UTILIZATION OF MACHINERY AND LABOUR IN WHEAT AND SHEEP FARMING

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1. INTRODUCTION

In this paper a study is made of the time required to carry out various farming operations and the distribution of work throughout the year. The data on which the discussion is based were derived primarily from diary records kept by a group of farmers in part of the cereal-producing Northern Mallee area of Victoria during 1957-58.

Some of a group of farmers who were associated with the writer in earlier work were asked to participate in this project.[1] The farms are located in a 12-inch rainfall area where most of the soils are sandy and the paddocks are intersected by sand dunes the cultivation of which is particularly hazardous because of the problem of wind erosion.

For the purpose of the original survey, 53 farms were randomly selected and the topography and other relevant features of each paddock were mapped in the field with the aid of aerial photographs. Blank diaries were offered to about half of the fifty-three farmers before the start of the general sowings in late March, 1957, and twenty-six agreed to keep records at least until the completion of cultivation in the next cropping season (about mid-1958). The records required were quite simple, taking only a few minutes per day.

* My thanks are due to officers of the Soil Conservation Authority of Victoria concerned with the Mallee for their interest in this study and help in the field, Mr. R. G. Downes for comments on the manuscript, Mr. R. Jardine for statistical advice and to the farmers for their efforts in keeping diaries.

[1] See I. Molnar, "Wheat and Sheep Production in the Wheat Belt", *Journal of the Australian Institute of Agricultural Science*, Vol. 22, No. 1 (March, 1956), and "Farming Efficiency on Some Wheat and Dairy Farms in Victoria", *Journal of the Australian Institute of Agricultural Science*, Vol. 22, No. 3 (September, 1956).

Co-operating farmers were visited five times during the year and on a further two occasions when the figures were being tabulated. Four farmers gave up recording within the first few months and the records of another three were two erratic for analysis. Thus useful diaries were kept by nineteen farmers. Of these, the records of twelve covered *all* farming work while the other seven covered field operations only. The present paper is based on these farm records.

2. EFFICIENCY OF CROPPING OPERATIONS

Method of Computation

Farmers recorded daily in their diaries the names of the paddocks where work was done, the time it took to the nearest half-hour (including minor repairs but excluding travel to and from the paddocks) and whether sand dunes or flats or both were involved in the particular operation. In addition, they noted the type of tractor, and the type and width of the implements used and the estimated speed of the tractor. Farmers estimation of the speed was based on the guide figure provided in the pamphlet of the manufacturer of the tractor for travel in various gears and modified by the farmer for variations in throttle setting and topographic difficulties.[2]

From the width of the implement and the speed of the tractor the maximum theoretical performance (assuming no loss of time) was calculated. This maximum performance (P_M), as acres per hour, was calculated from the formula:

$$P_M = \frac{\text{Width of the implement (ft.)} \times \text{Speed of Tractor (mph)} \times 5{,}280}{43{,}560}$$

The observed performance (P), as acres per hour, was determined from the time records shown in the diaries and with the aid of the farm maps. A measure of efficiency (E), of performance is established by expressing P as percentage of P_M.

It was expected that E would be influenced primarily by three factors, namely, the total acreage (A) worked as a unit[3]; average length of run (L) in chains involved in working that area;[4] and the per cent of the total acreage classified as "flat" (F) as opposed to dunes.[5] In addition, the horsepower of the tractor used was considered. However, the exact horsepower

[2] The estimated speed was seldom below 4½ m.p.h. or above 6 m.p.h. The average speeds for the various operations on "flats", or on dunes and flats, were as follows: 5-7 ft. ploughing with discs 5.0 m.p.h., working with 9-12 ft. tynes on plough land 5.0 m.p.h., sowing with seed and superphosphate on ploughed land using 9-12 ft. combines 5.0 m.p.h., and harvesting with 8-12 ft. header or harvester 4.7 m.p.h.

[3] The areas were either whole paddocks (fenced areas) or only parts of a paddock (unfenced or partly fenced areas). Individual paddocks were often used for the production of several types of crops in the same season.

[4] Length was assessed by taking measurements on the farm map at 2-chain intervals.

[5] In practice, any particular type of field operation may cover the sand dunes only or flats only or it may cover both. It is generally regarded as more time-consuming to confine operations to the dunes but the data were inadequate to test this general opinion statistically. Consequently, only those operations which were carried out either on the dunes and flats combined or on the flat areas alone were considered.

of many types of tractors was often difficult to establish on a uniform basis even by consulting the manufacturers.[6] For this reason, and because all tractors could be regarded as having more than adequate power for the operation performed, variations in the horsepower of the tractors were ignored for the purpose of statistical analysis. Thus, only those factors were taken into account in the analysis of efficiency which could be determined with reasonable accuracy with the aid of the diaries and farm maps as noted above.

Regression Analysis of Data

Four field operations were considered, namely initial ploughing, working of fallow, sowing of seed with superphosphate, and harvesting cereals into bags. The effect of the acreage (A), length of run (L) and the per cent "flat" (F) area on efficiency were assessed by multiple regression analysis. Graphical presentation indicates that efficiency is linearly related to the above factors taken on a logarithmic scale, and this transformation has, therefore been adopted. One result of the regression analysis was that for each operation only one factor was found to be relevant, either A or L so that the final analysis was one of simple regression. The factor F proved unnecessary due probably to the light sandy nature of many of the flats; consequently there was insufficient difference in tractor wheel slip between sand dunes and flats.

(i) *Initial Ploughing of Stubble or "Pasture" (Mainly Weeds)* (N = 28).

Only the length of the run (L) affected efficiency. The length varied between 13 and 78 chains with an average of 36 chains.

Thirty-two per cent of the variation in efficiency could be attributed to the length of the run, the other 68 per cent being due to a host of other factors not readily identifiable. Efficiency (E) could be calculated for various lengths of run by the regression equation:—

$$E = 21{\cdot}0 + 33{\cdot}66 \log L$$

and 95 per cent fiducial limits for the regression coefficient are $\pm$ 19·94. Average efficiencies for specific values of L are shown in Table 1.

(ii) *Working of the Fallow after Initial Ploughing* (N = 19).

Only the acreage (A) affected efficiency. Acreage varied between 64 and 300 acres with an average of 210 acres.

Thirty-six per cent of the variation in efficiency could be attributed to acreage. Efficiency (E) could be calculated for various acreages by the regression equation:—

$$E = 10{\cdot}1 + 23{\cdot}44 \log A$$

and 95 per cent fiducial limits for the regression coefficient are $\pm$ 15·93. Average efficiencies for specific values of A are shown in Table 1.

[6] Attempts were made to establish the horsepower of the various tractors in terms of either rated draw-bar horsepower or rated brake horsepower but independent tractor test figures were not always available and sometimes no figures at all were available. The approximate range of the tractors' horsepower (of varied authenticity) and the width of various types of implements are shown in Appendix I.

It was thought that acreage and not length of run affected the workings because even when a whole paddock acreage is worked the working often proceeds from the most weedy areas to the less weedy ones and does not therefore take advantage of the longest available runs in the paddock.

(iii) *Sowing Cereals on Fallow with Superphosphate* (N = 40)

Only the acreage (A) affected efficiency. Acreage varied between 30 and 373 acres with an average of 176 acres.

Nineteen per cent of the variation in efficiency could be attributed to acreage. Efficiency (E) could be calculated for the various acreages by the regression equation:—

$$E = 27.0 + 15.30 \log A$$

and 95 per cent fiducial limits for the regression coefficient are ± 10·38. Average efficiencies for specific values of A are shown in Table 1.

It is not surprising to find no relationship between efficiency and the length of run because of the constant interruption of the sowing operation for refilling the combine with seed and superphosphate.[7] This interruption is likely to account for the much smaller variation in efficiency ascribable to acreage in case of sowing than in case of cultivation, though both operations were carried out by tyned implements.

(iv) *Harvesting Cereals into Bags (Not Sown) by One Man* (N = 17)

Only the acreage (A) affected efficiency. Acreage varied between 14 and 373 acres with an average of 163 acres.

Twenty-eight per cent of the variation in efficiency could be attributed to acreage. Efficiency (E) could be calculated for the various acreages by the regression equation:

$$E = 26.7 + 15.81 \log A$$

and 95 per cent fiducial limits for the regression coefficient are ± 14·10. Average efficiencies for specific values of A are shown in Table 1.

