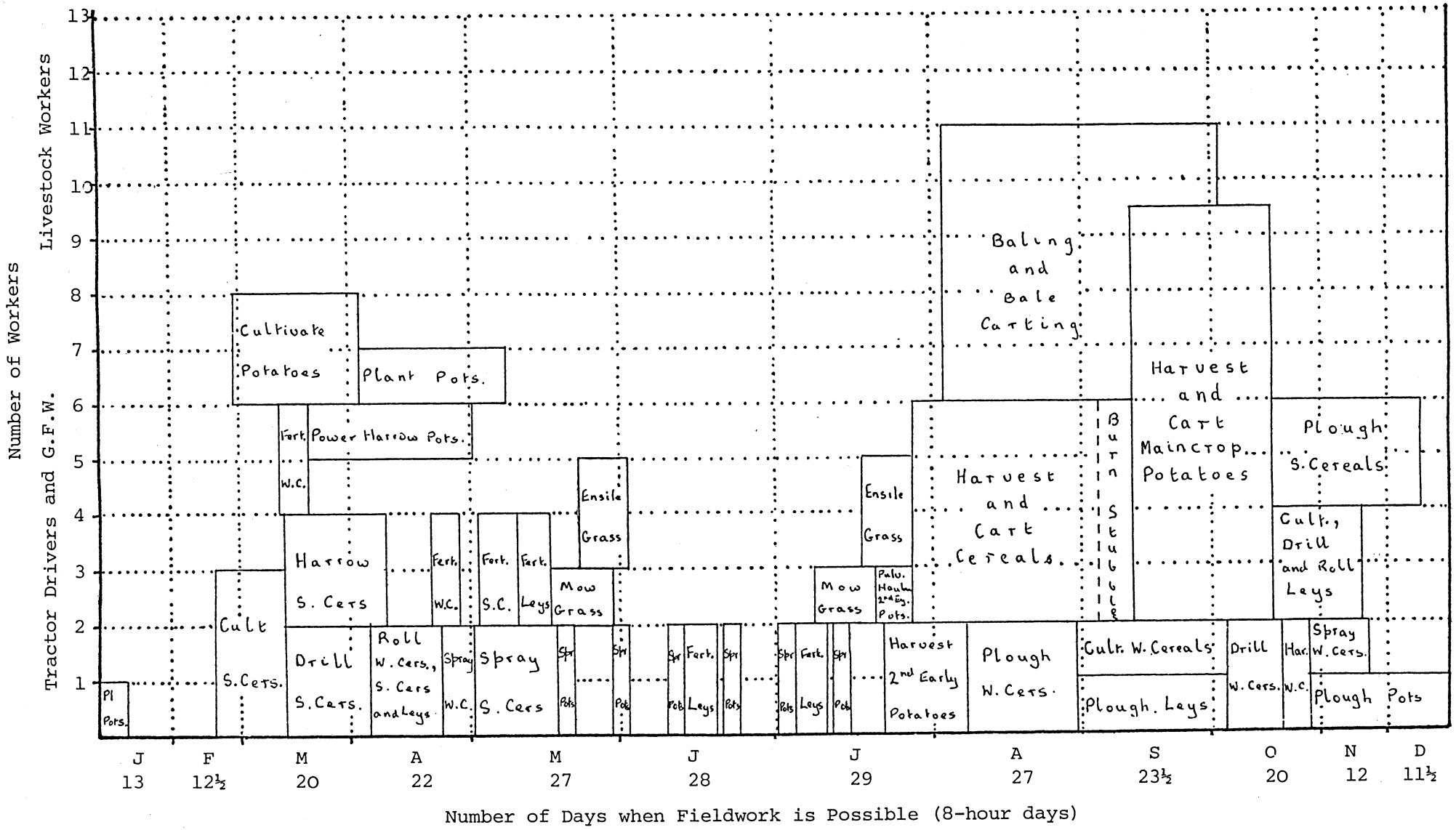
One important difference between the farms, shown in the final line of the table, is the total labour requirement, comprised of the labour implied by the rates of work, areas of crops and sequence of operations for fieldwork, together with the estimated labour for livestock requirement based on standard premium figures and a 15% allowance for maintenance, as a percentage of the labour available, based on the number of ordinary plus average overtime hours for the different types of regular employed workers present. In this regard, the farms were selected as examples of high and low values.

