Farm Management Report No. 14

PLANNING WHEAT FARMS IN NORTH WESTERN NEW SOUTH WALES

[Armidale, Australia

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by

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1968

Grateful acknowledgement is expressed to the Wheat Industry Research Council for financial assistance which made this study possible. Valuable help in identifying problems and in specifying data was provided by the farmers of the Warialda Farm Advisory Group, and by their adviser Mr. Bruce Allan. Finally, the authors are indebted for helpful comments and suggestions to Mr. Arthur Rickards.

Printed by the University of New England, Armidale.

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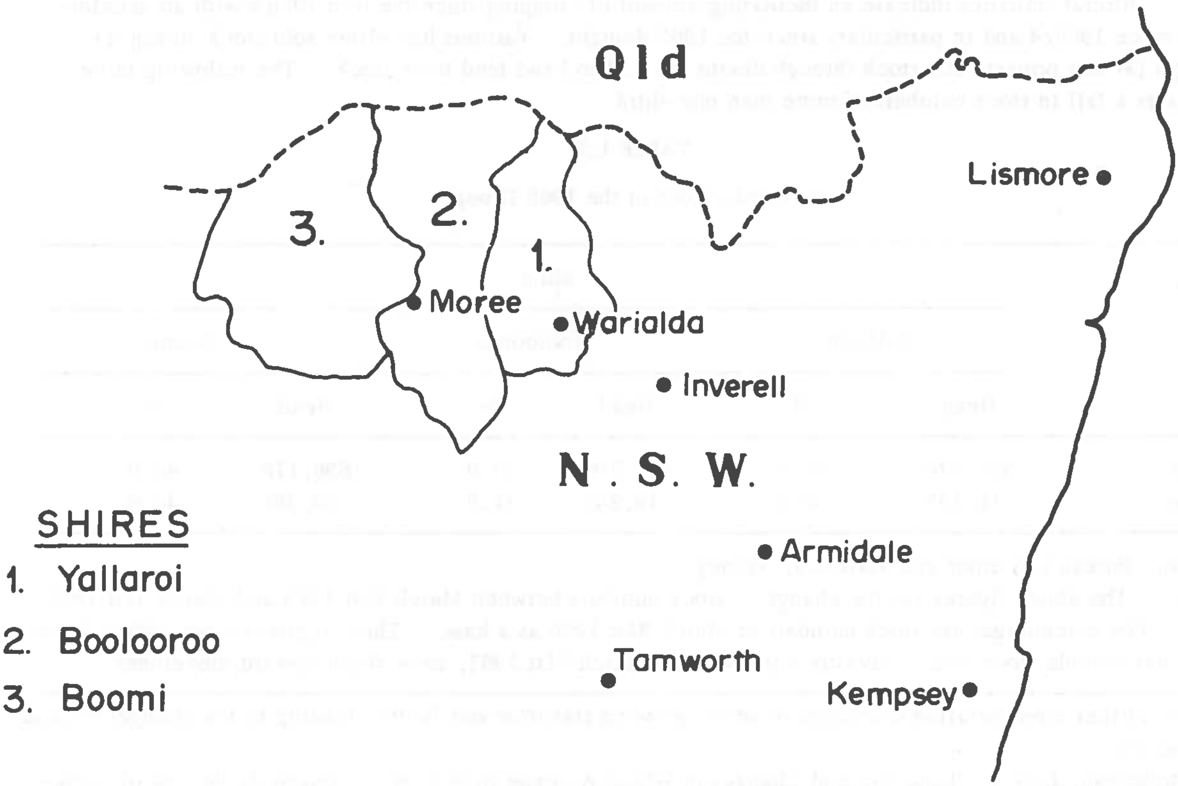
1. THE AREA STUDIED: ITS PROBLEMS AND OPPORTUNITIES

1.1 Introduction

There has been a considerable increase in wheat acreage in New South Wales in recent years. The North West has been a major area for expansion with a large amount of wheat being grown in what was previously thought to be 'marginal'or 'grazing only' areas. It was decided to investigate wheat growing in this area. The farm advisory group at Warialda provided a number of co-operating farmers in an area where wheat acreage has recently shown rapid expansion. The farms studied were located in Yallaroi Shire between Warialda and the Shire's western boundary. (see Fig.1.)

Fig 1. Location of the Area Studied



The changes in wheat acreage over the last decade in Yallaroi Shire and in the neighbouring shires of Boolooroo and Boomi are shown in Table 1.1

TABLE 1.1

Wheat Acreages in Three North West Shires[1]

	1956-7		1966-7	
	Wheat Acreage	Wheat Acreage as % of Farm Area	Wheat Acreage	Wheat Acreage as % of Farm Area
Yallaroi	62,609	5.17	277,887	22.94
Boolooroo	49,472	2.82	312,466	17.84
Boomi	7,270	0.32	96,725	4.25

Source: Bureau of Census and Statistics, Statistical Register of N.S.W.

Official statistics indicate an increasing amount of cropping since the mid 1950's with an acceleration since 1963/4 and in particular, since the 1965 drought. Farmers had either sold stock during the drought (at low prices), lost stock through deaths, or had to hand feed their stock. The following table indicates a fall in stock numbers of more than one-third.

TABLE 1.2

Stock Reductions in the 1965 Drought

	Shire					
	Yallaroi		Boolooroo		Boomi	
	Head	%	Head	%	Head	%
Sheep	316,376	38.6	452,298	37.0	636,115	40.6
Cattle	15,137	31.2	18,242	31.8	30,385	40.6

Source: Bureau of Census and Statistics, Sydney.

Note: The above figures are the change in stock numbers between March 31st 1965 and March 31st 1966. The percentages use stock numbers at March 31st 1965 as a base. These figures do not reflect losses only, but include stock sold. Livestock statistics to March 31st 1967, show slight upward movement.

1. For further more detailed discussion of wheat growing statistics and factors leading to the changes in land use see:-
McLennan, L.W., "Land Use and Changes in Wheat Acreage in N.S.W." Quarterly Review of Agricultural Economics. Vol.X. No.3 (July 1957) pp 135-41.
McLennan, L.W., "Recent Wheat Acreage Changes in Australian States and Likely Future Movements". Quarterly Review of Agricultural Economics. Vol.XVI, No.3 (July 1963) pp.136-144.
McLennan, L.W., and R.A. Daly., "Wheat Acreage Changes in N.S.W. 1955-6 to 1964-5" Quarterly Review of Agricultural Economics, Vol.XX, No.1 (Jan. 1967) pp.21-38.
Maccallum, D., "Some Measures of Trends in Land Use on N.S.W. Wheat Farms" Review of Marketing and Agricultural Economics, Vol.29 No.2 (June 1961) pp.58-98.

Whatever the farmer's drought policy, it meant a depleted cash position in the post-drought period, and with high stock prices, adequate restocking of properties was difficult. The alternative was cropping. Many farms were already equipped with some cropping machinery, so that capital costs were lower than for restocking and the cash returns both higher and more rapid - hence, increased cropping, particularly wheat.

Figure 2 shows the area sown to wheat in the three shires, Yallaroi, Boolooroo and Boomi. Since 1956-7 wheat acreage increased steadily until the 1965 drought. The drought caused a sharp reduction in acreage sown, but was followed by an accelerated increase in wheat acreage in 1966-7.

The region is still recovering from the drought, with many properties still in the transition phase and still understocked. These circumstances affect the objectives and actions of many farmers. Many are currently motivated by short-term objectives, endeavouring to recoup drought losses and consolidate their financial positions. Once these objectives have been achieved, further changes in the farming pattern can be expected. Farmers are concerned about the present emphasis on wheat production, particularly the uncertain future for wheat and the consequences of continuous cropping leading to a build up of black oats. Therefore, more diverse farming systems are likely to emerge in the future.

Farmers have invested heavily in equipment and property improvements to prepare for increased grain production, and this continues. Considerable encouragement was given by the 1966-7 crop which produced record yields and boosted cash resources. A second crop of that magnitude in 1967-8 would have meant complete recovery for most farmers. However, that was not to be as yields were down considerably due to the failure of rains to finish off the crops.

This area of the North West, having experienced considerable changes in the farming pattern in the past, and with further changes in the farming pattern imminent, provides an interesting area for study. This study consists of three parts. Initially, there is a consideration of present and possible crop and livestock activities in the area. Some of the problems associated with these activities are elaborated. Secondly, in Part 2, a linear programming model is formulated and optimal farm plans computed for a number of farms. The effect of varying wheat prices on optimal farm plans is also evaluated. Thirdly, in Part 3, there is an investigation of farmer objectives other than the maximization of income. These objectives were formulated in a linear programming model and a number of sub-optimal plans computed. From this analysis, some indication of likely future farming trends in the area can be obtained.

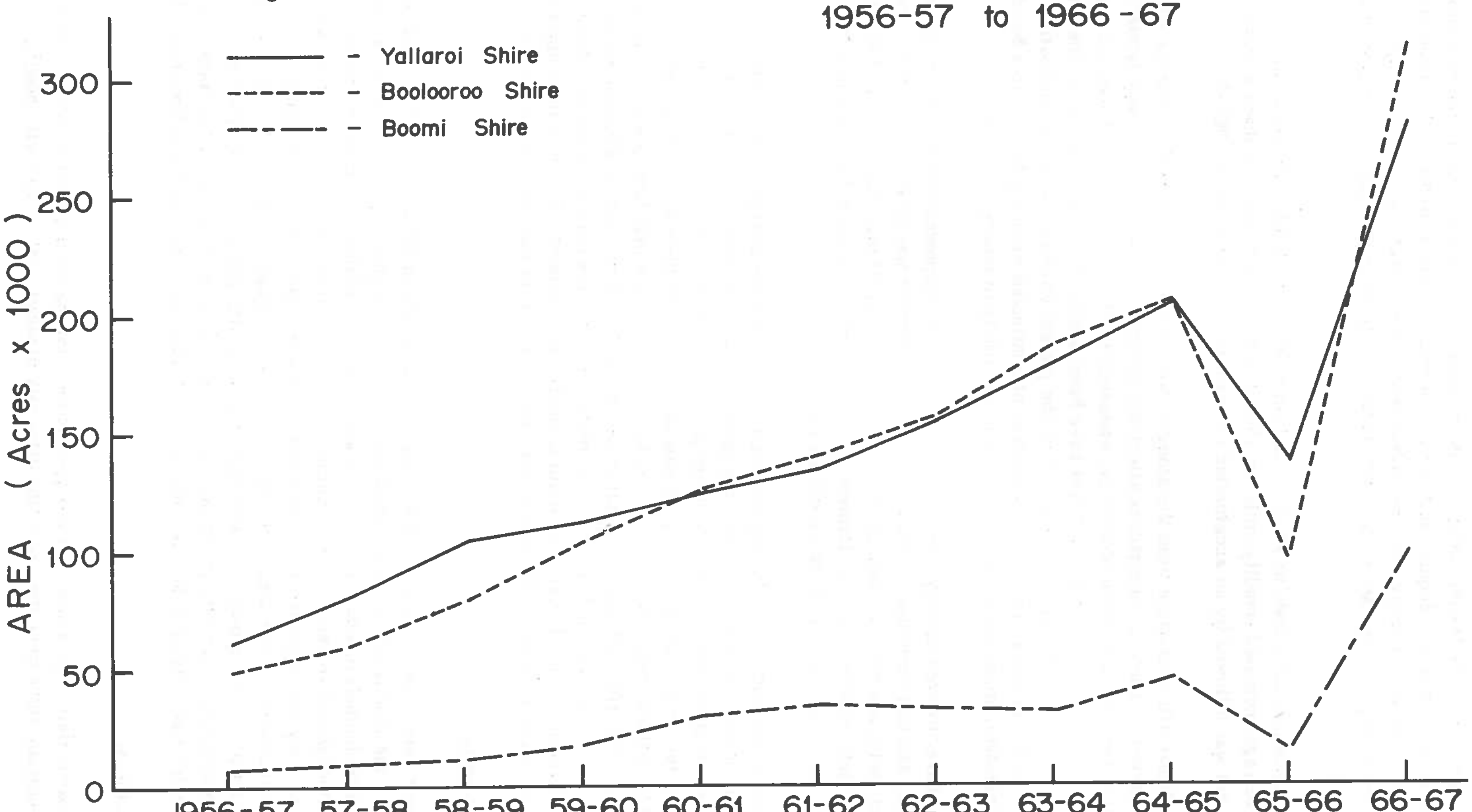
1.2. Wheat Cropping

The wheat crop is usually sown in April-May and harvested in November. After burning the stubble in December, the land is normally ploughed and fallowed until planting time. Most farmers are quite competent in the techniques of wheat growing and are achieving satisfactory yields at low cost. The use of fertilizers, although only recent, is now common. This has raised yields on the red-brown earths in particular, so that they now approach those obtained on heavier black soils. It is generally accepted that worthwhile yield increases are obtained from the use of superphosphate, although the optimal application rate is still uncertain. Some growers are also experimenting with applications of nitrogen. However, the response is more erratic than with phosphate, and considerable uncertainty still surrounds the use of nitrogen. Suspected trace element deficiencies, zinc in particular, are also being investigated.