TABLE 1

Average Efficiencies of Field Operations (Calculated from Regression Equations)

Ploughing		Working Fallow		Sowing		Harvesting	
Length of Run (L)	Efficiency (E)	Acreage (A)	Efficiency (E)	Acreage (A)	Efficiency (E)	Acreage (A)	Efficiency (E)
Chains	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent
10	55	50	50	50	53	50	54
20	65	100	57	100	58	100	58
30	71	150	61	150	60	150	61
40	75	200	64	200	62	200	63
50	78	250	66	250	64	250	65
60	81	300	68	300	65	300	66
70	83	350	70	350	66	350	67
80	85	400	71	400	67	400	68

[7] The rate of seeding was usually 1 bushel per acre for grain production and 1½ bushels per acre for grazing. Superphosphate application varied between 45 lb. and 60 lb. per acre. At such rates of seed and superphosphate applications, combines are usually refilled at every 2 to 12 acres.

Efficiency is likely to be affected by the number of stoppages to empty the bin of the harvester into bags which in turn would depend on the yield per acre. It was not thought reasonable to ask farmers to count the number of bags in every field during the busy period of harvesting. Consequently, yields could not be taken into account in the calculation of efficiency.

Effect of a Gain in Efficiency

If efficiency changes from E_1 to E_2, the gain (e) $= (E_2 - E_1)$ and the effect of this gain is a saving of time. If h_{100} is the hours saved per 100 acres as a consequence of this gain then

$$h_{100} = \frac{10{,}000e}{P_M E_1 E_2}$$

P_M being the maximum theoretical performance for a given machine as previously noted. E.g., if P $= 8.0$ acre/hour and efficiency is increased from 50 per cent to 57 per cent then

$$h_{100} = \frac{70{,}000}{8.50.57} = 3.1 \text{ hours.}$$

Size Distribution of Cultivated Land

It was shown that efficiency of the cropping operations increases with an increase in the length of the run for ploughing and increase in the acreage for other operations. A size distribution of the areas and paddocks used for cropping in 1957 or 1958 on nineteen farms, shown in Table 2, indicates that a large proportion of the cultivated areas and paddocks are of inadequate size for efficient farming.

TABLE 2

Size Distribution of 122 Paddocks and 82 Selected Areas on 19 Farms, Northern Mallee, Victoria, 1957-58*

	Under 100 Acres	101-150 Acres	151-200 Acres	201-250 Acres	251 and Over	Total	
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Number
Paddocks†	17	20	24	13	26	100	122
Selected Areas‡ ..	34	24	12	11	19	100	82

* These 82 selected areas were used for regression analysis.

† Small paddocks around the homesteads were excluded.

‡ i.e., paddocks or parts of paddocks.

The distribution of the average length of the 82 areas was: 17 per cent under 21 chains, 23 per cent between 21-30 chains, 32 per cent between 31-40 chains and 28 per cent over 40 chains.

Individual paddocks are often used for the production of more than one type of crop in any one year; this is borne out by the larger per cent of areas than paddocks in the small acreage groups. The use of a paddock as two or more separate areas, however, does not necessarily mean in itself either erosion control or grazing control. Because of variations in farm acreage, flock size and management, no hard and fast rule can be made as to the optimum paddock size. Nevertheless, it is safe to state that the large proportion of paddocks in the relatively small acreage categories can be attributed to a legacy of the days when cultivation was done by small horse teams.

Economic Implications

In Tables 3 and 4 the amounts saved in fuel and labour costs *per* 100 *acres* are shown to illustrate the effects of various increases in the size of cultivated land. In these examples, which are purely for illustration, only one working of the fallow is taken into account though in practice more are usually involved. Since in the opinion of the farmers fuel consumption per hour of field operations varied usually between 1½ and 2 gallons per hour, these two levels of fuel usage were used in the calculations.

TABLE 3

Savings in Fuel and Labour Costs per 100 *Acres when the Length of the Run is Increased from* 10 *chain to* 30 *chains (for Ploughing) and the area from* 50 *acres to* 150 *acres (for Other Operations)*

Type of Field Operation	P_M*	Gain in Efficiency†	Savings in Time	Savings in Fuel Costs at:		Savings in Labour Cost§
				1½ Gallons Consumption per Hour‡	2 Gallons Consumption per Hour‡	
	Ac/Hr.	Per Cent	Hours	£	£	£
Initial Ploughing	4	16	10·2	2·0	2·7	3·5
Working after Initial Ploughing	6	11	6·0	1·2	1·6	2·1
Sowing Cereals with Superphosphate	6	7	3·7	0·7	1·0	1·3
Harvesting by One Man into Bags	6	7	3·5	0·7	0·9	1·2
Total	..	..	..	4·6	6·2	8·1

* Appropriate sample averages of maximum theoretical performance.

† As per Table 1 for increase in length of run (for ploughing) and increase in acreage (for other operations).

‡ Cost of fuel 2s. 8d. per gallon i.e. average price of power kerosene and distillate on the farm at June, 1959.

§ £13 15s. 0d. per 40 hours, i.e. basic wage, June, 1959.

TABLE 4

Savings in Fuel and Labour Costs per 100 *acres when the Length of the Run is Increased from* 20 *chains to* 40 *chains (for Ploughing) and the Area from* 150 *acres to* 250 *acres (for Other Operations)*

Type of Field Operation	P_M*	Gain in Efficiency†	Savings in Time	Savings in Fuel Costs at:		Savings in Labour Costs
				1½ Gallons Consumption per Hour	2 Gallons Consumption per Hour	
	Ac./Hr.	Per Cent	Hours	£	£	£
Initial Ploughing	4	10	5·1	1·0	1·4	1·8
Working After Initial Ploughing	6	5	2·1	0·4	0·6	0·7
Sowing Cereals with Superphosphate	6	4	1·7	0·3	0·5	0·6
Harvesting by One Man into Bags	6	4	1·7	0·3	0·5	0·6
Total	..	..	..	2·0	3·0	3·7

* Appropriate sample averages of maximum theoretical performance.

† As per Table 1 for increase in length of run (for ploughing) and increase in acreage (for other operations).

Tables 3 and 4 show that considerable amounts could be saved in fuel and labour costs (or opportunity costs) particularly when cultivated land of relatively small size is enlarged (Table 3). The amounts saved by increasing land of relatively large size are, however, much less (Table 4). Probably several larger areas could be formed on many individual farms by the amalgamation of groups of smaller areas without adversely affecting other managerial practices.

3. TIME REQUIREMENTS FOR CROPPING OPERATIONS

The times required for the various cropping operations in cereal production are set out in Table 5, both averages and ranges being quoted due to the small number of observations for most types of operations. Due to the small number of observations, *average* hours do not always reflect differences in time for identical operations with implements of different width.

Table 6 contains similar information for Manitoba, Canada. It will be noted that the ranges of time are considerably smaller for all the operations in the Canadian study than in the Northern Mallee. Furthermore, the number of observations in the former was much greater than in the latter.

It is interesting to observe that a comparison between average hours per acre in the two studies shows a remarkable similarity for corresponding operations in Tables 5 and 6. Initial ploughing with a 6 ft. wide plough is shown to take slightly longer in Manitoba than in the Northern Mallee. The Manitoba figures, however, refer to smaller acreages and to a type of plough which has all the discs placed on a single shaft, while the Mallee ploughs are "stump-jump". Initial ploughing with a 7 ft. wide plough in the Northern Mallee and with an 8 ft. one in Manitoba (No. 2 operation) show almost identical figures; apparently the advantage of a wider cut is cancelled by the smaller acreages in Manitoba. Comparisons with the other types of operations show almost perfect uniformity.

It is pertinent to add that the Manitoba figures are also available separately on a regional basis.[8] These regions varied in soil texture from relatively heavy to relatively light. The variation in the hour-per-acre figures was usually negligible for identical operations with identical implements in the different regions. One may conclude, therefore, that within a a 25.48 to 32.56 rated draw-bar horsepower range there is more than adequate power available to perform the various field operations on any of the Manitoba soils.

For further comparison, Table 7 contains somewhat similar data for the Great Plains in the United States. In this Table the tractor horsepower figures refer to all types of field operations which were carried out in the course of wheat production in each particular region.

A comparison between the Northern Mallee and the Great Plains shows that there is little variation in the time required for corresponding operations for similar acreages in these two cereal-growing areas.