The compilation of the charts involves determining the number of days required to complete each operation in the sequence that the farmer typically undertakes for the different crops, based on the rates of work being achieved and the size of the gang required. Secondly, the number of men and machines available for completion of these tasks is assessed. Finally, these two components are combined and inserted on the charts, which effectively represent the number of days required and available for fieldwork per year based on the standard monthly figures and the number of arable and general workers on the farm in question. Thus the chart more accurately represents and compares the fieldwork labour requirements and availability than the figures used in calculating the labour requirement as a percentage of that available, referred to in Table 25.

The gang-work day charts for these farms (Figures 6 to 8) - which give the number of workers employed on the left-hand axes - demonstrate clearly the two peak periods of labour requirement: from the end of July through to the beginning of November and, to a lesser extent, from the beginning of March to early May. This latter period is distinctly less pronounced in the case of Farm B, where the area of spring cereals is only 15 ha (37 acres). In the former period, the labour provided by the full-time regular labour force (including overtime) is apparently insufficient to meet the requirements. This shortfall may be met in different ways: by employment of part-time or part-year workers (Farms B and C); use of livestock workers for fieldwork (Farms A and B); or manual work by the manager, farmer or family (Farms A and C). Casual labour requirements are additional to those presented on the charts. The operations that are relatively most demanding in terms of labour, and thus important in contributing to the peaks, are the harvesting of cereals and potatoes, baling and carting of straw and to a lesser degree ploughing and cultivation work. In sharp contrast to these labour peaks, slack periods appear to occur during winter and pre-harvest months, when labour is undoubtedly engaged in routine maintenace work, for which no one was specifically employed on any of these three farms.

With regard to the question of overcapacity, it has already been pointed out that, with allowances having been made for days lost due to unsuitable weather, illness and holidays, the area of the chart relating to the number of workers employed represents the number of standard 8-hour days (comprised of both ordinary and overtime hours) available for fieldwork a year. Superimposed on this are the areas representing labour requirements. The number of days available from each member of the tractor driver and general farm worker sections of the labour forces is 245½ 8-hour days. This gives a total availability for each farm of 2455 (Farm A), 1105 (Farm B) and 735 (Farm C)

FIGURE 6: GANG WORK DAY CHART: FARM A



N.B. Work on Forage Kale is excluded (40.5 ha, 100 acres)