1.3. Weed Problems

Weeds, particularly black oats, are a major problem for the farmer growing wheat continuously. At present, farmers are more concerned with the difficulty of weed control than with possible longer-term

Fig 2. Wheat Acreage in Yallaroi, Boolooroo and Boomi Shires 1956-57 to 1966-67



Source : Bureau of Census and Statistics, Statistical Register of N.S.W.

problems of soil fertility and structure. Black oats compete for moisture and nutrients with the growing wheat crop, and more importantly, raise problems of wheat purity. This means either that the wheat has to be graded, or a price dockage accepted. Black oats create similar problems in alternative winter crops such as barley for malting and linseed, where seed purity is also important. The later planting date of safflower largely overcomes the problem.

There are a number of ways of controlling black oats:

(i) The most common method is to spray with a pre-emergent spray (Avadex) either shortly before or at planting. This costs approximately $4.00 per acre, and may give control for two years. However, not all applications are successful because critical factors such as soil moisture and soil conditions are difficult to control.

(ii) Control of black oats is possible by fallowing the land during winter. Thus a fallow of eighteen months is maintained, providing a good opportunity for the black oats to germinate and to be killed by cultivation. This method of control is effective but is not common because the costs of maintaining the fallow are considerable and the cropping opportunity foregone in keeping the land idle means a substantial loss of income.

(iii) A grain/grazing crop rotation which prevents the oats from seeding during the grazing phase is also effective against black oats. The grazing phase may be pasture, oats or lucerne - the oats being grazed out in spring and the land ploughed. Lucerne is the grazing crop most commonly used in this type of rotation, particularly on the lighter soils. However, stocking rates are low, and with most farmers currently concentrating on cash crop production, this method is not favoured.

(iv) A winter/summer crop rotation can also be used for weed control. A variety of possible summer crops including cowpeas, soya beans, maize and millets are described below.

Cowpeas and millets have small and diminishing markets and hence are relatively unimportant. Soya beans have a large potential market. Being a legume with a short growing season and no trash or stalk disposal problems, soya beans are suited agronomically for inclusion in crop rotations. Unfortunately, the varieties readily available do not thrive in the area. More research is needed if soya beans are to become an attractive cropping alternative.

Maize yields have been very erratic, and the crop seems to be unsuited to dryland production in this area. This leaves grain sorghum which has become the major dryland summer crop. With an expanding export market, disposal of this crop should be relatively easy. A variety of rotations are possible. One rotation suggested by a grower was wheat-sorghum/winter fallow-sorghum/winter fallow-summer fallow/wheat-summer fallow/wheat-summer fallow - i.e. three wheat crops and two sorghum crops in five years. Sorghum, has a lower gross margin per acre than wheat, and with the land idle for considerable periods, this rotation would result in a considerable reduction in returns.

An alternative (and more intensive) rotation would be wheat-sorghum/winter fallow-sorghum/wheat-summer fallow/wheat-summer fallow - i.e. three wheat crops and two sorghum crops in four years. This entails two years of double cropping separated by a winter fallow. Land is idle for one winter only as wheat is sown immediately following the second sorghum crop.

1.4. Alternative Enterprises to Wheat

1.4.1. Crop activities

The emphasis which farmers have placed on wheat in recent years has meant that they have tended to neglect alternative enterprises. It appears that the level of management applied to other crop and livestock activities is often considerably inferior to that applied to wheat. (Wheat is providing an adequate return, so farmers may well argue, "Why bother about alternatives? We are doing quite well as it is!") Part of this study involved a look at alternative activities to wheat, some of which have been mentioned.

Alternative winter crops include barley, oats, linseed and safflower. The inputs required to grow barley or oats for grain are similar to those for wheat, which generally gives a higher return. Thus barley and oats are not usually economically attractive alternatives to wheat. A limited amount of barley is grown on those soils which produce grain of malting quality, commanding premium prices, while oats are quite widely grown as a winter fodder crop.

Linseed is a highly profitable crop if grown successfully. The crop is normally produced under a contract with a guaranteed price announced before planting each year. There has been a tendency towards over-supply in recent years, but the situation is currently improving. (The fortunes of linseed are closely linked to developments in the paint industry.) Yields of half a ton per acre (20 bushels) can be attained and a price of $120 per ton, less freight to Moree, makes linseed an attractive proposition. Land for linseed must be relatively free of weeds as the crop is not a strong competitor, and spraying is not always possible or successful. Disposal of the fibrous stubble is a further problem.

Safflower, which is yet to reach a situation of over-supply, is also a profitable crop if grown successfully. A guaranteed price is established for each season, currently around $100 per ton less freight to Moree. Yields of half a ton per acre (25 bushels) can be attained from the Gila variety so that revenue per acre is almost as high as for linseed. There are some further advantages in growing safflower. The later planting date (July-August) to avoid frost damage, enables better weed control and spreads the work at both planting and harvesting. Dependence on November rains to finish the crop, rather than the September-October rains required for wheat, spreads risk and takes advantage of the greater reliability of rainfall in November compared to September and October. On the other hand, experiences with the crop have not been uniformly favourable. Yields have been erratic with total failures not uncommon. It may be that varieties better suited to local conditions are needed and perhaps cultural methods could be improved. In any event, the future role of safflower in the area is not yet established.

Both linseed and safflower are more difficult crops to harvest than wheat, barley or oats. Thus, the operator's skill could be severly taxed to cope with these crops, and this may deter some farmers from growing them. However, probably the major factor preventing more widespread growing of linseed and safflower is farmer conservatism - staying with a crop they know rather than changing to a crop about which they are uncertain. As yet, financial returns from wheat have not forced farmers to consider alternative enterprises.

1.4.2. Livestock Activities

Rapidly improving techniques and skills have not been applied to livestock activities as they have to wheat. Previously, this area was a grazing area, producing wool and with some beef cattle as a sideline. It now appears that livestock production will become a residual activity in the area. The numbers of stock grazed will depend upon the amount of land unsuited to crop production and upon the acreage of fodder crops and lucerne grown primarily for rotational reasons on the cropped land.

An estimate of the potential arable area in the North West would be a useful guide to the future importance of livestock activities. Maccallum[1] in 1961, used the total area of crops, fallow and sown pasture as an estimate of potential arable area. This estimate proved conservative, and between 1959-60

1. Maccallum, D., op. cit., p.65.

and 1963-64, over 750,000 acres were added to the area under crops, fallow and sown pasture in the Northern Region. From 1963-4 to 1966-7 a further 326,000 acres were added in the three shires, Yallaroi, Boolooroo and Boomi alone. Further increases can be expected, although there is evidence that the expansion is slowing down, at least in the older wheat growing areas. For example, in Yallaroi Shire, where the farms in this study are located, only small areas of land suitable for cultivation remain to be brought into use (see Table 2.5) In Boolooroo and Boomi Shires rainfall is lower and less reliable than in Yallaroi Shire. Thus the incentive to expand cropping is reduced. Nevertheless, substantial possibilities for further increases in the arable area exist and livestock grazing based on natural pasture can be expected to decline further in the future.

Since past attempts at pasture improvement have generally been thwarted by erratic rainfall, most of the non-arable areas are likely to remain as natural pasture. These natural pastures are best suited to wool or beef production. However, if lucerne is grown on a portion of the arable area in a cropping rotation, then fat lamb production is possible. (Many graziers are currently running Merino ewes with Border Leicester rams, or running first cross Merino-Border Leicester ewes with British breed rams.) Lucerne needs to be rotationally grazed for best use, and this places further demands on management, and requires more fencing and stock watering facilities. Most farmers consider grazed lucerne gives inferior returns to cropping. They concede, however, that if similar levels of management were applied to grazing as are applied to wheat the returns from grazing may be comparable. At the assumed gross margin for Merino ewes, the break-even return is achieved at a stocking rate of 3½ ewes per acre. In reality, a higher stocking rate than this would be required to compensate for the cost of additional fencing and stock watering facilities required for rotational grazing of lucerne.

Farmers in the district seem to prefer grazing cattle to sheep. The favoured enterprise is running beef cows, with calves turned off at 10-14 months of age. There is also the possibility of fattening cattle using farm-produced grain. (This could be a profitable outlet for grain if grain prices were to fall in future, so long as beef prices remained around present levels.) While cattle can be profitably fattened on grain at the moment, there are two major problems preventing the widespread adoption of this practice.

(i) It is difficult to secure sufficient calves or steers suitable for fattening.

(ii) Variable market prices make the enterprise very risky. A fall in prices could cancel out the gain arising from increased carcase weight. In the long term the market gains and losses may offset one another, but in the short term, considerable variation in returns are likely.

Having reviewed the agricultural possibilities of the area, the study now turns to an economic evaluation of these activities.

2. OPTIMAL FARM PLANS

2.1. Introduction

The objective of this study is to throw light upon some types of farming systems appropriate for the North West. No attempt is made to lay down "blueprint" farm plans intended to be of general applicability. Rather the study seeks to determine plans appropriate for a range of farm situations and assumptions and to distil from these results some principles of general relevance for farms in the area. To this end, a number of linear programming models have been constructed and analysed. These models were all developed using the same input-output coefficients, but with differing assumptions about farm circumstances, production opportunities and farmer preferences and objectives.

2.2. The Linear Programming Model

Linear programming is a mathematical technique for solving profit maximizing problems. Use of the technique requires the services of a high-speed computer. In this instance linear programming has been used to determine the optimal combination of farm activities, i.e. that combination which provides the largest possible TGM[1]. In addition to this, values are imputed to scarce farm resources, indicating the amount by which TGM would rise if one more unit of the resource was available. These values are called marginal value products. Likewise, the "shadow prices" of activities not in the optimal farm plan are computed, indicating by how much the gross margin of the excluded activity would need to increase before that activity would enter the optimal farm plan. Thus, the solution provided by the computer to the linear programming problem includes the optimal farm plan, and an analysis of the sensitivity of that plan to changes in prices and resource supplies.[2]

The linear programming model was developed first for Farm X - a hypothetical farm situation constructed by "normalizing" the circumstances of an actual farm in the area. For example, the real farm area of 3877 acres was adjusted to 3500 acres for Farm X. While Farm X is not representative of other farms in the area in any statistical sense, it nevertheless is a portrayal of a situation of some general interest. It is of intermediate size when judged in comparison with the range of actual farm sizes in the area, and the assumed labour and machinery complement would be normal for a farm of this size and type. The main characteristics of Farm X are as follows:-

Total farm area	3,500 acres
Arable area	2,500 acres
Potential arable area after rock picking, clearing and contour banking, where necessary	500 acres
Land suited to natural pasture only	500 acres

The farm has two headers, two combines and employs two fulltime workers in addition to the owner/operator. Additional casual labour is employed at harvest and planting, and wheat is carried to the rail silo by contract carriers.

In the short term, it appears that permanent farm labour is relatively fixed on farms in this area. Thus labour is assumed to be non-limiting on the farms under consideration. However, in Part 3, labour requirements for some of the derived farm plans have been analysed.

2.2.1. Crop Activities

The various crops which can be grown on the arable land are mentioned briefly below, with full details in Appendix II. The non-arable land is under natural pasture, but if it is suitable for cultivation,

1. The gross margin of a farm activity is the difference between the gross income from the activity's output, and the variable costs of producing that output. Total Gross Margin (TGM) is the sum of the gross margins of all the activities included in the farm plan. Net Farm Income (NFI) is equal to TGM less fixed or overhead costs e.g. rates, depreciation etc. This represents the return to the operator's labour, management and capital invested in the farm. Overhead costs have been charged at the rate of $7.00 per arable acre, and $1.50 per non-arable acre.

