SOIL-MANAGEMENT PRACTICES ON NORTH-WESTERN WHEAT FARMS*

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William Farrer's statement that "a function of theory is to examine the foundations of practice, and by this means to modify it and extend it advantageously" [1] may be applied to the branch of theory concerned with the *business* of farming. An important part of farm-management research is consultation with farmers in order to understand their reasons for the adoption of certain practices and non-adoption of others. Farmers need to make their own management decisions, and whether certain practices are adopted depends partly upon knowledge and ability but also upon other considerations, such as financial resources, farm income, land tenure, the availability of materials and equipment, and costs of introducing certain practices compared with the additional income expected to result. Thus, although convinced of the improved technical efficiency to be achieved by the adoption of a certain practice, a farmer may delay making a change for economic or other reasons.

During March, April and May, 1952, a field survey was conducted in the North-Western Slope division of the New South Wales wheat belt, with the objective of examining various aspects of farm management, with particular reference to soil, machinery and livestock. In this article it is proposed to discuss soil-management practices in the survey area.

Seventy-six farms were visited in certain sub-divisions (ridings) of the shires of Peel, Liverpool Plains, Macintyre and Yallaroi. In selecting the farmers to be interviewed the names and addresses of all "farmers" and/or "graziers" were obtained from the shire electoral rolls for the four shires. "Farmers" whose names also appeared in the electoral roll of wheatgrowers compiled under the Wheat Industry Stabilization Act, 1948, were deemed to be wheat farmers and eligible for inclusion in the sample. From the lists so obtained the following numbers were chosen, by the use of random numbers, to comprise the sample of properties to be visited.

* It is desired to thank the seventy-six farmers who willingly supplied the information on which this article is based. Thanks are also expressed to Messrs. R. M. Parish and J. L. Dillon, Assistant Economics Research Officers and Messrs. J. A. O'Reilly, J. W. Boyle and A. Johnson, District Agronomists, for assistance with the field work.

[1] Quoted by Archer Russell in his biography: "William James Farrer", F. W. Cheshire Pty. Ltd., Melbourne, 1949, p. 26.

TABLE I.

Composition of Sample.

Shire.	Number in Sample.	Percentage of Population.
		Per cent.
Liverpool Plains—		
A Riding	12	5
B Riding	12	5
Yallaroi—		
A Riding	10	20
C Riding	10	10
Peel—		
C Riding	10	10
F Riding	11	10
Macintyre—		
B Riding	11	10
Total in Sample ...	76	...

As the survey was concerned mainly with practices on wheat farms, the sample was drawn from important wheat-growing ridings. In addition, the survey was conducted in different parts of the North-Western Slope in order to study adjustments in the methods adopted by operators due to the influence of such factors as type and fertility of soil, farm-size, topography and climatic conditions. The distribution of survey districts, and farms, is shown in the accompanying map (Figure 1). For purposes of the present article, two non-wheat growing farms have been excluded.

1. LAND USE IN THE AREA.

The principal enterprises on farms on the North-Western Slope are wheat-growing and fat-lamb raising, with production of wool and beef-cattle important associated activities. Fine-wool type sheep are preferred by some operators, but the more typical practice is to carry dual-purpose sheep with the objective of producing first-class fat lambs and, also, good quality wool. Some of the larger holdings are devoted almost entirely to sheep and cattle grazing.

Other crops of importance in this section of the State include oats (for grain), linseed, grain-sorghum and barley. Maize, dairy products, pigs, poultry and vegetables are also of some significance. The principal fodder crops are oats and lucerne, both of which are grown on a large proportion of farms throughout the area. Lucerne farming has been successfully developed in the Tamworth and Inverell districts (especially the former), with irrigation from the Peel, Namoi and Macintyre rivers.

A wide variety of natural grasses, clovers and trefoil species occurs throughout the area, and care of these is an important form of pasture improvement. Some sown pastures have been established, but most farmers rely on lucerne (which is extremely popular), oats and natural pastures for grazing and use in rotation with grain crops [2].

[2] For details of natural species and recommended sowings see J. N. Whittet: "Pasture Improvement in the Slopes, Plains and Western Division, 1949". (N.S.W. Department of Agriculture pamphlet).

Wheat has been grown for approximately fifty to sixty years on the North-Western Slope, except in the northern portion, toward the Queensland border, where extensive cropping did not commence until the mid-1930s. Recently-developed land in the North Star-Yetman district is very suitable for wheat-growing, and there appears to be considerable scope for further clearing to increase the area under crop.

Wheat Harvesting on the North-Western Slope.

There is a large area of country between Rocky Dam, North Star, Boggabilla and Yetman which, if the natural vegetation (brigalow-belah-wilga) were cleared could be used for the production of wheat, other grain crops, wool and meat. It has been estimated that there is an area of roughly 360,000 acres suitable for cropping in Yallaroi Shire, of which approximately 70,000 acres is at present under cultivation. Thus, if one-third of the potential area were cropped each year, the annual area under crop in this shire could be increased by about 50,000 acres.

2. SIZE OF FARMS.

To facilitate discussion several terms and abbreviations have been used in this article, and these are defined below:

Arable Land: Cleared land, suitable for cultivation.

Potentially Arable Land: Uncleared land, otherwise suitable for cultivation.

Small Farms: Farms not exceeding 600 acres arable and/or 1,000 acres total area.

Large Farms: Holdings of more than 600 acres arable and/or 1,000 acres total area.

Yallaroi A or YA: A Riding of Yallaroi Shire. (Similarly for other districts.)

TABLE II.

Total Acreage of Sample Farms.

Size of Farms.	Liverpool Plains Shire.						Yallaroi Shire.						Peel Shire.						Macintyre Shire.		
	A Riding.			B Riding.			A Riding.			C Riding.			C Riding.			F Riding.			B Riding.		
	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage.
acres.																					
200–600	1	9·1	9·1	2	16·7	16·7	...	...	...	...	...	...	5	50·0	50·0	5	45·4	45·4	8	72·7	72·7
601–1000	...	...	...	4	33·3	50·0	...	...	...	1	10·0	10·0	2	20·0	70·0	2	18:2	63·6	2	18·2	90·9
1001–1400	1	9·1	18·2	...	...	...	...	...	...	2	20·0	30·0	1	10·0	80·0	2	18·2	81·8	1	9·1	100·0
1401–1800	2	18·1	36·3	...	...	...	...	...	...	2	20·0	50·0	2	20·0	100·0	1	9·1	90·9	...	...	...
1801–2200	1	9·1	45·4	3	25·0	75·0	...	...	...	1	10·0	60·0	...	...	...	...	...	...	...	...	...
2201–2600	2	18·2	63·6	2	16·7	91·7	...	...	...	...	...	...	...	...	...	1	9·1	100·0	...	...	...
2601–3000	2	18·2	81·8	...	...	...	3	33·3	33·3	2	20·0	80·0	...	...	...	...	...	...	...	...	...
Over 3000*	2	18·2	100·0	1	8·3	100·0	6	66·7	100·0	2	20·0	100·0	...	...	...	...	...	...	...	...	...
Totals ...	11	100·0	100·0	12	100·0	100·0	9	100·0	100·0	10	100·0	100·0	10	100·0	100·0	11	100·0	100·0	11	100·0	100·0

* Includes three farms over 4,000 acres in Liverpool Plains Shire and five over 4,000 acres in Yallaroi Shire.