[8] S. W. Garland and L. M. Johnson, *Crop Production Requirements in Manitoba,* Economics Division, Department of Agriculture, Ottawa, Canada, 1958, p. 27.

TABLE 5

Man-Hours Required in Cereal Production for Various Field Operations, Northern Mallee, Victoria, 1957-58.

	Type of Field Operation	Type of Implement	Width of Implement (Ft.)	Time per Acre (Once Over)		Acreage		Tractor Size		Number of Observations	Number of Farms
				Average Hours	Range Hours	Average	Range	RBHP	RDBHP		
		FIELDS CONSISTING OF DUNES AND FLATS OR FLATS ONLY									
1.	Initial Ploughing	12 Disc Plough	6	0·39	0·28-0·51	104	64–176	35–39	22–31	12	8
2.	Initial Ploughing	14 Disc Plough	7	0·39	0·30-0·46	234	89–458	33–40	27–32	11	6
3.	Working of Fallow After Initial Ploughing.	16 Run Combine§	9·33*	0·28	0·15-0·47	179	56–357	35–43	28–34	8	6
4.	Working of Fallow After Initial Ploughing.	20 Run Combine§	11·66†	0·29	0·23-0·36	184	90–295	n.a.	37	4	2
5.	Sowing of Fallow without Superphosphate.	16 Run Combine§	9·33*	0·30	0·18-0·47	125	14–205	35	28–31	4	3
6.	Sowing of Fallow with Superphosphate‡.	20 Run Combine§	11·66†	0·32	0·24-0·41	151	26–351	35–37	28–31	8	4
7.	Sowing of Fallow with Superphosphate‡.	16 Run Combine§	9·33*	0·29	0·20-0·59	150	26–295	33–46	28–35	23	11
8.	Initial Ploughing and Sowing in One Operation.	14 Disc Plough with "Seed Box".	7	0·44	0·29-0·64	224	95–494	37–47	28–38	5	4
9.	Harvesting into Bags (not Sown) by One Man.	Header or Harvester	10	0·34	0·14-0·77	174	28–275	33–43	22–31	12	5
10.	Harvesting into Bags (not Sown) by One Man.	Header or Harvester	12	0·22	0·17-0·28	250	26–373	27–35	21–31	3	2
		FIELDS CONSISTING OF DUNES ONLY									
11.	Initial Disc Harrowing	Tandem Discs	10	0·40	0·25-0·64	47	32–50	35	31	5	2
12.	Sowing of Fallow with Superphosphate.	20 Run Combine§	11·66†	0·31	0·24-0·46	60	32–112	35	31	5	2
13.	Sowing of Fallow with Superphosphate.	16 Run Combine§	9·33*	0·41	0·33-0·70	38	15–62	35–43	31–35	7	4
14.	Harvesting into Bags (not Sown) by One Man.	Header or Harvester	10	0·45	0·34-0·56	45	23–62	33–43	22–35	4	3

* Normally referred to as 10 ft.
† Normally referred to as 12 ft.
‡ Range of superphosphate application 45-60 lb./acre.
§ Some combines had disc undercarriage.
n.a. — Not available.

TABLE 6

Man-Hours Required for Various Field Operations—Manitoba (Canada) 1952-56

(Tractor RDBHP Range 25.5 to 32.5)

	Type of Operation	Type of Implement	Width of Implement	Time per Acre Once Over		Acreage		No. of Observations
				Average*	Range	Average	Range	
			Ft.	Hour	Hour	Acres	Acres	
1.	Ploughing	One-way Plough	6	0·48*	0·47-0·51‡	30–67‡	5–175	219
2.	Ploughing	One-way Plough	8	0·38*	0·33-0·42‡	35–90‡	7–225	117
3.	Cultivation	Cultivator	10	0·31*	0·28-0·34‡	33–65‡	5–175	492
4.	Cultivation	Cultivator	12	0·27*	0·25-0·29‡	44–90‡	5–230	207
5.	Sowing (Usually Without Fertilizer)	Seed Drill	10	0·29†	0·26-0·37§	29–43†	3–140	334

* Average of 5 Regions averages.

† Average of 4 Regions averages.

‡ Range of averages in 5 Regions.

§ Range of averages in 4 Regions.

Source: *Crop Production Requirements in Manitoba* by S. W. Garland and L. M. Johnson, Economics Division, Department of Agriculture, Ottawa, Canada (1958) and Private Communications.

TABLE 7

Man-Hours Required in Wheat Production for Various Field Operations—Great Plains (U.S.A.) 1950

	Type of Field Operation	Type of Implement	Width of Implement	Average Time per Acre Once Over	Average Acreage per Farm	Geographical Regions Where Observations Were Made	H.P. of Tractors Used in the Region		No. of Farms Used for Observations
							Most Common RDBHP	Range of RDBHP	
				Hour	Acres				
1.	Ploughing of Summer Fallow.	One Way Plough	7	0·44	139	Nth. Cent. Kansas and Sth. Cent. Nebraska.	25	11–69	8
2.			8	0·39	290	Nth.-East Montana and Sth. West Sth. Dakota.	26	17-34	16
3.	Working of Summer Fallow.	Cultivator	10	0·28	80	West'n Sth. Dakota.	24	11–36	11
4.	Sowing Without Fertilizer*.	Seed Drill	10	0·38	133	Nth. Cent. Kansas and Sth. Cent. Nebraska.	23	14–69	19
5.	Sowing with Fertilizer†		10	0·38	100	Nth. Cent. Kansas and Sth. Cent. Nebraska.	25	11–69	10
6.			12	0·32	160				9

* Average 1 bushel seed/acre.

† Average of 0·9 bushel seed and 0·75 cwt. fertilizer per acre.

Source: Crop Production Practices—labour, power and materials by operation. *Great Plains*—Bureau of Agricultural Economics, U.S. Department of Agriculture (F.M. 92. Section 4, 1953) and Private Communication.

TABLE 8

Fixed Costs of Operating Tractors (11 *Farms*) *and Implements* (12 *Farms*) *per Hour of Work**

	Tractors	12-14 Disc Ploughs	10-12 ft. Combines	8-10 ft. Tandem Discs	10-12 ft. Headers and Harvesters
Number of Tractors or Implements Used in Calculations† ..	15	13	12	9	9
Working Hours per Tractor and per Implement During a Cropping Cycle‡—					
Average	870	254	259	77	184
Range	552–1813	45–482	142–529	12–196	136–240
Depreciation per Working Hour—					
Average	2s. 9d.	2s. 4d.	2s. 10d.	1s. 8d.	8s. 6d.
Range	8d.–8s. 2d.	0d.–9s. 1d.	0d.–17s. 2d.	0d.–2s. 9d.	15s. 10d.–£1 1s. 7d.
5 Per Cent Interest per Working Hour— (Based on 1959 Valuation Figures.)					
Average	7d.	1s. 2d.	11d.	1s. 6d.	2s. 10d.
Range	3d.–1s. 1d.	4d.–5s.7d.	3d.–2s. 4d.	5d.–4s. 2d.	1s. 10d.–5s. 5d.
5 Per Cent Interest/Working Hour— (Based on 1959 Replacement Values.)					
Average	1s. 10d.	2s. 8d.	2s. 5d.	3s. 2d.	6s. 10d.
Range	11d.–2s. 7d.	9d.–12s. 3d.	9d.–4s. 0d.	11d.–10s. 0d.	4s. 5d.–9s. 6d.

* Excludes: 1. Tractors or implements not used for sowing or harvest in 1957 or for cultivation in 1958.
2. Tractors or implements with slightly appreciated values.
3. Tractors or implements for which values could not be provided by the farmers.

† More than one tractor or implement of the same type was used on some farms.

‡ On and off the farm.

Although the time required for the various field operations in the Northern Malee is generally comparable with those in Manitoba and the Great Plains, there seems to be scope in other directions for improving the efficiency of such operations in the Northern Mallee. The amalgamation of areas of relatively small size was mentioned earlier as one way of achieving increased efficiency. Another way would be less frequent cropping.

In the opinion of farmers in the Northern Mallee, field operations usually take considerably longer when confined to dunes only when the fields consist of dunes and flats, or entirely flats. In Table 5 the times recorded in areas consisting of dunes only are greater (except for sowing) than for the other areas. Although the times shown for the dunes are based on both smaller acreages and smaller numbers of observations than in the other areas, the figures seem to support the opinion of the farmers.

