THE POTENTIAL FOR ENTERPRISE DIVERSIFICATION AND RESOURCE ADJUSTMENT IN THE WIMMERA REGION OF VICTORIA

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The study concerns an important specialized wheatgrowing area of Western Victoria, located approximately 200 miles northwest of Melbourne. Linear programming was used to examine the effect of changes in enterprise mix and resource combination on farm income. The adoption of uncommon enterprises, and increases in the land/labour and wheat quota/land ratios were found to improve returns on the typical farm.

1 INTRODUCTION

The area known locally as the Wimmera Plains contains properties generally smaller in size than other wheatgrowing areas. Farms have specialized in wheatgrowing, and the imposition of wheat quotas on April 30th, 1969, together with the small farm acreages, point to enterprise adjustment becoming a pressing problem in the area.

Table 1 illustrates the lack of enterprise diversity in the Kalkee parish, prior to the imposition of wheat quotas. This parish lies wholly within and is typical of the Wimmera Plains.

TABLE 1

Land-use and Livestock on the 45 *Holdings Comprising Kalkee Parish,* 1968–69

Land Use	*Acres*
Wheat	14,572
Barley	742
Oats	292
Cereals for hay	296
Oats grazed	20
Other crops	74
Fallow	11,390
Pasture	7,951
Total area of holdings	35,337
Livestock	*Numbers*
Breeding ewes	5,685
Wethers	3,551
Beef cows and heifers	116
Breeding sows	63

Source: Bureau of Census and Statistics, Melbourne.

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With the usual *caveat*, the author is indebted to Mr Peter England and Professor Alan Lloyd of Melbourne University for their comments on a thesis which was the basis for this paper.

Funds for the project came from the Victorian Wheat Research Committee.

G 90129—2

A typical Wimmera Plains farm in 1970–71 was 625 acres in size, and had a wheat quota of 4,680 bushels.[1] On this farm only 156 acres are required to be under wheat in a fertility-maintaining rotation, assuming a yield of 30 bushels of wheat per acre. This leaves almost 100 acres available annually for alternative crops. The adoption of a less intensive rotation would allow more livestock to be carried. Choosing the types of enterprises and deciding on their profit-maximizing combination is a problem now faced by many farm operators. This is especially the case for farmers whose production in the recent past has been confined almost exclusively to the commodities wheat, wool and lamb (see table 1). The first aim of the study was to identify the profit-maximizing combination of enterprises and rotations for a Wimmera Plains farm with fixed land, wheat quota and full-time labour resources. The possibility that plans may require additional capital investment was to be borne in mind.

A second aim was to study the effects of changing farm size on profitability and to determine the area that can be comfortably worked by one man, given modal plant. Mauldon [5] has suggested that economies of size are possible on wheat farms. In the population of 129 farms sampled there was 14 per cent under 500 acres in size and 50 per cent under 680 acres in size.

As well as size of farm, the quota/land ratio is likely to be important in determining the viability of wheat farms, assuming that wheat quotas are not abolished. A third purpose of the study was, therefore, to investigate the influence of this ratio on farm income.

2 METHOD OF ANALYSIS

Linear programming was used to generate optimal plans, with profit maximization as the goal of planning. In order to avoid programming every individual farm and analysing the many solutions, a convenient method of analysis is through the use of a typical farm model. The typical model is an attempt to reflect a range of resources and production possibilities in one compounded farm by using modal or average values for resource levels, yields and input-output co-efficients. Opinions in the literature differ somewhat on the validity of this approach, but most writers point out that the method has various shortcomings.[2]

In using the technique these pitfalls have been borne in mind. For instance, care was taken in defining the population to ensure that a high level of homogeneity with respect to soil type was present in the sample. This, combined with uniform topography and little variation in climatic factors on the Wimmera Plains, ensures that enterprise possibilities are similar from farm to farm. The relatively small variation in yields between the randomly sampled farms suggested that technology is

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[1] The resource levels of this typical farm were modal values for 20 surveyed farms.

[2] Examples of authors who have commented on representative farm models are Thomson [11], Heady [4], McFarquhar [6], Barnard [1], Carter [2], Day [3], Sheehy and McAlexander [10] and Rickards and McCarthy [8].

similar, at least with respect to cropping. The distribution of arable acreage of farms exhibited strong modal tendencies and only one-man farms were considered. Together, these factors give some measure of uniformity in resource ratios.

