

'LAND, DAIRY PRODUCTION AND RURAL POPULATION PROSPECTS  
IN COASTAL N.S.W., WITH SPECIAL REFERENCE TO  
THE MACLEAY VALLEY.'

by

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Volume I

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Except where otherwise acknowledged in the text,  
this thesis represents the original research of  
the author.

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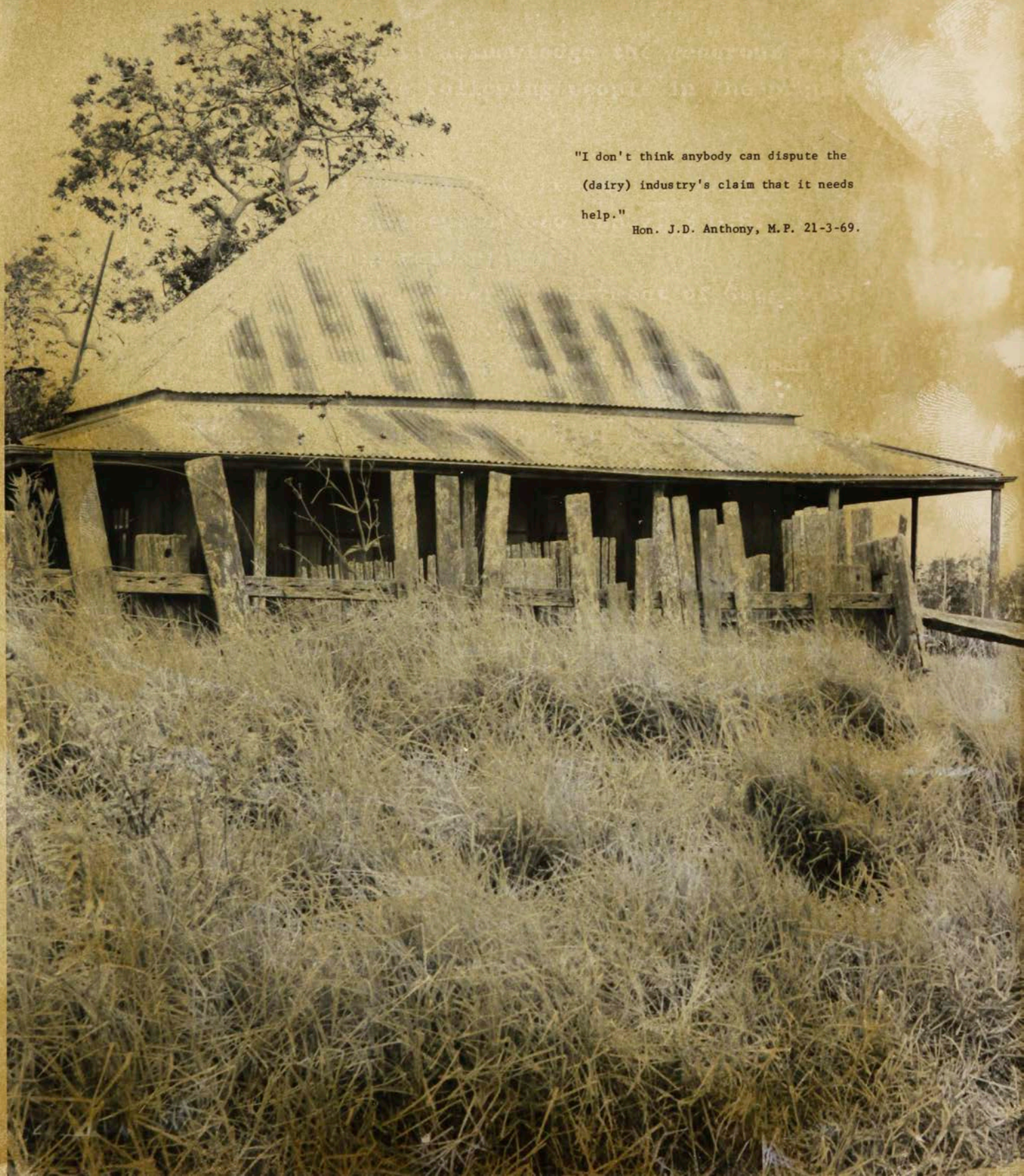
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Peter Laut.

"I don't think anybody can dispute the  
(dairy) industry's claim that it needs  
help."

Hon. J.D. Anthony, M.P. 21-3-69.



## Part A. Introduction.

There is only one chapter in this section which serves to introduce a number of aspects of the study. The thesis is presented, Government dairy policy is discussed, the organization of the N.S.W. dairy industry is outlined and there is reference to social science research in the N.S.W. dairy region. Finally there is a short theoretical discussion concerning marginal dairyfarming situations.

## Chapter I.

### THE THESIS AND SOME BACKGROUND.

#### The Thesis

Government policy towards the Australian dairy industry has been concerned with improving the economic condition of milk producers. This policy has been developed through Commonwealth-wide appraisals of conditions within the Australian dairy industry and assessment of future market opportunities for Australian dairy products. Commonwealth-State relationships in the Australian dairy industry are such that Commonwealth dairy industry policy cannot allow for variations in physical and economic comparative advantages provided by some dairy regions. It is assumed that dairy policy is to foster not only the economic well-being of the industry as a whole, but also that of the individuals operating in it. A further assumption is that the Government is concerned to keep rural depopulation as low as possible. This thesis contends that a more flexible policy is necessary, able to recognise and allow for regional comparative advantage within the Australian dairy industry. Otherwise, considerable rural depopulation of some dairy regions can be expected to continue.

#### Government Dairy Industry Policy

Production of dairy, as for other agricultural goods, is dependent upon the effectiveness of the combination of land, capital, management and labour

resources at the farm level. Federal Government policies aimed at increasing per farm income within the region have tended to stimulate dairy production in districts located along the extensive margin of dairy production as well as stimulating per farm activity within this margin.<sup>1</sup> This has tended to create new marginal producers rather than remove the previously existing group of marginal producers while preventing the entry of a new marginal group. Recently, proposals have been made by the Australian Federal Government and the N.S.W. State Government to assist marginal dairy producers out of the industry.<sup>2</sup> The aims of these policies appear to be to reduce the number of dairymen, presumably with less than proportional decrease in dairy production. To date, information on both Federal and State policies has given little reason to assume that consideration will be given to maintaining the present distribution of the Australian dairy industry, nor has it acknowledged that many districts now devoted to dairying might cease to produce dairy products, if economic efficiency is to be the only criterion for Government policy decisions in the industry. The consequences of district and perhaps regional abandonment of dairying on rural population distribution could be considerable in some coastal regions of N.S.W.

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1

Drane, N.T. and Edwards, H.R. The Australian Dairy Industry. pp. 22-24. Cheshire. Melbourne. 1961.

2

Address by the Minister for Primary Industry, the Hon. J.D. Anthony, at a meeting of dairy farmers at Ipswich, Qld. 15 March, 1968.

## The N.S.W. Dairy Industry

In N.S.W. State Government policy aimed at maintaining metropolitan milk supplies has divided the N.S.W. coastal dairy region into two product-oriented formal regions.<sup>1</sup> The Milk Board Zone (See Fig.I-1) is a statutorily delimited region in which dairymen are able to sell a varying but comparatively high proportion of their milk as a whole milk at premium prices.<sup>2</sup> The Milk Solids Region (See Fig. I-1) consists of the remaining dairying districts to the north and south of the Milk Board Zone, in which dairymen sell milk or cream to dairy factories for the manufacture of butter, cheese and other milk solids products.<sup>3</sup> In this region some milk is sold directly by dairymen as whole milk and some is sold by factories for consumption as whole milk, but the total volume forms a small proportion of total milk production. It is proposed to treat here only the dairying industry of the Milk Solids Region to avoid unnecessary complication and confusion of issues, for while the regions have several problems in common, the situation within the Milk Board Zone is complicated by the necessity of having to maintain winter production.

Within the N.S.W. Milk Solids region the total area of land suited to dairying under present technology and economic conditions is distinctly limited. There

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<sup>1</sup> Laut, P., Agricultural Geography. Vol.2, pp. 424-428.

<sup>2</sup> Ibid.

<sup>3</sup> Ibid.

are two reasons for this. First, pasture requirements for commercial dairying are especially demanding and there are severe limitations to substitution of either additional area of similar or lower quality of land, or additional capital, or some combination of the two. A common assumption among dairymen is that if land will not support approximately one milking cow per acre it is of inferior quality for dairy purposes. Second, land which is climatically, edaphically and topographically suited to pasture production of sufficient quality for dairying in N.S.W. is limited to areas of alluvial deposition and basalt flows along the coastal valleys and eastern margins of the highlands. Both types of land are found in very restricted areas and only in the Richmond Valley is the total area of land suitable for dairying of any extent. (See Fig. I-2).

The N.S.W. Milk Solids Region extends to the north and south of the N.S.W. Milk Board Zone and includes twenty-nine government areas (See Fig. I-1). Dairying activities are generally confined to the major river valley alluvial floors and occasional basalt plateaux, and are thus very unevenly distributed.<sup>1</sup> The location of dairy farms and of stock within these farms is directly related to the ability of these lands to produce pastures suitable for milking cows. Ideally, dairy cows require in excess of 10,500 lbs of dry matter, with a

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1

Holmes, J., The Distribution of dairying in coastal N.S.W. The Australian Geographer. 1962. p. 210.

minimum protein content of 65 per cent per annum for actual consumption.<sup>1</sup> If allowance is made for pasture losses due to the normal system of open range grazing practised in N.S.W., spoilage and uneven distribution of pasture growth in relation to dry matter demand, something in excess of 30,000lbs of dry matter per annum would be required.<sup>2</sup> This volume of feed should be available within half a mile or so of milking sheds, although some herds are walked up to a mile between pastures and milking place.<sup>3</sup> These requirements preclude all but the most vigorous pasture grasses, such as the sub-tropical naturalised grasses paspalum (Paspalum dilatatum), kikuyu (Pennisetum clandestinum) and temperate exotics such as rye grasses (Lolium spp.) and clovers (Trifolium spp). These grasses and legumes require considerable soil moisture to maintain suitable rates of growth.<sup>4</sup> For example, on soils with water storage capacity of 7.00" or better in the top 18"

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1

Calculated on the basis of a mean body-weight of 1,000 to 1,200 lbs per cow and a mean production of 200 to 250 gals. of milk of 4% butterfat content from feed requirement data listed in A Manual of Australian Agriculture. Editor Molnar, I. 2nd edition, pp. 556-557.

2

Hutton, J.B. Investigations of the efficiency of pasture conversion by dairy cattle. New Zealand Agricultural Science. Jan. 1966, pp. 18-24.

3

Personal communication, Mr. J. Noonan, now District Agronomist, N.S.W. Department of Agriculture, Taree N.S.W.

4

For general moisture requirements see Anon. Pasture Legumes and Grasses. Bank of N.S.W., Sydney. 1961. (Soil moisture requirements for kikuyu are examined in detail in Chapter X.)

of the profile, such as fine-grained alluvials and basaltic loams, approximately 40" of annual rainfall with a moderate summer maximum are required to maintain continuous pasture growth in the northern section of the N.S.W. Milk Solids Region.<sup>1</sup> Within the N.S.W. Milk Solids Region, seasonal distribution of rainfall and probability of dry spells and drought are climatic characteristics of equal importance with volume of rainfall to the dairy industry. Fitzpatrick and Nix have classed the northern section of the region as suitable for growth of sub-tropical and some cold-tolerant tropical pasture species, and the southern section as being more suited to temperate pasture species.<sup>2</sup> The seasonal distribution of rainfall, temperature and growing season index are outlined for a number of typical stations in Fig. I-3A to I-3E, and I-4A to I-4E, and the areal distribution of mean annual rainfall and variations from the mean are depicted in Fig. I-5 and I-5B. Data for rainfall distribution in the region demonstrates the marked tendency to mid-summer early autumn maxima in the south. Both northern and southern sections of the region are within Lawrence's two lowest dry-year/drought frequency belts in N.S.W., most parts of

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1

These criteria were gathered from personal communications with agricultural scientists working in this region: Mr J. Noonan, Taree; Mr R. Coleman, N.S.W. Department of Agriculture, attached to University of New England; and Dr J. Murtagh, Wollongbar Research Station, Lismore N.S.W.

2

Fitzpatrick, E.A., and Nix, H.A., Climate and Australian Grasslands. Editor. Moore, M. In press.

the region having less than 1 and the remainder 1-6 dry years in a 35 year period.<sup>1</sup>

Summer temperatures are suitable for the growth of paspalum (Paspalum dilitatum) in both the south and the north of the Milk Solids Region and of kikuyu (Pennisetum clandestinum) in the north only. Winter temperatures, with occasional frosts to the south of the Richmond Valley restrict winter growth of both these grasses, but appear to permit limited growth of sub-tropical pasture legumes such as Stylo (Stylosanthes gracilis), glycine, (Glycine javanica), Siratro (Phaseolus atropurpureus) and desmodium (Desmodium spp), which have been introduced experimentally in the Macleay Valley.<sup>2</sup> However, the southern section of the region has some compensating climatic advantages. Autumn, winter and spring temperatures are well within the range of temperate species and paspalum (the predominant pasture species), once ploughed and harrowed prior to sowing temperate exotic species, is comparatively slow to re-establish. There is no similar compensating advantage in the northern districts of the region, for while summer legumes can be sown these only add to the already plentiful summer pasture supply. On the other hand, despite its slight winter growth, kikuyu is

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1

Lawrence, E.F. A Climatic analysis of N.S.W. The Australian Geographer. 1937. pp.5-34.

2

For general notes on temperature effects see Anon. Pasture Legumes and Grasses, Bank of N.S.W. Sydney. 1961. Comments on effects of winter temperatures on growth rates are based partly on personal observation and partly on personal communication with Dr. J. Murtagh.

sufficiently vigorous during summer months to rapidly invade areas cultivated and planted to winter-growing temperate exotic species, which consequently seldom survive more than eighteen months before they are over-run and must be replanted.

The south has the advantage of marginally more suitable climatic conditions for all year round pasture growth, but it has comparatively limited areas of suitable soils, these being restricted mainly to the Bega and Moruya River Valleys. In contrast, the northern section of the region includes a series of comparatively large river valleys, each with considerable areas of alluvials.<sup>1</sup> In addition, there are several notable areas of basalt plateau which have developed deep fertile loams highly suitable to dairy pasture production.<sup>2</sup>

Although the N.S.W. Milk Solids Region is not directly dependent upon overseas markets for sale of its dairy products, it is indirectly dependent upon them through the operation of the Australian Commonwealth Equalization Scheme, which provides a uniform factory price for all butter and cheese produced in the

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1

Atlas of Australian Soils. CSIRO.

Sheet 2. Melbourne-Tasmania Area. 1961.

Sheet 3. Sydney-Canberra-Bourke-Armidale Area. 1965.