It is likely that the more costly cultivations on the difficult sand dunes could often be avoided by putting such dunes to lucerne. Alternatively, when the erection of temporary fences would entail much expense, as where paddocks consist mainly of dunes or are of a small size, the dunes could be sown to lucerne and the flats to barrel medic and used less frequently for crop production.

The green cut yields obtained with lucerne and barrel medic in experiments of short duration in the Northern Mallee do not enable the economic implications of such a change on the livestock production to be shown. However, the beneficial effect of barrel medic on subsequent wheat yields has been proved adequately.[9] In the expansion of lucerne and barrel medic acreages, paddocks of relatively small size and with difficult erodible dunes could therefore be given first preference.

4. UTILIZATION OF TRACTORS AND IMPLEMENTS

Hours of Work During a Cropping Cycle

Under the wheatgrowing conditions in the Victorian Northern Mallee fallowing starts for the next season's crop before the harvest of the current crop. Furthermore, the timing of identical field operations varies greatly from farm to farm even within a 30-mile radius. This is illustrated by Figs. 1A and 1B. For these reasons it was not practicable to compare working hours by tractors and implements on the different farms on a purely calendar basis. The hours of use during a cropping cycle were arrived at by adding together the hours worked with tractor-driven implements on sowing and harvesting the 1956-57 crop, on tilling in 1957 in preparation for the 1957-58 crop and the tractor hours spent on non-cropping operations or outside the farm during a period of 12 months.[10]

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[9] *Guide Book to the Mallee Research Station* 1958-59, Victorian Department of Agriculture, p. 8 and "The Mallee Wheat Crop Championships, 1959" by A. P. Mann, *The Journal of Agriculture*, Victoria, Vol. 58, Part 4, 1960, p. 261.

[10] The hours spent on non-cropping work or outside farm work with the tractor during the various periods which were covered by farm records were expressed pro rata for 12 months, i.e., as if such tractor or machinery work had been evenly distributed throughout the year.

TABLE 9

Hours of Work per Tractor (11 *Farms*) *and per Implement* (12 *Farms**) *During a Cropping Cycle in the Northern Mallee, Victoria,* 1957-58 (*Tractors Not Fit for Cropping Operations are Excluded*)

	Working Hours						Total Number‡
	600–700	701–800	801–900	901–1,000	1,001–1,100	2,009	
	Number of Tractors						
Tractors on 2-Tractor Farms†	2	2	..	4	..	..	8
Tractors on 1-Tractor Farms	2	1	1	..	2	1	7
	Working Hours						
	Less than 100	101–200	201–300	301–400	401–500	Over 500	
	Number of Implements						
Ploughs (12 and 14 Discs)	5	3	3	3	1	1	16
Combines (16 and 20 Runs)	1	8	4	3	1	1	18
Disc Harrows (10 ft. Tandem)	7	2	..	..	..	..	9
Harvesters or Headers (9 ft. to 12 ft.)	..	7	4	..	..	..	11
Heavy Harrows or Tyned Cultivators	5	1	1	..	..	..	7

* Headers and Harvesters 11 farms only.
† On two-tractor farms average working hours are shown.
‡ More than one implement of the same type was used on some farms.

Rainfall during the fallowing period of 1957-58 was considerably below normal. Nevertheless, farmers on eight out of the twelve farms claimed that the fallow was given the "usual" number of workings. Three farmers claimed one to three less workings and one farmer claimed one more working.[11]

Complete tractor work records were available for eleven farms and the hourly use of tractors and implements on these is shown in Table 8. Omitting tractor work performed outside the farm, the total hours worked with one or more tractors varied between 568 and 2,009 hours per farm during a cropping cycle. The average was 1,145 hours. As one would expect, there was a close relationship between the acreage under crop and the hours worked with tractors. From 66 to 86 per cent of the hours of tractor work was on cropping operations, the average being 79 per cent.

Some Selected Cost Items[12]

In Table 10 depreciation and interest on invested capital in tractors and implements are expressed *per working hour*. Depreciation per working hour was arrived at by calculating first the annual depreciation which was taken as the difference between the purchase price and the 1959 valuations,[13] divided by the number of years of use by the farmer.[14] The annual depreciation was then divided by the working hours during the cropping cycle to give the depreciation per working hour. Since both annual depreciation and working hours per cropping cycle had a wide range, a correspondingly wide range is shown for depreciation and interest per working hour in Table 10.

Not all the implements shown in Table 9 were used for the calculation of depreciation and interest in Table 10. Those implements for which purchase price or valuation figures were not available, or those which had appreciated in value since their purchase, were excluded from the calculations. Costs of operating headers and harvesters are naturally high on account of their relatively high initial values and limited usage.

Other costs taken into account were those for fuel, seed and superphosphate, all at observed rates of use. The relative importance of these costs is shown in Table 11. Variations in the relative prices of seed and superphosphate, or variations in the rate of interest, would, of course, influence the magnitude of each of these cost items. It should also be mentioned that the cost of repairs, other than those of a minor type, have not been taken into account in this study.

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[11] A description of these farms is given in Appendix 3.

[12] No attempt is made here to calculate costs of production of any particular produce. These calculations were made to show the relative magnitude of certain costs of field operations with tractor-driven implements.

[13] Both purchase price and valuations in 1959 were provided by the farmers.

[14] This method of calculating depreciation is affected by the inflation during recent years. Even so, it was thought to be a more appropriate method than using an arbitrary number of years, e.g., those stipulated for taxation purposes.

TABLE 10

Percentage Distribution of Average Costs, Excluding Seed and Superphosphate of Field Operations, Northern Mallee Wheat-Sheep Farms, Victoria,
(Based on Observed Rates of Performance)

Type of Field Operation	Average Acreage	5 Per Cent. Interest on Farmers' Equity in Machinery Used	Depreciation	Fuel	Labour	"Total"*	Number of Farms Used in the Calculations	Number of Fields Used in the Calculations
	Acres	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent		
1. All Field Operations	116	8	33	22	37	100	4	5
2. All Field Operations Excluding Harvest	91	8	39	21	32	100	3	6
3. Tilling and Sowing in One (with Superphosphate)	136	8	37	22	33	100	5	6
4. Tilling and Sowing in One (without Superphosphate)	235	8	41	20	31	100	5	7
5. Initial Disc Harrowing	59	6	44	20	30	100	1	4
6. Initial Ploughing	149	7	17	31	45	100	6	7
7. Working after Initial Ploughing	209	7	11	32	50	100	4	7
8. Sowing Cereals on Fallow (with Superphosphate)	133	7	43	19	31	100	6	13
9. Harvesting	65	12	37	18	33	100	6	6
Total of Operations 6–9†	..	9	30	24	37	100		

* Total for items of cost included.

† Differences between these figures and the corresponding ones shown for No. 1 type of operation are due to variations in the number of farms, acreages, workings, etc.

TABLE 11

Percentage Distribution of Average Costs of Selected Field Operations, Northern Mallee Wheat-Sheep Farms, Victoria, 1957-58

(Based on Observed Rates of Performance)

Type of Field Operation	Average Acreage	5 Per Cent. Interest and Depreciation on Farmers' Equity in Machinery Used	Fuel and Labour	Seed	Superphosphate	"Total"*	Number of Farms Used in the Calculations	Number of Fields Used in the Calculations
	Acres	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent		
1. All Field Operations	116	23	33	30	14	100	4	5
2. All Field Operations Excluding Harvest	91	21	25	38	16	100	3	6
3. Tilling and Sowing in One (with Superphosphate)	136	13	17	50	20	100	5	6
4. Tilling and Sowing in One (without Superphosphate)	235	17	17	66	..	100	5	7

* Total for items of cost included.

Seeding rate was taken at 1 bushel per acre for all cereal crops other than oats sown for feed for which the rate was taken as 1½ bushels.

Engine oil costs were added to each operation on a pro-rata basis and are included under "Fuel" costs.

Fuel consumption was taken at rates provided by the various farmers for the different operations.

Prices used in the calculations were:—

Fuel per 44 gallons at Ouyen at June, 1959; Power kerosene £5 18s. 3d., Distillate £5 11s. 10d., Diesel oil £4 14s. 7d., Engine oil £22 17s. 6d.

Labour per 40 hour week at £13 15s. 0d. basic wage at June, 1959.