TABLE III.

Arable Acreage on Sample Farms.

Arable Area.	Liverpool Plains Shire.						Yallaroi Shire.						Peel Shire.						Macintyre Shire.		
	A Riding.			B Riding.			A Riding.			C Riding.			C Riding.			F Riding.			B Riding.		
	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage.	No. of farms.	Per cent.	Cumulative percentage.
Acres.																					
150–300	...	...	...	2	16·7	16·7	1	11·1	11·1	1	10·0	10·0	...	...	...	1	9·1	9·1	7	63·6	63·6
301–450	1	9·1	9·1	1	8·3	25·0	...	...	...	3	30·0	40·0	3	30·0	30·0	3	27·3	36·4	1	9·1	72·7
451–600	1	9·1	18·2	1	8·3	33·3	2	22·2	33·3	3	30·0	70·0	5	50·0	80·0	2	18·1	54·5	1	9·1	81·8
601–750	1	9·1	27·3	4	33·3	66·6	...	...	...	...	...	...	...	...	...	...	...	...	2	18·2	100·0
751–900	1	9·1	36·4	1	8·3	74·9	...	...	...	2	20·0	90·0	...	...	...	3	27·3	81·8	...	...	...
901–1050	2	18·2	54·6	1	8·3	83·2	3	33·3	66·6	...	...	...	...	...	...	...	...	...	...	...	...
1051–1200	1	9·1	63·7	...	...	...	1	11·2	77·8	...	...	...	...	...	...	2	18·2	100·0	...	...	...
Over 1200	4	36·3	100·0	2	16·8	100·0	2	22·2	100·0	1	10·0	100·0	2	20·0	100·0	...	...	...	...	...	...
Totals ...	11	100·0	100·0	12	100·0	100·0	9	100·0	100·0	10	100·0	100·0	10	100·0	100·0	11	100·0	100·0	11	100·0	100·0

As can be seen from Tables II and III, most farms in Macintyre and Peel Shires are very much smaller than those in Liverpool Plains and Yallaroi. For instance, seventy-three per cent. of survey farms in Macintyre B are not larger than 600 acres, whereas all properties visited in Yallaroi A exceed 2,600 acres. There is also a sharp contrast, between districts, in the amount of arable land available to operators, and, again, holdings are smallest in Macintyre and Peel. It will be seen later that these differences in the size of farms influence the cropping practices adopted by operators.

The amount of uncleared land, otherwise suitable for cultivation, also has an important bearing on management practices. It can be seen from Table IV that very little additional land could be brought into cultivation on Peel Shire farms, and there is not a very high proportion available in Liverpool Plains or Macintyre. On the other hand, there is a large area of potentially arable land in Yallaroi, particularly in the northern portion. Clearly, the knowledge that virgin land can be later cleared and cropped influences the way in which operators manage their existing cultivation paddocks.

TABLE IV.

Comparison of Proportions of Arable and Potentially Arable Land to Total Area of Farms in Survey Districts.

	District.						
	LA.	LB.	YA.	YC.	PC.	PF.	MB.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
(1) Mean proportion of arable land to total area	54	62	23	28	84	80	70
(2) Mean proportion of arable *plus* potentially arable land to total area	64	74	67	50	87	86	82
Difference between (1) and (2) ...	10	12	44	22	3	6	12

The more recent development of wheat-growing in Yallaroi is depicted in Figure 11 which shows the area sown to wheat (for grain) in each survey shire since 1926-27. It can also be seen that the rising trend in the wheat acreage in Yallaroi has continued in the period since 1947-48, while there has been a decline in other shires. There was very little cropping at all in Yallaroi A until the mid-1930's, when the area under wheat increased sharply, so that land at present being cropped is relatively new and still has abundant fertility. It is therefore possible, and probably economic, for farmers in this area to crop their land heavily for a time, with the knowledge that fertility can be restored, when additional land is cleared, by including a leguminous plant such as lucerne in the rotation. Thus Yallaroi Shire farmers are, at this stage, less restricted in their practices than are operators in the other districts where little uncleared wheat land is available and existing paddocks have been cropped for a longer period.

Farmers in this newer area are gradually clearing the natural vegetation to give them larger areas of cultivable land and their management practices may be changed as the area available for cropping increases. Whilst it might be economic to exploit the stores of fertility in the relatively new land at present being cultivated, after a time depletion of nutrients, the intrusion of weeds or deterioration in soil structure may become evident and induce farmers to introduce soil-improving or conserving practices.

In many cases operators of small farms are endeavouring to acquire additional land to enable them to improve their cropping practices. The total area of approximately one-third of the survey farms has been increased during the occupancy of present operators. This tendency to increase the size of holdings is greatest in Macintyre Shire where the restrictive influence of small farms is greatest. In this shire the area of eight of the eleven survey farms have been increased by present owners.

The original small size of holdings in Macintyre Shire is largely attributable to the fact that dairying was the principal farm enterprise in the early part of this century. As wheat and maize-growing became more popular, the dairying industry declined and is now of minor importance. Maize-growing has also declined since World War I, leaving wheat and sheep as the main industries. The pressure to increase the size of farms in the Inverell district is thus associated with a change in the type of farming.

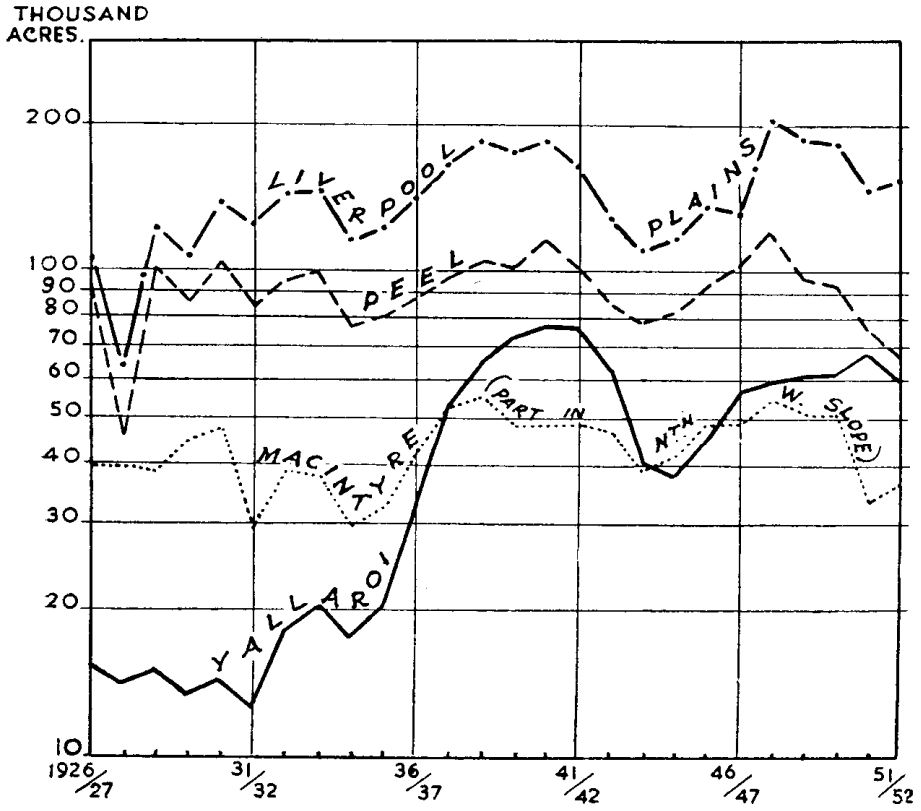


Fig. II.—Wheat Acreages, Survey Shires, 1926/27 to 1951/52.