2

Predominantly in the Tweed and Richmond Valleys and on the Dorrigo plateau. Soils derived from basaltic parent material are classified in the: SOILS WITH GRADATIONAL TEXTURE PROFILES: Red Friable Earths, Brown Friable Earths. Red Friable Porous Earths and Brown Friable Porous Earths. (Atlas of Australian Soils.)

Commonwealth whether sold on local markets or overseas.<sup>1</sup> Should overseas markets be closed to the Australian dairy industry, the N.S.W. market would be highly attractive to the Victorian dairy industry. In the long run the continued security of the N.S.W. Milk Solids Region is therefore as dependent upon continued overseas sales of dairy products as the Victorian milk solids industry. The total value of Australian dairy exports has remained relatively steady between \$A35m. and \$A45m. since the early 1950's, but the value of these exports as a proportion of all Australian exports has been declining gradually (See Table I-1 and Fig. I-6). With the decreasing importance of dairy production as a source of overseas funds, and an increasing awareness of the economic inefficiency of much of the Australian industry, the advisability of continuing the current rate of subsidy has been openly questioned, although it seems unlikely to be abandoned in the near future.<sup>2</sup> Removal or decrease of the Commonwealth dairy subsidy, according to the Economic surveys conducted by the Bureau of Agricultural Economics, would have dire effects on the economy of the N.S.W. Milk Solids Region, which in

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1

Official yearbook of the Commonwealth of Australia.

No. 48.1962. pp. 998-999. Commonwealth Bureau of Census and Statistics. Canberra, Australia.

2

Official Yearbook of the Commonwealth of Australia.

No. 49.1963. p.1084

No. 52.1966. p.961.

many districts is already suffering economic stringency.<sup>1</sup>

Social science research in the N.S.W. dairy industry.

A variety of research results treating economic and settlement aspects of the N.S.W. dairy industry have been published since the mid-1950's. Among the earliest, Rutherford conducted a regional survey of the dairy industry in the Manning River district covering many aspects of the industry in this valley.<sup>2</sup> These included area of land resources per farm, farm population, farming activities and levels of production, as well as a variety of economic indicators and sociological considerations. He also examined some aspects of irrigation dairy farming in the Murray Valley, and with Kingsland and possibilities of supplementary irrigation in the Warrell Creek District, N.S.W.<sup>3,4</sup>

1

The Australian Dairy Industry: An economic survey 1961-62 to 1963-64.

Bureau of Agricultural Economics. Canberra, Australia. 1966.

2

Rutherford J. 'Some aspects of land utilisation on dairy farms on the Lower North Coast.' Review of Marketing and Agricultural Economics. Vol. 19, No. 1, March 1951. Ibid. 'Further aspects of dairy farming on the Lower North Coast.' Review of Marketing and Agricultural Economics. Vol. 20, No. 1, March 1952.

3

Rutherford, J. 'Dairy farming in the Berriquin and Denimein Irrigation Districts.' Review of Marketing and Agricultural Economics. 1954. pp 87-164.

4

Kingsland, A.M. and Rutherford, J. 'Coastal river improvement in N.S.W. A study of Agricultural conditions and possibilities of supplementary irrigation in Warrell Creek District or the North Coast.' Review of Marketing and Agricultural Economics. 1950.

Gruen, Waring and Bird, all agricultural economists, have been concerned with diverse aspects of dairy farming ranging from farm labour employment to levels of farm production, and the effects of a variety of innovations of farm production.<sup>1</sup>

Holmes has investigated changes in rural settlement patterns associated with the decline of dairying in two districts of coastal valleys in N.S.W.<sup>2</sup> In addition, the Bureau of Agricultural Economics has conducted and published the results of a series of economic surveys of the industry to provide the basis for estimation of Commonwealth Government subsidy, and for Government policy decisions on the dairy industry.

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1

Gruen, F.H. 'A survey of small North Coast dairy farms.' Review of Marketing and Agricultural Economics. 1958. pp. 5-28. Waring E.J. 'Supplementary irrigation of pastures in humid areas.' Review of Marketing and Agricultural Economics. 1959. pp.239-54. Bird, J.G. 'The dairy industry on the Far North Coast of N.S.W.' Review of Marketing and Agricultural Economics, 1962. pp.13-70. Ibid., and Mason, G. 'The economics of spray irrigation in the Far North area of N.S.W.' Review of Marketing and Agricultural Economics. 1962. pp.32-47. Musgrave, W.F. and Bird, J.G. 'Adjustment possibilities and marginality in the "Big Scrub".' Review of Marketing and Agricultural Economics. 1966. pp.5-28. Bird, J.G. and Marriot, B.W. 'A regional case study of dairy industry adjustment.' Review of Marketing and Agricultural Economics. 1966. pp.202-211 (This is not a complete list of publications by agricultural economists in this field, but these titles suggest the various lines of research undertaken by these workers.)

2

Holmes, J.H. 'The Derivation and use of an index of dairy potential.' Review of Marketing and Agricultural Economics. 1961. pp. 184-205. Ibid. 'The distribution of dairying in coastal N.S.W.' The Australian Geographer. VIII. 1962. pp.207-220.

The majority of these studies provide some description of the land resources involved in dairy farming and in some cases mean productivity ratings per acre of farmland have been given, but none have attempted to analyse the relationships which might be observed between land area/land quality, labour, management and capital investment and dairy production.

These studies, especially those of the Bureau of Agricultural Economics, and at State level those of the Department of Agriculture agricultural economists, have had considerable impact upon the direction of Government policy, both Federal and State. The problems of achieving a predictably satisfactory Government policy, or even of deciding the most desirable aims for Government policy without an appreciation of current and potential productivity of land resources used for dairying was highlighted in the 'Report of the Dairy Industry Committee of Enquiry.'<sup>1</sup> It was, in fact, the need to find a means of recognising marginal dairy farms and the problems associated with increasing per farm production and per farm income, implicit in the McCarthy Report, which provided the initial stimulus for this study.

#### The marginal dairyman.

Economically marginal dairymen may be defined as those dairymen receiving little or no interest and in

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1

'Report of the Dairy Industry Committee of Enquiry.'  
McCarthy, M.E. (Chairman). Canberra, 1960. Part VII b.  
Paragraphs 917-918 and V. Paragraphs 1117 to 1122.

some cases negative returns on capital investment when labour charges are made. They may be divided roughly into two groups: Those whose land resources are within the extensive margin of core dairying districts, but whose combinations of land, capital and management are unable to achieve an adequate level of production; and those whose land resources are outside the extensive margin of core dairying districts, and despite large areas of land, land quality (often combined with inadequate management), prevents achievement of adequate levels of production and consequently of returns. Assuming land, labour/management and capital to be the resource input groups, four possible production outcomes are possible.<sup>1, 2</sup> (See Fig. I-7). In Fig. I-7A successive units of labour/management and land/capital combine to produce proportional increases in production so neither scale economies nor diseconomies operate. It could be assumed that where this situation held there would be little opportunity for increasing returns through increasing scale of activities alone, and the best approach to increasing returns may lie in increasing the efficiency of management. In Fig. I-7B the problem

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1

Land and capital investment in stock and plant are commonly closely correlated in the N.S.W. dairy industry, especially in economically small farm units where there are few mechanical items.

2

Labour and management are so commonly provided by the one person (frequently of very limited managerial ability) in the N.S.W. Milk Solids Region that they can be considered the same resource unit in this analysis.

is somewhat different for here, an increase in land/capital from  $\underline{ob}$  to  $\underline{ob}_1$  provides a marked increase in production from  $\underline{oc}$  to  $\underline{oc}_1$ . In this case, the increase in production is almost directly proportional to the increase in land/capital, suggesting that labour/management is markedly under-employed.

Fig. I-7C illustrates the situation in which successive inputs of land/capital,  $\underline{ob}$ ,  $\underline{ob}_1$ ,  $\underline{ob}_2$ , yield considerably less than proportional increases in production, represented by  $\underline{oc}$ ,  $\underline{oc}_1$ , and  $\underline{oc}_2$ . When the labour/management input is concurrently increased from  $\underline{oa}$  to  $\underline{oa}_1$ , the resultant planes  $\underline{a}_1\underline{bc}_3$ ,  $\underline{a}_1\underline{b}_2\underline{c}_4$  and  $\underline{a}_1\underline{b}_2\underline{c}_5$  repeat the initial pattern of production increases, with  $\underline{oc}_3$  proportional to  $\underline{oa}$  and  $\underline{oa}_1$ . Only when the relationships illustrated in Fig. I-7D pertain are increasing economies of scale available. Fig. I-7B represents the case of a small dairy farm located in a core dairying region with inadequate land resources and consequent under-employment of labour-management, and is typical of the first group of marginal farms discussed above. Fig. I-7C is representative of the farmer whose land resources are located outside the extensive margins of core dairying districts, where land quality would require very heavy capital investment to make it suitable for dairying. In the former case, the solution usually lies in increasing farm land-resources to allow fuller employment of labour/management, and perhaps economies of scale. In the latter, there may be no effective solution while the farm is concerned with dairying. The only economic solution may be reorganisation of resource inputs, abandoning the land to other forms of rural production.

Should sufficient information relating to production/labour/management/land/capital relationships be available, it is theoretically possible to achieve solutions concerning the optimal combination of these resources. Even so, translation of theoretical optimal solutions to actual solutions would be exceedingly difficult. One of the most important impediments in any attempt to achieve optimal resource combination is the rigidity of the farm land-resource, divided as it is into discrete units or farms with title or ownership rights vested in individuals. Land title precludes the assumption of ready divisibility of land, of even ready manipulation of land by division into discrete units of equal potential productive capacity, unless titles were abandoned for whole districts and reallocation undertaken. In the normal situation the probability of a land owner seeking to sell land being near another land owner both needing and desiring to increase the size of his land resource, and having land of suitable area/quality to provide an optimal solution for the would-be purchaser, would be slight indeed. When the ability to secure finance and chances for a satisfactory price agreement without successful competition from others seeking additional land-resources are also considered, it becomes apparent that chances of reaching optimal farm-size solutions throughout any region are practically nil without compulsory redistribution of land.

### Trends in the N.S.W. Milk Solids Region.

Three general trends have been observed in the N.S.W. dairy industry, especially in the Milk Solids Region.

1. Decline, and in some cases abandonment of dairy farming in districts possessing more marginal physical environments. Because of the isolated or strip nature of many of the land resources associated with the more marginal physical environments, this trend is also coupled with transport problems between farm and factory.

2. Increased scale of production based on both increases in area of land resources per farm and increased application of capital to land resources. This tendency has been most readily observed in core dairying regions, and in those where a notable proportion of milk production is sold by factories as wholemilk.

3. Improved technology and management with consequent improved productivity and returns. Again this trend has been most commonly observed in core dairying regions.

### Organisation of this study

The aim of the present study is not to demonstrate these trends in the N.S.W. Milk Solids Region in detail, but to elucidate the relationships between farm land resources and current productivity and potential productivity in terms of milk production, and through these relationships to assess the probable

effects of policies which Governments may implement on regional dairy production and consequently on rural population distribution in the region. To achieve this purpose, the study was divided into three sections:

1. An analysis of trends in the dairy industry, population, workforce and age distribution data for the N.S.W. Milk Solids Region.
2. The use of an input/output model to predict butterfat production in the Macleay valley, given farm resource input information.
3. Some conclusions concerning the probable effects of two types of dairy policies on production and population in the Macleay Valley, N.S.W. The discussion leading to these conclusions includes the use of a pasture growth rate model.

The structure of the thesis is summarised in Fig. I-8.

Part B: THE N.S.W. MILK SOLIDS REGION, is devoted to the analysis of dairy industry and population data provided by the Commonwealth Bureau of Census and Statistics and demonstrates, within the limitations imposed by the available data, the trends currently associated with the dairy industry and the population of the N.S.W. Milk Solids Region.

Part C: THE MACLEAY VALLEY, N.S.W., is divided into three sections. The first section examines available data for rural holding use and dairy industry production, and the second to population trends in the Macleay Valley. The third is devoted to detailed analysis of dairy farm resource inputs and dairy production in the Macleay Valley,

to establish predictive functions related to the more readily measurable of these inputs. The final section of the study, Part D: CONCLUSIONS, discusses the probable effects of Government policies designed to increase land per farm, or land productivity on rural population in the Macleay Valley particularly and in the N.S.W. Milk Solids Region generally.

## Part B. The N.S.W. Milk Solids Region.

Part B of the study examines two economic aspects of the N.S.W. Milk Solids Region in detail to indicate the overall trends in both its dairy industry and its population. In order to examine areal variations in trends, for these variables, data for local government areas have been aggregated to form regions which correspond to coastal river watersheds as far as possible.

In Chapter II dairy industry data used include:-

1. The number of registered dairy farms.
2. The number of milking cows reported on registered dairy farms.
3. The volume of milk products reported delivered by registered dairy farms to dairy factories.

These variables and three mean measures derived from them are treated by trend analysis, both for the Milk Solids Region as a whole, and for individual valley regions. Using the results of these analyses, several commonly held hypotheses concerning developments in the dairy industry of the Milk Solids Region are examined.

Population, workforce and age group data for the N.S.W. Milk Solids Region for the four post-war censuses are treated in Chapter III. Trends in the rural/urban ratio are examined for the Milk Solids Region as a whole and population, workforce and industry employment are analysed by valley regions in considerably

more detail. Although population data extend from 1947 to 1966, they are only available at four points of time and cannot be treated in the same manner as the annual dairy industry data without raising serious questions of statistical validity.

Examination of these two economic aspects of the N.S.W. Milk Solids Region assists the study in two ways:-

1. It allows an appreciation of dairy industry and population trends as a background to the major section of the study which examines the dairy industry of one valley region in great detail.
2. It provides a means of assessing how typical any valley region is of the Milk Solids Region as a whole with regard to these two characteristics. This is an important consideration in the choice of a study region for detailed examination of its dairy industry in relation to the thesis.

## Chapter II

DAIRY INDUSTRY TRENDS IN THE N.S.W. MILK SOLIDS REGION  
1946-67.Introduction.

There has been considerable change within the N.S.W. Milk Solids Region during the past 20 years. In part, these changes have been short-term responses to seasonal conditions, but more important, many of the changes have been consistently in the same direction and represent long-term trends. It is commonly accepted that the N.S.W. dairy industry as a whole has suffered a severe decline in the number of registered dairy farms, and within the Milk Solids Region it is commonly suggested that the number of dairy stock and the volume of milk produced have also declined markedly. However, no survey of trends for these variables has been published on a regional basis and little is known about the comparative rates of decline or increase of these measures of the dairy industry among regions, and their effects on regional rural population distribution.