Although these facts tend to justify the use of the typical farm technique, the results were tested by planning actual farms, where particular attention was paid to the sensitivity of solutions to variations in resource ratios. The Wimmera Plains typical farm model incorporated information gathered by a survey of 20 farms randomly selected from a population of 129 farm operating units. Where this data was not adequate, information was sought from Victorian Department of Agriculture extension and research officers. The results of crop trials carried out at Longerenong College, on the Wimmera Plains, are well-documented; this information was used in specifying co-efficients for rotations which were each represented by a single vector. The final basic matrix comprised 80 activities and 30 restraints. Participating farmers were invited to comment on the basic assumptions used in the model at a well-attended meeting.

The second and third facets of the study, land and quota/land adjustment potential, were also facilitated by employing the typical farm model. The arable acreage resource was parametized from 0 to 2,000 acres, with the wheat quota to land ratio held constant. Subsequently, the objective function was made the minimization of the wheat quota resource, and required levels of total gross margin were then specified, while arable area was parametized.

Total gross margin is profit prior to the allocation of fixed costs. Returns to labour and management and returns to capital are better criteria for judging the benefits of farm resource adjustments than is total gross margin. It was, therefore, necessary to make estimates of fixed costs and capital values associated with farm plans.

Five actual farms were used to check results generated for the hypothetical typical farm. The resource complements and optimal plans for each of these farms were compared with those of the typical farm.

3 FARM PLANNING RESULTS

This first section of results covers the most important inferences with respect to the first aim of the study, i.e., finding optimal rotations, enterprises and combinations thereof, for the typical farm.

3.1 CROP ROTATIONS AND INCOME

Because soil moisture is often a limiting factor in cereal production on the Wimmera Plains, bare fallowing for 8 to 12 months prior to cropping is a common practice. The extra income earnt through higher yields from crops on fallow is considered by farmers to outweigh the costs of cultivations and loss of grazing associated with fallowing. Likewise, farmers prefer early (1st August) to late (1st October) fallowing because of the greater yield response to the former. Of the twenty-eight rotations

included in the typical farm model, most contained a fallow phase which was either early or late. Crop yield differences associated with time of fallow were derived from the work of Rooney, Sims and Tuohey [9]. Results confirmed that rotations with fallow are more profitable than those containing no fallow phase.

Where only the cereal crops were considered as alternatives, and oil seed crops were excluded, early fallowing dominated profit-maximizing plans at high feed grain prices.[3] At low feed grain prices, where livestock enterprises were relatively more profitable, late fallowing entered optimal plans.

Profit-maximizing plans often contained more than one rotation. To generate practical farm plans and to examine the cost of suboptimal rotations, solutions were generated including only single rotations. Again, only the traditional enterprises of cereals and fat lamb production were considered.

Planning results for the typical farm suggest that the single rotation that will maximize profits over a period of years with fluctuating feed grain prices is the five-course rotation: pasture, early fallow, crop, fallow, crop. This rotation was optimal at high feed grain prices, and its opportunity cost at low feed grain prices was only $57—less than one per cent of the total gross margin of the optimal rotation combination.

3.2 ALTERNATIVE CROPS TO CEREALS

Rapeseed and safflower appear to be the most promising alternative crops to cereals that can be grown on Wimmera Plains farms. Patton [11] reported Longerenong experimental yields for rapeseed of 13·9 bushels per acre in the unfavourable 1969–70 season and an average for safflower of 22·2 bushels over 9 years. Only experience will indicate the levels of expected yields under farm conditions. "High" and "low" yields assumed for various rotation vectors can be found in appendix A.

A Melbourne firm paid $88 per ton (less freight) for the 1970–71 and 1971–72 rapeseed crops, but Patton [4] considered the possibility that production increases could cause a drop in Victorian prices to export parity, i.e., about $75 per ton gross. Two levels of prices were used in studying oil seed crops: current prices, and levels 15 per cent lower. Details of the gross and net prices are set out in appendix A.

Table 2 illustrates gains in income for the typical farm when oil seed crops were allowed to enter farm plans at low feed grain prices.[5] At

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[3] Where "high" on-farm prices were the prices ruling for 1970–71: 75·7 cents per bushel for third grade feed barley and 49·4 cents for oats. "Low" on-farm prices were 40 per cent below these levels: 45·4 cents per bushel for barley and 29·6 cents for oats.

[4] Personal communication.

[5] At high feed grain prices safflower did not enter optimal plans, and rapeseed, although more profitable than barley, increased farm income by only a small amount. (See footnote 3 for feed grain prices.)

optimistic prices and yields, both oil seed crops have the potential to raise farm income. At low prices and low yields rapeseed can still be profitable but safflower promises only small income gains.