Size of Paddocks.

The size of paddocks on a mixed crop-and-livestock property is partly determined by the total area of the farm because the association of the two enterprises necessitates the provision of a certain minimum number of paddocks to facilitate such practices as segregation of certain classes of livestock (such as lambing ewes), grazing of stubble, fallowing and the establishment of lucerne and pasture stands. Grazing of livestock forms an integral part of the crop rotation and, therefore, influences plans for the farm layout. In view of this, decisions regarding the number, shape, location and area of paddocks are influenced by soil management considerations and also by convenience for livestock management.

Throughout the survey area there is a wider variety of paddock sizes on the larger farms but, despite this, paddocks of 100 acres or less are most common in *all* survey districts. There are also many paddocks of 100-200 acres in Liverpool Plains and Yallaroi and some of 500 acres or more in A Riding of the latter shire. In Peel and Macintyre, where farms are smaller, there is a preponderance of paddocks of fifty acres or less.

3. SOIL MANAGEMENT PRACTICES.

Farm-Size and Cropping Practices.

It has already been seen, in Tables II and III, that a large proportion of survey farms in some districts have an arable area not exceeding 600 acres and/or a total area of 1,000 acres or less. In order to compare the cropping practices of farms of different size-groups, these farms have been separated from the larger ones. For convenience, the two groups will be referred to as "small" and "large" farms.

The proportions of small and large farms, in each district, having rotations of one-year-in-two or shorter, and longer than one-in-two, are shown in Tables V and VI. More detail of the variety of rotations adopted throughout the area can be seen in Table VII. The latter table

TABLE V.

Relation of Cropping Practices to Total Area.

District.	Farms of 1,000 Acres or less.			Farms of over 1,000 Acres.		
	No. of Farms.	Proportion with Rotation of 1-in-2 or Shorter.	Proportion with Rotation Longer than 1-in-2.	No. of Farms.	Proportion with Rotation of 1-in-2 or Shorter.	Proportion with Rotation Longer than 1-in-2.
		per cent.	per cent.		per cent.	per cent.
LA	1	100	0	10	60	40
LB	6	83	17	6	83	17
YA	0	...	...	9	78	22
YC	1	100	0	9	67	33
PC	7	100	0	3	33	67
PF	7	71	29	4	50	50
MB	10	90	10	1	0	100
Whole Area ...	32	90	10	42	53	47

reveals that most farms (seventy-four per cent.) in the whole area have a crop rotation of one-in-two or shorter[3]. However, Tables V and VI show that the proportion of *small* farms having the shorter rotation, expressed as a percentage of the total number of small farms, was ninety per cent. as against fifty-five per cent. (fifty-three per cent. in Table V) for the *large* farms. This difference was found to be statistically significant[4].

TABLE VI.

Relation of Cropping Practices to Arable Area.

District.	Farms with 600 Acres, or less, Arable.			Farms with over 600 Acres Arable.		
	No. of Farms.	Proportion with Rotation of 1-in-2 or Shorter.	Proportion with Rotation Longer than 1-in-2.	No. of Farms.	Proportion with Rotation of 1-in-2 or Shorter.	Proportion with Rotation Longer than 1-in-2.
		per cent.	per cent.		per cent.	per cent.
LA	2	100	0	9	55	45
LB	4	100	0	8	75	25
YA	3	100	0	6	67	33
YC	7	57	43	3	100	0
PC	8	100	0	2	0	100
PF	6	83	17	5	40	60
MB	9	89	11	2	50	50
Whole Area ...	39	90	10	35	55	45

It will also be observed that the greatest disparity between the practices of the small and large farms exists in Peel and Macintyre. In these districts a high proportion of the small farms and a relatively low proportion of the large holdings are cropped heavily. On the other hand, there is less variation in the intensity of cropping on properties of different sizes in Liverpool Plains and Yallaroi, where approximately sixty per cent. or more of the large farms have short rotations. It seems likely that farmers' management decisions in the latter districts have been influenced by the more favourable soil-type and topography of their land and, in Yallaroi, by the more recent development of wheat-growing. An additional point is that since about 1936 wheat has been grown in Liverpool Plains on plain country hitherto generally considered unsuitable. In Yallaroi A and Liverpool Plains B, where the highest proportion of heavy cropping occurs, most properties have extensive flat areas of chernozem-like soils and some, in the extreme

[3] For a summary of rotations in parts of the South-Western Slope and Eastern Riverina wheat districts, see Ross Parish, "Recent Trends in Land Use on South-Western Wheat Farms," *Review of Marketing and Agricultural Economics,* Vol. 20, No. 1, March, 1952, p. 41. See also, J. G. Crawford, "The Economics of Conservation," Bureau of Agricultural Economics, Canberra, 1952, p. 41, for a comparison of the apparent rotational practices of wheat farmers in selected districts of New South Wales and Victoria.

[4] The statistical technique employed was that proposed by W. G. Cochran, "Analysis of Variance for Percentages Based on Unequal Numbers," Journal of the American Statistical Society, Vol. 38, pp. 287-301, 1943.

TABLE VII—*Number and Proportion of Survey Farms Using Various Crop Rotations.*

Key: W=Wheat; O=Oats; Og=Grazing Oats; P=Pasture or land left out of cultivation; F=Fallow; S=Grain Sorghum; L=Lucerne.