Dairy Industry Data

Data were obtained from the Rural Industries section of the N.S.W. branch of the Commonwealth Bureau of Census and Statistics for each of the local government areas within the N.S.W. Milk Solids Region for three variables:

1. the number of registered dairy farms,
2. the number of milking cows reported on registered dairy farms, and
3. milk products reported delivered by registered dairy farms to dairy factories.<sup>1</sup>

(Hereafter these variables will be referred to as the number of dairy farms, the number of milking cows and the volume of commercial milk).

From these variables were derived the mean volume of milk reported sold by registered dairy farms to dairy factories (commercial milk per farm), the mean volume of milk reported sold by registered dairy farms to dairy factories per milking cow on registered dairy farms (commercial milk per cow), and the mean number of milking cows reported on registered dairy farms per registered dairy farm (milking cows per farm).<sup>2</sup>

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1

On 31 March each year, every landholder of one acre or more of land used for agricultural purposes completes an agricultural return listing details of agricultural activities and stock supported on the holding. Data are summed by Police Districts, then local government areas. They are not available by farm characteristic or by farm population.

2

Aggregated data for each of the six variables listed above for each of the eight valley regions are tabulated in Tables II-1 to II-6.

To present these data in a more manageable form, the 29 local government areas within the region were aggregated to conform as closely as possible to the watersheds of the coastal river valleys. The two exceptions were the Bellingen-Coffs Harbour-Dorrigo local government areas in the north whose boundaries were so altered by re-organisation of local government areas in 1956 that they cannot be satisfactorily disaggregated, and Eurobodalla Shire, which consists of several small river valleys which cannot be usefully separated. (See Figs II-IA and II-IB). By this means it was possible to provide directly comparable data for eight sub-regions or valley regions continuously from 1946 to 1967, a time span quite adequate for time series analysis and covering the four post-war censuses 1947, 1954, 1961 and 1966.

Selection and use of the six variables provided a number of problems. First, the Bureau of Census and Statistics provides dairy production data in a variety of measures which were frequently altered during the period 1946-67. To overcome this difficulty all milk products were converted to standard milk equivalents in gallons<sup>1</sup>. Second, the Bureau has noted a consistent

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Conversions to standard milk equivalents in gallons:

Commercial butter (lbs) x 2.075.

Butterfat (lbs) x 2.5263.

Cheese (lbs) x 1.0.

Molnar, I. Ed. Australian Agriculture. 1966. Melbourne. p. 604.

discrepancy between the volume of milk products reported delivered to dairy factories by registered dairy farms and the volume reported received by milk factories.<sup>1</sup> The discrepancy generally varies between 1 and 5% per annum, with five exceptional years (1945-46, 1947-48, 1952-53, 1954-55 and 1960-61) when the differences were calculated to be closer to 10%. To overcome this discrepancy all valley region totals were raised for each year by a state sales receipts difference factor provided by the Bureau. Thus while state totals are probably very accurate, there is a greater probability of error for the valley region data which cannot be assessed, despite attempts to minimise it. To some extent the inherent probability of error in production data reduces its potential usefulness. However, the trends in production for each of the valley regions were so marked that it is considered that the errors will not materially alter the trend patterns. Third, it was impossible for the Bureau to provide total populations for each of the basic variables, hence little is known of the distributions for these variables. It seems likely that in all but the smallest of the valley regions, i.e., Eurobodalla, the populations are sufficiently large to assume normal distributions based on the evidence of published data from the census

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Because of these discrepancies, the Bureau has asked that these data should be treated with caution and not published in a raw state. See Appendix I, examiners' copies only.

of rural holdings.<sup>1</sup> Fourth, during the period 1946 to 1967 the Bureau altered a number of categories of data to be reported, for example, registered dairy farms became commercial dairy farms, and milking cows data were divided into cows in milk and dry cows. Direct comparison of annual returns for subsequent years by Police Districts<sup>2</sup> indicated that most variations in data categories did not produce significantly different totals and in some cases information from several categories could be aggregated to provide uniformity.

#### Dairy industry trends.

The three basic variables used in this analysis proved useful measures of farmers' confidence in the dairy industry. The number of milking cows on registered dairy farms provides a measure of short-term confidence of dairy farmers in both the industry, alternative activities<sup>3</sup> and seasonal conditions, while

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'Classification of rural holdings by size and type of activity.' No. 1. N.S.W. Bureau of Census and Statistics, Canberra, Australia. 1960-66 and 1965-66.

2

Until 1967 the N.S.W. Police Department was responsible for delivering and collecting annually rural holdings returns. The returns were first aggregated by Police Districts and later by local government areas, Statistical Divisions and State totals.

3

Gruen, F.H., Ward, L.E. and Powell, A. 'Changes in supply of agricultural products.' Williams, D.B. (Ed). 'Agriculture in the Australian Economy.' Sydney. Sydney University Press. 1967.

the number of registered dairy farms provides a longer-term measure of confidence in the industry. The volume of commercial milk is a useful measure to determine the extent of problems of milk supply facing dairy factories. Data for the three derived variables, commercial milk per farm, commercial milk per cow and milking cows per farm, are useful measures of trends at farm level. (Table II-7 sets out the quadratic equations and first derivatives for each of these variables allowing direct comparison of slopes for each of the trend curves.)

During the period 1946-67 the total number of registered dairy farms in N.S.W. Milk Solids Region declined from 8,636 to 5,337. This decline was continuous except for a short period of expansion from 1952 to 1956. However, the proportions of the total number of dairy farms in each valley region changed only slightly.<sup>1</sup> The overall decline between 1946 and 1967 amounted to 39.2% of the 1946 total. The trend curve:

$$(Eq.I) \quad y_a = 7970 - 140t - 9.2t^2$$

provides a good fit to the graphed data and suggests a continued rapid decline in the number of registered dairy farms in the N.S.W. Milk Solids Region over the next few years. Beyond this the curve becomes so

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Detailed changes in farm numbers in each valley region will be discussed in a later section of this chapter.

precipitous as to be of doubtful use for predicting the future dairy farm population of the region<sup>1</sup> (See Fig. II-2.). Similarly, the number of milking cows reported on registered dairy farms had declined markedly (See Fig. II-3), but not quite as precipitously as the number of dairy farms, c.f. the trend curves (Eq.1) and (Eq.2).

$$(Eq.1) \quad y_a = 7970 - 140t - 9.2t^2$$

and

$$(Eq.2) \quad y_b = 162,165 - 4709t + 4921t^2$$

the difference between the angles of the slopes representing the increase in the number of milking cows per farm. The number of milking cows reported on registered dairy farms better indicates short-term anticipations of both economic conditions which are based on prices received for dairy products and for beef and seasonal conditions. Thus it is a reasonable measure of declining short-term confidence in the milk solids industry. Returns for 1967 indicated some 312,815 milking cows in the Milk Solids Region compared with 436,260 in 1947, the difference representing 23.3% of the 1947 total. Annual variations in the number of milking cows are more noticeable during the slight milk solids industry boom in the early and mid-1950's, than for the number of registered dairy farms, clearly illustrating the greater flexibility of herd size to

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Moroney, M.J. 'Facts from Figures'. Chapter 17. Time series and fortune telling. pp. 321. Middlesex. Pelican. 1962.

economic anticipations in the very short run. Dairy farmers anticipating poor seasonal conditions following a series of droughts or floods may purposely reduce milking herds for one or two seasons, with the view to increasing herd size when seasonal conditions appear more favourable. Such responses are predictable reactions to seasonal fluctuations, but provide little scientific basis for predictive activities.

While such changes may be widespread they tend to be short-lived compared with herd reductions which result from decisions to withdraw from the dairy industry. There may be a considerable time lapse between the initial decisions of a dairyman to seek other employment if he is abandoning rural industry altogether, and the time dairying actually ceases. It is common under these circumstances for the wife to remain on the farm and milk a reduced herd during the interim between the time the ex-farmer gains other employment and when the family group feels sufficiently secure, economically and socially, to abandon the farm. No statistical evidence is available, but it seems very probable that such temporarily reduced herds mask real increases in scale of dairying activities within the milk solids region as measured by number of cows per farm.

Data for the total volume of milk reported sold by registered dairy farms to dairy factories, i.e., commercial milk production, for this period displays a notably differing trend curve, which is represented by the equation

$$(Eq.3) \quad y_c = 132.0 + .584t - .117t^2 \quad (\text{by factor of } 000)$$

(See Fig.II-4). The curve indicates an increase in commercial milk production from 124 million gallons p.a. in 1947 to around 132.5 million gallons in the mid-1950's, despite a constant decline in the number of cows and the number of dairy farms since 1947. However, after the mid-1950's commercial milk production in the region began to decline, so that by the early 1960's the rate of decline was similar to the trend curves for the two previous variables. While seasonal conditions in the region were generally favourable for milk production between 1949 and 1963, the relationships observed between the trend curves for the number of dairy farms, the number of milking cows and commercial milk production suggests that at least till 1955 the region was benefiting from the removal of inefficient or marginal producers.

The most notable feature of annual milk production data in the Region is its marked variability. From 147 million gallons in 1953 to 106 million gallons in 1966, or approximately 20 million gallons from the actual mean of 126.7 million gallons. While the impact of the decline in the number of dairy cows in commercial milk production has been considerable, especially in the latter half of the period, the impact of seasonal conditions is even more obvious. Possibilities of correlating seasonal conditions and commercial milk production for each of the valley regions have been explored, but problems associated with seasonal distribution of climatic elements, soil moisture storage and carry-over of pasture make this too complicated a relationship to warrant inclusion in this

study. The occurrence of flood conditions in some valley regions during years of high rainfall further complicates the issue.

As would be expected with a proportionally greater decline in the number of dairy farms than in the number of milking cows, the number of milking cows per farm was somewhat higher at the end of the period than at the beginning (See Fig.II-5). This increase, described by the trend curve

$$(Eq.4) \quad y_d = 496 + 3.7t + .05t^2$$

was continuous from 1954 onwards. Similarly the trend curve for commercial milk per milking cow

$$(Eq.5) \quad y_e = 327 + 2.5t - 0.01t^2$$

showed a consistent but slight rate of increase throughout the period (See Fig.II-6), although in terms of actual production per cow seasonal conditions caused a series of minor peaks and depressions. As a consequence of the increase in the number of milking cows per dairy farm and the increase in the production of commercial milk per cow, commercial milk production per farm demonstrated a significant increase between 1946-67, represented by the trend curve

$$(Eq.6) \quad y_f = 16,491 + 258t + 11.6t^2$$

Again actual data demonstrated considerable annual variation either side of the trend curve (See Fig.II-7). The volume of standard milk per farm suggested as providing a minimum level of economic reward by the McCarthy Report is represented by the 16,600 gallon line which first intersected the trend curve in

1956.<sup>1</sup> Only during the last nine years of the period was actual mean commercial milk production per farm in the Milk Solids Region in excess of 16,600 gallons.

### Trends by Valley Regions

These data indicate the broad pattern of trends in the N.S.W. Milk Solids Region, but do not distinguish sub-regional variations within the various districts which comprise the region, and provide little opportunity to develop hypotheses concerning relationships between milk production and the factors utilised in its production. For this purpose it was decided to analyse the data for the same six variables by each of the valley regions. The three basic variables: number of farms, number of milking cows and commercial milk production; have been shown in Figs. II-8, 9 and 10 as divided proportionally among valley regions.

By far the most important valley region in the N.S.W. Milk Solids Region is the Richmond. Its proportion of registered dairy farms gradually increased from 47.7% to 52.1% of the Region's total, despite a marked decline in its own dairy farm population during this period. The valley regions with the greatest decline in number of dairy farms were the Clarence (40% of its 1946 total) and the Tweed (49% of its 1946 total). In both, the dairy industry faced considerable competition for land resources from the sugarcane industry in the lower valleys and with the beef cattle industry in the upper river and tributary valleys, especially of the Clarence.

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<sup>1</sup> Standard milk has a butterfat content of 3.3% as required by the N.S.W. Milk Board.

The Richmond Valley, which is the major producing valley region of the N.S.W. Milk Solids Region, increased its proportion of total milking cow population from 51.8% to 54.7% between 1946 and 1967, while most other valleys in the northern section of the Region lost considerable proportions of their milking cow populations, e.g., the Tweed's proportion of milking cows declined from 10.7% to 7.8%. In contrast, the valley regions in the southern section of the Region increased their milking cow populations significantly, e.g., Eurobodalla milking cow population rose from 1.3% of the Region's total to 2.1%. However, the southern section of the Region provides only a small proportion of the region's total dairy farm dairy cow populations and commercial milk production.

Despite some marked seasonal fluctuations in the proportional distribution of the Region's total commercial milk production among the valley regions, e.g., the Macleay in 1962, the general pattern of distribution for this variable was very similar to those of the two other basic variables. The only features worthy of comment are that the Richmond, Tweed and Clarence provided a marginally lower proportion of commercial milk than of registered dairy farms and of milking cows while the Bega, Eurobodalla and Bellingen-Coffs Harbour-Dorrigo regions provided a marginally higher proportion of commercial milk production.

By examining both the basic and derived variable data for each of the Valley regions in turn it should prove possible to test several hypotheses which have been commonly held concerning trends in the Milk Solids Region. Three of these hypotheses could be examined using this data:

- (a) That the greatest rate of decline in the number of registered dairy farms has occurred where opportunities for alternative forms of land-use are greatest;
- (b) that scale of activities (represented by the mean number of milking cows per registered dairy farm) is greatest in the core dairying districts where physical environmental conditions are the most favourable for dairying (represented by commercial milk production per cow), i.e., that scale of activities is greatest where physical comparative advantage is greatest; and
- (c) that the decline in the number of registered dairy farms represents the removal of small-scale dairy farmers from the industry and is accompanied by an increase in the level of scale of activities.

There has been a marked decline in the number of registered dairy farms in every valley region of the N.S.W. Milk Solids Region (See Figs. II-11 to II-18). The actual rate of decline has varied considerably from valley region to valley region, as did the time

of commencement of this decline. First derivatives from the quadratic equations calculated for trend curve analysis in Table II-8 indicate the initial slope of trend curves in 1946 and the rate of change of slopes in succeeding time periods for each valley region. In Bega, Eurobodalla, Macleay and Clarence Valley Regions the decline in number of registered dairy farms commenced prior to 1946. In the Nambucca, Bellingen-Coffs Harbour-Dorrigo, Richmond and Tweed regions there was a period of slight to marked fluctuation in the number of dairy farms between 1946 and 1955, but after 1955 the decline commenced in each of these regions and the rate of decline rapidly became greater than that of the previous group of valley regions. The southern valley regions, Bega and Eurobodalla, showed the slightest percentage decline (28.7%) in the number of registered farms but Nambucca, Richmond and Bellingen-Coffs Harbour-Dorrigo each had a decline of only between 32% and 33% in the number of dairy farms between 1946 and 1967. On the other hand, the Clarence had a decline of over 60% and Tweed of almost 53% in the same period.