TABLE 2

Gains in Farm Income From Growing Rapeseed and Safflower

	High yield		Low yield	
	High price	Low price	High price	Low price
	$	$	$	$
113 acre rapeseed* ..	1,488	744	669	82
113 acre safflower* ..	709	139	78	0

* Quota wheat, the most profitable crop, occupied the remaining 137 acres available for crop under the 5-course rotation.

3.3 BEEF CATTLE AS A POTENTIAL SOURCE OF INCOME

In the past, sheep have been the most common means by which Wimmera Plains farmers have utilized the pasture necessary in the rotation to maintain soil fertility (see Table 1). In plans that exclude cattle, sheep only contribute about 15 per cent of the total gross margin.

Currently the gross margin per breeding cow is about 16 times greater than the gross margin for a winter-lambing Merino ewe.[6] However, in the winter, which is the critical time for feed on the Wimmera Plains, the substitution rate between ewes and cows for feed is only ten to one. This indicates that cattle might be more profitable then sheep.

Planning results suggested that if 300 ewes are replaced by 30 breeding cows and followers, on the typical farm the annual increase in income would be $270. Assuming a capital investment of $4,200 is necessary to change to 30 cows and followers, the internal rate of return on the investment is 10 per cent over 10 years. But if all the necessary capital has to be borrowed, say on a 10-year loan at 7½ per cent interest per annum, principal and interest payments will exceed the increase in income attributable to cattle over that period.

Fattening farm-bred yearling cattle on home-produced barley and hay is a feasible enterprise. However, it was only profitable at low feed grain prices; barley price had to drop to below 60 cents net per bushel before it paid to grain feed yearlings. At the "low" barley price, an internal rate of return on livestock and equipment capital of 16 per cent was calculated.

[6] The most profitable of the sheep enterprises tested was the production of Dorset-cross prime lambs from June-lambing Merino ewes.

3.4 THE PIG ENTERPRISE

Pig-raising has been of minor importance in the Wimmera Plains area (see table 1). But high yields of barley are possible and owner-operator labour tends to be in surplus supply on smaller farms. These attributes suggest that pigs could be profitably integrated into the farming system. Of course, management is a critical factor in determining the profitability of this enterprise. Therefore, three levels of management were assumed in the programming; these are set out in table 3 on the basis of expected returns from twenty sows, at a pigmeat price of 25 cents per lb gross.

Substantial increases in farm income can be expected from a pig enterprise. If, however, pigmeat declined to below 20 cents per lb gross, pigs became unprofitable at poor management levels.

TABLE 3

*Performance at Three Levels of Management in a 20 Sow Herd**

	Good management	Average management	Poor management
Management factors:			
200 lb pigs reared per sow, per year ..	16	13	10
Carcase meat sold (lb)	44,000	35,700	27,300
Feed per lb carcase produced (lb) ..	5	6	7
Total costs ($)	4,410	4,280	3,900
Increase in farm income ($):			
(a) high barley price	3,600	1,700	550
(b) low barley price	4,700	2,800	1,100

* Costs for a 20 sow herd do not include the opportunity cost and storage cost of barley, which was calculated at 86·2 cents per bushel at the high selling price and 53·5 cents at the low selling price.

A capital investment of $500 per sow for buildings and equipment (which were assumed to depreciate to nil value over 10 years), plus the purchase price of twenty sows, followers and boars, brings total investment to $11,150. At average management and a price of 25 cents per lb gross for pigmeat, the rates of return that equilibrated income over a 10-year period with initial capital were: 8 per cent at the high barley price, and 21 per cent at the low barley price.

The above results suggest that oil-seed crops, beef cattle and pigs offer scope for improving farm incomes on the Wimmera Plains.

4 FARM RESOURCE ADJUSTMENT RESULTS

This section of the results reports findings of the study in respect of land and wheat quota resources and their importance in the determination of farm income.

As stated in section 2 it is necessary to derive fixed costs in order to calculate net returns from total gross margins. Returns to labour and management for any farm resource combination were calculated as follows:[7]

$$R = T.G.M. - (T.F.C. + I.R.C.)$$

where R = return to labour and management
$T.G.M.$ = total gross margin
$T.F.C.$ = total fixed costs (including depreciation)
$I.R.C.$ = imputed return to capital.

An acceptable level of return to farm operators for their labour and management was assumed to be $3,000 plus one per cent of total farm capital. Returns derived from various resource combinations were compared with this benchmark. The prospects for farm size adjustment (with quota/land ratio held constant) and wheat quota/land ratio adjustment will now be considered in turn.