Frequency of Cropping.	Rotation.	Liverpool Plains Shire.				Yallaroi Shire.				Peel Shire.				Macintyre Shire.		Whole Area.	
		A Riding.		B Riding.		A Riding.		C Riding.		C Riding.		F Riding.		B Riding.			
		No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
Continuous	.....	1	9·1	2	16·7	4	44·5	4	40·0	1	10·0	...	...	...	...	12	16·2
Almost Continuous*	.....	...	...	3	25·0	1	11·1	2	20·0	...	...	...	...	2	18·2	8	10·8
3 years in 4	WWOP ...	...	...	...	...	...	...	1	10·0	...	...	...	...	...	...	...	...
	WWWP ...	...	...	...	...	...	...	...	...	...	...	...	...	1	9·1	...	...
	Total ...	...	...	...	...	...	...	1	10·0	...	...	...	...	1	9·1	2	2·7
2 years in 3	WPO ...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...
	WW Og/F ...	2	...	...	...	...	...	...	...	1	...	1	...	...	...	...	...
	WWP	1	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...
	Total ...	3	27·3	...	...	...	...	...	...	1	10·0	2	18·2	2	18·2	8	10·8
1 year in 2	W Og	1	...	1	...	1	...	...	...	3	...	2	...	3	...	...	...
	WP/F	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...
	WPW	1	...	3	...	1	...	...	...	3	...	3	...	1	...	..	...
	Total ...	3	27·3	5	41·6	2	22·2	...	...	6	60·0	5	45·4	4	36·3	25	33·8
2 years in 4	WWPP ...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...
	WW Og FSP ...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	....	...
	Total ...	...	...	...	...	...	...	...	...	...	...	1	9·1	2	18·2	3	4·1
1 year in 3	WPP	...	...	...	...	...	...	...	...	...	...	1	9·1	...	...	1	1·3
3 or 4 years Continuous Wheat then 3 or 4 years Lucerne or Pasture.	W_4L_5	1	...	...	...	2	...	1	...	...	...	...	...	...	...	...	...
	W_3P_2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	W_4P_4	...	...	1	...	...	...	1	...	...	...	...	...	...	...	...	...
	W_3L_3 ...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...
	Total ...	3	27·3	2	16·7	2	22·2	2	20·0	...	...	...	...	...	...	9	12·2
1 year in 2 or Shorter for Few Years then Period with Lucerne	.....	...	...	...	...	...	...	...	...	2	20·0	2	18·2	...	...	4	5·4
No definite Rotation	.....	1	9·0	...	...	...	...	1	10·0	...	...	...	...	...	...	2	2·7
	Total ...	11	100·0	12	100·0	9	100·0	10	100·0	10	100·0	11	100·0	11	100·0	74	100·0

* Continuous except for an occasional ley year.

north of the area, are on the "red-brown soils of the Mungle Scrub"[5]. The soil in Yallaroi C and Liverpool Plains A is mainly either the chernozem-like or red-brown earth association. Thus operators in Yallaroi and Liverpool Plains are able (at least, for a time) to adopt different practices, involving shorter rotations, than are operators in Peel Shire where soils are lighter and mainly of the podsolized red-brown earth association. In Macintyre Shire survey farms are mainly on chocolate soil (chernozem and euchrozem associations) and the risk of erosion arising from the undulating topography induces wider rotations.

That more intensive rotations are followed on the heavy black soils is also indicated by the fact that fifty-five to sixty per cent. of farmers in Yallaroi and forty-two per cent. of those in Liverpool Plains B crop paddocks continuously or almost continuously. In contrast, the more difficult management problem confronting farmers with lighter soil and smaller holdings (in Peel and Macintyre) is further illustrated by the relatively high proportion of operators using a rotation of one-in-two and the virtual absence of continuous cropping.

An interesting point revealed in Table VII is that about twenty per cent. of survey farmers in Liverpool Plains and Yallaroi Shires have a rotation programme involving a continuous-wheat cropping phase of three or four years followed by pasture or lucerne for a similar period. Farmers in these shires have found that a good cover of natural grasses and leguminous plants can usually be obtained within one to three years after a wheat crop. There is some interest in sown pastures to obtain quicker grazing, or to combat weeds such as mint, but as yet, natural species and lucerne are most commonly used in the pasture phase. Lucerne is usually established by sowing the seed with the last wheat crop in the rotation, and a good stand is said to provide excellent grazing for four to seven years or longer. Among the factors taken into consideration by farmers adopting this type of rotation are the cost of establishment and life of lucerne stands, the effects on stock carrying capacity and the value of the legume in restoring nitrogen to the soil.

Methods of Handling Wheat Stubble.

Many farmers in the area have, in recent years, eliminated or greatly reduced the practice of burning stubble. As shown in Table VIII, twelve of the seventy-four farmers always burn stubble, thirty-five never burn and twenty-four vary their practices. Where practices are varied the most common reason for burning is to facilitate successive cropping in a paddock containing thick straw from the previous crop. After a light crop, the smaller quantity of stubble is frequently ploughed in. On farms where burning is never practised, paddocks are usually either left out of cultivation for a year or more or sown to oats for grazing if there is an excessive quantity of stubble from the last crop.

[5] Soil classifications used here are taken from the *Soils Map of Namoi Region* prepared by F. R. Gibbons and E. G. Hallsworth, University of Sydney, August, 1950 (Issued by the Division of Reconstruction and Development, Premier's Department, N.S.W.)

The farmer's decision on how to deal with stubble in any particular year is influenced largely by other objectives and also by the size of his farm. For example, if he has a small farm and considers his most efficient method of maintaining income is by growing wheat he will be more restricted in his methods of handling stubble than a farmer with

TABLE VIII.

Method of Handling Stubble.

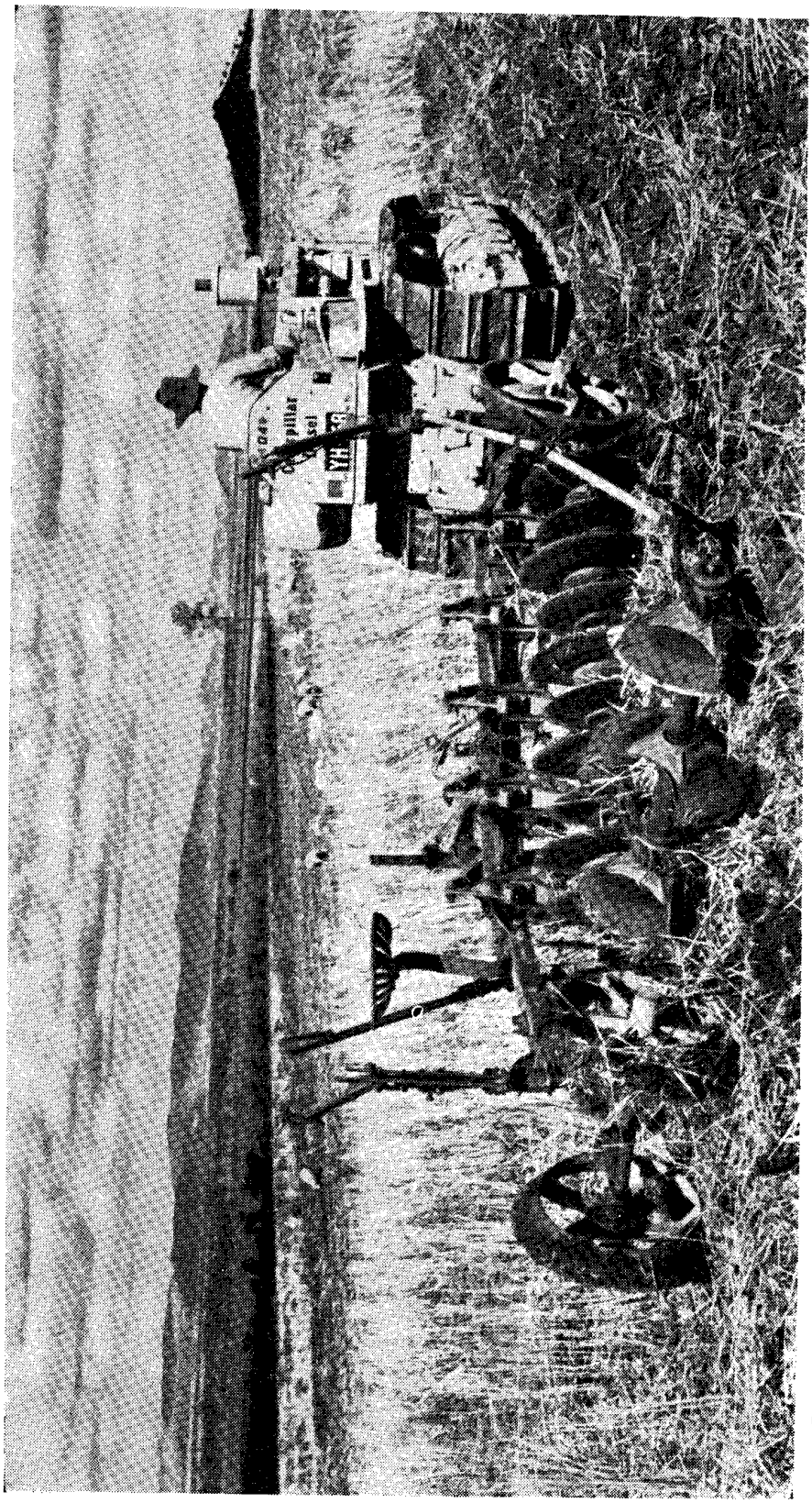
Method.	District.							
	LA.	LB.	YA.	YC.	PC.	PF.	MB.	Whol Area.
	Number of farms.							
A. Burned	1	3	2	2	1	0	3	12
B. Fire Harrowed ...	1	0	1	0	0	0	1	3
C. Ploughed in	8	5	4	4	5	5	4	35
Varies between A, B and C	1	4	2	4	4	6	3	24
Totals	11	12	9	10	10	11	11	74