Data for the second variable, the number of milking cows on registered dairy farms (Figs. II-19 to II-26) indicate a less marked decline in all valley regions than for the number of registered dairy farms. In Eurobodalla the decline after 1959, became a marked increase which by 1967 amounted to a 17.7% increase in the number of milking cows in the region. (Table II-9 provides arithmetic comparison of the slopes of the trend curves for this variable for each valley region.)

The third variable, volume of milk sold by registered dairy farms to dairy factories, provides generally similar trend curves as the second variable, except in the southern valley regions (See Figs. II-27 to II-34 and Table II-10). After the 1952 season, Bega region had a marked increase in commercial milk production while Eurobodalla had had a slight linear rate of increase which had commenced prior to 1947.

Among the northern valley regions Richmond and Nambucca data provides trend curves with approximately the same proportional changes which began with a gradual increase in commercial milk production reaching a peak around 1959, then declining progressively more rapidly during the rest of the period. Bellingen-Coffs Harbour-Dorrigo region alone of those in the north provides data which indicates a consistent but gradually diminishing increase in total milk production throughout the period,

$$(Eq. 7) \quad y_c = 9356 + 79.7t - 2.4t^2$$

The remaining northern valley regions, especially Clarence and Tweed demonstrates a marked and increasing rate of decline in commercial milk production throughout the period.

Of the derived variables, mean volume of milk reported sold per registered dairy farm to dairy factories provides the most interesting series of trend curves (See Figs. II-35 to II-42), especially when these are considered in relation to the 16,600 gallon line which represents the equivalent of the McCarthy

Commission's minimum desirable level of butterfat production.<sup>1</sup>

Both southern valley regions have trend curves for commercial milk per dairy farm well above the 16,600 gallon level, with the lowest point of their trend curves for this variable in the early 1950's, rapidly increasing thereafter to the vicinity of 38,000 gallons per farm in 1967. Actual mean per farm milk production in the Bega valley rose from a minimum of 17,400 gallons in 1947 to in excess of 38,500 gallons in 1967. The level of mean per farm milk production was considerably more variable in Eurobodalla region than in Bega valley, with 7 years in which actual mean milk production was under 16,600 gallons per farm, and a range of from 13,600 gallons to 38,500 gallons per farm.

Data for mean per farm milk production in the northern valley regions reveals lower levels of dairy farm activity. Only in the Richmond valley has the trend curve for this variable been above the 16,600 gallon line for the majority of the period 1946-67. In this region however the rate of increase per farm was diminishing in comparison with the rapidly increasing trend curves provided by the Macleay, Bellingen-Coffs Harbour-Dorrigo and Clarence Regions data. The general level of per farm milk production in the Nambucca region has been outstandingly low throughout the period starting

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Report of the Dairy Industry Committee of Enquiry. 1960. Commonwealth of Australia. Canberra. p.87, par.918.

at 10,390 gallons in 1946 and rising very gradually to 13,580 gallons in 1967. Actual commercial milk production per farm in the Nambucca only reached the McCarthy Report minimum level in one year, 1967.

Increases in commercial milk production per farm may be accounted for by increases in the mean number of milking cows per farm or increases in milk production per cow, or by some combination of the two. Marked increases in per farm milk production in southern valley regions are the results of marked increase in production per cow, combined with a slight increase in the number of cows per farm in the Eurobodalla region and a marked increase in the number of cows per farm, and a slight increase in production per cow in the Bega valley.

In the northern valleys (See Figs II-43 to II-58) only data for the Bellingen-Coffs Harbour-Dorrigo region provides a trend curve with a notable increase in per cow production (270 to 440 gallons per cow). Hence, increases in per farm production were very closely related to increases in the mean number of cows per farm, suggesting that the general improvement noted in per farm production was the result of either increased scale of land resources per farm or increased carrying capacity per unit of land, the latter resulting from either short-term improvement of seasonal conditions or improved management.

Valley region data generally do not suggest there was a notable relationship between the number of milking cows per farm and milk production per cow.

For example, Richmond and Nambucca regions both had very comparable actual values and trend curves for production per cow but Nambucca, with 40.1 to 44.5 cows per herd, had significantly smaller mean herd size than Richmond (52.8 to 61.6 cows). Similarly, Macleay and Bellingen-Coffs Harbour-Dorrigo had a mean herd size difference of between 6 and 7 milking cows although mean production per cow trend curves were very similar, especially in the early years of the period.

### Conclusions.

From these data it appears that in those valley regions where alternative land-use opportunities have been greatest, i.e., the Clarence and Tweed and to a lesser extent the Macleay, the proportional decrease in the number of dairy farms has been greatest, giving support to the first hypothesis, that the greatest rate of decline in the number of registered dairy farms has occurred where opportunities for alternative forms of land-use are greatest. In these valley regions there are several alternative opportunities for land-use, but unless data were disaggregated to very small-scale units, i.e., Police District, it would be impossible to determine whether the proportional decrease has been greatest along the intensive dairy-farming margin in the Tweed and Clarence where sugarcane cultivation has proved a more profitable enterprise than dairy farming, or along the extensive margin of dairying as is more likely the case in the Macleay, where dairying has given way to beef cattle grazing because of marginal

physical environments for dairying activities. It would also be possible, if data were available on a small-scale basis, to determine the impact of increasing scale of activities within the core dairying districts on the distribution of land resources.

While scale of activities, as measured by mean number of milking cows per farm has been increasing throughout the N.S.W. Milk Solids Region, the increase has in fact been greatest where suitability of the physical environment for dairy farming, as measured by mean volume of milk per cow, has been highest, i.e., in the two southern valley regions, thus apparently satisfying the second contention that the scale of activities is greatest in the core dairying districts where physical environmental conditions are the most favourable. However, these regions have had greater opportunity to sell whole milk either to the Canberra market or as supplementary supplies to factories within the N.S.W. Milk Board Zone, and the problem becomes one of establishing the respective degrees of importance of each group of factors, physical and economic.

The relationship between these two derived variables is not particularly clear in the northern valley regions although there is sufficient evidence to suggest that the hypothesis is null. Much of the lower Richmond district of the Richmond valley region and the Dorrigo district of the Bellingen-Coffs Harbour-Dorrigo region are noted as environmentally favourable for dairy farming. The Richmond valley has

the highest mean number of cows per dairy, and the Bellingen-Coffs Harbour-Dorrigo region has had the most rapidly increasing mean herd size, but because of local government area boundaries it is impossible to segregate districts within these regions for closer examination. At local government area level, for which data must be divided into two eleven year spans (1946-55 and 1957-67), no significant differences in trends were observed, strongly suggesting that either the hypothesis or the form of measurement is not applicable. As the form of measurement adopted does appear to provide a reasonable measure of scale of environment for dairying purposes, it would be necessary to sub-divide regions into the smallest possible data collection areas, which in N.S.W. are the Police Districts, to test the second hypothesis adequately. Because of the arbitrary nature of the Police District boundaries these proved to be of little additional value when trials using Police District data were conducted.

The third hypothesis, that concerning scale of dairy farming activities and decline in the number of registered dairy farms, may be examined by comparing the mean number of milking cows per farm and the proportional decline in the number of registered dairy farms. An examination of data for these variables suggests there is little or no relation between them, and not only small scale dairy farms have abandoned the industry. It follows that forces which stimulated the general decline of the dairy industry in the N.S.W. Milk Solids Region 1947-67 have had a similar effect on both small and large-scale units. While this appears

to negate the hypothesis, there are general field observations which suggest that on one hand there are masking elements which at least temporarily make deductions from data risky and on the other, that the hypothesis is invalid. In practice, two types of dairy producers tend to leave the dairy industry; the smallest, who are economically marginal producers, who leave the industry to seek other employment, and the largest producers who, for a variety of sociological and economic reasons, abandon dairying in favour of some other enterprise, e.g., beef cattle raising. The possible effects of the first group on data on scale of activities has been discussed earlier in this chapter, while the effect of the second group leaving the industry is to nullify the effects on mean data of those of the first group, who ultimately leave the industry.

In the Clarence and Tweed regions, assessment of effects of abandonment on scale of activities in dairying is more complex because the land-use alternative, sugar-cane cultivation, is more economically attractive than dairying. Their lower valley districts which would be important larger-scale dairying districts were the alternative of sugar-cane cultivation not available, experienced absolute abandonment of dairying on land suitable for cane when additional cane assignments became available. These partial explanations are based on field observations, but provide some suggestions why the third hypothesis concerning scale of activities and the decline in the number of registered dairy farms cannot be established from available data.

No data on dairy farm land resources are available from the Bureau of Census and Statistics. This is unfortunate for such information when considered with dairy stock and production data might provide a more accurate assessment of the trends in scale of dairying activities, especially if it were possible to consider mean land resources per milking cow or mean commercial milk production per acre of farmland. The possibilities of explaining the distribution of proportional decline in the number of dairy farms in terms of production per cow and number of dairy farms proved even less fruitful and it appears an alternative hypothesis is required for this task. As the distribution of proportional decline in the number of registered dairy farms is greater in the northern valley regions than in the southern, and more atypical of the higher rainfall, basaltic regions (i.e. Richmond and Dorrigo), there are strong grounds for linking decline in the number of dairy farms with less favourable environmental conditions and perhaps with unfavourable local economic conditions related to location and transport factors.

## Chapter III

POPULATION AND WORKFORCE EMPLOYMENT IN  
THE N.S.W. MILK SOLIDS REGION, 1947-66Population data

The proportional distribution of population in the N.S.W. Milk Solids Region by valley regions corresponds generally to the distribution of dairy stock, dairy farms and commercial milk production. The Richmond valley is once again the most important valley region providing between 38.1 per cent (1961) and 39.9 per cent (1947) of the Region's total population (See Fig. III-1 and Table III-1). Data for the post-war censuses 1947, 1954, 1961 and 1966, indicate there has been no marked change in the populations of the valley regions during this period, the northern section of the region having either marginal increases or decreases and the southern section marginal increases in their respective populations.

Urban/rural ratios

Within each valley region there were notable changes in the urban/rural distribution of the population with marked increases in the proportion of total population in urban locations for each census from 1947 to 1966. (See Table III-2.) In the small regions such as Eurobodalla, Nambucca and Bellingen-Coffs Harbour-Dorrigo, the marked decline of rural population from 100 per cent in 1947 to less than 50 per cent of the total population in 1966 is partly due to the omission of the smaller urban centres in the 1947 data. The same

data problem plagues interpretation of changing urban/rural population to some extent for all regions. Table III-3 has been included to give some idea of the proportions of this problem in each of the valley regions. Nevertheless, there have been obvious changes in the urban/rural distribution of the population which indicate the extent of intra-regional migration in these years and also reflect the considerable impact of changing employment of the workforce among industry groups.

#### Distribution of population and workforce among valley regions

The proportional distribution of the Region's workforce among the valley regions is almost identical with that of total populations and bears no further comment (See Fig. III-2 and Table III-1). Again, the workforce engaged in primary industry was similarly distributed among the valley regions (See Fig. III-3 and Table III-1), but with the Richmond, Tweed, Bega and Nambucca valleys providing slightly higher proportions of the Region's primary production workforce compared with their corresponding proportions of the total workforce (mean differences for the four censuses of 2.3 per cent, 1.5 per cent, 0.9 per cent and 0.6 per cent respectively), and all other valley regions contributing slightly lower proportions to the primary production workforce.

However, while both the Region's total population and workforce increased from the 1947 census to the 1966 census by 10.6 per cent and 6.2 per cent respectively, employment in the primary production

workforce consistently declined by a total of 31.8 per cent between 1947 and 1966. Employment on dairy farms is also concentrated in the Richmond valley which averaged 49.8 per cent of the Region's total. There were also some valley regions with notable increases in the proportion of the Region's total dairy farm employment such as the Macleay and the Bega, which have high proportions of their primary production workforce employed in the dairy industry, in comparison with other regions not so heavily dependent upon the industry, e.g. the Tweed and Clarence.

There has been a marked decline in the absolute numbers employed on dairy farms amounting to 25.2 per cent of the 1947 total, although the rate of decline has not been as great as for employment in primary production. In marked contrast, employment in the services and construction sectors of the Milk Solids Region has consistently grown, with a total increase of 22.3 per cent between 1947 and 1966.

Census evidence demonstrates that there has been a distinctive change in the employment structures and consequently in the economies of valley regions within the Milk Solids Region. There has been a growing emphasis on the service industries, especially in the hotels and amusement categories reflecting the increase in tourism so readily observed in the N.S.W. coastal districts. In turn, this suggests intra-region migration from the primary industry, including dairy farming locations to tourist locations. As with dairy industry statistics, it would be well to examine the census data for individual valley regions to determine the extent of

regional variations from the Region norm for employment structure.

As the proportional distribution of the Region's total population, workforce and employment sectors have already been treated, it was decided to use separate indexes of valley region population and industry groups employment. This simplifies analysis of trends for these characteristics which could not be subjected to, and did not require, the type of mathematical treatment used for dairy industry data. These indexes were based on the 1947 workforce because most valley region workforces demonstrated comparatively little change between the 1947 and the 1966 censuses. Also, by using a single index, it was possible to provide a two dimensional comparison, industry group employment and time, concurrently. Figs. III-4 and III-11 provide graphic presentations of valley region population and employment indexes.

One of the outstanding features of this series of data is the varying relationships between workforce and total population. In some valley regions, e.g. Bega, Eurobodalla, Bellingen-Coffs Harbour and Richmond, there is an obvious correlation between the two measures, but there are an equal number of other valley regions in which there is obviously no relationship between them. The second comment on population and workforce index data for valley regions is that employment sector trends are similar for all valley regions and differences are more a matter of degree than direction. Trends in employment sectors can be summarised as follows:

1. Employment in primary production has decreased consistently throughout the period 1947-66 in all valley regions from providing between 34 per cent and 52 per cent of employment opportunities in 1947 to between 20 per cent and 35 per cent in 1966. In all valleys the rate of decline in employment on dairy farms has been slightly less than for primary industries as a whole.
2. The proportion of the workforce employed in manufacturing has remained generally constant, although the absolute number of employment opportunities in manufacturing has increased in most valley regions.
3. Services and building sectors have been increasing in importance as employment opportunities in all valley regions. Regions with the lowest rates of increase in these sectors have been those such as the Macleay and the Richmond which have limited opportunities for coastal tourist developments.

#### Age group characteristics

Age group data for the N.S.W. Milk Solids Region reveal some important variations between the age distribution of the N.S.W. population and that of the Region as a whole, which have important implications for the age composition of the workforce. Data for workforce age groups are not available. Age group data have been plotted as proportions of the total population for N.S.W., the Milk Solids Region and for each of the valley regions in Figs. III-12 to III-21, and as

proportional variations from the N.S.W. data in Figs. III-22A to III-22H.