Seed per bushel: Wheat 13s., Melbourne price 1957-58, Rye 17s., Melbourne price 1957-58, Oats 10s. 6d. average 1957-58 for Victoria, and Barley 12s. average 1957-58 for Victoria.

Superphosphate £14 3s. per ton at Ouyen at June, 1959.

It will be appreciated that the cost of interest could vary considerably from the allowance made in Tables 10 and 11 for two reasons: firstly the rate of interest would probably be higher than 5 per cent in some circumstances and, secondly, plant valuations would be higher if replacement valuations rather than current valuations were used. An indication of the capital requirements for tractors and implements based on 1959 valuations compared with requirements based on 1959 replacement valuations is contained in Table 12. The average capital invested in tractors and implements at 1959 valuations was £1,900 while the average replacement valuation in 1959 was £4,917. Although for five years most farmers will not need capital for replacing farm machinery, substantial amounts will be needed from then onwards. This is shown in Table 13. The average requirement of the three farms needing replacement in less than five years was £1,496 and that of the 12 farms needing replacement during five to ten years £3,088.

The high hourly rates of depreciation and interest would be reduced by increased use of the tractors and implements. Without increasing the size of the farm a limited increase in use could be achieved by increasing the number of workings of the fallow after the initial ploughing or by increasing the proportion of the farm area put to crops. Both methods are undesirable because they would not increase the yields per acre[15] but would increase the erosion risk.

TABLE 12

Investment in Tractors and Implements, 12 *Northern Mallee Wheat-Sheep Farms,* 1957-58

Valuations	Number of Farms with Investment of:						
	Under £1,000	£1,000-2,000	£2,001-3,000	£3,001-4,000	£4,001-5,000	£5,001-6,000	Over £6,000
1959 Valuations ..	2	5	5	..	..	..	..
1959 Replacement Values	..	1	1	1	2	4	3

TABLE 13

Capital Requirements for Tractors and Cropping Implements, Survey Farms, Northern Mallee, Victoria, 1958

Period during which Replacements will be Needed	Capital Required at 1959 Replacement Values				Total Number of Farms
	Less Than £1,000	£1,000-3,000	£3,001-5,000	£5,001-6,000	
	Number of Farms				
Less Than 5 Years	..	3	..	..	3
5-10 Years	2	3	5	2	12

[15] *Guide Book to the Mallee Research Station* 1958-59, Victorian Department of Agriculture, p. 4.

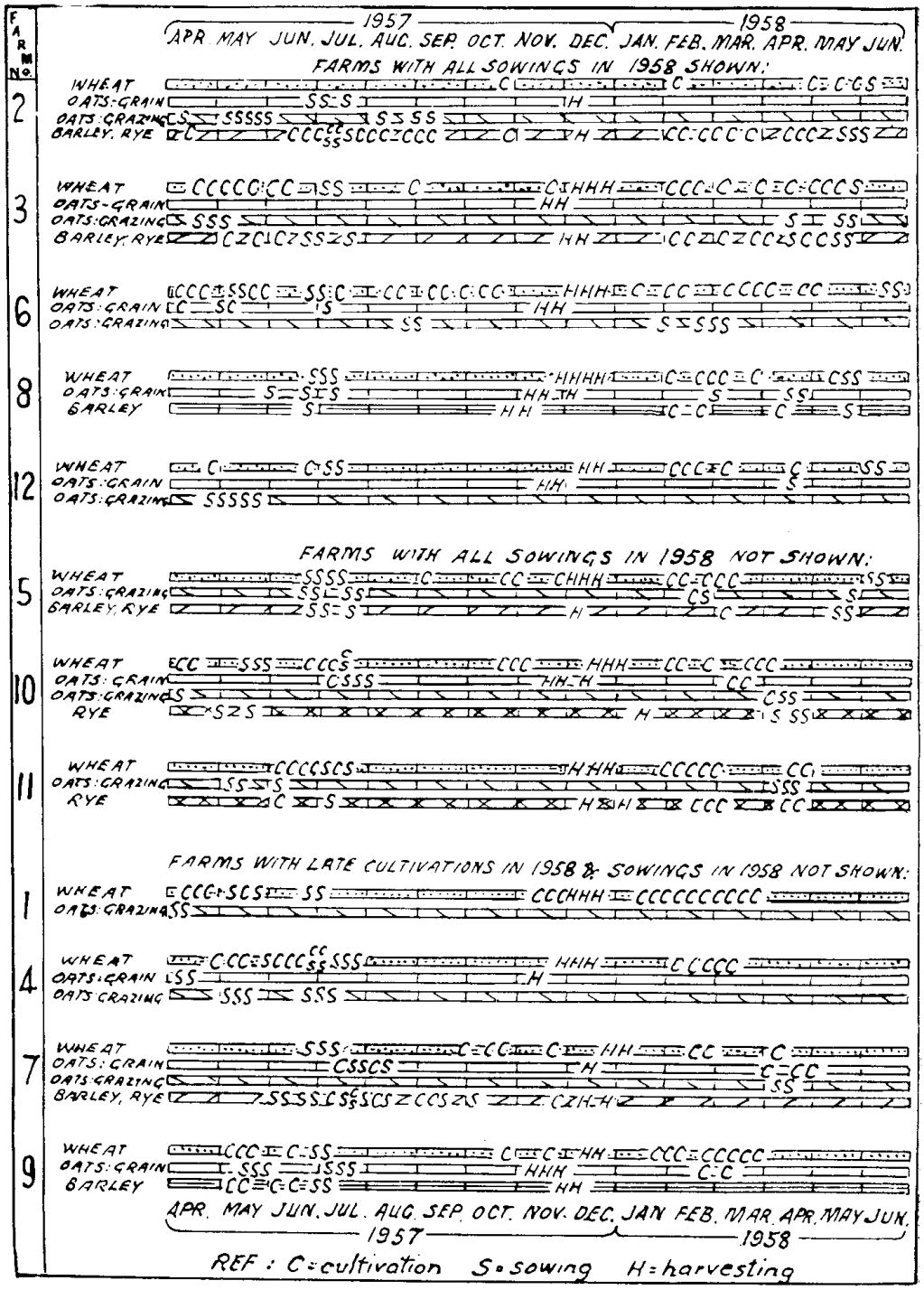

Fig. 1A—Distribution of Time Spent on Cropping Operations, Northern Mallee Farms, Victoria, 1957-58

Without increasing farm size, another alternative would be some arrangement between farmers for the sharing of implements, particularly those which are used over short periods only and are relatively expensive. For some operations there may be scope for sharing machinery without upsetting managerial procedures. There may, however, be other reasons (such as desire for independence) which would preclude this solution.

Using tractors and implements of smaller size than the existing ones is not likely to appeal to most of the farmers even if this would ensure lower overhead costs. Using smaller-sized machinery (when available) would mean not just longer working hours but also a loss of the advantage of fast work in seasons when sowings and harvesting have to be completed with the least delay. Such an argument cannot be dismissed by referring back to the days when instead of tractors horses were used on all the wheat and sheep farms. It would be impossible to estimate the number of seasons when crop failures were due to slow sowing or harvesting in the past.

It appears, therefore, that an increase in the size of farms, without an increase in the number of tractors and implements is the logical answer to the situation. Such a solution would be in line with the modern tendency, namely increase in the length of the rotation with more use of lucerne and medics during the pasture phase. In the light of the substantial expenditure needed for tractors and implements after the next five years on most of the farms, over-capitalization could be prevented by the amalgamation of the smaller-sized farms. It will be shown later that this would be desirable from the labour utilization point of view also.

5. UTILIZATION OF LABOUR

Utilization of labour was also examined in the light of the hours worked on 12 farms. The farm work recorded included the time spent on miscellaneous business matters such as travel to sheep sales or for the purchase of machinery parts, attendance at field days, etc. Time spent around the homestead in gardening, wood cutting or milking was, however, ignored. Time spent by contractors on wheat carting to the railway siding was ignored also. Some features of these 12 farms are set out in Appendix 3.