a larger holding of similar land. This is reflected in Tables IX and X, which compare the methods of handling stubble on large and small holdings. Although the differences were not found to be statistically significant, the figures reveal that approximately 58 per cent. of the operators of large farms plough in stubble compared with 48 per cent. on the small farms.

TABLE IX.

Relation of Methods of Handling Stubble to Total Area.

District.	Farms of 1,000 Acres or less.			Farms of Over 1,000 Acres.		
	No. of Farms.	Proportion Burning Some or All Stubble.	Proportion Ploughing-in Stubble.	No. of Farms.	Proportion Burning Some or All Stubble.	Proportion Ploughing-in Stubble.
		per cent.	per cent.		per cent.	per cent
LA	1	0	100	10	30	70
LB	6	33	67	6	83	17
YA	0	...	...	9	55	45
YC	1	100	0	9	55	45
PC	7	57	43	3	33	67
PF	7	57	43	4	50	50
MB	10	70	30	1	0	100
Whole Area ...	32	53	47	42	44	56



Cultivating wheat stubble with a twin-disc plough. A Muirhead storm-trap attachment is also being used to retain moisture in "basins" and prevent "washing."

—Photo by courtesy of the Rural Bank of New South Wales.

TABLE X.

Relation of Methods of Handling Stubble to Arable Area.

District.	Farms with 600 Acres, or Less, Arable.			Farms with Over 600 Acres, Arable.		
	No. of Farms.	Proportion Burning Some or All Stubble.	Proportion Ploughing-in Stubble.	No. of Farms.	Proportion Burning Some or All Stubble.	Proportion Ploughing-in Stubble.
		per cent.	per cent.		per cent.	per cent.
LA	2	50	50	9	22	78
LB	4	50	50	8	62	38
YA	3	0	100	6	83	17
YC	7	71	29	3	33	67
PC	8	62	38	2	0	100
PF	6	67	33	5	40	60
MB	9	67	33	2	50	50
Whole Area ...	39	52	48	35	41	59

Although there is a widespread belief among farmers in the survey area that stubble burning, *as a regular practice,* is not desirable from a soil-conservation point of view, the question of whether it is best to turn the straw under, partly cover it or cultivate so as to leave as much as possible on the surface is still controversial. Various factors, such as weed growth, soil moisture, topography, soil-type and erosion danger influence farmers' decisions regarding the implements they use in preparing land for wheat. Thus the most satisfactory procedure is likely to vary from year to year. The implements most widely used are the twin-disc plough for the first working and the scarifier and harrows for subsequent workings. The combine (used for sowing) is also frequently used as a cultivating implement. Some farmers expressed preference for mouldboard ploughs and others like to do the first working with a scarifier when the condition of the soil permits. Disc-harrows are used on a number of farms and are becoming more popular, mainly for ploughing-in stubble[6]. Thus, although there is a semblance of uniformity in methods of soil preparation for wheat, there are likely to be further changes in the implements used, arising mainly from the problem of handling stubble.

Fallowing.

In general, fallowing is commenced later on the North-Western Slope than in other parts of the New South Wales wheat belt[7]. The occurrence of summer rainfall (from November to March) enables farmers

[6] The increasing popularity of disc-harrows has also been noted in other districts. See P. C. Druce, "Machinery Usage on Wheat Farms in the Central-West", *Review of Marketing and Agricultural Economics,* Vol. 19, No. 2, June, 1951, Pp. 71-72.

[7] In a recent survey in the South-Western Slope and Eastern Riverina districts it was found that 87 per cent. of the area sown to wheat on survey farms in 1951 was sown on land fallowed before or during October in the previous year (see Ross Parish: op. cit. p. 42).

to grow successful wheat crops on land that has received a short summer-fallow. In Liverpool Plains, Peel and Macintyre, land receiving long-fallow is usually ploughed between August and October, and that receiving short-fallow is ploughed between December and February. Some farmers plough earlier or later than these times, that is, in June and July or March. There is practically no fallowing in Yallaroi and paddocks are often grazed until April and sown to wheat as late as July. With a shorter growing period, harvesting is sometimes commenced in October in this shire and the greater proportion completed in November or early December. In the other shires, sowing normally takes place in April and May and harvesting in November and December.

Although a far more detailed investigation would be required to determine whether or not long-fallowing (that is, ploughing in October or earlier) is economic in the North-West, most farmers who have practised both long and short-fallowing have found that more moisture is retained and yields are higher after winter or spring-fallowing. Early ploughing has also been found to be an effective means of weed control.