4.1 FARM SIZE ADJUSTMENT POSSIBILITIES

Farm planning results indicated that on the 625-acre, one-man farm, there is a substantial labour surplus. Profitable use of this slack resource appears possible only through (a) the introduction of pigs, (b) off-farm employment, or (c) by increasing farm size. The effect of farm size on total labour requirement was investigated (by parametizing arable acreage but maintaining the wheat quota to land ratio of 7·5 bushels per acre). It was found, given the assumptions in the model, that up to 1,000 acres could be run by one man. In the sample, all properties less than 1,000 acres in size had a full-time labour force of only one man. Four farms had two or more full-time men, but these were all greater than 1,000 acres in area. These facts tend to confirm conclusions drawn from planning results regarding possibilities for farm size adjustment.

4.2 THE WHEAT QUOTA/LAND RATIO, FARM SIZE AND RETURNS

The typical farm model was used to investigate the effect of changing this resource ratio on income. Only the results generated with the assumption of low feed grain prices are presented here. Also, only cereal growing and sheep enterprises were allowed to enter optimal solutions; oil seed crops, cattle and pigs were excluded from the enterprise possibilities.

Table 4 summarizes the results and shows increases in returns from increasing wheat quota/land ratios and from increasing farm size from 625 to 825 acres. Nineteen of the twenty surveyed properties were endowed with quota/land ratios that fall between ratios considered in the table, 4·5 to 10·5.

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[7] Total gross margin was the objective function in linear programming. *T.F.C.* and *I.R.C.* were derived as described in Appendix B.

From table 4, it can be seen that the level of quota is important in determining the level of income. For the two farm sizes, a quota level of 4·5 bushels per acre has potential for a return to labour and management of only 25 to 36 per cent of the acceptable level, respectively, if seven per cent is the charge on capital invested. On the other hand, at a quota level of 10·5 bushels per acre, returns to labour and management rise to 63 per cent and 85 per cent, respectively, of the satisfactory level. Returns to capital also strongly reflect the level of wheat quota per acre. The effect on returns of a 200 acre increase in farm size (from 625 to 825 acres) is shown to be quite favourable, at all levels of quota investigated. When high feed grain prices were used, it was found that even the relatively small farm of 625 acres with a relatively small quota endowment of 4·5 bushels per acre can generate returns of adequate levels, and a five per cent return to capital can be expected. With the larger farm size (825 acres) potential returns were also found to be quite satisfactory, being in the region of seven per cent of invested capital. If only three per cent is the return sought from invested capital, the possible returns to labour and management are above or equal to acceptable levels in all but one case examined, either at low or high feed grain prices. The exception is at the smaller farm size, with small quota endowment and low feed grain prices.

TABLE 4

The Effect of Farm Size and Wheat Quota on Returns to Labour and Management, and Capital

Quota level (bush/ac.)	Farm size 625 acres			Farm size 825 acres		
	4·5	7·5	10·5	4·5	7·5	10·5
Total farm capital ($)	44,964	47,496	49,883	58,503	61,617	64,740
Acceptable levels of returns to labour and management ($)	3,450	3,475	3,499	3,583	3,616	3,647
Return to labour and management ($) and proportion of acceptable level:						
(i) Imputing 7 per cent return to capital ..	843 (25 per cent)	1,487 (43 per cent)	2,210 (63 per cent)	1,283 (36 per cent)	2,146 (59 per cent)	3,102 (85 per cent)
(ii) Imputing 3 per cent return to capital ..	2,641 (77 per cent)	3,387 (97 per cent)	4,206 (120 per cent)	3,615 (101 per cent)	4,610 (127 per cent)	5,692 (156 per cent)
Return on capital (per cent) ..	1·20	2·81	4·41	3·05	4·61	6·16

Investigations were made, using the typical farm model, of substitution rates between land and wheat quota. At low feed grain prices, and at a constant return to labour and management, it was found that the marginal rate of substitution of land for wheat quota was about three; one extra arable acre makes up for the loss of three bushels of wheat

quota. At high feed grain prices the marginal rate of substitution of land for wheat quota was much greater.

It can be concluded that as well as farm size *per se*, the quota/land ratio is extremely important in determining returns at low feed grain prices.

5 IMPLICATIONS

The farm planning results derived will apply to areas of the Wimmera dominated by heavy grey soils. The main area is bounded by Birchip and Horsham in the north and south and St Arnaud and Dimboola in the east and west. There are also considerable areas centred on Goroke and Serviceton in the Western Wimmera. The rapid decline in rainfall to the north makes Warracknabeal the northern limit to the area to which results apply.

Although individual farm planning is ideal, it is probably too expensive ever to be employed in more than a few instances. Individual farm planning results tended to confirm that the less expensive typical farm model approach was justified in this case. However, the general usefulness of the technique depends on the homogeneity of the group being represented.