If off-farm work, such as sharefarming or work on neighbouring properties, is disregarded the monthly utilization of labour is greatly affected by the timing of cropping operations; since there is considerable variation in the timing of identical cropping operations, from farm to farm, there are also marked variations in the hours worked in each month of the year. The total man-hours worked in a complete cropping cycle was calculated by adding together the hours worked on sowing and harvesting the 1956-57 crop, preparation for the 1957-58 crop and on non-cropping work performed during a period of 12 months.[16]

On one farm (No. 9), 107 acres of virgin Mallee scrub was cleared during 1957-58 while on another an older member of the family did almost all sheep and fencing work and had no other farming tasks (No. 10).

[16] The hours spent on non-cropping work during the various periods which were covered by farm records were expressed pro rata for 12 months, i.e., as if such work had been evenly distributed throughout the year.

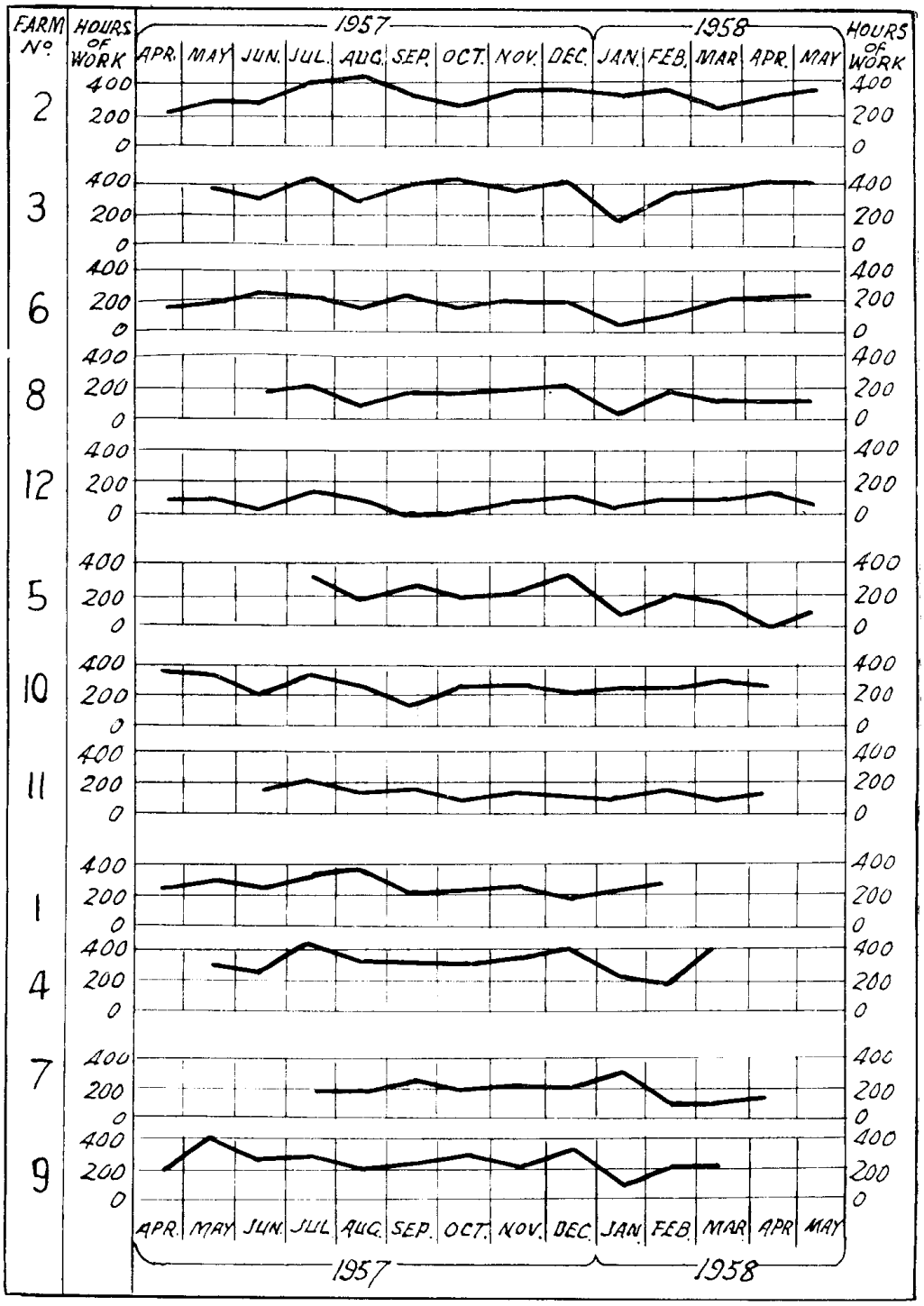

Fig. 1B—Distribution of Time Spent on Cropping Operations, Northern Mallee Farms, Victoria, 1957-58

By omitting these two farms from the calculations it was found that 1.1 man-hours were utilized per acre of cleared land, with an average of 1.3 hours.

Distribution of Working Hours

The proportion of the total working time spent on different types of work is shown in Fig. 2. It is interesting to observe that the operators of the three smallest farms worked over 100 hours "outside the farm" during a period of 12 months. Relatively little "fencing" work was done on most farms and "rabbiting" played a still smaller part in the total programme.

TABLE 14

Man-Hours Worked by the Owner(s). (Full-time Working Manager(s).)

Farm Number	Farm Acreage*	Work Performed by Owner(s) as Percentage of Total Man-Hours	Work Performed by Each Owner	
			Hours	Hours per Working Week
	"Large Farms" (Over 2,000 Acres) Without Sharefarming			
1 ..	2,622	78	2,924	62
2 ..	2,464†	99	2,030	43
3 ..	3,522	92	1,896	40
4 ..	2,813	98	1,941	41
5 ..	2,191	94	1,053	22
	"Small Farms" (Under 2,000 Acres) Without Sharefarming			
6 ..	1,516	71	1,652	35
7 ..	1,291	84	1,732	36
8 ..	1,435	97	1,900	40
9 ..	1,382‡	98	1,663	35
	"Small Farms" (Under 2,000 Acres) With Sharefarming			
10 ..	1,293	93	1,500	32
11 ..	1,389	88	1,456	31
12 ..	980	72	954	20

* Excludes areas farmed on shares by the owner(s).

† Excludes 300 acres cropped by sharefarmer.

‡ Includes 107 acres newly cleared virgin Mallee.

"Sheep" work varied considerably from fram to farm but it was not possible to relate this to differences in stock numbers or rates of stocking because no accurate stock records were kept. The approximate rates of stocking for the 1957-58 season are shown in Appendix 3.

"Other tractor and machinery" work includes repairs and major maintenance work, clearing of dams and some carting. A fairly uniform proportion of the total working hours was spent on these works on all farms except No. 12.