FIGURE 7: GANG WORK DAY CHART: FARM B

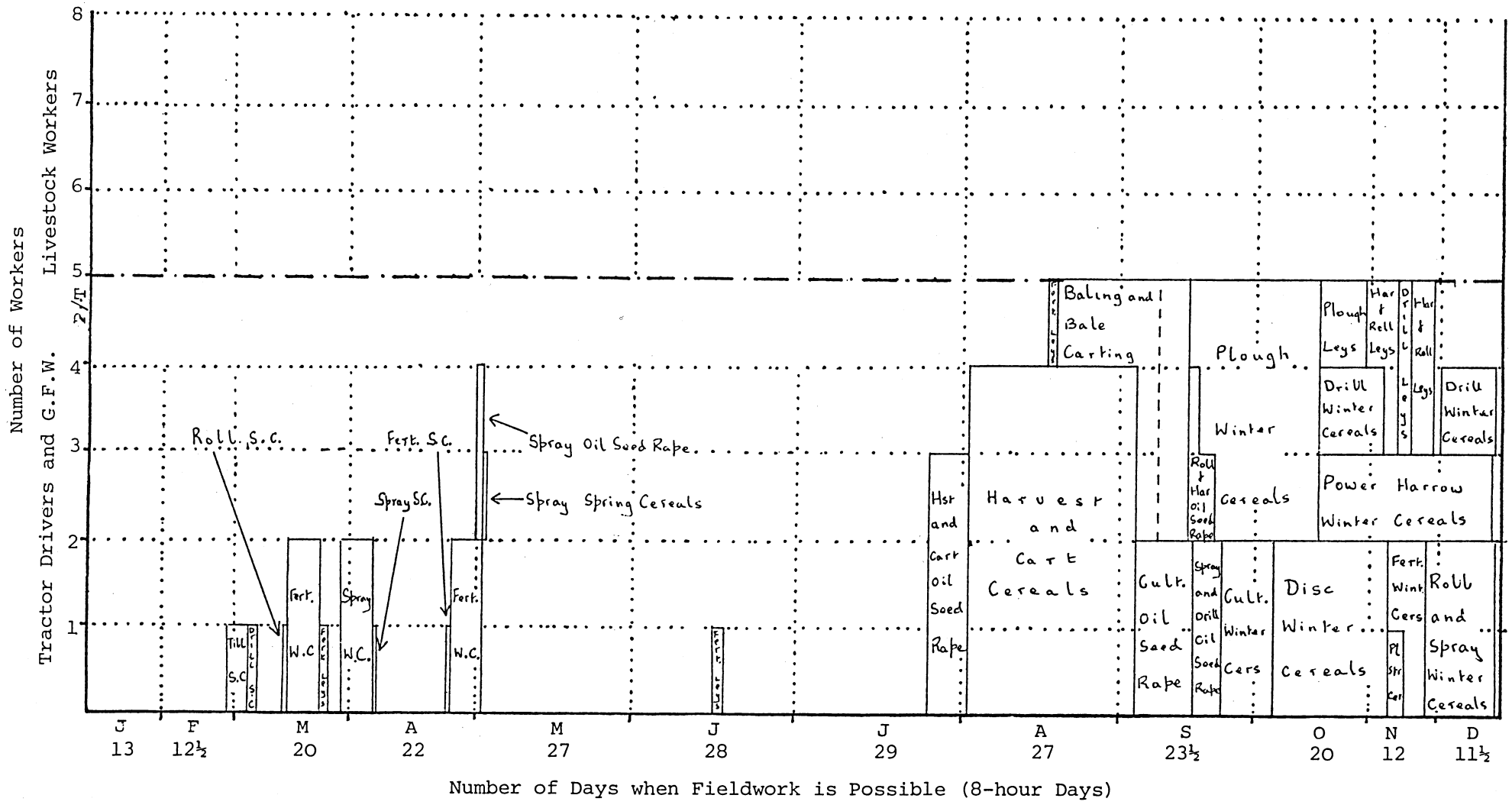
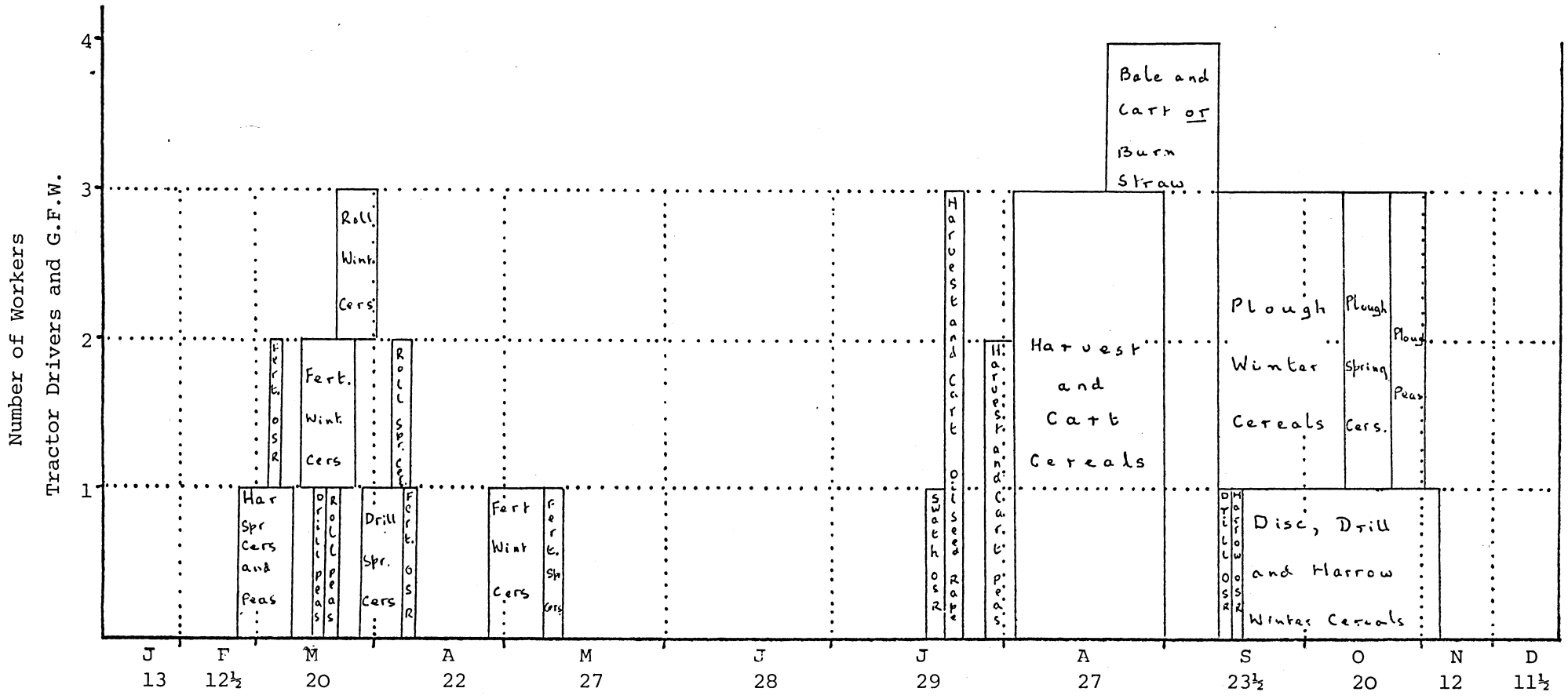