2. For a full discussion of the technique of linear programming see Rickards, P.A. and D. J. McConnell, "Budgeting, Gross Margins and Programming for Farm Planning". Professional Farm Management Guidebook No. 3, Department of Farm Management, University of New England, 1967.

it can be converted to arable land by the removal of trees and stones and contour banking where necessary. The assumed cost of $22 per acre for clearing this land and bringing it into cultivation has been amortized at seven per cent interest over ten years.

Four cash grain crops are included in the matrix. Two wheat activities are considered, one for wheat grown after a summer fallow, and the other for wheat following a summer crop. Likewise, two sorghum activities are included to cover sorghum grown after a winter fallow and after a winter crop. The other cash grain crops are linseed and safflower. Oats are considered mainly as a fodder crop, but provision is made for the crop to be harvested for grain if profitable. Lucerne can be undersown under a winter crop (usually wheat) and used for grazing. A well managed stand is assumed to remain productive for five years without renovation, in addition to providing effective control of black oats.

2.2.2. Crop Restraints

(a) Rotations

To simplify presentation, the following symbols have been used to represent the various activities in the rotations.

- WG - A winter grain crop which can be either wheat, oats for grain, linseed or barley
- SG - A summer grain crop, grain sorghum in all cases
- Sa - Safflower
- O - Oats for grazing only i.e. <u>not</u> harvested for grain
- L - Lucerne
- WF - Winter fallow
- SF - Summer fallow
- A - This indicates that Avadex spray is used in conjunction with the crop e.g. WG A.

In specifying the rotations, a slash (/) designates the years of the rotation, and a dash (-) is used to indicate where more than one activity is undertaken on the same land in any year. e.g. The rotation shown below is a four year rotation involving three winter grain crops (WG) and one winter fallow (WF), each separated by a summer fallow (SF).

WG - SF / WG - SF / WG - SF / WF - SF /

The rotational restraints included in the model are based on the need to control weeds rather than on the maintenance of soil nutrients or organic matter status[1]. Thus, a winter crop (wheat, linseed or oats) requires some method of controlling black oats. These methods, which have been discussed previously, include the use of lucerne, grazing oats, winter fallow or Avadex spray. Rotational restraints have been included in the matrix to ensure that one or other of these weed control methods will be adopted. The following rotations are consistent with the restraints employed.

i) WG - SF / WG - SF / WG - SF / WF - SF /
ii) WG - SF / WG A - SF / (i.e. continuous winter grain cropping, spraying with Avadex every second year)

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1. This can be compared with the legume restraints used by:
Tyler, G.J., "Optimum Programmes for Wheat Farms in the North Western Slope", <u>Review of Marketing and Agricultural Economics</u>, Vol. 32, No. 1, March 1964, p. 22, and
Waring, E.J., J.D. Fahy, and N.H. Sturgess, <u>Farm Planning in the Graman District of N.S.W.</u> Farm Management Report No. 7, Faculty of Agricultural Economics, University of New England.

iii) WG / L (i.e. equal number of years of each, e.g. 4 winter grain crops, 4 years lucerne)
iv) WG - SF / WG - SF / O - SF /
v) WG - SG / WF - SG / WG - SF / WG - SF /
vi) WG - SF / Sa - SF /

(b) Other crop restraints

Restraints are placed on the acreage of land sown to linseed and safflower. Linseed is difficult to market and a contract is needed. Safflower is free of problems now, but contracts may be more difficult to obtain in the future. Because few farmers grow these crops, the information on them is sketchy. Consequently, acreage limits have initially been set equal to zero and relaxed in subsequent programmes.

(c) Machinery restraints

Restraints have been formulated after analysis of daily rainfall records for Inverell covering a period of 18 years. (Inverell has a higher rainfall than Warialda, so the estimates of time available for planting and harvesting may be slightly pessimistic).

It was estimated that there is a 95% chance of obtaining 10 days or more with suitable conditions for planting winter crops in the months of April and May. Thus, working 20 hours per day, it may safely be assumed that 200 hours are available for planting. There is an estimated 82% chance of obtaining at least 7 suitable sowing days in December providing at least 140 hours for sowing summer crops. A limit was also placed on the amount of land that could be prepared for summer crops grown after winter crops. This uses casual or contract labour for ploughing after harvesting and stubble burning. Based on November rainfall data, 200 hours of ploughing was assumed. At a ploughing rate of 5 acres per hour, this sets a maximum of 100 acres for summer crops.

The wheat harvest takes place in November. The month was divided into two 15 day periods. It was estimated that there is a 78% chance of at least 9 harvesting days in the first half of November. Harvesting for 12 hours per day, 108 harvesting hours are available in the first 15 days of November. Similarly, there is an estimated 83% chance of at least 7 days in the second half of November, making a total of 16 days, or 192 hours over the whole harvest period. Provision has been made for the purchase of contract planting and contract harvesting if required. Provision for purchasing additional farm equipment has not been included in the matrix, but the demand for contract machinery services may be used to indicate whether such machinery is needed. On farms where contractors are extensively used, simple budgeting procedures would enable the farmer to ascertain the optimal complement of machinery to undertake the proposed farm plan.

Appendix III contains estimates of expected losses due to rain over the harvest period. The average or expected loss for wheat harvested in the period 1st-15th November has been calculated at $0.65 per acre, while the expected loss for wheat harvested in the 16-30th November period has been estimated at $2.37 per acre. These estimates have been added to harvesting costs, whether the crop is harvested by farm equipment or by contractor.

2.2.3. Livestock Activities

The livestock activities included in the matrix embrace a number of sheep and cattle enterprises. Full details appear in Appendix II. Both spring and autumn lambing of crossbred ewes are included along with Merino wethers and spring lambing Merino ewes. A beef cow grazing activity is included, with three possible methods of disposing of the calves. Calves can be sold as weaners at five months, fattened for a further five months on grain in a feedlot or grazed and sold as vealers at twelve months of age. Store cattle or five-month-old calves can be bought for fattening on grain. The grain, assumed to be oats, could be either farm produced or purchased. Barley can be substituted for oats if desired.

2.2.4. Livestock Restraints

(i) The feed restraints involve the following assumptions:
   (a) Sorghum stubble is suitable for cattle only.
   (b) No grazing is obtained from the stubble of other crops.
   (c) Lucerne grazing is suitable for sheep only because of danger of bloat in cattle. This restraint is relaxed in some later programmes.

(ii) Feed pools have been calculated covering four periods, December to February, March to May, June to August, and September to November. All calculations have been made in terms of dry sheep months, i.e. the amount of feed required to sustain a dry sheep for one month. The sources of feed for these pools, and the requirements for the various livestock activities are tabulated in Appendix IV.

(iii) A limit has been placed on the number of cattle which can be fattened in the grain feedlot. As this activity is not widely practised, the maximum was fixed initially at zero, so that shadow prices could be obtained. This restraint was relaxed in later programmes.

Allowance has been made in all livestock-grazing activities for supplementary feeding over short periods of feed shortage. Using rainfall data a simple feed budget was constructed and the cost of feeding, based on a maintenance ration of wheat was calculated. At the assumed stocking rate it was estimated that stock would have to be fed for an average of approximately one month per year. Thus, $1.00 for feed was deducted from the gross margin of the breeding ewe enterprises, $0.75 from wethers, $8.00 from the breeding cows, and $2.00 from grazing claves.

2.3 Wheat Prices

Under the fourth five-year stabilization plan, the wheat price paid to growers is an equalized price which consists of four major components:

(i) returns from domestic consumption of wheat.
(ii) returns from guaranteed price wheat exports,
(iii) returns from non-guaranteed price wheat exports, and
(iv) Wheat Board handling charges.

Proceeds from (i) to (iii) are paid into a pool and growers receive that amount, less the Wheat Board handling charges.

The stabilization plan provides for a cost survey to establish the average cost of production in the first year of the plan. The guaranteed price is fixed equal to the assessed cost of production. In the remaining four years of the plan, costs, and so the guaranteed price, are adjusted annually according to changes in the cost index, although the assumed average yield is held constant for the duration of the plan. The guaranteed price, plus a small loading to cover the cost of transporting wheat to Tasmania, is the price of wheat on the domestic market.

The guaranteed price also applies to 150 million bushels of exported wheat. If the export price is less than the guaranteed price as has been the case for all years since 1956/7, the difference is made up by drawing on the stabilization fund in the first instance, and if additional funds are required, the Federal

Treasury provides the balance. The stabilization fund is accumulated in years when the export price exceeds the guaranteed price. The excess of the export price over the guaranteed price up to a maximum of 15 cents per bushel is paid into the stablilzation fund. No such contributions have been made since 1956/7. As a result, virtually all deficiencies i.e., when the export price is below the guaranteed price, have been made up by the Federal Treasury. Exports over and above 150 million bushels are not eligible to receive a guaranteed price and so they earn the world market price.

The fourth plan described above, expires with the 1967/8 crop. If it is assumed that a new plan, with similar features to the fourth plan, comes into effect with the 1968/9 crop, then a number of factors may affect the expected price paid to growers.

1. A possible change in the guaranteed price through either a change in the assessed cost of production per acre, or a change in the assumed average yield per acre. These factors resulted in a reduction to the guaranteed price for wheat of 14.1 cents per bushel at the inception of the fourth plan in 1963/4. It seems probable that the average yield will be increased from the present 17 bushels per acre, and this would reduce the guaranteed price.

2. There may be a change in the amount of wheat subject to the price guarantee. In the existing plan, domestic consumption and 150 million bushels of exported wheat receives the guaranteed price. An increase in the amount of exported wheat subject to the price guarantee would increase payments to growers. However, such a change seems unlikely.

3. The price received for exported wheat over and above 150 million bushels may change. Currently (1968) the world wheat market is weak with prices tending slightly downwards. However, this may be offset by the new International Wheat Agreement which comes into operation in July, 1968.

Overall, it seems that growers will receive a lower price for wheat in the initial years of the new plan, as suming that the main features of the fourth plan are retained.

Throughout this study, wheat prices quoted refer to the estimated payment to growers at ports. This price is subject to deduction of freight from the railway silo to the nearest port. For farmers in the area studied, freight to Newcastle costs 25 cents per bushel. Because of the marketing arrangements described above, the wheat price paid to growers is not certain. However, an estimate of $1.46 per bushel has been used as the wheat price for the 1967/8 crop.

2.4. The Results

The initial solutions obtained for the model farm were discussed with some of the farmers in the area. As a result, some small adjustments were made to the matrix. In addition, adjustments were made to the wheat activity budgets to take account of the rise in the guaranteed price for wheat which was announced during the course of this study.

The optimal income plan for Farm X with wheat prices at $1.46 per bushel, is shown in Table 2.1. In this plan 2,880 acres of the 3,000 acres of arable land is under wheat and 120 acres is committed to oats. The latter crop provides additional winter feed for the sheep as well as being harvested for grain. Weed control is obtained by spraying with Avadex.

TABLE 2.1
Optimal Farm Plan at Current Wheat Price

Activity	Unit	Level
Wheat	ac	2,880
Grain oats	ac	120
Summer fallow	ac	3,000
Natural pasture	ac	500
Clearing	ac	500
Avadex spray	ac	1,500
Merino ewes	head	727
Net farm income [a]	$	35,907

[a] Net farm income (NFI) is equal to TGM less fixed costs.

Wheat so dominates this first plan, that it was considered desirable to investigate the influence of wheat prices on optimal farm organization. In addition, Section 2.3 suggests that a fall in the price of wheat is not improbable in the near future. Thus, the wheat price was set initially at $1.20 per bushel and an optimal plan (plan 1, Table 2.2) was computed. The price of wheat was then progressively increased until at $1.22 per bushel, another plan (plan 2, Table 2.2) became the optimal farm organization. This procedure, known as variable price programming, was continued until all arable land was committed to wheat with the wheat price at $1.47 per bushel. In all, seven plans were computed in the price range $1.20 to $1.47 per bushel. These are shown in Table 2.2, along with the plan corresponding to the current wheat price of $1.46 per bushel.

TABLE 2.2
Optimal Farm Plans with Varying Wheat Prices

		Plan							Current
Activity	Unit	1	2	3	4	5	6	7	Price
Wheat Price [a]	$	1.20	1.22	1.28	1.41	1.41	1.41	1.47	1.46
Wheat	ac	1,000	1,800	2,130	2,130	2,667	2,880	3,000	2,880
Grain Oats	ac	784	314	120	120	120	120	-	120
Sorghum	ac	1,284	1,614	1,750	1,500	462	-	-	-
Winter fallow	ac	284	614	750	750	213	-	-	-
Summer fallow	ac	784	1,114	1,250	1,500	2,584	3,000	3,000	3,000
Lucerne	ac	932	272	-	-	-	-	-	-
Natural pasture	ac	500	500	500	500	500	500	500	500
Clearing	ac	500	500	500	500	500	500	500	500
Avadex spray	ac	-	-	-	-	1,074	1,500	1,500	1,500
Merino ewes	head	3,269	1,469	727	727	727	727	515	727
Net farm income[b]	$	22,447	22,766	25,416	31,782	31,792	32,414	36,492	35,907

[a] Wheat price paid to growers at ports.
[b] It is assumed that there is no increase in fixed costs as a result of changes in the farm plan.