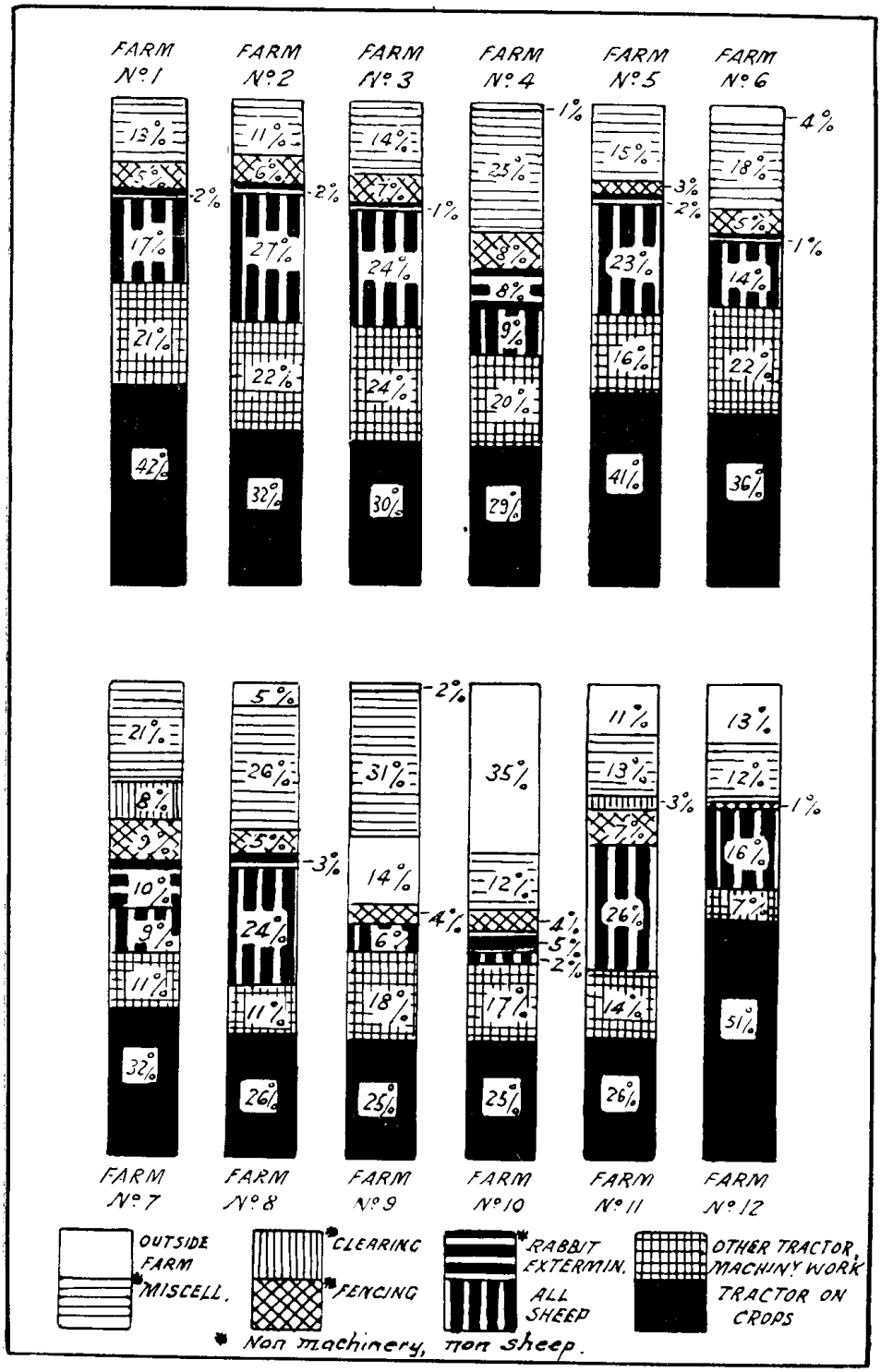

Fig. 2.—Percentage Distribution of Time Spent on Different Types of Work During a Cropping Cycle, Northern Mallee Farms, Victoria. (Excludes 1,152 Hours Spent on Sheep and Fencing Work by an Older Member of Family on Farm No. 10)

Table 14 shows the working hours of the owner(s) on the farm and outside the farm as per cent of the total man-hours worked on the farm; it shows also the working hours performed by each owner. There were two owners (working managers) on each of farms two to five and nine and ten. The owners of these farms were either brothers or father and son.

In 1957 and 1958 the owners (working managers) on five farms did not take recreation leave except for occasional days, while on another two farms the duration of such leave could not be ascertained with any accuracy. Therefore, in Table 14 the working hours per week are based on 47½ working weeks per year, the assumption being that leave is taken according to the provisions of the Agricultural Award, namely, fourteen days recreation leave, ten public holidays and seven days sick leave.

Table 14 shows that on the "large farms" the owners were adequately occupied except on farm No. 5, where after the diary-keeping period, the farm was subdivided between the two owners. Among the "small farms" there was inadequate work even when combined with sharefarming. An exception is farm No. 8, due probably to the additional work involved in some spray irrigation and frequent dealing in sheep for fattening. On farm No. 9 the hours of work would have been considerably smaller than shown in the Table but for the long hours spent on clearing virgin Mallee scrub and relatively long hours spent on time-filling "miscellaneous" types of work.

In Table 15 the working hours are shown pro rata for 1,000 acres for those farms which were managed without any sharefarming arrangement outside the farm, namely Nos. one to nine. The working hours shown in this table are based on total man-hours worked on the farm. Figures shown in Table 15 indicate that 1,000 acres can be regarded as inadequate to occupy fully one man throughout the year.

TABLE 15

Man-Hours Worked by All Farm Workers Expressed per 1,000 *Acres.*

Farm Number	Total Hours	Hours per Working Week*
1	1,437	30
2	1,671	35
3	1,175	25
4	1,406	30
5	1,018	21
6	1,546	33
7	1,599	34
8	1,359	29
9	2,451†	52

* Based on 47½ working weeks per year.

† Includes 486 hours spent on clearing virgin Mallee scrub.

Implications of Inadequate Labour Utilization

The lack of opportunity for more useful farm work raises two questions. First, how far are the work hours shown in Table 15 applicable to the Northern Mallee, and second, what are the remedies, since increased work hours spent on rabbiting or fencing obviously would not alter the situation appreciably. Sharefarming or clearing can also be ignored as a means of fuller utilization of labour because opportunities for sharefarming or safe clearing are small. In view of the hours worked on these farms one may conclude that farms under 1,000 acres per person engaged in full-time farming would provide even less work. This would be so provided farming were carried out with comparable equipment and rotation.

The farms, as managerial units, were listed in nine parishes in which diary-keeping farmers were situated. These parishes had a total area of about 330,000 acres and had 169 farms. By making inquiries in these parishes it was found that 76 farms (or about 45 per cent of the total number and about 44 per cent of the total acreage) were partly outside the boundaries of these parishes, were used mainly for pastoral pursuits, or their owners were not engaged in full-time farming. The remaining 93 farms (or about 55 per cent of the total number and about 56 per cent of the total acreage) were then grouped by size, number of owners and whether or not these owners were also engaged in sharefarming. It was found that the owners of only two farms were involved in sharefarming. The distribution of the 91 farms without sharefarming is shown in Table 16 with the farm acreages expressed per each owner (full-time working manager).

TABLE 16

*Farm Size Distribution in Nine Parishes**

Number of Owners (Full-time Working Managers) on Farm	Farm Area per Owner (Full-time Working-Manager)							
	Less Than 1,000 Acres		1,000-1,999 Acres		Over 2,000 Acres		Total	
	Number of Farms	%	Number of Farms	%	Number of Farms	%	Number of Farms	%
1	7	17	25	61	9	22	41	100
2	21	53	18	45	1	3	40	100
3	8	89	1	11	..	..	9	100
5	1	100	..	..	..	..	1	100
	37	41	44	48	10	11	91	100

* The nine parishes are: Gerahmin, Kattyong, Kia, Nyang, Ouyen, Paignie, Pier Millan, Tiega and Walpeup.

This Table shows that on 41 per cent of the farms the acreage per each owner engaged in farming as full-time working manager is less than 1,000 acres and can, therefore, be regarded as inadequate in size for the full utilization of the available labour. The solution to the problem appears to be either finding some additional lines of production as adjuncts to wheat and sheep farming or using small farms for the enlargement of other farms where the efficiency of the available labour and machinery could thereby be increased.

Possibilities for Greater Utilization of Labour

In view of the wide variations in the utilization of labour on the farms studied it would appear that in some cases there is scope for the introduction of additional activities to make greater use of the labour available. Pigs and/or poultry enterprises were therefore examined in 1957 as possible sidelines on wheat farms in the north-west of Victoria.

Wheat farmers with such subsidiary enterprizes are few in the north-west of Victoria, but it was possible to make some assessment of the contribution of pigs and poultry from the records of eight farmers in the area. Striking features of six farms on which pigs were produced were:—(i) more than one man was working the farm; (ii) the farms were relatively small (under 2,000 acres) and (iii) some of the farmers were also engaged in sharefarming.

The time required for pigs was found to be approximately half an hour per day where the number of sows was under ten, two hours per day with 15 to 20 sows and two days per week with 45 sows. Full-time work was required with 100 sows. Capital required for housing was virtually nil under the dry climatic conditions of the Mallee and the outlay on feeders and grain crushing machinery was relatively small on most of the farms.

A poultry enterprise is less likely to make a substantial contribution to income on wheat farms, due to the greater labour requirements involved. However, as in sideline pig production, there may be circumstances in which a poultry enterprise can be usefully introduced. In each case, of course, the comparative prices of products will have the greatest influence, i.e., the egg-wheat price relationship and the pig-wheat price relationship.

Farms with inadequate acreages could be either amalgamated or used for the enlargement of farms which are not quite adequate in size for the full utilization of their machinery and labour. Either method would be possible only through voluntary sales and when the farms which would be brought under one management were not far apart. Perhaps schemes such as those available in the United States under the Farmers' Home Administration scheme would be worth considering.