The Milk Solids Region population exhibits two notable age group characteristics. First, there has been a very high proportion of the population in the under 15 age group in all censuses from 1947 to 1966, and second, there have been progressively smaller proportions of the population in the 20-39 years age groups. Thus despite relatively high pre-school and school age groups, a high proportion of the Region's potential workforce has migrated, and the total population of the Region has been increasing very slowly compared with N.S.W. as a whole. The out-migration of so many native born members at the commencement of their working lives is not restricted to this part of N.S.W. alone, but clearly reflects the lack of employment opportunities for younger people in this region.

Equally important for future populations is the corollary of this movement of the potential family-raising age groups, for the 0-4 age group had begun to decrease in 1961 and provided only the second highest proportional age group in the 1966 census. Valley region age groups data are more notable for their similarities than for inter-valley variations, although the extent of valley age group variations from the N.S.W. norm indicate some local features. However, the overall characteristics of valley age group data are so similar to those of the Region as a whole as to make detailed discussion of them pointless. Perhaps the most disappointing feature of the population data for both

employment and age group distributions is that they are so similar as to preclude the establishment of relationships between dairy industry and population data. Again, an attempt to use local government areas as the basis for observing variations in population data proved unsuccessful, the same trends observed for the larger valley regions being generally observed for local government areas.

### Part C. The Macleay Valley, N.S.W.

Part C. may be divided into three sections. The first, in Chapter IV, is concerned with the development of a suitable model to examine dairy industry input/output relationships in the N.S.W. Milk Solids Region. It also describes the choice of study region and the methodology adopted in accordance with the purpose of the study and trends within the Milk Solids Region dairy industry described in Part B.

The second section consists of description and analysis of some facets of the study region. In Chapter V. the physical characteristics of the Middle and Lower Macleay valley are described and comments made on land use and dairy industry organization, based on both field observations and rural holdings data. Chapter VI. deals with the population of the study region in detail. Both urban and rural population trends are discussed. Comments are made on workforce employment and age group distribution of the population, although data available for these aspects of the study region population are limited to the 1961 and 1966 Censuses. The purpose of this section is to provide the setting for the following section which treats sample farm data and its analysis, and to allow some appreciation of population dynamics in relation to dairy industry trends and alternative industry employment opportunities in the study region.

The remaining section of Part C. is concerned with analysis of sample farm data to establish input/output relationships for the dairy industry of the study

region. Chapter VII provides an analysis of the distribution and use of rural holdings, and of sample farm data to indicate the strong relationships between land classes and land use/farm organization. It also notes the need to classify sample farms in order to establish land resource/dairy production relationships of statistical significance. Chapter VIII deals at length with the development and statistical testing of a suitable classification for analysing these relationships, while Chapter IX describes the steps whereby these relationships were established and supplemented by other resource input relationships through multiple correlation and regression analysis.

## Chapter IV

THE MODEL AND METHODOLOGYDevelopment of the model

In dairy farming in the N.S.W. Milk Solids Region as in other pasture-dependent agricultural activities, land is the central resource to which other factors of production are applied. Land quality, as measured by potential productivity, is one of the least understood and most difficult to assess inputs because of its variability. Despite continued attack by a number of soil scientists including Kellogg,<sup>1</sup>

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Kellogg, C.E., 'Soil and land classification'. Journal of Farm Economics. Vol. XXXIII, 1951, pp.499-513.

Storie, R.E., 'An index for rating the agricultural value of soils', Californian Agricultural Experimental Station Bulletin, 556, 1933.

Kellogg, C.E., 'Soil classification and cartography in relationship to other soil research', Proceedings of the Soil Science Society of America, 1939-40, pp.339-342.

Conrey, G.W., 'Primary soil features considered in land-use', Proceedings of the Soil Science Society of America, 5, 1950-51, pp.307-312.

Simonson, R.W. and Englehorn, A.J., 'Interpretation and use of soil classification in the solution of soil management problems', Soil Science of America Proceedings, 7, 1943, pp.419-426.

Black, J.D., 'Notes on "poor land" and "sub-marginal land"', Journal of Farm Economics, Vol. XXVII, 1945, p.45.

Hockensmith, R.D. and Steele, J.G., 'Recent trends in the use of the land capability classification', Soil Science Society of America Proceedings, 14, 1949, pp.383-388.

Hockensmith, R.D., 'Classifying land according to its capabilities', Transactions of the Fourth International Congress of Soil Science, 1950, pp.342-345.

(continued on p.53 )

attempts to provide an objective measure of soil potential productivity have been noted for their lack of precision and soil scientists can rarely provide agronomists with a fertilizer input/vegetable matter output programme. Similarly, the effects of varying climatic conditions, both macro- and micro-, on pasture growth, although generally understood theoretically, cannot be used in an objective predictive model. Agro-climatologists have been forced to resort to empirical models to provide some measure of probable plant growth.<sup>1</sup> However, it is fundamental that at least empirically observed relationships between land quality/management and production should be understood before government policies with specific aims are determined for the dairy industry. To achieve this purpose, the input/output model below was developed and data sought to analyse input/output relationships empirically.

1 (continued from p.52 )

O'Dell, R.T., 'Measurement of the productivity of soils under various environmental conditions', Agronomy Journal, 42, 1950, pp.282-292.

Spence, C.A. and Hasse, G., 'Land classification in the Prairie Provinces', Journal of Farm Economics, Vol. XXXIII, 1951, pp.768-775.

O'Dell, T.R., 'Soil survey interpretation - yield prediction', Soil Science Society of America Proceedings, 22, 1958, pp.157-160.

Rennie, D.A. and Clayton, J.S., 'The significance of local soil types to soil fertility studies', Canadian Journal of Soil Science, 40, 1960, pp.146-156.

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Nix, H.A., 'The Assessment of Biological Productivity', Stewart, G.A. (Ed.), Land Evaluation, Melbourne, Australia, 1968.

Pegg, R.E., 'Relation of slash pine index to soil, vegetation and climate in South-east Queensland', Queensland Dept. of Forestry Bulletin No. 19, 1967.

The first stage in the development of the model was:

$$P_x = f(L_x, E_x, C_x, M+Lb_x, Sr)$$

where  $P_x$  = butterfat production for farm x. <sup>1</sup>

$L_x$  = some measure of the land resource available to and used by farm x for dairy farming purposes.

$E_x$  = ecosystem energy available at farm x.

$C_x$  = capital invested in stock and fixed items on farm x.

$M+Lb_x$  = management and labour inputs on farm x.

$Sr$  = a social constant related to regional cultural patterns.

$f$  = some function to be specified.

The problems of securing suitable data to provide solutions using this model are at present almost insuperable for many of the relationships implicit in the model, e.g. the relationship between ecosystem/

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In the N.S.W. Milk Solids Region the three common dairy production measures are lbs butterfat, lbs commercial butter and gallons of milk, in that order of importance. In this study, two measures have been used. Regional production based on Bureau of Census and Statistics data has been in terms of standard milk equivalents, in keeping with the tendency of the Bureau to use this measure, and Macleay Valley data has been in terms of lbs butterfat because this is the common measure used in this Valley Region.

pasture inputs and milk outputs are not sufficiently understood.<sup>1</sup> For this reason the model was adapted so that implicit relationships did not have to be specifically known and empirical data from farm information relating to land resources, capital, labour and management could be used to provide functional relationships which in turn could be used to predict potential production associated with various combinations of inputs. Problems concerned with measurement of ecosystem energy were avoided by assuming that the measure used for land resources took into account not only land area but also land quality, which in turn rested on the assumption that groups of farms or formal regions possessed comparable inputs of climatic and edaphic factors. Problems in selection of suitable measurement characteristics and units of measurement for these characteristics are discussed in Chapter IX.

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Yates, F., Boyd, D.A. and Pettit, G.H.N., 'The influence of changes in level of feeding on milk production', Journal of Agricultural Science, 32, 1942, p.428.

Jawetz, M.B., 'Input-output relationships in feeding dairy cows', Dairy Science Abstracts, 18, 1956, p.1.

Orton, F.J., 'The economy of feed input in milk production: I. A summary of survey data', The Farm Economist, IX, 1958, pp.11-25.

Ibid., 'The economy of feed input in milk production, II', The Farm Economist, IX, 1958, pp.43-54.

Antill, A.S. and Clark, C., 'The overfeeding of dairy cows', Westminster Bank Review, February 1958.

Jawetz, M.B., 'On the question of the productivity of concentrates in feeding dairy cows - a critical appraisal of two recent papers', The Farm Economist, IX, 1959, pp.91-99.

Gardner, T.W., 'A footnote to the controversy concerning the productivity of concentrates in feeding cows', The Farm Economist, IX, 1959, pp.193-195.

In its second stage of development the model was expressed mathematically as:

$$P_{i_x} = f_i(L_x, C_x, M + Lb_x)$$

where  $P_{i_x}$  = butterfat production from farm  $x$  in region  $i$  and

$f_i(L_x, C_x, M + Lb_x)$  = a function of the combined resources of land, capital, management and labour as conditioned by local social factors and ecosystem energy inputs through land resources available to farm  $x$ . These local social factors and energy inputs are held constant within formal region  $i$ .

By combining farms possessing similar suites of resources, i.e. by creating formal regions, it could be assumed that empirical arithmetic data relating to each of these factors could be examined by statistical analysis to provide an arithmetic mean of the relationships observed between these factors, thus establishing quantitatively the relative importance of each of the various inputs and allowing the prediction of probable output given any combination of these inputs.

Data suitable for this purpose must meet a number of conditions. First, they must include a detailed inventory of each of the resources and characteristics of the resources used and of consequent outputs. Second, the data must be derived from a sufficiently long time-span to include as wide a range

of seasonal conditions as possible. Similarly the longer the time-span the greater the opportunity to separate short-term seasonal effects and longer-term economic trends. Third, all data should be convertible to a numerical form for statistical analysis. Securing suitable data for use in this model proved to be the major time consuming task of the study.

### Methodology

The limitations of the data available from the Bureau of Census and Statistics in assessing the importance of farmland resources to dairy production and to rural population are obvious. The need to secure more detailed farm information is equally apparent. The task became one of finding an approach which, within the time scale allowed for the present study, would provide a detailed assessment of sufficient dairy farm resources, production and related income and profitability to be able to determine the probable effects of changes in government dairy industry policy on the structure of the industry and consequently on the rural population associated with the industry.

This problem can be sub-divided into two closely linked sub-problems:

1. The choice of scale of survey, i.e. whether the survey should involve the entire area of the Milk Solids Region or only some section of it, or whether it should take a nested form involving the entire area of the Region for some types of information and limited sections of it for others, and

2. the form of the survey, i.e. whether it should involve the entire farm population of the Region or any section of it chosen for examination or only certain individuals of the farm population. This in turn provides the further problem of method of selection of farms for examination if only a proportion of the total farm population are to be examined.

Decisions related to satisfying the first of the sub-problems were largely determined by availability of time and resources for field work. It was decided to restrict the farm survey to one section of the Milk Solids Region and thereby concentrate farm survey activity on a relatively small area allowing closer examination of the regional setting associated with the particular section of the Region chosen. The possibility of adopting a nested survey approach was also abandoned on the grounds of time and resources available for field work.

#### Selection of the region for field survey

To be suited to the purpose of the present study, the section of the Region chosen should include such desirable attributes as a median position among the Valley Regions in dairy industry and population trends discussed in Chapter II, a sufficiently varied land resource in classes which could be readily recognised and defined and a location which experienced physical environmental conditions well within the range of those experienced in the N.S.W. Milk Solids Region. In addition, as the candidate was stationed at Armidale,

N.S.W., at the commencement of this study, it was desirable to undertake field survey work as close to Armidale as possible. Map study, reconnaissance excursions and detailed examination of Bureau of Census and Statistics for rural industries by local government areas and Police Districts suggested that the Macleay Valley would fulfill most of the conditions required of a study region. As no other UNE geographers were interested in this region and it was marginal to the interests of the Wollongbar Research Station, that part of the Macleay Valley within the Macleay Shire was selected as the study area.<sup>1</sup>

This valley region was relatively close to Armidale, small in total area yet diverse in landform/soil associations, and had a total rural holdings population of just over 850 (1961-62), of which some 464 were reported to be registered dairy farms. Furthermore, trend curves and values for the derived variables discussed in the previous chapter for the Macleay valley data placed its dairy farm population well within the range of those of the Milk Solids Region in all respects.<sup>2</sup> Similarly, population data for the Macleay Shire demonstrated the same tendencies as other valleys within the Region. When the time series was expanded to include dairy industry data for 1962-67 and the 1966 census, the

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In particular:-

Mr J. Holmes, Clarence Valley,  
Dr R. Warner, Bellinger Valley,  
Dr G. Bird, Richmond Valley.

2

Based on the initial examination of Bureau of Census and Statistics data from 1946-61.

position of the Macleay remained very similar to the earlier assessment and the original justification for the choice of the region remained valid.

### Selection of sample farms

The second farm survey sub-problem, i.e. the form of the survey, was partly resolved by the decision to concentrate survey resources in the Macleay valley. The question remained whether the total farm population was to be surveyed or whether something less than this was to be attempted. In 1961-62 the number of rural holdings comprising 1 acre of land or more used for agricultural purposes totalled 850. Although this was estimated to represent something less than 800 farm units it was considered that it would be unnecessary duplication to include all farms in the survey.

Farm units were defined as rural holdings or groups of rural holdings used for a common rural enterprise, whether the holdings were registered under separate ownership or not. Where a number of farming enterprises were conducted on the same rural holding, these were regarded as separate farms. There were numerous examples of the former situation, but only one of the latter, where a father and four adult sons each conducted a separate farm enterprise on the one rural holding. Where the farm operator conducted what appeared to be separate enterprises on different holdings the decision as to what comprised his farm enterprise was left to him. It was also considered that time and other resources available for field work would permit detailed survey of around 100 farms, so the next consideration became the choice of the sample farms.

Three selection methods have been used widely for selection of farms for detailed examination similar to that planned in this study:

1. Case studies,
2. random sampling, and
3. stratified random sampling.

The case study approach involves the subjective selection of farms possessing particular characteristics which the researcher wishes to observe. An extension of the case study method considered for this survey was the block sample method used for a number of surveys by agricultural economists at Cornell.<sup>1</sup> This method has the advantage of being easily applied without previous knowledge of the extent of the farms in question and in the present study would have allowed selection of groups of farms located on particular land types. This approach has two inherent weaknesses. First, as a completely subjective approach is made to farm selection, probability statistics cannot be used validly in interpreting farm data, a weakness which seriously limits the usefulness of survey data collected using this method. Second, because groups of farms are chosen on the basis of one or at most several common characteristics, there is presumption of limited variability in other characteristics.<sup>2</sup> The concept of block or some form of

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Cunningham, L.C. and Warren, S.W., 'Sampling methods in use in some of the farm management research at Cornell', Journal of Farm Economics, 1947, pp.1267-1270.