The rotations implied in these farm plans are rather complex but are theoretically possible. Implementation of these plans would be difficult on some farms as paddock sizes etc. have not been considered in drawing up the plans. Nevertheless, the plans are a guide to the farm organization that would be optimal at the specified wheat prices. Rotations corresponding to the farm plans in Table 2.2 are shown below in Table 2.3

TABLE 2.3
Rotations for Farm Plans with Varying Wheat Prices.

Rotation		Plan 1	2	3	4	5	6	7	Current Price
A	ac	1,136	2,456	3,000	3,000	852	-	-	-
B	ac	1,864	544	-	-	-	-	-	-
C	ac	-	-	-	-	2,148	3,000	3,000	3,000
Crop Area	ac	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000

Rotation A. WG - SG / WF - SG / WG - SF* / WG - SF*/
B. WG - SG / WG - SG / WG - SG / WG - L / L / L / L - SF /
C. WG - SF / WG A - SF /

* In some instances, a summer grain crop is substituted for the summer fallow

The main features of Table 2.2 are discussed below.

i) At a wheat price of $1.20 per bushel, 1,000 acres of wheat is included in the plan in rotation with sorghum and lucerne. Although there is only a small acreage of natural pasture, large areas of oats for grain and lucerne enable 3,269 Merino ewes to be carried. It is also profitable to clear and crop all the potentially arable land.

ii) In plan 2, with the wheat price at $1.22 per bushel, the lucerne rotation is less important, and less oats are grown. As a consequence, sheep numbers fall. An additional 800 acres of wheat is grown and the rotation WG - SG / WF - SG / WG - SF / WG - SF / is of major importance. This rotation enables large acreages of both sorghum and wheat to be grown, as well as providing weed control. The same rotation remains an important element in plans 3 and 4, which are similar in organization to plan 2. However, the NFI of plans 3 and 4 is higher, because of the increased wheat price.

iii) In plan 5, still greater acreages of wheat are profitable, so the crop rotations diminish in importance, and Avadex spray is used for weed control.

iv) At a wheat price of $1.47 per bushel, the final solution is reached. All the arable area is under wheat and Avadex provides the weed control. Merino ewes are grazed on natural pasture only. Further increases in the wheat price would not lead to any further changes in farm organization, although NFI would increase.

v) Plans 4, 5 and 6 are all obtained with the wheat price at $1.41. There are considerable differences between the three plans, as the summer cropping is turned over to winter cropping and weed control is obtained through spraying with Avadex. Thus, there are a number of solutions providing approximately the same income. This is discussed further in Part 3.

vi) The optimal plan at the current wheat price is the same as plan 6. However, because of the higher wheat price, NFI is greater than in plan 6.

From a study of Table 2.2 and from the additional information included in the linear programming solution, the stability of the optimal farm plan at the current wheat price can be evaluated. A slight increase in the price of wheat to $1.47 per bushel would mean that the 120 acres committed to oats would be transferred to wheat production. Further increases beyond $1.47 would not alter the optimal farm organization, as the entire arable area is under wheat, but would increase NFI. On the other hand, a fall in the price of wheat of 5 cents or more per bushel would cause substantial changes in farm organization as is shown by plans 4 and 5 in Table 2.2.

In the above analysis, lot-feeding of cattle and linseed and safflower production were restrained to zero levels. High marginal value products for these restraints indicated the opportunity costs of limiting these forms of production. Thus, an optimal farm plan was recomputed, permitting up to 150 head of grain-fed cattle and 200 acres of both linseed and safflower. Each of the three activities entered the plan to the new maximum limit as shown in Table 2.4.

TABLE 2.4

Optimal Farm Plan at Current Wheat Price Including Grain-fed Cattle, Safflower and Linseed.

Activity	Unit	Level
Wheat	ac	2,480
Grain oats	ac	120
Sorghum	ac	200
Summer fallow	ac	2,800
Safflower	ac	200
Linseed	ac	200
Natural pasture	ac	500
Clearing	ac	500
Avadex spray	ac	1,300
Merino ewes	head	727
Grain-fed calves	head	150
Net farm income[a]	$	52,427

[a] It is assumed that there is no increase in fixed costs as a result of the introduction of the additional activities to the farm plan.

This diversified farm plan adds $16,520 to NFI assuming no increase in fixed costs. Grain-fed calves contributed $4,194 to the increased income, safflower $7,084, linseed $5,242, while the remainder came from grain sorghum and cost adjustments, e.g. less Avadex spray is used. Furthermore, the results indicate that substantial falls in the gross margins of grain-fed calves, safflower and linseed would have to occur before the levels of these activities would decline. For example, at the assumed prices, linseed yields could fall from 20 bushels to 12 bushels per acre and safflower yields from 25 bushels to 9 bushels per acre before these activities become unprofitable. Grain-fed calves would remain in the farm plan so long as the gross margin exceeded $15.90 per calf. This compares with the assumed gross margin of $29.78 per calf. No allowance has been made in this gross margin for capital costs associated with the provision of yards, troughs, etc. However, the inclusion of these costs would not give rise to any changes in the farm plans described above, and the effect on profits would be marginal.

2.5. Planning Five Farms

To obtain greater generality, five farms in the area have been programmed and the results compared with those of Farm X[1]. The matrix coefficients have not been varied, but the resources have been changed to fit individual farms. (See Table 2.5)

TABLE 2.5

Resource Supplies for Five Programmed Farms

Resource	Unit	Farm 1	2	3	4	5
1. Total land	ac	6,000	4,200	3,700	2,940	2,455
2. Arable land	ac	4,500	4,200	1,400	700	1,600
3. Potential arable land	ac	500	0	200	0	200
4. 2 + 3 as % of 1	%	83.3	100	43.2	23.8	73.3
5. Winter crop sowing capacity	hours	800	800	200	200	200
6. Summer crop sowing capacity	hours	560	560	140	140	140
7. Harvesting capacity 1st-15th November	hours	216	216	108	108	108
8. Harvesting capacity 16th-30th November	hours	168	168	84	84	84
9. Total November harvesting capacity	hours	384	384	192	192	192
10. Contract harvesting capacity 1st-15th November	hours	108	108	108	108	108

The Optimal income plans for each of the five farms are shown in Table 2.6 and details of individual plans are discussed below.

TABLE 2.6

Optimal Farm Plans for Five Programmed Farms

Activity	Unit	Farm 1	2	3	4	5
Wheat	ac	4,100	4,100	1,333	700	1,642
Grain oats	ac	-	-	267	-	158
Sorghum	ac	1,800	200	-	-	-
Winter fallow	ac	900	100	-	-	-
Summer fallow	ac	3,200	4,000	1,600	700	1,800
Natural pasture	ac	1,000	-	2,100	2,240	655
Clearing	ac	500	-	200	-	200
Avadex spray	ac	700	1,900	800	350	900
Merino ewes	head	1,029	-	2,632	2,306	953
Net farm income	$	57,288	46,852	28,194	19,572	23,025

1. Basic data were collected from a number of farms and five of these were selected on the basis of their size and proportion of arable area.

Farm 1

Harvesting capacity limits the area of wheat to 4,100 acres, even after using contractors to harvest 900 acres. The plan includes the WG - SG / WF - SG / WG - SF / WG - SF / rotation rather than further contract harvesting which would permit the whole farm to be cropped with wheat. (Increasing the size of farm machinery is not provided for. An additional header would probably be justified in this case, and would allow all of the arable area to be cropped with wheat).

Farm 2

Machinery capacity is almost adequate on this farm where all but 200 acres of land is growing wheat continuously. The summer crop rotation uses the remaining area. Most weed control is obtained through the use of Avadex. As the entire farm is arable, and no fodder crops are grown, there are no livestock on the property.

Farm 3

On this farm, sowing capacity limits wheat acreage to 1,333 acres. The remaining arable area is sown to oats for grain production. With over half the farm under natural pasture, the livestock enterprises are more important. Grazing oats raises the overall stocking rate on natural pasture by approximately 0.25 DSE[1] per acre. The farm has sufficient harvesting capacity to harvest grain crops without the use of contract harvesting.

Farm 4

Less than one quarter of this farm is arable so that livestock activities predominate in the plan. With ample machinery for sowing and harvesting, the 700 acres of arable land is sown to wheat. Avadex is used to control weeds.

Farm 5

This is the smallest farm, but has a high proportion of arable land. The farm complement of sowing and harvesting machinery is deficient, so contract sowing and harvesting is employed. The stocking rate on natural pasture is raised to 1.45 DSE per acre by the winter grazing available from 158 acres of oats. At this stocking rate, feed in the December to February period becomes limiting due to the high feed demands to "finish off" the lambs for market. Therefore, it is not profitable to grow more oats which do not produce feed in the critical summer period. Wheat is sown on the remaining 1642 acres of arable land and **a small quantity of contract planting is required.**

Table 2.7 indicates the marginal value products for some of the farm resources and restraints.

The marginal value product for arable land exceeds $15.00 per acre in all cases. The lowest values are for Farms 1 and 2 where wheat acreage in limited by plant capacity so that additional land would be diverted to crops of lower gross margins. The highest value is for Farm 4 where all the land is cropped with wheat, and no machinery problems arise. The marginal value product of potential arable land is equal to the marginal value product of arable land, less that of non-arable land and the cost of clearing, assumed to be $3.00 per acre. This means that clearing is profitable up to an annual cost of $3.00 plus the marginal value product of potential arable land, i.e. $9.46 per acre for Farms 1 and 2 and even higher for the other farms.

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1. A DSE is a dry sheep of approximately 80 to 100 lbs liveweight.

As with the model farm, Farm X, high marginal value products are attached to the restraints on grain-fed cattle, safflower and linseed. If not restrained these activities would be included in the farm plans as was the case for Farm X.

TABLE 2.7
Marginal Value Products of Selected Resources for Five Programmed Farms

Resource	Unit	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
		$	$	$	$	$
Non-arable land	ac	6.37	6.37	6.37	6.37	6.42
Potential arable land	ac	6.46	6.46	7.30	10.00	7.05
Arable land - winter	ac	15.83	15.83	16.67	18.75	16.47
Arable land - summer	ac	-	-	-	0.62	-
Maximum cattle	head	29.75	29.75	29.75	27.00	29.75
Maximum safflower	ac	36.94	36.94	36.47	33.15	36.30
Maximum linseed	ac	24.58	24.58	25.33	25.11	25.33

2.6 Conclusions

The plans computed for Farms 1-5 are broadly similar to the initial plan for the model farm, Farm X. Variations between farms in machinery capacity relative to arable land give rise to differences observed in optimal plans. Where machinery is adequate, no oats or sorghum is included; where planting machinery is inadequate, oats are included; and where harvesting machinery is limiting, the WG - SG / WF - SG / WG - SF / WG - SF / rotation enters the plan. In this instance, the model farm provides useful information on general farm plans in the area. Two factors lead to this situation. Firstly, the input/output matrix has not been changed to account for inter-farm variation in input/output relationships. Such variation does not appear to be significant in the study area. However, considerable differences are apparent between the objectives of one farmer and another. These are discussed in Part 3. Secondly, the dominance of wheat cropping as the major activity results in broadly similar plans, with only small variations occurring as a result of differences in the circumstances of individual farms.

The results support the emphasis given to wheat production in this area. Spring lambing Merino ewes joined to British breed rams appears to be the most attractive grazing activity for natural pasture on non-arable areas. However subsequent analysis indicates that returns from beef cows are comparable to returns from Merino ewes, particularly where it is possible to reduce fixed costs. In some cases the stocking rate can be boosted by winter feed made available from oat crops. Lot feeding of calves, and safflower and linseed production are activities which may be profitably included in a farm plan provided the operator accepts the increase in risk.

As mentioned elsewhere, it is felt that the present situation is a transitory one, and that in the future, greater emphasis will be given to rotations and livestock activities. The worry and problems of planting and harvesting wheat may well induce operators to grow less wheat and run more cattle, even if it means less profit. This study now turns to consider various alternative objectives that may be sought by farm operators.