In years of low rainfall, it has been noted that higher yields were obtained from wheat sown on long-fallowed land, and knowledge of this method of reducing the risk of losses due to crop failure has induced some farmers to sow a proportion (such as one-half or one-third) of the crop on long-fallow each year. Whether this pays or not depends upon the local situation with respect to costs, yields and climatic risk. A recent study of practices in the United States suggests that fallowing is more profitable in some areas, and less profitable in others, than continuous cropping. "In appraising the effectiveness of summer fallowing as a device for meeting weather risks, two situations should be distinguished. In the drier areas of the Great Plains, the difference in yield between summer fallow and continuous wheat is large enough to make summer fallowing the more profitable practice. In other areas the difference in yield does not offset the additional cost of fallowing, but there is a gain in the stability of yields. In the latter situation, fallowing can be regarded as an alternative that reduces the risk of crop failure, but at a cost in terms of a lower average net income over a period of years [8].

Variations in the time of fallowing in the different parts of the North-Western Slope are caused partly by agronomic considerations such as soil fertility and erosion danger, but there is also evidence of attempts to follow practices that will maximize or stabilize income over a period of time. Whereas continuous cropping may be practicable and more profitable than fallowing in Yallaroi during the period when the land will stand heavy cropping, several operators in Liverpool Plains sow at least a part of each wheat crop on fallow in order to reduce the risk of financial losses through crop failure. Even if the latter practice produces a lower net return than continuous cropping it may still be adopted in order to avoid situations in which total returns fall below requirements for essential family expenditure.

Other factors, such as danger of erosion from summer storms in Macintyre Shire, sometimes dissuade farmers from long-fallowing, but this is not the only method of risk-bearing open to wheat growers in

[8] E. Lloyd Barber: "Summer-fallowing to Meet Weather Risks in Wheat Farming," *Agricultural Economics Research* (United States Department of Agriculture), Vol. III, No. 4, October, 1951, p. 118.

the North-West. The maintenance of cash reserves, diversification with livestock and alternating periods of continuous cropping with pasture or lucerne phases may be considered more efficient methods of meeting risks of crop failures. Another alternative frequently practised is to substitute grazing oats for long-fallow. Whether or not long-fallowing is adopted is thus largely determined by agronomic factors, and a comparison with the costs and returns associated with alternative practices.

Wheat Varieties Sown and Seeding Rate.

Many factors, most important of which are probably climatic conditions and soil fertility, affect wheat growth and hence the varieties sown. The principal varieties currently grown in survey districts are listed below in what appears to be their order of preference:

Gabo	Warigo
Charter	Celebration
Kendee	Glenwarie
Ford	

Essential characteristics in varieties most suitable for the North-Western Slope are early maturity, milling quality, yielding ability and stem-rust resistance. Farmers consider the quick-growing variety, Gabo, suits conditions best and is most popular in all survey Shires except Peel where the growing period is slightly longer and the soil less fertile. Kendee is, apparently, considered to be better suited to these conditions than Gabo.

One factor contributing to lower costs of wheat production in Yallaroi Shire is the relatively low seeding rate necessary for successful crops. Presumably this is due largely to the present high level of soil fertility, especially in A riding where between twenty and forty pounds per acre is sown on seventy-five per cent. of survey farms. In fact, some extremely good yields have resulted from sowing slightly less than twenty pounds per acre. In contrast, seventy-five per cent. of farmers visited in Peel Shire usually sow fifty-five to sixty pounds per acre, and in Liverpool Plains and Macintyre the rate varies, approximately, between forty and sixty pounds per acre. Thus, on the present value of seed-wheat, a saving of approximately eight shillings per acre is possible in areas where a seeding rate of about thirty pounds per acre is sufficient for a good crop.

Use of Fertilizer.

Unlike other wheat-growing districts in New South Wales, fertilizer is not used as a regular practice throughout the North-Western Slope. Due to the inherent fertility of the soil, no benefit is, in general, derived from its application. However, experiments carried out at various times by farmers and scientists have shown that superphosphate improves wheat yields on certain soils.

Eight of the farmers visited have used superphosphate experimentally and reported improved yields on light soils that have been growing wheat fairly regularly for forty to sixty years. Such soil types occur in Peel and parts of Liverpool Plains, and it was principally in these areas that the successful responses were obtained. One farmer claimed the application of forty to forty-two pounds per acre of superphosphate doubled the yield; another that forty-five pounds per acre increased the yield by twelve to fifteen bushels per acre. In the latter case the

operator considered the use of fertilizer was necessary to maintain yields if cropping a paddock (on light soil) for more than two years in succession, but unnecessary with a wider rotation.

Although fertilizer is not often used at present in the North-West it seems possible that the practice will become more popular in some light-soil areas, such as Peel Shire, when supplies of superphosphate are more readily available.

4. SOIL FERTILITY AND WHEAT YIELDS.

The amount of fertility depletion that is occurring on any farm is not easily recognized by a decline in wheat yields, due to the influence of other factors such as the introduction of improved varieties. However, a decline in the humus content of cultivation paddocks is indicated by an increased tendency of the soil to "wash" or "run together" after rain. This distinction between fertility depletion and soil-deterioration is important because the former can be replaced without any permanent damage to the productive capacity of the soil, whereas the latter reduces productive capacity, and hence the capital value, of the soil. On some survey farms heavy cropping, to maintain income in past years, has caused soil erosion, and erosion-control work is now being carried out.

TABLE XI.

Average Wheat Yields Per Acre in Survey Shires, 1926-27 to 1951-52.

Year.	Shire.			
	Liverpool Plains.	Yallaroi.	Peel.	Macintyre*.
	Bushels.	Bushels.	Bushels.	Bushels.
1926–27	15.8	6.1	17.8	10.5
1927–28	4.1	2.5	4.3	5.3
1928–29	14.9	10.7	16.2	18.2
1929–30	12.2	16.3	15.3	24.2
1930–31	15.9	16.1	15.5	12.9
1931–32	17.7	18.9	17.1	16.4
1932–33	10.9	12.8	13.8	19.5
1933–34	17.9	19.5	17.4	21.2
1934–35	14.8	17.0	12.9	16.7
1935–36	9.1	10.7	10.0	13.4
1936–37	14.4	12.7	14.5	14.0
1937–38	8.4	13.8	18.1	15.9
1938–39	22.1	22.9	22.5	24.1
1939–40	13.0	12.9	12.7	16.2
1940–41	3.8	1.6	4.9	3.5
1941–42	18.1	3.9	23.1	10.1
1942–43	18.1	7.4	19.2	12.8
1943–44	16.6	10.9	22.7	17.0
1944–45	16.0	14.2	16.8	23.2
1945–46	19.6	18.2	17.6	21.8
1946–47	0.2	3.3	1.6	4.7
1947–48	19.3	17.0	17.5	17.8
1948–49	16.6	21.3	18.0	20.1
1949–50	25.5	25.5	22.1	25.2
1950–51	10.5	10.5	10.7	10.3
1951–52	16.1	16.1	13.7	15.5

* Portion in North-Western Slope Division.

Source: New South Wales *Statistical Register* and the Bureau of Statistics and Economics, Sydney.