FIGURE 8: GANG WORK DAY CHART: FARM C



standard man days from tractor drivers and general farm workers. The proportion of these totals for which no field operations have been scheduled are 51% (Farm A), 55% (Farm B) and 58% (Farm (C). These proportions might suggest less overcapacity than when the number of standard man days for fieldwork is expressed simply as a percentage of the total annual labour potentially available from tractor drivers and general farm workers, disregarding days lost due to weather, holidays and illness (Cf. Table 24). This latter set of figures is 63%, 65% and 71% for farms A,B and C respectively. The amount of labour employed on the farms is thus apparently justified by the peak-period requirements - although this is not to say that they might not be run with less labour given a revised cropping programme, larger tractors and machines and possibly less insistence on timeliness. The large spaces on the charts containing no labour requirements are misleading. To begin with, statutory holidays and an average number of days lost through illness account for nearly 10% of the total labour hours "available". It is also necessary to allow for general farm mainenance (for hedging, ditching, repairs to roads and buildings, cleaning and repairing machinery, etc.). This is usually put at about 15% of direct labour requirements, although it is true that some of this work can be done during bad weather, the time lost for which has been excluded from the charts. There is also the need to allow for the flexibility needed in order to cope with our variable climate. A further point is that the days available include (before deductions are made for bad weather) up to 4 hours overtime per weekday in summer and 3 in winter, plus 12 to 14 hours' week-end overtime, according to season. At a maximum this represents more than 50% of the basic hours (40 a week). The average hours of overtime worked a year by a tractor driver is of course considerably less - about 7½. The long hours of overtime will naturally only be worked at peak times. Few farmers would wish to try to organise their labour force so that it has to work "flat out" all the year round. The staff would not be likely to remain for long if this were so, apart from the strain on health that such a policy would entail.

APPENDIX A

TABLE (i): PERCENTAGE FREQUENCY DISTRIBUTION OF ENTERPRISE TYPE BY SIZE

	Less than 40 ha		40 - 61 ha		61 - 182 ha		182 - 243 ha		243 ha and over	
	A	B	A	B	A	B	A	B	A	B
Winter Cereals	2	2	4	4	49	49	19	19	26	26
Spring Cereals	26	30	10	11	44	50	5	5	3	4
Maincrop Potatoes	34	92	2	4	2	4	-	-	-	-
2nd Early Potatoes	18	100	-	-	-	-	-	-	-	-
Early Potatoes	11	88	-	-	2	12	-	-	-	-
Sugar Beet	2	100	-	-	-	-	-	-	-	-
Oil Seed Crops	21	81	3	13	2	6	-	-	-	-
Vining Peas	3	67	2	33	-	-	-	-	-	-
Seed Peas(threshed)	16	77	5	23	-	-	-	-	-	-
Other Legumes	11	70	5	30	-	-	-	-	-	-
Root Vegetable	8	100	-	-	-	-	-	-	-	-
Brassicas	7	100	-	-	-	-	-	-	-	-
Top Fruit/Hops	8	100	-	-	-	-	-	-	-	-
Herbage Seeds	26	72	5	14	5	14	-	-	-	-
Grass Leys	11	12	10	10	57	60	13	14	3	4
Other Fodder	40	71	10	17	7	12	-	-	-	-
Permanent Pasture	34	36	21	22	23	24	7	7	11	11
Fallow	3	67	2	33	-	-	-	-	-	-