3. INVESTIGATION OF FARMERS' OBJECTIVES

3.1. Introduction

Before the results of a linear programming study of farm activities can be applied to any particular farm, it is necessary to take account of farmer objectives other than income maximization. In the previous section, maximum income plans were computed for a number of farms without recognizing any additional objectives the individual farmer may prescribe. These objectives may be very important in determining an acceptable plan for an individual farm. Detailed examination of alternative farmer objectives was considered worthwhile for a number of reasons.

i) Discussion with farmers in the Warialda Farm Advisory Group suggested that objectives other than profit maximization influenced the farm organization they adopted.

ii) The results of the variable wheat price programmes (see Table 2.2) showed that at certain prices, a number of quite different plans produced approximately the same income level, implying that alternative objectives might be attained with little sacrifice of income.

iii) An alternative farm plan which better satisfies a farmer's true objectives would obviously be of more interest to him. Where these individual objectives are widely held, the results could be widely applicable, and by considering a number of alternative objectives and a number of farm situations, greater generality of the results should be achieved.

Additional objectives or preferences may be included in the linear programming model by incorporating additional restraints which specify certain minimum or maximum acreages of crops or designated numbers of livestock etc., while maintaining the original maximum income objective function. This method has the disadvantage that the sub-optimal solutions so obtained might involve a considerable and perhaps unacceptable loss of income. In this analysis the study of sub-optimal solutions was effected by changing the original income maximizing objective function to a minimum income restraint, and formulating alternative objective functions representing alternative management goals to be maximized or minimized. An outline of this technique is contained in Appendix V.

3.2. Farmers' Objectives

A meeting of the Warialda Farm Advisory Group provided an opportunity to discuss initial results and to review some farming objectives. Using this discussion as a guide, a number of farmers' objectives were formulated. These were thought to be of general interest to farmers in the area.

Results were obtained for the following objectives:

i) Maximization of the acreage of lucerne
ii) Maximization of the acreage of summer crops
iii) Maximization of income from wheat and cattle only
iv) Minimization of total man days of labour.
v) Maximization of income from cattle only

The results computed are discussed below.

3.2.1. Maximization of the Acreage of Lucerne

Using this objective, solutions were computed for all five farms. This permitted between-farm comparisons as well as a comparison of the solutions for a particular farm.

By permitting NFI to fall by 15%, large areas of lucerne enter the farm plans. In contrast, none of the income maximization plans for the five farms include lucerne. The results are summarized in Table 3.1) , while full details appear in Appendix V.

TABLE 3.1
Maximum Lucerne Acreages for Five Programmed Farms

Farm No.	Arable Area as % Total Farm Area	Lucerne Acreage as % of Arable Area	
		Net Farm Income 92.5% Maximum	Net Farm Income 85% Maximum
1	83	18.2	33.3
2	100	15.2	29.1
3	43	20.5	40.7
4	24	25.6	50.6
5	73	16.7	31.8

For a 15% reduction of NFI, the proportion of arable land which can be brought into a wheat/lucerne rotation is higher on those farms with lower proportions of their land devoted to cropping. Thus, for a given proportionate reduction in NFI, Farms 3 and 4 transfer larger proportions of their arable land to lucerne than Farms 1, 2 and 5.

Generally, lucerne displaces wheat. On Farms 3 and 5 oats are also displaced. In the case of Farm 1 the W/L rotation replaces the WG - SG / WF - SG / WG - SF / WG - SF / rotation.

If returns from cropping were to fall relative to the returns from livestock, for example as a consequence of a decline in wheat prices, then greater areas of land could be diverted to lucerne with a given proportionate reduction in net income.

When the present transitory drought recovery phase in the area is over and cash reserves are restored, greater acreages of lucerne are likely. Farmers may deem it worthwhile to forgo some income in return for the benefits of lucerne. These include diversification into livestock, and resting the land from cropping - probably a long-run necessity on the red-brown earths. Additional benefits arise from the improved nitrogen status of the soil and the control of weeds. Demands placed on labour and machinery at planting and harvesting of crops would also be reduced.

Lucerne needs to be rotationally grazed by sheep for most economic utilization and the additional fencing and watering facilities required may deter some farmers. Rotational grazing is not so important with cattle, and this may partially overcome the fencing problem. However, careful grazing management would be needed to control bloat, and even so the gross margin obtained appears to be slightly lower than from sheep.

3.2.2. Maximization of Summer Crops Area

The consequences of expanding summer crop production to even out labour demands, or as a risk aversion measure were investigated for Farm 1. The amount of summer crops able to be grown after winter crops is limited by the time available for land preparation. This model includes a November ploughing restraint limiting the amount of land able to be prepared for December planting, (see pp.) This ploughing is assumed to be done by casual labour, enabling full-time farm labour to concentrate on harvesting the winter grain crops. Thus, the limit of 1000 acres is an estimate of the amount of land one man could plough in November after winter grain crops are harvested. The computed farm plans appear in Table 3.2.

A large amount of summer crops is included in plan 1, the maximum NFI plan. Plan 2 shows a small increase in summer crops for a small loss of NFI. The increase in limited because of the land preparation restraint explained above. Plans 3, 4 and 5 involve the transfer of land from wheat to the WG - SG / WF - SG / WG - SF / WG - SF / rotation. Net farm income falls rapidly even though some savings in Avadex spray and contract machinery services are made. In plans 2 to 5, total labour usage remains at about the same level as in the optimal plan but minor variations in the seasonal pattern occur. The increase in sorghum acreage of 2,637 - 1,822 or 815 acres is small considering the substantial reduction of $57,288 - $48,695 or $8,593 in NFI. However, this is largely because of the restraint on summer crop land preparation. Because this restraint severely limits the amount of summer crop that can be sown, the solutions were recomputed, permitting up to 2,500 acres of land to be ploughed in November. These results appear in Table 3.3

TABLE 3.2
Farm Plans to Maximize the Acreage of Summer Crops I

Activity	Unit	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5
Wheat	ac	4,100	4,100	4,000	3,750	3,363
Sorghum	ac	1,822	1,900	2,000	2,250	2,637
Winter fallow	ac	900	900	1,000	1,250	1,637
Summer fallow	ac	3,178	3,100	3,000	2,750	2,363
Natural pasture	ac	1,000	1,000	1,000	1,000	1,000
Clearing	ac	500	500	500	500	500
Avadex spray	ac	700	700	500	-	-
Merino ewes	head	1,029	1,029	1,029	1,029	1,029
Summer crop	ac	1,822	1,900	2,000	2,250	2,637
Net farm income	$	57,288	57,259	57,202	55,077	48,695
Net farm income % of maximum income	%	100	99.9	99.8	96.1	85.0

Relaxation of the summer crop land preparation restraint permits larger areas of summer crop to be grown for a smaller loss of income. Plan 2 transfers 1578 acres from continuous wheat to double cropping, i.e. a crop of sorghum and a crop of wheat in one year. The area under wheat remains at 4,100 acres. However, sorghum acreage is increased to 3,400 acres with a small reduction NFI of $57,288 - $56,704 or $584.

The farm plans incorporating larger amounts of sorghum increase labour needs in November and December when planting of summer crops takes place, and in April when harvesting of summer crops and planting of winter crops overlap. On the other hand, less land under summer fallow means less labour is needed in January and Fabruary for weed-control cultivation. Thus, plans 2 to 5 accentuate the peak labour demands in the November-December and April-May periods. If adequate supplies of suitable casual

TABLE 3.3

Farm Plans to Maximize the Acreage of Summer Crop II

Activity	Unit	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5
Wheat	ac	4,100	4,100	3,750	3,200	2,872
Sorghum	ac	1,822	3,400	3,750	4,300	4,627
Winter fallow	ac	900	900	1,250	1,800	2,128
Summer fallow	ac	3,178	1,600	1,250	700	373
Natural pasture	ac	1,000	1,000	1,000	1,000	1,000
Clearing	ac	500	500	500	500	500
Avadex spray	ac	700	700	-	-	-
Merino ewes	head	1,029	1,029	1,029	1,029	1,029
Summer crop	ac	1,822	3,400	3,750	4,300	4,627
Net farm income	$	57,288	56,704	56,505	51,791	48,695
Net farm income % of maximum income	%	100	99.0	98.6	90.4	85.0

labour are not available at these times, the cost of employing sufficient full-time labour or contractors to meet this need could be considerable.

Plans 3,4 and 5 transfer land from continuous wheat to the WG - SG / WF - SG / WG - SF / WG - SF rotation. In plan 5, the sorghum acreage has increased from 1,822 acres in plan 1 to 4,627 acres for a reduction of $8,593 in NFI. Plan 5 also contains 2,872 acres of wheat, indicating that over half the arable land is growing two crops each year., Such a policy could be continued for only a short time, even on the best soils of the area. The increased cropping and reduced amount of land under fallow for accumulation of soil moisture would probably increase the risk of low crop yields with concommitant depressions of net farm income.

3.2.3. Maximization of Income from Wheat and Cattle

Some farmers prefer wheat and cattle because of easier management. They prefer to concentrate their managerial efforts on these two activities with no need to worry about rotations etc. Solutions emphasising wheat and cattle production were obtained for Farm 3, and results are summarized in Table 3.4. These results are computed on the assumption that total fixed costs remain constant over all farm plans. In fact, the fixed costs may be reduced as one moves from plan 1 to plan 4, provided the permanent labour force can be reduced. Section 3.2.4. shows that after labour adjustments, the NFI from plans 1 and 4 are comparable.

Plan 1 is the maximum income plan where 36.4% of the total gross margin is earned from sheep - the remainder coming from grain-fed calves and wheat. Plans 2 and 3 have less oats, this area being diverted to wheat. Winter feed is reduced and so sheep numbers fall. Oats for the grain-fed calves are now purchased. This adjustment is accomplished with only a slight reduction of $32,647, - $32,190 or $457 in NFI.

Plan 4 substitutes beef cows (producing calves for sale at approximately twelve months of age) for sheep until only 19 ewes remain in the plan. The net farm income is $27,751 and this needs only to fall by $40 for all sheep to be replaced by cattle. At this point all income would be earned from the two enterprises wheat and cattle.

TABLE 3.4

Farm Plans to Maximize Income from Wheat and Cattle

Activity	Unit	Plan 1	2	3	4
Wheat	ac	1,259	1,333	1,600	1,600
Grain oats	ac	341	267	-	-
Summer fallow	ac	1,600	1,600	1,600	1,600
Natural pasture	ac	2,100	2,100	2,100	2,100
Clearing	ac	200	200	200	200
Avadex	ac	800	800	800	800
Merino ewes	head	2,764	2,632	2 162	19
Beef cows	head	-	-	-	150
Grain-fed calves[a]	head	150	150	150	150
Total gross margin from cattle and wheat[b]	$	32,176	33,730	39,282	48,106
Net farm income[c]	$	32,647	32,565	32,190	27,751
Net farm income % of maximum income	%	100.0	99.7	98.6	85.0

a In this instance the zero restraint on grain-fed cattle has been relaxed to a maximum of 150 head.

b These figures are prior to deduction of harvesting costs, Avadex spray and purchased contract services.

c Net farm income is computed on the assumption that total fixed costs remain constant over all farm plans.

Thus, the farm plan may be simplified to just wheat and cattle with the sacrifice of $32,647 - $27,751 or $4,896 which represents 15% of NFI. There may be additional savings of labour costs from this adjustment in the farm plan, and these are discussed in the next section.

3.2.4. Minimization of Total Man Days of Labour.

The objective here is to minimize the amount of farm labour used. This could be interpreted as maximizing leisure time. In conjunction with the minimum income restraint, this means that the operator wishes to earn a certain income by doing as little work as possible. Alternatively, since the direction and supervision of employed labour requires considerable managerial effort, this objective could be said to be directed towards the reduction of the demands on management. Such objectives may be widespread among farmers, particularly those free of debt and middle aged or beyond.

The man days required for the direct operations associated with each activity were estimated, and incorporated into an objective function which was minimized. Time spent on overhead or general farm work such as erecting and maintaining fences, yards and sheds, major repairs and overhauls to machinery or time spent buying and selling stock etc. is not included. The range of solutions obtained enable the operator to choose the income level he desires, in relation to the amount of work he wishes to undertake himself, or the number of men he employs.