2

Marsh, M. and Conklin, H.E., 'Farm variability within block samples', Journal of Farm Economics, 1953, pp.283-285.

group sampling was attractive because it would allow selection of farms possessing similar land resources, both in area and in quality, and would minimise time and expense in field work. However, the approach lost its attraction when it was appreciated that farm data could not be subjected to probability statistics. Simple random sampling apparently offered a satisfactory alternative because it afforded the benefit of use of probability statistics.<sup>1</sup>

As examination of relationships between land resources and dairy production was the main object of the study, the sampling method used should ensure selection of farms possessing a variety of types of land resources. The only means of combining this requirement with that of randomness of selection and concomitant validity of probability statistics appeared to be the use of a form of stratified random sampling.<sup>2</sup>

Few agricultural geography studies give details of the actual steps used in sampling, but personal communications with agricultural economists and geographers at UNE suggested the common method of random sampling employed was to number a list of rural landholders obtained from local government rate-payers lists and sample using random numbers. This selection

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Blaut, J.M., 'Micro-geographic sampling - a quantitative approach to regional agricultural geography', Economic Geography, 1959, pp.79-88.

2

An early example of this approach was 'Use of stratified random samples in a land-use study', Wood, W.F., Annals of Association of American Geographers, 1955, pp.350-367.

technique appears to sample rural holdings rather than farms, with no opportunity for ensuring an even dispersal of selected holdings or of ensuring selection of holdings including all land classes.

At this time Mr J. Holmes, of the Geography Department, UNE, was preparing a paper for presentation to the Third Conference of the Institute of Australian Geographers, in which he outlined a method of stratifying a random sample by section lines.<sup>1</sup> The method was logical and promised a dispersed sample which should at least include all major land classes in the sample. Holmes' method provided a well-distributed sample of farms (See Fig. IV-1), but the number of farms possessing particular land-class resources were roughly in proportion to the total area of that land class. In some cases this led to an inadequate number of farms representing particular land resources, or groups of land resources (See Chapter VII.), and as the study progressed it was appreciated that some other form of stratification according to farm land resources and the use of a varying sampling fraction would have provided a more satisfactory means of achieving the desired end than classification of farms into formal regions after taking the sample.

A further advantage of Holmes' method was that it did not provide undue opportunity for selection of larger farm units, an important factor in sampling farm populations in N.S.W. coastal valleys where farm

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This paper was later extended, revised and published under the title 'Problems in location sampling', Annals of Association of American Geographers, 1967, pp.757-780.

densities vary considerably. It was this consideration which led to the rejection of systematic grid sampling, which is more rigid in its definition of sample points.<sup>1</sup> A major operational difficulty in the use of Holmes' method is that the areal extent of all farms must be known prior to the execution of the sampling procedure. As the acquisition of this information required a survey of all rural holdings before selecting sample farms, it was decided to adopt a two level survey. The first level consisted of identifying mapping and visiting all rural holdings in the study region.

Information on ownership of all rural holdings in the study region was taken from Shire Rate Books and N.S.W. Valuer-General's valuation records at the Macleay Shire Council Offices at Kempsey, and the Port Macquarie offices of the N.S.W. Valuer-General's Department. The information was plotted on Parish maps supplied by the N.S.W. Lands Department, then checked in the field to identify farm units. In this section of the field survey ownership of all holdings was established, their status as primary or subsidiary holdings in a farm unit, and the use to which they were put noted. Where farm units consisted of one rural holding, this was designated as the primary holding. Where a farm unit consisted of more than one rural holding, the rural holding which the farmer considered earned the greatest proportion of farm income was designated the primary holding and was included in the sample. Other holdings were then noted as

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<sup>1</sup>Birch, J.W., 'Observations on the delimitation of farming type regions with special reference to the Isle of Man', Transactions, Institute of British Geographers, 1954, pp.141-158.

subsidiary holdings and were not included in the sample. Where the farmer considered two non-adjacent holdings to be of equal income-earning importance, the rural holding with the farmer's house or permanent farm buildings was designated the primary holding. This information was later transferred to a base map from which Figs. V-1, VII-1 and VII-2 were drawn. Concurrent with the survey of rural holdings the physiography of the Middle and Lower Macleay was mapped and geology, soils associations and vegetation associations noted.<sup>1</sup>

While this section of the survey was very time consuming it had the advantage of providing familiarity with the study region before commencing farm surveys. Once all farms were identified, the sample farms were selected.

#### Sampling procedure

The sample farm population was derived by the following procedures which are in accordance with Holmes' method:

- (a) A straight edge was spun over the base map to provide a random alignment for the section lines which were drawn parallel to it and three inches apart (a three inch vertical distance between section lines was adopted after experiment because this distance provided a useful compromise between the advantages provided by greater and smaller distance for recognition of large and small holdings respectively within the section lines).
- (b) The starting corner was selected by tossing a coin.

- (c) Farms were numbered in groups of twenty as they were encountered with a parallel rule moving at right-angles to the section lines. Between section lines numbering was continued in a serpentine movement.
- (d) From each group of twenty, four farms were selected using random number tables (Cambridge Elementary Statistical Tables). A 20 per cent sample was adopted because it was known there were over 450 dairy farms in the study region at the time of sampling and it was anticipated that non-co-operators would bring the sample population to somewhere around 100 farms which was regarded as a sufficiently large population for the purposes of the survey and yet within the compass of the time and resources available for field survey.

At this stage it was decided to remove all farms whose total area was not at least 20 acres from the sample. This was done first because these farms were all operated by part-time farmers who usually undertook a whole range of activities, many of which were for subsistence purposes. They were, in fact, part of the 'billy can' section of the dairy industry alluded to by the McCarthy Report. Second, because of the diverse activities carried on on many of these farms, the relationship between land resources and production became more complicated and difficult to assess.

### Field Survey

Farm visits commenced in December 1963 and continued until February 1968. Four visits were made to most farms.

The first visit was devoted to detailed assessment of the farm's land resources.<sup>1</sup> This approach served to gain the farmer's confidence and to get him to talk freely about his use of various sections of the farm. The second and third visits were mainly devoted to acquiring data on stock, cropping activities, commercial production and income data. In several cases the second visit provided little more than information on stock and cropping activities, but few refused access to milk production records and income tax assessments after the third visit. The last visit was concerned with checking earlier information and gaining data on changes of land-use, stocking rates and so on, and with conducting a survey of farm management techniques and farm operator personal data.

Of the original 120 sample farms (which included 20 non-dairy farms), only one farmer refused co-operation outright. Another, a complete illiterate, was willing to help but proved so difficult to interview and had such a tangle of records that his farm was omitted from the sample. Two other farmers refused access to income tax assessment but one prepared income data and forwarded it at a later date. This information was in accordance with milk production and stock records already acquired.

The three dairy factories provided all production data for suppliers who gave written permission.

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Detailed land-class maps with notes on pastures and other physical features for each farm are included in Appendix II (Examiners' copies if required).

Data for one year from one factory proved difficult to obtain when the factory lost all milk receipt records in an office fire. For that year, the candidate had to rely on monthly supply summaries kept by the sample farmers. Solicitors and accountants holding income tax assessments for sample farmers allowed access to these records on production of written permission by the client.

At the end of each field survey excursion sample farm data were organised into regular format. At the conclusion of the field survey all sample farm data were transferred to an IBM computer card storage system and later programmed onto a disc storage unit for use in the IBM 360 computer. Data were then recalled for tabulation, classification, cross-classification and statistical manipulation as required. A schedule of data recorded for each sample farm forms Appendix III.

The study region has very poor map coverage consisting of co-ordinated one inch to one mile sheets without contours for the lower middle and lower valley only, and a non-co-ordinated County map based on the original Parish sub-division maps compiled by the N.S.W. Lands Department at a scale of one inch to one mile. Unfortunately there are notable discrepancies between the two, so it was decided to employ the Lands Department map as the base map: first because it covered the whole of the study region; second because it included the original holding subdivision information and third because information from Parish maps which were used in the field as base maps could be transferred directly to it. In addition, as the map was based on area survey information and despite its not being co-ordinated, it

could be used to measure areas, an important consideration in this study. The N.S.W. Lands Department were also able to provide an excellent set of stereoscopic aerial photographs flown in May 1956, and a set of composite mosaics. Both aerial photographs and mosaics covered the entire study region.

## Chapter V

### THE STUDY REGION

#### Introduction

Except for local configuration and size, the Macleay Valley is similar in appearance, in sequence of landforms, in type and distribution of vegetation associations, and in man's use of the environment to many coastal valleys of N.S.W. Despite the tremendous enthusiasm of the local population for their valley, it is not richly endowed with land resources and in many ways, but especially in the more readily observed criteria such as quality and condition of rural housing, farm buildings and fencing, it has a slightly depressed air. One cannot but be aware of previous better times evidenced by the substantial but often neglected farmhouses built in the late 1910's and early 20's. Decay is clearly evident in the smaller urban centres both upstream and downstream of Kempsey, except for the developing holiday centre South-west Rocks, but the municipality itself gives the appearance of steady advancement.

An aerial reconnaissance quickly dispells any impressions of widespread rural occupation of the middle and lower valley which constitutes the study region. Farm houses, many deserted, dot the narrow green strip of floodplain and terrace sequences upstream of Kempsey, being progressively further apart as these land classes narrow. Downstream, rural

settlement is considerably denser, but away from the main river rapidly thins along the lower river tributary levees. There are obvious limits to the economically useful land classes which to a large extent have determined the progress and development of the region

The following sections of this chapter are devoted to description of the physical environment, to discussion of areal relationships among the elements of the physical environment and to analysis of man's use of these resources.

## Physiography

The Macleay River watershed covers an area of approximately 4,340 sq. miles, which can be divided into three distinctive sections.<sup>1</sup> The upper or tablelands section included the principal tributaries of the Macleay and ends in a well defined gorge section below the Apsley/Macleay junction. The middle river or central section between the Apsley junction and Kempsey consists of a variety of hill-lands in which a number of minor tributaries rise. Finally the floodplain section, or lower river, which consists of a broad deltaic floodplain varying in height from sea level to approximately 20 feet above sea level. The study region consists of the lower river and most of the middle river sections of the Macleay watershed (See Fig. V-1) which, with the exception of a small area between the Maria River, the Pacific Highway and the Crescent Head road, comprises the Macleay Shire.

Within the study region there are three major physiographic units:

1. The steep hill-lands to the north and south of the Macleay River in the Western half of the region.
2. The low open hill-lands between the steep hill lands and
3. the lower river floodplain. (See Fig. V-2).

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'Water Resources of the Macleay Valley'. Water Conservation and Irrigation Commission, N.S.W., 1968. p. 2.

Hill-lands extend in an eastward opening v-shape from Bellbrook to Hickeys Creek in the north, and almost to the junction of Dungay Creek and the Macleay River in the south. In the north, the steep hill-lands have developed in a variety of Silurian rocks including greywackes, slates, phyllites and quartzites. In the south there are two groups of parent materials: the Permian, two stages of which provide a physiographic sub-region, and the Carboniferous, which forms the main area of steep hill-lands. The Warbro stage of the Permian series (mudstones and tuffs) runs parallel to the Macleay River, which Voisey suggests may flow partly along a fault line in this area, in a north-west/south-east alignment. It provides a sub-region of alternate steep and open hill-lands. In sharp contrast, the succeeding Yessabah stage outcropping to the south provides a sharp break of slope and relief with the hill-lands of the Warbro stage. The Yessabah stage includes a coarse crystalline limestone which is responsible for the pronounced relief forming the boundary between the sub-region and the steep hill-lands. The Carboniferous series (Kullatine Stage) consists of more resistant sandstones, fine conglomerates and tuffs. Mt. Yarrahapinni in the north-eastern corner of the study region is a heavily eroded, uplifted area of Lower Palaeozoic rocks bordering the Kempsey fault.<sup>1</sup>

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Voisey, A.H. 'A preliminary account of the geology of the Middle North Coast District of N.S.W. Proceedings, Linnean Society N.S.W. 1934. pp. 333-347. Ibid. 'The physiography of the Middle North Coast of N.S.W.' Journal and Proceedings, Royal Society N.S.W. 1935. pp. 88-103. Ibid. The Permian rocks of the Manning-Macleay Province, N.S.W. Journal and Proceedings, Royal Society N.S.W. 1950. pp. 64-67.

The second major physiographic region, the low open hill-lands, is located between the steep hill-lands and the lower river floodplain. Slopes are generally less than seven degrees, tributary streams have developed areas of alluvial deposition, and interfluves are progressively lower eastward. The Macleay River bed further upstream consists of shingle deposits, but large areas of old alluvial soils have developed on a series of terraces, and some remnants of the current floodplain not eroded by floodwaters remain on the insides of the meanders. The grade of the river alters sharply at Belgrave Falls some four river miles above Kempsey. Below the falls the river is affected by tidal influences. The change in stream grade is also evident from the deposits of sandy alluvia on the floodplain from Aldavilla to Glenrock during the recent series of floods. The open hill-lands on the southern side of the valley have developed in Permian mudstones but in the north, where the slopes become comparatively gentle and the valleys open, parent materials are Carboniferous sandstones and shales of the Kempsey stage.

The lower river floodplain is the third and economically by far the most important of the major physiographic regions. The floodplain extends to the north-east and east of Kempsey in an elongated fan shape tipped by a series of hard rock headlands which are linked by barriers of old fixed sand dunes. This region is notable for the variety of floodplain, estuarine and coastal landforms.

As the Macleay emerges from its shallow trench in the hill-lands above Kempsey, it flows northward roughly parallel to the coast through a series of broad meanders for almost 30 river miles before reaching its estuary. The estuary extends further north to an old mouth near Stuarts Point. The floodplain provides abundant evidence of many previous river channels and associated levees. At present there are two large ex-distributaries, Belmore River and Kinchela Creek, which flow naturally back from their junctions into freshwater swamps which surround them. Downslope from the river and abandoned channel levees there are numerous expanses of freshwater swamps, most of which are barely above sea level. Between the eastern margins of the coastal swamps and the sea rise a series of old coastal dunes fixed by a sclerophyllous woodland association. The dunes are continuous from Crescent Head in the south to Smokey Cape in the north. The Macleay estuary consists of a number of mangrove islands barely above the tidal zone, intermixed with broken barriers of old sand dunes.<sup>1</sup>

### Soils

Walker has noted the close relation between soils associations and physiography in the middle and

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For a detailed examination of the development of the lower river floodplain, see Hails, J.R. 'The geomorphological history of the Macleay Deltaic Plain.' Australian Journal of Science. 1965. pp. 214-215.

lower Macleay valley.<sup>1</sup> A copy of the map of 'The soils associations of the Kempsey District N.S.W.', which includes a brief summary of the associations and of the members of the Great Soils Groups found within each association, forms Appendix IV.