Results have three policy implications. Firstly, they indicated that two small properties could be amalgamated to form a more profitable 1,000 acre unit. Moreover, the 1,000 acre unit could be run by one man with no more than the usual complement of machinery. Secondly, the beneficial effect on net income of improving the wheat quota/land ratio may also have reconstruction implications for the study area: to produce a given increase in net income, the extra quota necessary could probably be acquired at a far lower cost than the needed extra land, especially in the event of low barley prices.

APPENDIX A

Assumed Yields and Prices for Oil Seed Crops

Yields (bushels per acre)

Rotation*	High yield	Low yield
PF(E)*R*	17·3	13·8
PF(L)*R*	15·0	12·0
PFWF*R*	16·3	13·0
PF(E)*S*	19·6	15·7
PF(L)*S*	17·0	13·6
PFWF*S*	18·4	14·7

* Where the phases of the rotations are as follows:

P = pasture, F = fallow, *R* = rapeseed, W = wheat, *S* = safflower and (E) and (L) are early fallow (1st August) and late fallow (1st October) respectively.

Prices (dollars per bushel)

Crop price		High	Low
Rapeseed:	Gross†	2·40	2·04
	Net (on farm)	2·22	1·82
Safflower:	Gross	1·90	1·62
	Net (on farm)	1·56	1·28

† $2.40 per bushel is equivalent to $88 per ton and $2.04 is equivalent to $75 per ton.

APPENDIX B

Derivation of Total Fixed Costs and Capital Values Associated with Farm Plans

Total Fixed Costs

Total fixed costs were made up of two components.

(a) A fixed cost per acre covering rates, insurances on buildings, vehicles and plant, registration of vehicles, repairs to buildings, fences and watering points, etc.

(b) Plant depreciation.

Capital Investment

Capital investment was made up of three components.

(a) The area of land and its value.

(b) The number of sheep and their value.

(c) The amount of cropping and non-cropping plant and its value.

Cropping plant valuation estimates were based on the relationship found between market value of cropping plant and crop acreage for 19 farms. This was:

(1) $Y = 3{,}372 + 10{\cdot}55\ X \qquad (R^2 = 0{\cdot}812)$

where

Y = 1970 market value of cropping plant ($), and

X = the average acreage of crop, 1965–1969.

Non-cropping plant showed no relationship to farm size in the surveyed sample. The average 1970 market value for 19 farms of $1,474 for non-cropping plant was used. Fixed costs were found to average $1.60 per acre for typical Wimmera Plains farms.

The expression used for estimating total fixed costs for any farm size, assuming a 10 per cent annual depreciation on plant, was:

(2) $T.F.C. = 1{\cdot}60\ A + 0{\cdot}1\ (1{,}474 + (3{,}372 + 10{\cdot}55\ X))$

where A = arable acreage of the farm, and

X = acreage of crop.

Estimation of the capital value of land presented a problem because the wheat quota endowment of land affects its value. Using a base value of $60 per acre for land with 7·5 bushels of wheat quota attached to it, [8] the value of land was derived using the following expression:

(3) $V = 60 + (M/0{\cdot}3\ (Q - 7{\cdot}5))$

where

V = value in $ per acre of land with a quota of Q bushels per acre

60 = value in $ per acre of land with a quota of 7·5 bushels per acre

M = marginal value product of wheat quota ($0.46 at low feed grain prices and $0.11 at high feed grain prices for the typical farm)

0·3 = capitalisation rate of M.V.P. of quota[9]

Q = quota/land ratio in bushels per acre, and

7·5 = quota/land ratio of land at a value of $60 per acre.

Sheep were valued at an average of $5 per head. Therefore, the expression for estimating total capital investment was:

(4) Capital investment ($) $= A\ (V) + 5{\cdot}0\ S + (1{,}474 + (3{,}372 + 10{\cdot}55X))$
where S = the number of ewes.

Total fixed costs and imputed returns to capital were obtained for farm plans (involving only cereal crops and sheep enterprises) using the relationships established above. Substitution in $R = T.G.M. - (T.F.C. + I.R.C.)$ gave returns to labour and management for farms of varying arable acreage, crop acreage, sheep numbers and wheat quota/land ratios.

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[8] At a meeting of farmers participating in the study, this value was generally agreed to be the likely average value at that time (November 1970).

[9] The capitalisation rate has a greater effect on V at low feed grain prices than at high prices. Even so, varying the rate from 10 per cent to 50 per cent had relatively little impact on the scale of returns.

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