Solutions were computed for Farm 3. The solutions obtained were identical to those above for maximizing TGM from wheat and cattle, (Table 3.4). The number of man days of labour required per annum for each of the plans are as follows:-

Plan	1	2	3	4
Man days	1039	1008	890	413

These labour needs were investigated further on a monthly basis. It was assumed that each employee works 21 man days per month, (assuming 8 hours per standard man day) and that the equivalent of a further 21 man days per month may be worked as overtime in periods of peak labour needs. Labour is assumed to be paid $2,300 per annum, plus overtime at a rate of $12 per day. The results of this seasonal analysis of labour requirements are summarized in Table 3.5.

TABLE 3.5
Income Effects of Varying Labour Use on Farm 3

Plan	Number of full-time men	NFI assuming constant fixed costs $	Estimated labour costs $	NFI after labour costs adjustments $
1	4	32,647	10,800	32,647
2	4	32,565	10,650	32,715
3	4	32,190	10,200	32,790
3	3.5	32,190	9,250	33,740
4	2	27,751	5,700	32,851

It was found that four men could operate plan 1 by working up to 30 man days each in peak months. Overtime would be worked from November to January and from March to May. Plan 2 requires the same number of men as plan 1, but a slight reduction in overtime would be possible.

Plan 3 would allow reduction in labour costs of $1,550 compared with plan 1, provided it was possible to emply one man for only seven months a year. If such part-time labour could not be obtained, an alternative would be to operate the farm with three full-time workers and to make greater use of contractors. However, heavy reliance on contractors would be unlikely to reduce the demands on management. Difficulties could be experienced in arranging for contractors to perform the crop operations when required, resulting in increased losses due to untimeliness of operations. Furthermore, the efficiency with which contracted operations are performed may be lower than if the work is done using on-farm labour and machinery.

If neither part-time labour nor contractors can satisfactorily be employed, then a fourth full-time worker would be required to operate plan 3. This would, of course, increase labour costs, although a saving in overtime of some $600 per annum would be possible.

Plan 4 could be operated by two men, with overtime being worked mostly in April, May and November. Labour would cost $5,700 per annum - a saving of $5,100 over plan 1. Further reductions in labour use below that of plan 4 would imply less than full utilization of land, and therefore have not been considered.

After allowance for labour costs, plans 2, 3 and 4 are all marginally more profitable than plan 1. Plan 3 is the most profitable assuming one man can be employed for only seven months a year. Otherwise, plan 4, which consists of wheat and beef cows only, is the most profitable.

These results are calculated on the assumption that farm labour can be reduced to the levels indicated.

However, it appears that on many farms in the area, changes in the labour force are not easily accomplished, at least in the short-run. Some farms may rely heavily on family labour, so that it might be very difficult to reduce the number of workers. In other cases, a farmer might prefer to maintain a larger labour force than necessary for social or prestige reasons, or as a hedge against the possibility of increased labour needs associated with some future change in his system of farming. Table 3.5 shows that the economic incentive to vary the existing labour force would generally not be very great. However, as labour costs continue to rise, the need for economy in labour use will become more pressing. This analysis shows that there is considerable scope for rationalization of labour use on farms in the North West, although this will vary with the particular situation existing on each farm.

3.2.5. Maximization of Income from Cattle Only

This objective emphasizes a preference for cattle and a desire to use lucerne as a rotation crop. The restriction preventing cattle from being grazed on lucerne is relaxed, but the zero restraint on grain-fed cattle is maintained. Thus Farm 5 is programmed to maximize income from cattle grazing. The solutions are summarized in Table 3.6.

TABLE 3.6
Farm Plans to Maximize Income from Cattle

		Plan					
Activity	Unit	1	2	3	4	5	6
Wheat	ac	1,641	1,442	1,333	1,333	1,291	1,243
Grain oats	ac	159	358	467	467	509	541
Summer fallow	ac	1,800	1,800	1,800	1,800	1,800	1,784
Lucerne	ac	-	-	-	-	-	16
Natural pasture	ac	655	655	655	655	655	655
Clearing	ac	200	200	200	200	200	200
Avadex spray	ac	900	900	900	900	900	884
Merino ewes	head	951	574	162	-	-	-
Beef cows	head	-	51	93	104	109	115
Gross margin from cattle	$	-	3,017	5,500	6,170	6,470	6,800
Net farm income	$	23,025	21,556	20,329	19,993	19,832	19,575
Net farm income % of maximum income	%	100.0	93.6	88.3	86.8	86.1	85.0

From plan 1, the maximum income plan, to plan 6, there is a transfer of arable land from wheat to oats for grazing and grain. Oats are preferred to lucerne because they produce more feed in the most critical winter period, June-August. Only in plan 6 where NFI is reduced by 15%, does lucerne make a token appearance. By then, 541 acres of oats are grown.

In the optimal income plan the only stock are Merino ewes. As income falls, sheep are displaced by cattle, being completely replaced in plan 4 when NFI is reduced by $23,025 - $19,993 or $3,032. However, crops still predominate in all plans. Even after NFI is reduced by 15% only 20.5% of gross income is derived from cattle. Of course, labour adjustments might be effected, as direct labour is reduced from 598 man days to 402 man days per annum. A monthly analysis of labour needs, as in section 3.2.4. above, indicated that plan 6 would save the labour of approximately one full-time worker compared to plan 1, a saving of $2250. Thus, after allowance for possible savings in labour, plan 6 would yield a NFI after adjustment of labour use of $21,825, compared with $23,025 for plan 1 - the optimal income plan. That is, while Merinos have been selected as the sole livestock activity in optimal plans, they can be replaced by cattle at current prices for a modest reduction in expected income. Clearly, only a relatively small increase in the gross margin of cattle relative to Merinos is required to displace sheep from the income - maximizing plans.

3.2.6. Maximization of Minimum Income

A serious drought occurs in this area with an average frequency of once in every ten years. The risks of financial set-backs associated with such droughts weigh heavily on farmers' minds, especially after their recollections of the very severe 1965/6 drought. There is a tendency to favour enterprises which are less vulnerable to drought, in the hope of reducing the risk of severe economic loss. Some consideration of this objective was effected by estimating for each activity the worst gross margin that could be expected under severe drought conditions.[1] In most cases these were negative. These drought losses were then minimized subject to a minimum average income restraint[2]. In other words, the risk of loss in a drought year was minimized subject to a restriction that the average income over several years was not unduly depressed by this strategy. The farm plans obtained by this analysis fulfilled the double objectives of:

i) earning at least a certain level of income on average,
ii) minimizing losses in a drought.

The solutions summarized in Table 3.7 were computed for Farm 5.

As the average NFI constraint is progressively relaxed, land is first diverted from growing oats to wheat, and sheep numbers decline. This reduces average NFI slightly but reduces losses in a drought year by a significant amount.

Plan 3 provides a small reduction in drought losses by diverting 200 acres of wheat to the WG - SG / WF - SG / WG - SF / WG - SF / rotation. This saves on Avadex spraying and some contract machinery services.

Plan 4 is interesting because sheep numbers are reduced to such an extent that the natural pasture is not fully utilized. If average NFI is reduced by a further $828, no sheep would be carried and the natural pasture area would be idle. This situation prevails on some properties in the area at present as farmers have not restocked following the 1965 drought. The high losses associated with livestock in a drought (either feeding, or selling and buying back after the drought) seem an important factor in the swing to cropping and the reluctance to restock.

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1. The minimum gross margins were derived on the assumption that crops were sown but failed completely, and that livestock had to be hand-fed for ten months. This over-simplifies the situation, but provides some guide as to why sheep in particular are held in such disfavour.

2. Quadratic risk programming could be used for this kind of problem. Lack of suitable data and computational problems prevented its use in this study.

TABLE 3.7

Farm Plans to Minimize Drought Losses

Activity	Unit	Plan 1	Plan 2	Plan 3	Plan 4
Wheat	ac	1,681	1,800	1,600	1,600
Grain oats	ac	119	-	-	-
Sorghum	ac	-	-	400	400
Winter fallow	ac	-	-	200	200
Summer fallow	ac	1,800	1,800	1,400	1,400
Natural pasture	ac	655	655	655	137
Clearing	ac	200	200	200	200
Avadex spray	ac	900	900	500	500
Merino ewes	head	885	674	674	141
Minimum net farm income	$	-30,653	-29,416	-29,116	-25,607
Average net farm income	$	23,025	23,001	22,873	19,572
Net farm income % of Maximum income	%	100.0	99.9	99.3	85.0

3.3. Conclusions

In Part 3, the sub-optimal solutions computed were directed to the attainment of goals additional to income maximization. These analyses were made because it was thought that further changes in farming systems in the area could be expected to occur. Some possible objectives which farmers might consider in making these changes were therefore investigated. Plans were computed with income reductions of up to 15% of the optimal level. Large differences in the individual farm plans occurred and these are summarized below.

i) While none of the optimal income plans included lucerne, between 33% and 51% of the arable area could be diverted to lucerne by accepting a fall in income to 85% of the optimal level. The actual proportion of the arable area diverted to lucerne depends on the characteristics of the particular farm.

ii) Assuming ample machinery to prepare land for summer crops immediately following a winter crop, it is possible to grow large amounts of grain sorghum with small income reductions. However, this can only be achieved if large areas of a farm are double cropped. Such a policy would be possible for a short period only as double cropping would impose heavy demands on soil fertility and structure.

iii) On Farm 3 it is possible to move entirely to wheat and cattle (beef breeding cows) with a modest reduction in TGM. However, subsequent analysis of labour requirements on this farm revealed the possibility of rationalizing labour usage so that this simple plan could generate the highest NFI as well as being the easiest to manage. It is interesting to note that this simplified plan is the current plan employed on this property, and is worked by two men.

iv) On Farm 5, it was found possible to substitute beef cows for sheep with no more than a 15% loss of NFI. Again, if rationalization of labour resources is possible, this plan could be achieved with somewhat less than a 15% reduction to NFI.

(v) As protection against the risk of drought, it was possible to reduce considerably the potential drought loss by moving out of livestock and concentrating on cropping. While this decreased the average NFI by 15%, the possible loss from a drought was reduced from $30,653 to $25,607 - a reduction of $5,046 or 16.5%.

A number of farm plans have been suggested which permit either partial or total fulfilment of some goal other than maximizing NFI. It is assumed that farm operators would be prepared to sacrifice some income to attain other personal goals. Some farmers may be prepared to forgo 15% of their NFI, while others may regard this as excessive. Plans involving smaller sacrifices of NFI have been included in the tables and by interpolation between the plans shown, a plan could be derived which would optimize a given alternative objective subject to any specified reduction of NFI. Thus, the farm plan can be adjusted to take account of the needs and aspirations of the individual farmer. This should result in a plan closely tailored to the farmer's needs, and presented in such a way as to make him aware of the income loss involved in seeking particular objectives other than maximization of NFI.

It has been shown above that quite wide variations in farm plans can occur without incurring large income reductions. Throughout this study, the input/output matrix has remained constant. If the input/output relationships were permitted to vary to take account of differences in the managerial abilities of farmers and in the physical factors associated with individual farms, further variation in farm plans would be likely. Despite the predominance of wheat in farm plans which maximize NFI, the wide variety of enterprise mixes among the near-optimal plans suggests that the plan most appropriate for a given farm is likely to be very dependent upon the specific circumstances of that farm and upon the individual preferences and abilities of the farmer.

4. SUMMARY AND CONCLUSIONS

This area of the North West of New South Wales has increased wheat production steadily since the mid 1950's and more rapidly in recent years. A number of reasons for the increased wheat cropping have been suggested in this study. Of major importance has been the steadily improving profitability of wheat production compared to sheep grazing. This has arisen because of the favourable prices for wheat relative to wool. In addition however, improved managerial skills, greater use of fertilizers and ready adoption of new technologies associated with wheat have encouraged greater production. The results in Part 2 of this study, where a number of farms were analysed using linear programming, confirm that wheat is the most profitable farm activity, with livestock restricted to the non-arable land. More recently, the 1965 drought, which resulted in large reductions in stock numbers, further encouraged farmers to expand wheat cropping rather than to restock to former levels. Wheat offers the best prospects for farmers to recoup drought losses and to restore their financial positions.

But what of the future? Without too much crystal ball gazing, it can be appreciated that the present situation is unlikely to persist for very long. For example, the soils in many areas could not be cropped continuously for many more years before fertility and structural problems would occur. In addition, as their equity improves some farmers may prefer more leisure or may wish to lighten their management load. Some of these factors have been considered in Part 3 of this study, where farmer objectives other than maximization of NFI were examined. There are also important questions about the future of wheat. For example, will Australia be able to sell the rapidly increasing amount of wheat she is producing? If not, will there be production controls? Will there be lower prices? Anxieties about such questions as these are causing farmers to consider what opportunities exist to diversify their production.