The 14 soils associations noted by Walker represent common topographic sequences of toposequences. Of the 14, only 4 are used for intensive grazing and cultivation, these being the Aldavilla-Sherwood, the Euroka-Cooroobong, the Kempsey-Cooroobong and the Glenrock associations. The Aldavilla-Sherwood association consists of a series of soils developed on the terrace complex upstream from Kempsey. There are four terrace members in this association (See Fig. V-3A), which vary from loose sands and gravels with little evidence of soil formation to well-developed dark crumbly soils with distinctive sub-soils.

The remaining three soils associations of this group occur on the riverine floodplain of the Macleay. The Euroka-Cooroobong association consists of sandy and loamy soils on present deposits adjacent to the river. The Kempsey-Cooroobong association consists of a soil series in the river-levee situation. The Glenrock association includes soils to the toe of the levee just above swamp level (See Fig. V-3B). Another soils association of the floodplain is the Belmore group, which contains highly acid swampland soils with high water tables (Sevenoaks series pH values 2.0-2.5).

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Walker, P.H. 'A reconnaissance of soils in the Kempsey District N.S.W.' Soils and Land Use Series No.44. C.S.I.R.O. 1963.

Walker makes the point that reclamation of soils in this association by heavy applications of lime is uneconomic.

The remaining associations can be divided into two groups: the hill-country soils associations and the sand dunes associations. The Redhill-Frederickton and Lovelock-Ballengara associations are somewhat more useful agriculturally than other hill-country soils, but most have some toposequences along their lower slopes which are used for grazing purposes. The Loftus-Broadwater association is potentially the more useful of the sand-dune soils association because large volumes of non-saline ground water are found in its water-table.

### Climate

The climatic regime of the Macleay Valley is typical of the North Coast valleys of N.S.W. Weekly climatic data illustrating the salient features of the seasonal distribution of maximum and minimum temperatures, rainfall and estimated evaporation (Australian Tank), for West Kempsey meteorological station are plotted in Fig. I-3C. Median monthly summer maximum temperatures are in excess of 80 degrees F., and median winter monthly maximum temperatures in the high 60's and low 70's giving a seasonal monthly range of 16 degrees F., while median minimum monthly temperatures range from the low 60's to the low 40's giving a mean seasonal range of almost 23 degrees F. Neither maximum nor minimum monthly temperatures particularly restrict the growth of temperate pasture species, but median monthly minimum temperatures do inhibit the growth of tropical pasture species, especially tropical

grasses whose optimum growth temperatures are in excess of 100 degrees F. (See Fig. I-4C for Index of Growth of pasture species for West Kempsey.) The range of median monthly maximum and minimum temperatures is quite small, being less than 3.5 degrees F. between quartiles for monthly maximum temperatures and 3.0 degrees F. or less for monthly minimum temperatures, and less than 2 degrees F. between the lower quartile and the lowest median monthly minimum temperature recorded (See Fig. V-4).

In sharp contrast with the narrow range of monthly temperatures, monthly rainfall varies considerably around the median. For West Kempsey, median monthly rainfall is lowest in August-September (1.43 inches) and gradually increases to 4.74 inches in March, followed by a sharp decline in April, with a continued but more gentle decline throughout May, June and July. However, the distribution of monthly rainfall from the median is very marked (See Fig. V-5 and Table V-1). In all months except November, the median-lower quartile difference exceeds 40% of the median value, with the greatest differences in June and July, when they exceed 74% of the value of the median.

The differences between the medians and upper quartiles are greater than those between the median and lower quartiles. With the exception of October and November, which have median-upper quartile differences of 42.4% and 43.1% of the median value respectively, all months have median-upper quartile differences of 60% or more of the median value. The greatest monthly differences occur in June, July, August and September, which have differences in excess of 105% of the

median value. These data indicate the higher reliability of rainfall from October to March than from April to September.

The areal pattern of median annual rainfall for the study region (See Fig. V-6) indicates that the highest rainfall occurs on the southern and northern hill-lands bounding the study region, and on the Mt. Yarrahapinni and lower Clybucca districts in the lower valley which all receive in excess of 50" p.a. The lowest rainfalls in the study region are received by the hill-lands in the centre of the middle valley, between the Macleay River and the middle Dungay and Parabell Creeks along a line due west of Kempsey.<sup>1</sup> The distributions for late summer/early autumn, the wettest and most reliable rainfall months, and late winter/early spring, the driest and most unreliable rainfall months, in the study region are depicted in Figs. V-7 to V-10. These suggest that the seasonal distribution of rainfall is similar throughout the study region, but the reliability of seasonal distribution is probably least in the lower rainfall districts and greatest in the highest rainfall districts.

Estimated mean weekly evaporation (Australian Tank) for West Kempsey exceeds mean weekly rainfall from late July to mid-February (See Fig. I-3C), suggesting that the growing season in the study region is considerably shorter than indicated by rainfall data. Estimated

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'Water Resources of the Macleay Valley.' Water Conservation and Irrigation Commission N.S.W. 1968. Figs. 3, 5-6, 10-11.

soil moisture storage for West Kempsey climatic data are graphed for two levels of soil moisture storage capacity at saturation level in Fig. V-11.<sup>1,2</sup> The 4.00" saturation level generally represents the soil moisture capacity of the higher terrace soils and some of the deeper soils developed over fine sedimentary parent rocks. The 7.00" saturation level is associated with the soil moisture storage capacity of the floodplain soils of the Euroka-Cooroobong, Kempsey-Cooroobong and Glenrock associations.

In the mean annual terms, soil moisture should provide few limitations on pasture growth in the study region in any season. However, the probability that soils possess sufficient soil moisture for pasture growth in all weeks of the year is a different matter. There is a 10% or better chance that all weeks in the month of November and December will have 0.00" of soil moisture if a 7.00" level is allowed for soil saturation and if a 4.00" level is assumed, the 10% or better chance of 0.00" of soil moisture extends from mid-September till mid-February, and there is a 20% or better chance that each week from the last week in September till the second week in January will have 0.00" of soil moisture. (See Figs. V-12 and V-13 and Tables V-2 and V-3).

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McAlpine, J.R., Fitzpatrick, E.A. and Keig, G. 'WATBAL - a computer system for the estimation and analysis of soil moisture regimes for simple climatic data.' Technical Memo in preparation. Division of Land Research. CSIRO.

2

Personal communication with Dr P.H. Walker, Division of Soils, CSIRO.

Farmers in the study region have come, through the experience of the past twenty years, to associate late summer/autumn rainfall with flooding. As a consequence, they have abandoned attempts to take advantage of the last flush of pasture growth which is available should there be no flood in this period of highest weekly rainfall, and of most reliable soil moisture. Classifying a rise in the Macleay River to a peak of at least 12 feet on the gauge at Kempsey road bridge as a flood, the lower Macleay valley has experienced 49 floods in the 105 years to 1968, and 23 of these have occurred since 1946. The monthly distribution of all floods in Table V-4 and the magnitude of all post-war floods depicted in Fig. V-14 suggests that late summer is the worst period for flooding, not only in frequency but also in severity.

During periods of flooding water rises above the main river levees to flood the swamps and concurrently backs up the Belmore and Kinchela and to a lesser extent the Clybucca, eventually flooding the freshwater swampland, much of which is very close to sea level. Although local drainage unions have been operating for many years in the lower Macleay to keep surface water in swamplands at a minimum level, the Macleay Valley County Council has recently undertaken a major programme of flood mitigation works which include a complex of drains and floodgates to facilitate entry and removal of floodwaters to the swamplands.<sup>1</sup>

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McDonald, G.T. 'A Report on the hydrological implications of flood mitigation works on the floodplain of the lower Macleay River below Kempsey.' 1967. UNE Research Series

(Footnote continued on p. ~~75~~  
82)

## Vegetation.

The vegetation cover of the study region may be divided into those associations which occur naturally and have been subjected to limited interference by man; those which occur naturally but in which man's interference has established the prominence of certain species; and those which have been introduced by man to replace native species. The pattern of both native species and those of introduced species are closely related to local climate, geomorphology and soils, and to man's assessment of the economic potential of these patterns of interrelated characteristics.

Only in the steep hill-lands does the natural vegetation remain in a preserved state, although fire and timber felling have modified the density and age structure of the species. The dominant species here belong to the sclerophyllous forest association including spotted gum, (Eucalyptus maculata), grey and red iron-bark (E.paniculata) and (E.sideroxyton), white mahogany (E.acmenioides) and white stringybark (E. eugioides). Under story members of this association include a variety of hard native grasses such as kangaroo grass (Themeda Australis),

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in Applied Geography No.9. ibid. 'An economic appraisal of flood mitigation works on the Macleay floodplain.' 1968. UNE Research Series in Applied Geography No.10. Lee, K.W. 'Problems of secondary drainage on the Macleay floodplain and their possible solution by the Macleay River County Council with extended powers.' 1968. UNE Research Series in Applied Geography No.22.

wallaby grass (Danthonia spp.), tussock grass (Poa australis), and scattered colonies of bladey grass (Imperata cylindrica). On the higher wetter slopes along the northern and southern boundaries of the study region and on Mt Yarrahapinni a wet sclerophyll/marginal rain forest association of flooded gum (E. grandis), tallow-wood (E. microcorys), blackbutt (E. pilularis), coachwood (Cenopetum opetalum), sassafras (Doryphora sassafras) and occasionally red cedar (Toona australis) dominate the landscape, with an understory of ferns and vines.

When the sclerophyllous forest species are cleared on the lower open slopes and river terraces, the native grasses provide the dominant cover except along the higher rainfall ridges where paspalum (Paspalum dilitatum) has been introduced as a pasture grass. The high initial humus content of deforested soils has gradually declined under paspalum pasture. These soils are frequently incapable of supporting paspalum any longer and it has been replaced by less demanding and poorer pasture species, especially carpet grass (Anoxopus compressus). In many previously cleared areas formerly occupied by sclerophyllous and wet sclerophyllous/marginal rain forest, tree species are regenerating and the area of cleared land is slowly diminishing. During field survey, only two large areas of newly cleared land were noted.

On the lower river floodplain, only the swamplands retain native species to any extent. All forest vegetation, except for the occasional Ficus spp.

now utilised for ornament and shade, have been removed from the levees and dense swards of volunteer kikuyu (Pennisetum clandestinum) cover the moister areas, while a mixed pasture of paspalum and white clover (Trifolium repens) cover the slightly drier areas and those newly reclaimed from swamp but not yet over-run by kikuyu. Marginal shallow swamp possesses a variety of pasture and weed cover including water-couch (Paspalum distichum), sedge (Cyperus spp.) and smart weed (Polygonum hydropiper). The open waters of deep swamps are fringed by the aquatic Typha, Cladium, Phragmites and Juncus spp. There are many areas of shallow permanent swamp in which the native tree species such as swamp oak (Casuarina glauca) and ti-tree (Melaleuca viridiflora) have not been cleared and grow in dense, almost impenetrable stands dominating the landscape.

The native species have either not been disturbed or are regenerating rapidly on the sand-ridge/-swamp soils of the old dune barrier. The upper story of the heath-woodland association which dominates these dunes includes scribbly gum (E.micrantha), bloodwood (E.gummifera), swamp mahogany (E.robusta), banksia (Banksia spp.), black she-oak (C.littoralis), swamp oak (C.glauca) and bottlebrush (Callistemon spp.). Beneath this story is a dense layer of shrubs including herbaceous species: Epacris, Cyperaceae, Restionaseae and Hakea spp. Where the shrub layer is incomplete a variety of native grasses and exotic buffalo grass (Stenotaphrum secundatum) provide the ground cover, but these are commonly invaded

by bracken (Pteridium aquilinum) during the secondary growth stage of regeneration.<sup>1</sup>

### Rural land-use

Over the past fifty years land utilisation in the study region has been resolved to two major forms: grazing dairy stock and grazing beef cattle. This pattern largely reflects the best-use opportunities for the middle and lower Macleay valley landowners in terms of physical conditions and location with respect to prevailing markets and market conditions. Dairying possesses special features of intensity of stocking, application of capital and application of labour which provide it with high returns per acre, and these in turn have given it a marked comparative advantage over beef cattle grazing in utilising the best pasture lands. While this is still so, increasing beef prices and a gradual reduction in the profitability of dairying have resulted in the loss of some of dairying's comparative advantage over the past ten years, and there has been a noticeable incursion of beef cattle grazing into what was previously dairy land.

At the turn of the century cultivating maize for grain was an important source of farm income in the study region. With the establishment of overseas dairy

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The candidate is indebted to several officers of the N.S.W. Forestry Commission stationed at Kempsey who, at different times, helped with identification of tree species, and Dr R. Robbins, formerly of ANU and the National Herbarium for identification of herbaceous plants and native grasses.

markets maize growing became less important, especially following World War II when high prices for milk and milk products were guaranteed. The series of major floods which began in 1949 and continued throughout the period of the field survey, provided a further setback to maize growing and to other forms of field cropping on the floodplain. Vegetable growing, another alternative to dairying, was similarly affected by floods, and suffers a double comparative disadvantage with several vegetable growing districts in N.S.W. - lack of irrigation water throughout the lower valley floodplain, and a railhead location over 200 miles from the Sydney metropolitan market. The choice of farming activities is restricted, and because of its comparative advantage dairying is the predominant farm activity wherever suitable pasture can be grown. Beef cattle grazing dominates land not suitable for dairying, except where landowners of dairying quality land possess sufficient area to gain a 'satisfactory' income level from beef cattle grazing and are prepared to forego the difference between actual and potential income because they can remove the responsibility of additional labour inputs, and to a lesser degree because of the increased social status accruing to the grazier.

#### Rural holding information

Rural holdings data for the study region are available from the Bureau of Census and Statistics for six Police Districts. These collection areas (See Fig. V-15) are designed purely for administration purposes and seldom correspond with changes in the

physical environment. They are therefore of limited value in analysis and interpretation of rural holdings data, but because they consist of groups of rural holdings in known locations within the study region, they provide an areal framework for examination of rural holdings data. Each Police District is characterised by important rural holdings features, e.g.:

1. The Bellbrook Police District includes the upper middle river section of the study region river.
2. The Kempsey Police District includes a large proportion of middle river terrace and low hill-land holdings, as well as some floodplain holdings between Aldavilla and Glenrock.
3. Frederickton and Gladstone Police Districts include both levee and swamp type lower river holdings, and Frederickton also has a few low hill-land holdings in the Colombatti area.
4. Smithtown Police District is restricted to Cooroobongatti which is one of the most favoured areas for dairying in the Macleay Shire.
5. South-west Rocks Police District includes estuary dairy farms and the banana holdings of Yarrahapinni making interpretation of rural holdings data difficult.