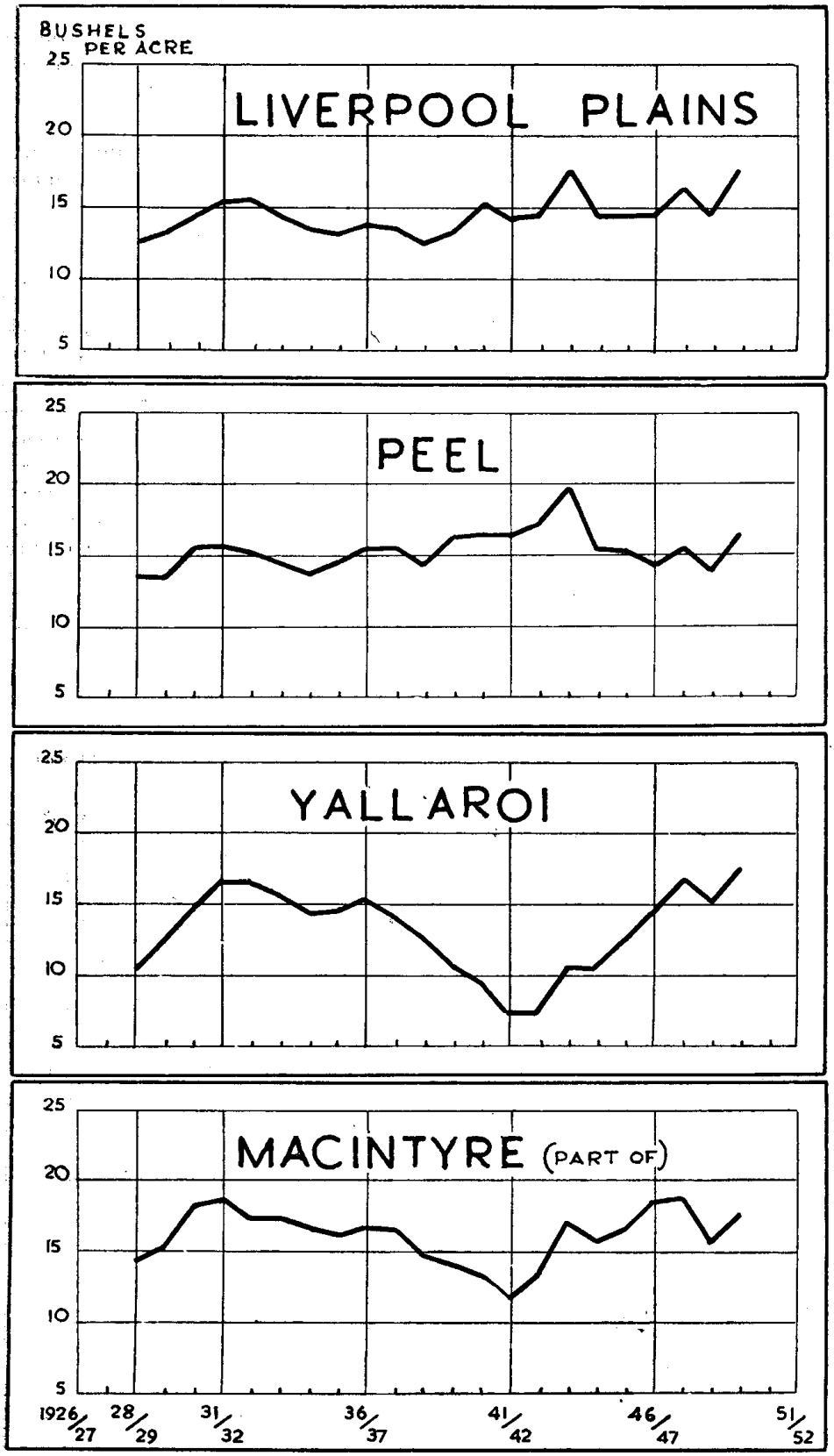


Fig. 111.—5 Year Moving Average of Wheat Yields, Survey Shires, 1926–27 to 1951–52.

Farmers interviewed were asked (*a*) whether they had noticed a decline in their wheat yields in recent years, and (*b*) whether they have noticed a decline in the fertility or moisture-holding capacity of the soil in any of their paddocks. The answers to these questions were much the same in all districts, except Yallaroi A, where no farmers reported a decline in yield or fertility. In the rest of the survey area approximately twenty-four per cent. of operators consider their wheat yields have declined and approximately thirty-seven per cent. consider there has been a loss of fertility and moisture-holding capacity in some of their paddocks.

As a matter of interest, the average wheat yields per acre in Liverpool Plains, Yallaroi, Peel and Macintyre Shires for the last twenty-five years are given in Table XI. Trends in yields during this period can be seen from Figure III, which shows the five-year moving average of yields in each shire. It will be noticed that the yields follow a similar pattern for the two adjoining shires (Liverpool Plains and Peel) in the southern portion of the area, and the same is true of the two northern shires (Yallaroi and Macintyre). It will also be observed that there is a slightly increasing trend in wheat yields in Liverpool Plains.

5. FARMERS' CONSERVATION DECISIONS.

Twenty-eight of the seventy-four farmers visited have, for a variety of reasons, reduced their wheat acreages in recent years. In most cases several reasons were advanced for this reduction, but some indication of the relative importance of particular factors can be seen from the following list which shows the number of times each reason was mentioned.

Soil conservation	14
Taxation	14
Dissatisfaction with the price of wheat	10
High wool prices	9
High meat prices	7
Shortage of labour	5
Cost of plant	5
Dissatisfaction with marketing arrangements	4
Cost of wheat production	4
High income	3
Shortage of machinery and parts	3
High linseed prices	3
Price of bags	2
Shortage of bags	2
Seasonal conditions	2
Ill health	2

It would appear that the three most potent reasons for reduced wheat acreages in the area are (1) a desire to improve soil-conservation practices, (2) taxation and (3) dissatisfaction with net returns from wheat compared with returns from other products, principally wool and meat. Less important reasons include shortages and costs of plant, materials and labour, and high linseed prices.

Most farmers interviewed were aware of the value of soil-conserving practices and also of the assistance available from the Soil Conservation Service. Erosion-control work and improved practices are being

implemented and, in many cases, certain changes have been contemplated for some years but not carried out for economic reasons. However, the advent of more favourable prices for livestock products than for wheat has had an important influence on the conservation decisions of wheat/sheep farmers during the last three or four years.

It is not easy to say just how changes in prices (paid and received) affect farmers' soil-management practices. Variations in the costs and returns associated with livestock products compared with crops doubtless have an influence, but it is possible to obtain a clearer picture by considering farm incomes. When incomes are low it is often harder for operators of small farms to carry out the soil-management practices they regard as desirable from a long-term point of view and they discount conservation for the time being in order to maintain present income. Thus high farm incomes give a greater impetus to conservation on the smaller farms and this was found to be the case on the North-Western Slope. Of the farmers growing less wheat for conservation reasons, fifty-seven per cent. had less than 500 acres of arable land and seventy-two per cent. had no more than 700 acres arable. Higher incomes, derived largely from higher prices for wool and meat, have induced operators of small farms to introduce wider crop rotations with the objective of improving soil-fertility and reducing the risk of erosion due to over-cropping.