In the light of these factors, some alternative activities to wheat cropping have been suggested. Rotations, particularly lucerne rotations associated with careful lucerne grazing management, are likely to increase the present role of livestock in the farm enterprise. However, cropping will remain important. Wheat, oats and barley are proven grain crops in this area, while grain sorghum, linseed and safflower are possible crops although they are not widely grown at present. Finally, there is the possibility of grain feeding livestock, particularly young cattle. In general, the area is fortunate in having a range of viable alternatives should wheat production become unprofitable or restricted by production controls or storage limitations.

APPENDIX I

BASIC PROGRAMMING MATRIX

		ACTIVITY NUMBER																												
Resources	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Gross Profit	$	22.02	14.05	24.29	7.56	43.21	45.86	-2.9	8.63	0	0	-3.0	-0.92	-4.0	5.7	4.17	2.75	6.19	19.35	-24.6	65.9	29.75	18.00	-0.05	50.0	-0.65	-2.37	-3.25	-4.97	-2.0
Non-arable Land	ac										1	1																		
Potentially Arable Land	ac											1																		
Arable Land - Winter	ac	1	1	2		1	1	1	1	1		-1	1																	
Arable Land - Summer	ac	1		1	1	1		1		1		-1																		
Winter Crop Restraint	ac	1	1	-2		-1	1	-2	1	-1			-3	-2																
Summer Crop Restraint	ac		-1	-1	1	-1																								
Total Stock Feed Pool																														
Dec-Feb	DSM'S									-15	-8				6.5	3.7	3.0	5.5	41	40										
March-May	DSM'S			-10	-10			-7	-5	-9	-6				3.5	5.6	3.0	3.2	44	25										
June-Aug	DSM'S							-8	-6	-5	-3.5				3.7	5.3	3.0	3.4	49	29										
Sept-Nov	DSM'S							-2		-20	-10				7.0	3.5	3.0	6.1	60	48										
Cattle Feed Pool																														
Dec-Feb	DSM'S										-8								41	40										
March-May	DSM'S			-10	-10			-7	-5		-6								44	25										
June-Aug	DSM'S							-8	-6		-3.5								49	29										
Sept-Nov	DSM'S							-2			-10								60	48										
Sheep Feed Pool	DSM'S																													
March-May	DSM'S							-7	-5	-9	-6				3.5	5.6	3.0	3.2												
Grain Oats Pool	bus.								-24												55	55	100	-1						
Calves Supply	No.																			-0.9	1				1					
Grain Fed Cattle Lim.	No.																				1	1	1.5							
Safflower Limit	ac			1																										
Linseed Limit	ac					1																								
Winter Crop Sowing Limit	hrs.	0.15	0.15	0.15																										-1
Summer Crop Sowing Limit	hrs.				0.15																									
Summer Crop Land Prep. Limit	hrs.				0.2																									
Wheat Harvest	ac	1	1	1																						-1	-1	-1	-1	
1st-15th Nov. Harvest Limit	hrs.																									.12				
16th-30th Nov. Harvest Limit	hrs.																										.12			
Nov. Harvest Limit	hrs.						0.24		0.12																	.12	.12			
1st-15th Nov. Contract Harvest	hrs.																											.12		

APPENDIX I (cont)

Activity Number	Activity	Unit
1	Wheat I	ac
2	Wheat II	ac
3	Winter fallow, sorghum, wheat	ac
4	Grain sorghum	ac
5	Safflower	ac
6	Linseed	ac
7	Grazing Oats	ac
8	Grain Oats	ac
9	Lucerne	ac
10	Natural pasture	ac
11	Clearing	ac
12	Winter fallow	ac
13	Avadex spray	ac
14	Crossbreds - spring lambing	head
15	Crossbreds - autumn lambing	head
16	Merino wethers	head
17	Merino ewes	head
18	Beef cows I	head
19	Beef cows II	head
20	Grain-fed property produced calves	head
21	Grain-fed purchased calves	head
22	Grain-fed purchased steers	head
23	Buy oats	bu.
24	Sell calves	head
25	Harvest wheat 1st-15th Nov.	ac
26	Harvest wheat 16th-30th Nov.	ac
27	Contract harvest wheat 1st-15th Nov.	ac
28	Contract harvest wheat 16th-30th Nov.	ac
29	Contract planting	ac

APPENDIX II

Activity Budgets

CROPS

WHEAT I

This is wheat sown after a summer fallow. It is assumed that the wheat is not grazed, and that small amounts of nitrogen are applied as well as superphosphate.

Gross Income	$	$
27 bu @ $1.46		39.42
Variable Costs		
Seed	1.00	
Fertilizer	1.45	
Spray	2.00	
Freight and insurance[1]	11.07	
Plant operating costs	1.88	17.40
Gross Margin per Acre		$22.02

WHEAT II

This is wheat sown after a summer crop. The incidence of crop failure is increased due to depleted soil moisture at sowing. However, inspection of rainfall records indicates that adequate rainfall would occur sufficiently often for an overall average of approximately 20 bushels per acre to be obtained,i.e. a yield reduction of 7 bushels per acre. Additional fertilizer inputs have been allowed for, but tractor and machine operating costs are reduced as a summer fallow is not maintained.

Gross Income	$	$
20 bu @ $1.46		29.20
Variable Costs		
Seed	1.00	
Fertilizer	2.50	
Spray	2.00	
Freight and insurance[1]	8.20	
Plant operating costs	1.41	15.11
Gross Margin Per Acre		$14.09

WINTER FALLOW, GRAIN SORGHUM, WHEAT

It is assumed that grain sorghum yields 20.5 bushels per acre after a winter fallow. The succeeding wheat crop is identical to Wheat II.. A composite gross margin budget is presented below.

1. Freight and insurance includes the cost of hail insurance of 7 cents per bushel, transport to the rail silo, assumed to be performed by contractors at 9 cents per bushel, and freight to the nearest port, Newcastle at 25 cents per bushel.

	$	$
Gross Income		
20.5 bu (11 cwt) @ $32.00/ton (net of freight)		17.60
Variable Costs		
Cost of winter fallow	0.92	
Seed	1.00	
Fertilizer	2.50	
Spray	2.00	
Plant operating costs	0.98	7.40
Gross Margin WF - SG		10.20
Gross Margin Wheat II		14.09
Gross Margin WF - SG / WG		$24.29

GRAIN SORGHUM

This is grain sorghum sown after a winter crop. The crop is heavily dependent on rain which falls during the summer period so that yields of 18.6 bushels per acre are only slightly lower than for sorghum after fallow. Additional fertilizer inputs have been included for this crop.

	$	$
Gross Income		
18.6 bu (½ton) @ $32.00/ton (net of freight)		16.00
Variable Costs		
Seed	1.00	
Fertilizer	3.60	
Spray	2.00	
Plant operating costs	1.84	8.44
Gross Margin per Acre		$ 7.56

SAFFLOWER

A yield of half a ton per acre can be expected, and the grower delivers the grain to Moree. To avoid frost damage, this crop is planted in late July-August, permitting a short winter fallow, thereby providing some weed control.

	$	$
Gross Income		
25 bu (½ton) @ $104.00/ton		52.00
Variable Costs		
Seed	1.15	
Fertilizer	2.50	
Freight	3.00	
Plant operating costs	2.14	8.79
Gross Margin Per Acre		$43.21

LINSEED

This crop should yield half a ton per acre assuming a clean seedbed is provided. Delivery is made to Moree.

Gross Income	$	$
20 bu (½ton) @ $119.00/ton		59.50
Variable Costs		
Seed	1.50	
Fertilizer	1.00	
Spray	6.00	
Freight	3.00	
Plant operating cost	2.14	13.64
Gross Margin Per Acre		$45.86

GRAZING OATS

This crop is grown to provide feed in autumn and winter to supplement the natural pasture. The crop is grazed out in the spring and the land ploughed for a summer fallow. Effective weed control is obtained with this crop.

Variable Costs	$
Seed	1.00
Fertilizer	0.80
Plant operating costs	1.10
Cost Per Acre	$2.90

GRAIN OATS

Again autumn and winter feed is produced, but the stock are removed in the spring and the crop permitted to run to head. The grain can either be sold, or used on the farm as stock feed. No weed control is obtained.

Gross Income	$	$
24 bu @ $0.50/bu (net of freight)		12.00
Variable Costs		
Seed	1.00	
Fertilizer	0.80	
Plant operating costs	1.57	3.37
Gross Margin Per Acre		$ 8.63

If preferred, barley could be grown in place of oats at a similar cost and yield.

LIVESTOCK [1]

CROSSBREDS - SPRING LAMBING

Merino-Border Leicester ewes are joined to British Breed rams. The ewes are assumed to produce 8.5 lbs of wool per head. Lambs and cast-for-age ewes are sold in January.

		$	$
Gross Income per 100 ewes			
90 lambs 36 lb	@ 20c/lb + $1 skin		738.00
20 cfa ewes	@ $4.35		87.00
Wool 886 lbs	@ av 32c/lb		283.52
Variable Costs per 100 ewes			
24 replacements	@ $8.50	204.00	
Shearing, crutching, dipping, drenching etc.	$0.85/hd	87.50	
Stock selling charges		42.00	
Wool selling charges		20.00	
Ram replacement		37.50	
6% interest on flock		48.00	
Supplementary feeding	@ $1. per hd	100.00	539.00
Gross Margin Per 100 Ewes			569.52
Gross Margin Per Ewe			$ 5.70

CROSSBREDS - AUTUMN LAMBING

Autumn lambing results in a lower lambing percentage, but slightly higher prices are obtained for the lambs sold in August.

		$	$
Gross Income Per 100 ewes			
70 lambs 32 lb	@ 22c/lb + $1 skin		562.80
20 cfa ewes	@ $5.15		103.00
Wool, 886 lbs	@ av 32c/lb		283.52
Variable Costs			
Stock selling charges		35.00	
Rest as for crossbreds (spr. lamb)		497.00	532.00
Gross Margin Per 100 Ewes			417.32
Gross Margin Per Ewe			$ 4.17

MERINO WETHERS

The wethers are assumed to cut 12 lbs of wool per head.

		$	$
Gross Income per 100 wethers			
Wool 1,200 lbs	@ av 45c/lb		540.00
20 cfa	@ $4.50		90.00

1. In all livestock activities, it is assumed that replacements are purchased.

Variable Cost Per 100 wethers		$	$
Wool selling charges		34.00	
Stock selling charges		4.40	
Replacements - 22	@ $6.00	132.00	
Shearing etc.	@ 80c/head	80.00	
Interest	@ 6%	30.00	
Supplementary feeding	@ 75c/head	75.00	355.40
Gross Margin per 100 wethers			274.60
Gross Margin Per Head			$ 2.75

MERINO EWES

The ewes are joined to Border Leicesters or other suitable British breed rams, and lamb in spring. The wethers and cast-for-age ewes are sold in January. The ewe weaners are sold in March. The ewes are assumed to cut 10 lbs of wool per head.

Gross Income		$	$
40 wethers 35 lbs	@ 18.5c/lb + $1 skin		298.00
40 ewe weaners	@ $8.60 per head		344.00
20 cfa	@ $4.90		98.00
Wool, 1000 lbs	@ 45c/lb		
36 lbs	@ 32c/lb		461.52
Variable Costs Per 100 ewes			
Stock selling charges		34.00	
Wool selling charges		30.00	
Replacements 24	@ $10.00	240.00	
Shearing, etc.	@ 85c/head	87.50	
Ram replacements		37.50	
Interest	@ 6%	54.00	
Supplementary feeding	@ $1/head	100.00	583.00
Gross Margin per 100 ewes			618.92
Gross Margin Per ewe			$ 6.19

BEEF COWS I

The cows calve in the spring, and the calves are sold at approximately 13 months of age.

Gross Income Per 100 cows		$	$
90 calves 13 mths old, 357 lbs	@ 28c/lb		9,000
12 cfa cows	@ $100		1,200
Variable Costs Per 100 cows			
Stock selling costs		465	
Replacements 14	@ $140	1,960	
Bull replacement		150	
Interest	@ 6%	690	
Supplementary feed	@ $10/head	1,000	4,265
Gross Margin Per 100 cows			5,935
Gross Margin Per Head			$59.35

BEEF COWS II

These cows calve as above, but the calves are either sold at 5 months of age, or fattened on grain for 5 - 6 months in a feedlot.