6. SUMMARY

Nineteen wheat and sheep farmers in an area subject to the hazard of wind erosion in the North Mallee, Victoria, agreed to keep diaries of their daily farming activities during 1957-58. All of the farms were within a radius of about 30 miles. Twelve farm diaries covered all farm work in detail and seven covered the field operations only. Detailed maps were available for all of the nineteen farms.

A large proportion of the paddocks or areas under crops on the nineteen farms were relatively small and consequently working with machinery took longer than when the acreages were larger. It was found that about £5.7 to £14.3 savings in fuel and labour costs could be obtained per 100 acres on a large percentage of the cultivated areas. Cultivated areas of relatively small size could either be enlarged or put to barrel medic and lucerne and

cropped less frequently. The latter practice would be most desirable when a large proportion of the paddock is of dunes the cultivation of which is particularly time consuming and which are most prone to wind erosion.

The man-hours required to carry out the field operations with various implements were of the same order on a per acre basis as in Manitoba (Canada) and in the Great Plains (United States).

The size of the farms for which complete farm diaries were available varied between 980 and 2,622 acres. Five farms with over 2,000 acres in size and two with under 2,000 acres were managed by two owner-operators. The owner-operators of three farms were also engaged in sharefarming.

During the 1957-58 fallowing period the rainfall was considerably below normal. Nevertheless, farmers on eight out of the twelve farms with complete diary records claimed that the fallow was given the "usual" number of workings. Three farmers claimed one to three less workings and one farmer claimed one more working.

When tractor work performed outside the farm was omitted, the total working hours with tractors on eleven farms varied between 568 and 2,009 hours during the cropping cycle, the average being 1,145 hours. Hours of usage per tractor, both on and off the farm, averaged 870 hours, varying between 552 and 1,813 hours during the cropping cycle. The average usage of implements on twelve farms was 254 hours for ploughs, 259 hours for combines, 184 hours for headers and harvesters and 77 hours for tandem discs per cropping cycle. All these times exclude time spent on repairs and maintenance, except when of a minor nature.

Average depreciation figures for tractors and implements varied between 1s. 8d. and 8s. 6d. per hour of use according to the type of machinery, while interest at 5 per cent on the invested capital in machinery averaged 7d. to 2s. 10d. per hour of usage. The interest figures were, of course, much higher when interest was calculated on replacement values. While the average capital invested in tractors and field implements was £1,900 per farm at 1959 valuations, at 1959 replacement values it was £4,917. When other items of cost were also taken into account, such as labour, fuel, seed and superphosphate, then the interest and depreciation amounted to about *one half to two-thirds* of the per-acre costs of all cropping operations. With the omission of the costs of seed and superphosphate from the "total" costs, the largest items were depreciation and labour followed by fuel and interest.

Most of the twelve farmers will not need capital for replacing field machinery for five years. From then onward, over a ten year period, however, substantial amounts will be needed for this purpose on all farms. The average capital requirements of the three farms needing replacement in less than five years will be £1,496, while that of the twelve farms needing replacements during five to ten years will be approximately £3,088.

Owing to differences in the timing of cropping operations, there were marked variations in the monthly utilization of labour on the twelve farms. On none of the farms was paid labour engaged throughout the cropping cycle.

Working hours per week per full-time owner-operator were 62 hours on one farm, 40-43 hours on four, 31-36 on five and 20-22 hours on two. Since with the exception of three of these twelve farms the farm acreage per owner-operator was over 1,000 acres, it could safely be assumed that farms with a size of under 1,000 acres per owner-operator provided even less work if farming was carried out with comparable equipment and rotation. By making enquiries in nine parishes in which some of the diary-keeping farmers were located, it was found that 55 per cent of the total farm number and 56 per cent of the total parish acreage of about 330,000 acres was made up of farms which had no land outside the boundaries of the nine parishes. These farms totalled 93 and the operators of only two farms were engaged in sharefarming also. It was found that 37 of the 91 farms, or 41 per cent had less than 1,000 acres per each owner-operator.

In the light of the relatively low man-hours and high depreciation and interest rates on the invested capital in tractors and implements, coupled with the substantial expenditure which will be required for replacing them after five years, the amalgamation of the small sized farms would be most desirable. Production of pigs and poultry as possible sidelines to wheat and sheep farming do not appear to be the solution to the problem. It may be worth considering the facilities available for the enlargement of farms of inadequate size in the United States under the Farmers' Home Administration scheme.

Anticipated increases in overhead costs in the not distant future, unless accompanied with corresponding increases in grain prices, may force farmers to shorten their rotation and crop more frequently with consequent serious erosion problems as witnessed in the depression years of the early 'thirties.

APPENDIX 1

Tractors and Implements on which Efficiency Calculations were Based

Type of Operation	Range of Tractor Horsepower		Type of Implement	Range of Implement Width
	RBHP*	RDBHP†		Ft.
Initial Ploughing	28-43	22-37	12 and 14 Disc Plough ..	6·00- 7·00
Working After Initial Ploughing	33-43	28-37	Tyne (Mainly 16 and 20 Run Combine).	8·50-11·66
Sowing Cereals with Superphosphate.	35-37	28-31	Combine (Mainly 16 and 20 Run).	7·00-11·66
Harvesting by One Man ..	28-43	22-35	Header or Harvester	8·00-12·00

* Rated Brake Horsepower.

† Rated Drawbar Horsepower.

APPENDIX 2

Frequency Distribution of Efficiency, Performance and Fuel Consumption

(a) Frequency Distribution of Efficiency Levels of Field Operations

Type of Field Operation	No. of Farms Used in Observations	Efficiency per cent						Total of all Areas observed	
		Under 40	40-50	51-60	61-70	71-80	Over 80	Per cent	No.
		Per cent of Areas Observed.							
Initial Ploughing	16	..	..	18	29	21	32	100	28
Working after Initial Ploughing	9	5	11	21	37	21	5	100	19
Sowing Cereals with Superphosphate	16	5	15	30	33	12	5	100	40
Harvesting by One Man ..	8	6	11	41	18	18	6	100	17

(b) Frequency Distributions of Observed Performance in Field Operations

Type of Field Operation	No. of Farms Used in Observations	Acreage Covered per Hour					Total of All Areas Observed	
		Under 2·00	2·00-2·99	3·00-3·99	4·00-5·00	Over 5·00	per cent	No.
		Per cent. of Areas Observed						
Initial Ploughing	16	7	54	39	..	..	100	28
Working after Initial Ploughing	9	11	5	42	26	16	100	19
Sowing Cereals with Superphosphate	16	3	25	50	17	5	100	40
Harvesting by One Man ..	8	6	29	35	18	12	100	17

APPENDIX 3

Features of the Farms Included in the Investigation of Machinery and Labour Use

	Farm Number	Number of Owner-Operators	Total Farm Area	Area Under Crops per Cropping Cycle	Per Cent. of Total Area Under Farm Crops per Cropping Cycle	Approximate Rate of Stocking	Man-Hours on Farm per Cropping Cycle	Man-Hours Outside the Farm per 12 Months	Total Man-Hours
			Acres	Acres	Per Cent	Acres per Dry Merino Sheep Equivalent			
"Large Farms" (Over 2,000 Acres) Without Sharefarming Outside the Farm—									
Farms in the Course of Development	1	1	2,622	1,374	52	2·5	3,769	....	3,769
	2	2	2,464*	1,017	41	2·5	4,118	....	4,118
	3	2	3,522	1,077	31	2·5	4,144	....	4,144
Developed Farms	4	2	2,813	749	27	4·0	3,901	52	3,953
	5	2	2,191	759	35	4·8	2,222	....	2,222
"Small Farms" (Under 2,000 Acres) without Sharefarming Outside the Farm—									
Developed Farms	6	1	1,516	880	58	2·3	2,253	90	2,343
	7	1	1,291	696	54	4·3	2,065	....	2,065
	8	1	1,435	579	40	2·6	1,863	87	1,950
Farm in the Course of Development	9	2	1,382†	754	55	3·5	3,315	72	3,387
"Small Farms" (Under 2,000 Acres) with Sharefarming Outside the Farm—									
Developed Farms	10	2	1,293	661	51	3·6	2,162	1,080	3,242
	11	1	1,389	518	37	3·2	1,479	185	1,664
	12	1	980	408	42	3·0	1,145	173	1,318

* Excludes 300 acres cropped by sharefarmer.
† Includes 107 acres newly cleared ground.