Although there has been a decline in wheat cropping on some of the survey farms, operators almost invariably stated that they have never considered eliminating the crop entirely from their programme. A widely held opinion is that best results are obtained by trying to maintain a certain balance between wheat and sheep (and, often, beef cattle). With two main enterprises, uncertainty is reduced and the two enterprises, in conjunction, are regarded as being conserving. This does not mean that farm products are thought of as conserving or depleting in themselves—that depends upon their place on the farm. For example some crops may be regarded as soil depleting if cropped continuously in the same paddocks, but conserving when grown in rotation with other crops or pastures or as a basis for a more diversified livestock programme.

Further evidence of the greater influence of changes in the level of income on the soil-conservation decision of small farms was obtained by asking farmers whether they would grow more wheat if the price were higher, with no change in other prices. Of the twenty-eight farmers who have reduced cropping, eleven said they would grow more wheat in response to a higher price, but all of these made some other qualification—for four, reduced taxation would also be a necessary condition, three would only increase cropping after soil fertility has been improved and two would require the price to rise to 20s. per bushel. Nine farmers would not grow more wheat in response to a higher price and the remaining eight were undecided. However, the main point of interest for the present discussion is that a higher price would not induce heavier cropping on *small* farms where operators have introduced improved soil-management practices. There would, no doubt, be a different response, on small farms, if a rise in the price of wheat were accompanied by substantially lower prices for livestock products. In these circumstances the operators would probably turn to wheat to maintain income and this would necessitate a return to a more fertility-depleting crop rotation.

6. SUMMARY.

1. In view of differences in the problems confronting individual farmers, it is difficult to make generalizations about their reasons for adopting certain practices, but it is possible to obtain some indication of the general importance of certain factors.

2. In order to compare the cropping practices of holdings of different size-groups, farms of 600 acres, or less, arable, and of a total area not exceeding 1,000 acres, were classed as "small" farms and the remainder as "large" farms. A significant difference was found to exist between the crop rotations followed on farms in these two size-groups, ninety per cent. of the small farms having a rotation of one-year-in-two or shorter, compared with fifty-five per cent. for the large farms.

3. More continuous cropping is practised in recently-developed areas than where wheat has been grown for a longer period. Heavy cropping is particularly noticeable in the northern part of Yallaroi Shire, where extensive wheat-growing was not commenced until about 1936. Farmers in this area have a large proportion of potentially arable land which is being cleared to facilitate the introduction of wider crop rotations, and to increase stock-carrying capacity.

4. In some respects, soil-management is less difficult on the North-Western Slope than in other sections of the New South Wales wheat belt. Owing to the occurrence of summer rainfall, fallowing (to retain moisture in the seedbed) is less essential, although it has been found to be beneficial in maintaining wheat yields in years of low rainfall. Fertilizer is not used in wheat-cropping in the area, except on light soil where there has been a depletion of fertility.

5. Several survey farmers believe there has been a decline in the fertility and moisture-holding capacity of the soil in some of their paddocks. As a result efforts are being made to introduce wider rotations and other soil conserving practices. During the last three or four years, higher farm incomes, largely as a result of higher wool and meat prices, have also given an impetus to soil conservation. The latter influence applies particularly to small farms where it is harder to follow soil-conserving practices when incomes are low.

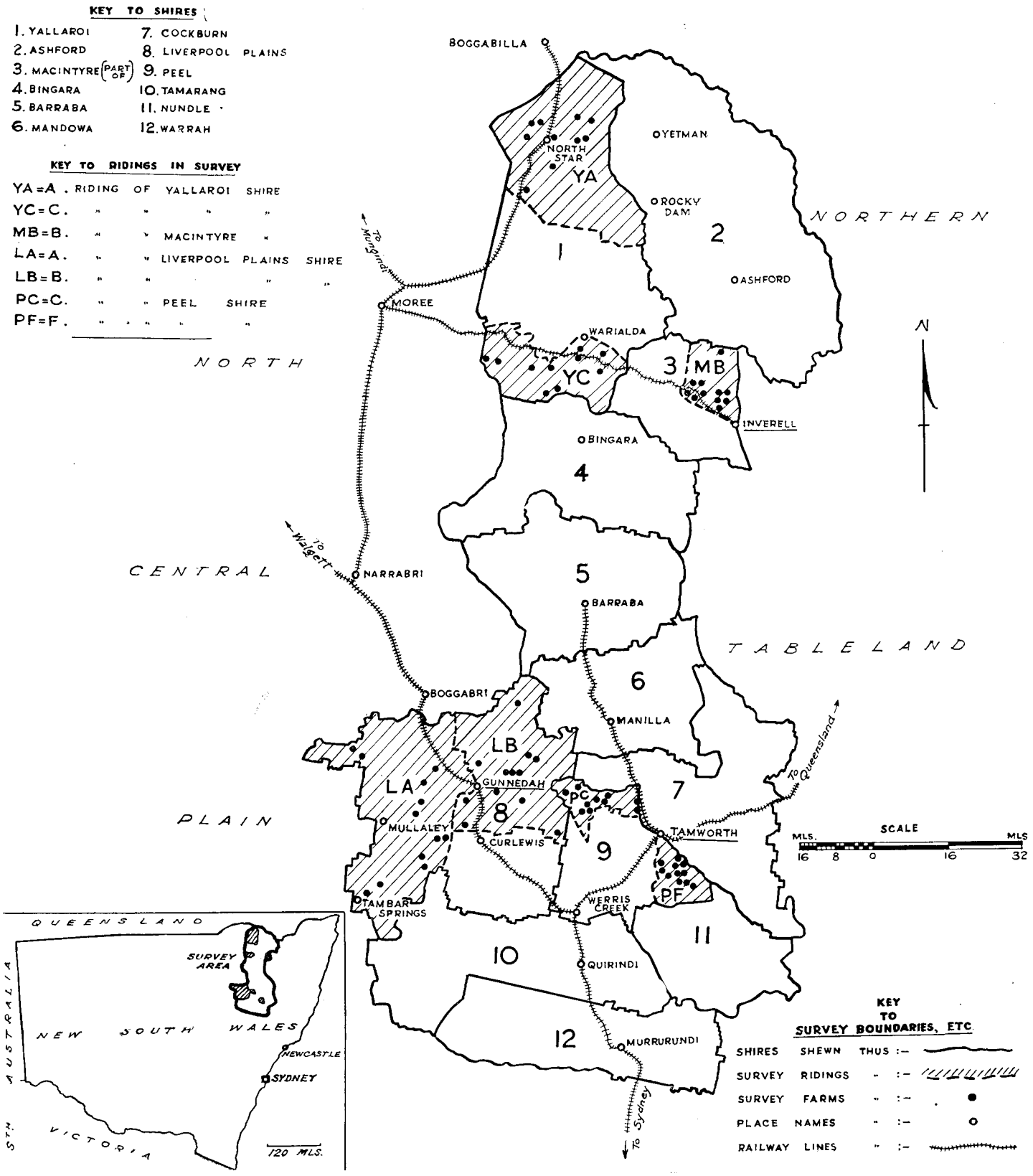


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Fig. I.—Map of Survey Area.