N.B. The percentages refer to the percentage of the area of each crop in each of the five area size groups. (The totals are read across the table). Columns A relate to the percentages of the whole area farmed, and Columns B to the percentages of those farms only where the crop was grown. For example, vining peas were grown on only 5% of the farms (i.e. 3 + 2); 67% of these farms had less than 40 ha of the crop; 33% had between 40 and 61 ha.

APPENDIX B

ITEMS OF MACHINERY INCLUDED IN THE SURVEY

2 Wheel Drive Tractor

4 Wheel Drive Tractor

Other Powered Machinery (e.g. Forklifts)

Combine Harvester

Baling and Bale Handling Machinery

- Baler
- Big Baler
- Trailer
- Sledge
- Accumulator
- Loader
- Carrier
- Elevator
- Straw Chopper

Grain Drying, Handling and Food Processing Machinery

- Hammer Mill
- Mill and Mixer
- Crushing Mill
- Cuber
- Mixer
- Meal Proportioner
- Sucker/Blower
- Flexible Auger
- Grain Auger 100 mm (4")
- Grain Auger 150 mm (6")

Potato Machinery

- Planter
- Fertiliser attachment
- Ridger
- Elevator Digger
- Spinner
- Harvester
- Haulm Pulveriser
- Elevator
- Swinghead Elevator
- Sorter

Sugar Beet Machinery

- Precision Drill unit wheel drive
- Precision Drill land wheel drive
- Hoe
- Trailed Harvester
- Two-stage Harvester
- Self-propelled Harvester
- Top saver
- Cleaner Loader with Engine

Fertiliser Spreading Machinery

- Full-width spreader
- Mounted spinner
- Trailed Spinner

Drilling Machinery

- Combine Drill
- Row-type Drill
- Spacing Drill
- Grass Seed Drill/Box

Spraying Machinery

- Mounted Sprayer
- Trailed Sprayer
- Self-propelled Sprayer
- Band Sprayer etc.

Ploughing Machinery

- Mounted Plough
- Reversible Plough
- Semi-mounted Plough

Cultivating and Tilling Machinery

- Chisel Plough
- Disc Harrow
- Furrow Press
- Harrow (Zig-Zag, Drag)
- Medium Cultivator
- Power Harrow
- Subsoiler
- Single Roll (Ring or flat)
- Springtine Cultivator
- Gang Roll (Ring or flat)
- Springtine Cultivator folding
- Rotavator/Rotary Cultivator
- Springtine Cultivator hydraulic folding
- Disc Plough
- Multiple Cultivator
- Rotary Harrow

Forage Machinery

- Flail Harvester
- Cutterbar Mower
- Double Chop Harvester
- Flail Mower
- Self-propelled Harvester
- Rotary Mower
- Precision Chop Harvester
- Mower Conditioner
- Buckrake
- Side Rake
- Crimper
- Tedder
- Grass Topper
- Other Turner

Haylage and Feed Machinery

- Dump Box
- Forage Box
- Blower
- Mechanised Feeder
- Spreader
- Tower Silo - concrete
- Unloader
- Tower Silo - enamel

General Machinery

- Farm Yard Manure Spreader
- Lorry/Truck
- Rotaspreader
- Irrigation Pump
- Loader
- Post Hole Driver
- Hedger
- Trailer Tank
- Ditcher
- Moisture Meter
- Yard Scraper
- Plough Washer
- Slurry Auger
- Cement Mixer
- Slurry Pump
- Power Hand
- Slurry Tanker/Spreader
- Water Tank
- Grain/Silage Trailer

Specific, non-allocated Machinery

- Transplanter
- Hop Picker
- Oilseed Swather
- Hop Drier
- Maize Header
- Draper Pick-up
- Maize Harvester
- Pickup Table
- Apple Grader

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