Gross Income per 100 cows	$	$
12 cfa cows @ $100		1,200
Variable costs per 100 cows		
Stock selling costs	61	
Supplementary feed @ $8.00/head	800	
Rest as for Beef Cows I	2,800	3,661
Gross Margin per 100 cows		-2,461
Cost per cow		$24.61

GRAIN-FED CALVES I

These calves are produced on the property and at five months of age, they are introduced to a feedlot where they are fed a ration of grain with a small amount of vitamin supplement.

Gross Income per calf	$	$
1 calf 11 months old, 363 lbs @ 28c lb		101.64
Variable Costs per calf		
55 bushels oats @50c/bu	27.50	
Selling costs	5.00	
Interest	2.24	
Vitamin supplement	1.00	35.74
Gross Margin per calf		$ 65.90

GRAIN-FED CALVES II

These are purchased calves fed on grain for six months. They are assumed to gain 360 lbs liveweight (2 lbs per day) and 65% of the liveweight gain is assumed to be carcase gain[1]. The fattened calves are sold on a weight basis[2].

Gross Income per calf	$	$
234 lbs @ 28c/lb		65.52
Variable Costs per calf		
As for Grain-fed calves I		35.74
Gross Margin per calf		$29.78

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1. Farm Management Reference Data 1. *Queensland Agricultural Journal*. Vol.91, No.7, July, 1965 p.429.

2. It is assumed that there is no gain or loss arising from changing market prices between purchase date and sale date.

GRAIN-FED STEERS

Twelve-month old steers are fed on grain for six months. They are assumed to gain 458 lbs live-weight (2.5 lbs per day), 65% of which is carcase gain[1]. The fattened steers are also sold on a weight basis.

	$	$
Gross Income per Head		
298 lbs @ 27c/lb		80.50
Variable Costs per Head		
100 bushels oats @ 50c/bu	50.00	
Selling costs	7.00	
Interest	3.50	
Vitamin supplement	2.00	62.50
Gross Margin Per Head		$18.00

1. Farm Management Reference Data 1. Queensland Agricultural Journal. Vol. 91, No. 7, July, 1965, p. 429.

APPENDIX III

Expected Wheat Harvesting Losses

Assuming non-premium wheat, the following losses as a result of rainfall, were assumed.

0 - 1.00"	no loss
1.00" - 3.00"	2 lb per bushel weight loss
3.00" - 4.00"	2 lb weight loss + 20c/bu dockage
4.00" +	4 lb weight loss + 20c/bu dockage

Losses by November 15th, assuming a 27 bu. per acre crop, are:

9/18 chance of 0-1" - no loss
7/18 chance of 1-3" - 7/18 x $1.40 = 0.54
2/18 chance of 3-4" - 2/18 x $6.80 = 0.76

$1.30

Therefore, wheat not harvested until day 15 sustains an expected loss of $1.30 per acre, thus the average expected loss for wheat harvested in the first half of November is $0.65 per acre.

Losses by November 30th, assuming a 27 bu. per acre crop, are:

3/18 chance of 0-1" - no loss
9/18 chance of 1-3" - 9/18 x $1.40 = 0.70
6/18 chance of 4" + - 6/18 x $8.20 = 2.74

$3.44

Therefore, wheat not harvested until day 30 sustains an expected loss of $3.44 per acre. Thus the average loss for wheat harvested in the second half of November is:

($1.30 + $3.44)/2 or $2.37 per acre.

APPENDIX IV

Feed Pool Supplies and Livestock Feed Requirements

	December to February	March to May	June to August	September to November
Feed Supplies (DSM per ac)[a]				
Natural pasture	8	6	3.5	10
Lucerne	15	9	5	20
Grazing Oats	-	7	8	2
Grain Oats	-	5	6	-
Sorghum stubble	-	10	-	-
Feed Requirements (DSM per head)[a]				
Crossbreds - spring lambing	6.5	3.5	3.7	7.0
Crossbreds - autumn lambing	3.7	5.6	5.3	3.5
Merino ewes - spring lambing	5.5	3.2	3.4	6.1
Merino wethers	3.0	3.0	3.0	3.0
Beef cows I	41	44	49	60
Beef cows II	40	25	29	48

a DSM = Feed required to sustain one dry sheep for one month.

APPENDIX V

Maximization of Lucerne Acreage - Results

(a) Variable NFI Programming

This method is similar to variable-price programming described earlier, but in this instance it is NFI which is varied. A farmer may seek an objective other than maximum income. To achieve such an objective will generally result in some loss of income. For example, if a farmer wants to grow lucerne, and lucerne yields a lower gross margin than wheat, then for every acre of land he transfers from wheat to lucerne, he reduces his income by an amount equal to the difference in the gross margins of wheat and lucerne. The technique can be illustrated by reference to the plans for Maximization of Lucerne Acreage, Farm 1, see below.

Plan 1 is the optimal income plan which does not include any lucerne. If income is permitted to fall by $4.73, one acre of lucerne in rotation with wheat can be grown in place of the WG - SG / WF - SG / WG - SF / WG - SF / rotation. This process of substitution continues until there is no sorghum or winter fallow in the plan, so a new plan, plan 2 is obtained. At this point, 900 acres of lucerne is grown, and income is reduced by $4,254. The process then continues, transferring land from wheat production to lucerne, with income falling by $5.66 per acre transferred. This process could then continue until all the arable land is under lucerne, of the process is halted by imposing a limit on the amount income can be reduced. In this case, NFI has been permitted to fall by 15%, and plan 3 is the plan at that level of NFI. Farmers would be unlikely to be interested in subsequent plans which would involve income reductions of more than 15%.

Using this computational procedure, it is possible to interpolate solutions between the plans shown. For example, if the owner of Farm 1 wished to grow 1000 acres of lucerne, the income loss could be calculated. There would be a loss of NFI of $57,288 - $53,034 or $4,254 for 900 acres, and a loss of $5.66 per acre for the remaining 100 acres, making a total of $4,254 + $566 or $4,820. Such a plan would include 1,000 acres of lucerne, and 4,000 acres of wheat.

(b) Maximization of Lucerne Acreage - Results

Farm 1

Activity	Unit	Plan 1	Plan 2	Plan 3
Wheat	ac	4,100	4,100	3,334
Sorghum	ac	1,800	-	-
Winter fallow	ac	900	-	-
Summer fallow	ac	3,200	4,100	3,334
Lucerne	ac	-	900	1,666
Natural pasture	ac	1,000	1,000	1,000
Clearing	ac	500	500	500
Avadex spray	ac	700	1,600	834
Merino ewes	head	1,029	2,353	3,479
Lucerne acreage as % arable area	%	-	18.0	33.3
Net farm income	$	57,288	53,034	48,695
Net farm income as % optimal income	%	100	92.6	85.0

Farm 2

Activity	Unit	Plan 1	2	3	4	5
Wheat	ac	4,100	4,100	3,733	3,200	2,977
Sorghum	ac	200	-	-	-	-
Winter fallow	ac	100	-	-	-	-
Summer fallow	ac	3,900	4,100	3,733	3,200	2,977
Lucerne	ac	-	100	467	1,000	1,223
Avadex spray	ac	1,900	2,000	1,633	1,100	877
Merino ewes	head	-	147	686	1,471	1,798
Lucerne acreage as % arable area	%	-	2.4	11.1	24.4	29.1
Net farm income	$	46,852	46,374	44,304	41,282	39,824
Net farm income as % optimal income	%	100	99.0	94.6	88.1	85.0

Farm 3

Activity	Unit	Plan 1	2	3
Wheat	ac	1,333	1,333	949
Grain Oats	ac	267	-	-
Summer fallow	ac	1,600	1,333	949
Lucerne	ac	-	267	651
Natural pasture	ac	2,100	2,100	2,100
Clearing	ac	200	200	200
Avadex spray	ac	800	533	149
Merino ewes	head	2,632	2,554	3,118
Lucerne acreage as % arable area	%	-	16.7	40.7
Net farm income	$	28,194	26,478	23,965
Net farm income as % optimal income	%	100	93.9	85.0

Farm 4

Activity	Unit	Plan 1	2	3
Wheat	ac	700	350	346
Summer fallow	ac	700	350	346
Lucerne	ac	-	350	354
Natural pasture	ac	2,240	2,240	2,240
Avadex spray	ac	350	-	-
Merino ewes	head	2,306	2,821	2,826
Lucerne acreage as % arable area	%	-	50.0	50.6
Net farm income	$	19.572	16,694	16,636
Net farm income as % optimal income	%	100	85.3	85.0

Farm 5

Activity	Unit	Plan 1	2	3	4
Wheat	ac	1,642	1,333	1,333	1,228
Grain Oats	ac	158	267	-	-
Summer fallow	ac	1,800	1,600	1,338	1,228
Lucerne	ac	-	200	467	572
Natural pasture	ac	655	655	655	655
Clearing	ac	200	200	200	200
Avadex spray	ac	900	700	433	328
Merino ewes	head	953	1,439	1,361	1,515
Lucerne acreage as % arable area	%	-	11.1	25.9	31.8
Net farm income	$	22,083	21,934	20,258	19,572
Net farm income as % optimal income	%	100	95.3	88.0	85.0

Farm Management Guidebooks available from the University at $1.50 are:

No. 1. Calculating the Best Bet Fodder Reserve by R. Officer and John L. Dillon. This Guidebook outlines a procedure for calculating the expected cost and associated risk of various-sized fodder reserves. It also specifies the data to be forwarded to the Centre if it is desired to have the calculation done by their computer routine.

No. 2. Discounting and Other Interest Rate Procedures in Farm Management by Anthony H. Chrisholm and John L. Dillon. This Guidebook outlines the procedures of discounting and compounding and, via a number of diverse examples, illustrates their application to farm management decisions involving payments over time. An extensive set of Interest Tables is included for reference purposes.

No. 3. Budgeting, Gross Margins and Programming for Farm Planning by P.A. Rickards and D.J. McConnell. This Guidebook shows how the problem of selecting the optimum combinations of enterprises on a farm can be analysed by simple budgeting methods and how these are related to more advanced computer planning techniques. As such, it introduces the Centre's computer planning service.

No. 4. Farm Management Accounting: A Commentary by John L. Dillon, E.O. Burns, R.C. Shoobridge and R.A. Pearse. This Guidebook reports on the 1966 National Workshop on Standardization of Terminology and Procedures in Farm Management Accounting. It reproduces the seven papers delivered on farm accounting and electronic data processing, details of the Workshop's recommendations and suggestions concerning the Queensland Joint Committee Report on Farm Management Accounting and includes a comprehensive bibliography of farm management accounting.

No. 5. Sheep Flock Growth Rate Tables by A. Wright and A.S. Watson. This Guidebook outlines the problem of obtaining information about the growth and composition of sheep flocks as required for forward planning exercises. The methods outlined, together with an extensive set of reference tables, are aimed at reducing the mathematical chores of advisers and their clients.

No. 6. Best Bet Farm Decisions by J.P. Makeham, A.N. Halter, and John L. Dillon. This Guidebook deals with farm management decisions involving risk. Recognising the personal aspects of risky choice, the book shows how complex alternative but possible decision in terms of individual preferences.

A special concession of $1.50 per Guidebook is available to students of High Schools, Agricultural colleges or Universities.

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Farm Management Reports available from the University, are:

No. 10. Budgets and Gross Margins for Irrigation-based Farm Enterprises in the North West by N.J. Dudley and D.J. McConnell. This report contains detailed physical and financial data for irrigation enterprises on the heavy soils of the North West Region of New South Wales. Input-output relationships, resource requirements, seasonal operations, costs and gross margins are presented for each enterprise. Price $1.00

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No. 12. Planning Procedures for Pasture Irrigation Projects Based on Large Farm Dams by D.J. McConnell. This report outlines procedures for preliminary planning and economic evaluation of dam-based pasture irrigation projects. Starting with an analysis of the environmental potential for pasture irrigation, sections discuss dam cost estimation, project reliability and alternative distribution systems. A potential dam-irrigation project on a New England property is used as an example. Price $2.50.

No. 13. Poultry Economics - A Report on the Results of Layer and Broiler Trials Carried Out at the Universities of New England, edited by D.J. McConnell. This report summarises results of economic significance arising from the University of New England's continuing series of poultry trials. Papers deal with broiler and layer stocking rates, yolk colour effects grain and roughage substitution in rations and broiler marketing. Price $1.00.