Between 1957 and 1962 26% of Macleay Shire rural holdings were located in the Kempsey Police District, between 15% and 18% in each of Bellbrook, Frederickton,

Gladstone and South-west Rocks Police Districts, and 7% in Smithtown Police District (See Table V-5). The mean area of rural holdings for each Police District varied from almost 1600 acres in Bellbrook to 233 acres in South-west Rocks. This wide range of rural holdings' areas reflects both the land-use opportunities available to land holders and the economic area of land required for particular purposes. Because of the variations of land quality and land use within each Police District, observations can only be very general. For example, the mean area of 1600 acres per rural holding in the Bellbrook Police District reflects the equal importance of beef cattle grazing and dairying (See Table V-6). In an intermediate situation, the Kempsey Police District has a mean rural holdings area of 609 acres and 55% of all holdings are dairy farms, while Gladstone Police District in which over 80% of rural holdings are registered dairy farms, has a mean area of 250 acres per rural holding. Mean holding area data for South-west Rocks is confusing because it includes banana farms which are usually less than 50 acres.

Useful measures of the relative importance of dairying are the proportions of dairy and beef cattle in the total stock population (See Table V-6). In Bellbrook Police District less than 20% of the total cattle population are in commercial dairy herds, compared with 49% in the Kempsey Police District and 74% in the Gladstone Police District. The only measures of suitability of rural holdings for dairying are the area of sown grasses and clovers (these include paspalum but not kikuyu), and the area of land used for cropping

activities (See Table V-7). For the same three Police Districts the areas of sown grasses and area of crops comprised 8.8% and 0.4% of the total area of Bellbrook, 7.1% and 1.0% of Kempsey and 16.7% and 0.9% of Gladstone Police Districts. However, while the sown grass category includes areas of paspalum which is a volunteer pasture in the middle valley Police Districts, it consists mainly of sown exotic temperate species, especially rye grasses (Lolium spp) and clover (Trifolium spp.) in the lower valley and the extensive areas of volunteer kikuyu are ignored.

In all Police Districts the small acreage devoted to cropping is used predominantly (75% of this area or more) for maize cultivation (See Table V-7). Some of this is sold, but much is used for winter feeding dairy stock. Of the remaining 25% of the area devoted to cropping activities, a further 14-18% is devoted to maize for green feed. No other fodder crop provides more than 1% of the cropping area indicating the heavy dependence upon maize for supplementary feeding.

The Frederickton Police District was abolished as such in 1962 and its area incorporated within the Kempsey, Smithtown and Gladstone Police Districts. It was possible to adjust dairy farm data, i.e., number of registered dairy farms, farm milk supplies to factories and number of milking cows for 1962 to provide an overlap for the one year. This provides a 10 year period to examine trends in the dairy industry of the Macleay Valley which, although too short for time series analysis, does give a general

impression of changes in the location of dairying activities in the Macleay Shire.

The total number of dairy farms in the Macleay Shire declined from 562 in 1957 to 398 in 1966. The lower valley Police Districts generally maintained or slightly improved their proportions of the Shire's dairy farms, but the middle river Police Districts (Bellbrook and Kempsey) appear to have lost around 2% and  $3\frac{1}{2}\%$  of their dairy farms respectively (See Table V-8 and Fig. V-16). Similarly there has been a slight decline in the proportions of the Shire's milking cows in these same Police Districts, especially during the last two years of the period which were drought years (See Table V-9 and Fig. V-17).

Commercial milk production provides a better assessment of the effects of seasonal conditions on the dairy industry than of actual trends in the industry (See Table V-10 and Fig. V-18). Milk production in the lower valley reached a peak in the lower valley in 1959 despite floods in January and December of that year. However, 1960 milk production was badly affected by the December '59 flood. The floods of 1962-63 depressed milk production considerably more than floods in the previous year and had long-term effects on per cow productivity so that the minor flood in early 1964 had a much greater effect on milk production than had been anticipated. Production continued at this very low level (7.47 m.gals.) in 1965 despite improved seasonal conditions in the lower valley, when drought conditions reduced swamp levels for the first time since 1957. Gladstone Police District, with its large area of low

tributary levee, was worst hit by the 1962-63 floods, but milk production increased very rapidly after 1964.

The slight decline in the number of dairy cows noted in the Bellbrook and Kempsey Police Districts was matched by a decline in milk production prior to 1965, despite the series of wetter than average seasons which favoured middle valley farming activities. The drought of 1965 and the comparatively dry season in 1966 accelerated the trend which resulted in the closure of the Toorooka factory, Bellbrook Police District which approximates the supply catchment of the Upper Macleay Dairy Co-operative factory at Toorooka, producing only 0.41 m.gals. of milk in 1965-1966.

Mean number of milking cows per registered dairy farm was used in Chapter II as one measure of the scale of dairy farming activities. This variable varies considerably from Police District to Police District in the Macleay Shire. Between 1957 and 1966, the mean number of cows per farm increased in all Police Districts except Bellbrook by 3-5 cows. In Bellbrook Police District the mean herd size decreased by almost 10 cows. Mean herd sizes in 1957 were highest in the poorest and richest environments (Bellbrook 59.6 cows and Smithtown 56.5 cows) and Kempsey Police District second least desirable environment for dairying had the smallest mean dairy herd size. (See Table V-11.) In 1966 Bellbrook mean herd size had dropped markedly and with Kempsey were the only Police Districts with mean herd sizes of less than 50 cows.

Mean milk production per cow followed a similar pattern among Police Districts to that of mean herd size in 1966 when allowance is made for seasonal variations in productivity. The poorest dairying environments provided the lowest productivity rates even during those seasons which favoured middle river farming activities (i.e., wet years,) and the best dairying environments the highest productivity rates (see Table V-12). Similarly milk production per farm in the Smithtown Police District was significantly higher than per farm production for other lower river Police Districts, and all lower river Police Districts had significantly higher per farm production than middle river Police Districts.

#### Organisation of the dairy industry

Within the middle and lower Macleay Valley location of farming enterprise in relation to local markets has played a major part in determining the form of dairy produce sold off the farm and the subsidiary farm enterprises undertaken. Of the three dairy factories operating within the Macleay since the mid-1920's (See Fig. V-19), the Toorooka factory served the most clearly defined hinterland, a tied community of farms in the middle Macleay and tributary valleys isolated by transport costs and a policy of non-competition between the two co-operatives. The two larger factories at Frederickton (Macleay Valley Dairy Co.) and Smithtown (Nestles Ltd.), approximately 4 miles apart, possess almost coincidental hinterlands, with slight tendencies towards monopsony along the eastern margin of the lower river tributaries in the case of the

Smithtown factory, and in the middle river between Sherwood and the Toorooka factory hinterland for the Frederickton factory. Frequently farmers supply both factories simultaneously to qualify for fringe benefits offered by both lower river factories.

The Toorooka factory was devoted entirely to butterfat production. Farms supplying this factory had to supply cream rather than whole milk and necessarily had a supply of skimmed milk which was utilised as pig feed. Hence pig-raising has been a universal subsidiary enterprise for those farmers within the Toorooka's milk supply hinterland. Pigs require grain feed for finishing and this has been supplied by growing maize. However, the limited area of tributary alluvials and river terraces suitable for cultivation purposes is usually inadequate to supply the needs of both pigs and dairy cattle. This is reflected in the comparatively low mean productivity of dairy cows in Bellbrook Police District (See Table V-12).

In sharp contrast, the Smithtown factory, a condensery, requires whole milk only. To ensure adequate supplies, this factory offers farmers incentive payments as partial compensation for loss of potential farm income from pig-raising. Compensatory payments combined with freedom from pig husbandry has appealed to many lower river farmers who have become specialist whole milk dairymen with no subsidiary farm activity. Willingness of the Frederickton factory to receive milk or cream (it produces butter, cheese and whole milk products) has had little impact on the lower river situation. Farmers supplying both factories tend

to sell whole milk off the farm and have whey waste from cheese-making returned for rearing calves. Upstream from Kempsey the Frederickton factory is the major receiver and the traditional pattern of dairying/pig-raising has not been radically altered. The tendency towards cropping activities in association with dairying in the lower section of the middle river between Turner's Flat and Kempsey is related to the considerable areas of suitable floodplain soils available on many farms and the availability of irrigation water.

Where farmland includes pastures unsuitable for dairy stock farmers tend to run some beef cattle. On lower tributary holdings which include swampland, and on middle river and upper tributary farmlands where slopes on sedimentary rocks comprise the majority of farmland, beef cattle grazing is an important subsidiary activity on dairy farms. In contrast to the widespread distribution of beef cattle grazing, banana growing is a highly localised activity being a successful enterprise only in the higher areas of the Yarrahapinni district.

## Chapter VI

### POPULATION OF THE STUDY REGION

The population of the study region has neither decreased nor increased significantly since World War II. In 1947 the population was 13,692. It rose to 14,719 by 1961 and fell to 14,361 in 1966. However, within the study region population distribution has changed notably with a marked increase in the proportion of the population in urban locations and a marked decline in middle river population. The trend towards a higher proportion of urban population has been continuous since 1947 (See Table VI-1) and is typical of many Valley Region populations in the N.S.W. Milk Solids Region, as noted in Chapter III. Urban population increase is confined mainly to Kempsey Municipality. Data is not available for the Smithtown, Gladstone and South-west Rocks centres prior to 1961, but the small total increase in the populations of these centres (0.6 per cent between 1961 and 1966) does not suggest a continuous increase in the population of non-municipal centres.

#### Urban population

Kempsey Municipality is the major service centre for the study region as well as for some distance north and south of the study region. It includes the majority of the study region's population (See Fig. VI-1). Census data indicate that population growth is slowing down in this centre having declined from a 2.5 per cent per annum increase in the first intercensal period to

less than 0.5 per cent per annum increase in the last. This decline may be partly the result of increasing non-primary production workforce seeking accommodation in flood-free dwellings (including a number of ex-dairy farm houses) in the nearby Euroka (Euroka-Kalateenee Census District) and Red Hill (Kempsey-Beranghi Census District)<sup>1</sup> (See Fig. VI-2 and Table VI-1). In 1961 and 1966 the small lower river urban centres, Smithtown, Gladstone and South-west Rocks together included 11.7 per cent and 12.1 per cent of the study region population respectively. The total increase of 0.6 per cent represents only 12 people. However, each centre displays varying growth characteristics. Smithtown's population remained reasonably constant (-2.2 per cent) reflecting its constant workforce employment opportunities which are tied almost exclusively to the local condensary. Gladstone, across the river, which was formerly the port for the Macleay River, has been steadily declining and lost 7.9 per cent of its population between 1947 and 1966. The remaining lower river urban centre, South-west Rocks, a local holiday resort which recently has been attracting some tourists and a number of retiring farmers. As a result, this centre has increased its population by 10 per cent since 1947. The very small middle river settlements, Willawarrin and Bellbrook, are not enumerated separately by the Census, but personal observation suggests that their populations are declining. This is

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<sup>1</sup>Names given to Census Districts are not official. They have been adopted to avoid confusion with the various coding systems used by the Bureau of Census and Statistics, and to help locate the districts and their populations.

especially true of Willawarrin, which has been linked with Kempsey by a well-graded bitumen road replacing a badly graded winding gravel road.

### Rural population

To help discern population trends rural Census Districts have been amalgamated into three areal groups: Middle River and Tributary Census Districts, Lower Middle River Census Districts and Lower River Census Districts. (See Table VI-1 and Fig. VI-1). In each of these groups population trends are generally similar for total population, workforce employment and age groups. Rural population has declined in most parts of the study region since 1947 except for the two Census Districts noted above in relation to Kempsey workforce.

In 1947 the Middle River and Tributaries Census Districts included 1,615 persons or 11.8 per cent of the study region population, the Lower Middle River Census Districts 702, or 5.1 per cent, and the Lower River Census Districts 5,045 or 36.8 per cent of the study region population. By the following census (1954) the Middle River and Tributaries Census Districts still included over 11 per cent of the population, but Lower Middle River and more especially Lower Census Districts had lost population and then included 4.3 per cent and 33.4 per cent of the study region's population respectively. Between 1954 and 1961 the Middle River and Tributaries Census Districts lost over 22 per cent of their population and included only 8.5 per cent of the study region population, whereas the Lower Middle River Census Districts almost held both their actual

population and their proportion of the study region population. Similarly between 1961 and 1966 the Middle River and Tributaries Census Districts lost a further 22 per cent of their population and their share of the study region population fell to 6.8 per cent while the Lower Middle River Census District population remained constant.

The position of the Lower River Census Districts is much harder to assess between 1954 and 1961 because the Lower River urban centres Smithtown, Gladstone and Southwest Rocks were enumerated separately from the rural population in 1961. If both non-municipal urban and rural populations are counted, there was a very slight proportional loss by these Census Districts from 33.4 per cent to 32.9 per cent to 32.0 per cent in 1954, 1961 and 1966 respectively, as well as a very slight actual loss between 1954 and 1961 (0.8 per cent), and a more marked loss in actual population between 1961 and 1966 (5.1 per cent). Overall, between 1947 and 1966 the Middle River and Tributary Census Districts lost 39.5 per cent of their population compared with a 12.7 per cent loss in the Lower Middle Census Districts and approximately a 9.0 per cent loss in the Lower River rural Census Districts, assuming the same rate of increase for Lower River non-municipal Census Districts throughout the period 1947 to 1966.

The rate of change of total population was not constant throughout the period within each group of rural Census Districts. In the Middle River and Tributaries Census Districts the population decline was greatest in those Census Districts which can be regarded as marginal

dairy land and reflect contraction in the dairy industry. Burragong, Tanban and Wittittrin-Boonanghi suffered losses of 85.9 per cent, 72.5 per cent and 63.0 per cent of their total populations between 1947 and 1966. Other Census Districts in this group include both more and less marginal dairy lands. The Census Districts with more marginal dairy lands such as Bellbrook, Peedee, Macleay and Warbro had total population losses of between 30 per cent and 50 per cent reflecting the lower proportions of population connecting the dairy industry in these Districts, while the two Census Districts which include less marginal dairy land, Hickey-Willawarrin and Colombatti, have suffered a decline and an increase of 30 per cent of their 1947 population respectively.

Population change in the Lower Middle River Census Districts reflects proximity to Kempsey and to a limited extent a growing local commuting population. This point is discussed later with reference to workforce employment. The Census District furthest from, and with the most difficult access to Kempsey is Parrabel-Kullatine on the southern side of the Macleay River. From 1947 to 1966 population losses represented 21.9 per cent of the 1947 population, but the majority of this decline occurred between 1947 and 1961. Between 1961 and 1966 the population of this Census District has remained constant. The Aldaville-Mooneba Census District along the northern bank of the river and partly overlapping Parrabel-Kullatine and Euroka-Kalateenee Census Districts in distance from Kempsey had an overall loss of 14.3 per cent of its 1947 population, but in this case there was a slight growth

of population between 1947 and 1961 (5 per cent) followed by a more notable loss between 1961 and 1966 (18.4 per cent). On the other hand, Euroka-Kalateenee Census District population declined between 1947 and 1954 (18.3 per cent), was constant between 1954 and 1961, then increased between 1961 and 1966 (18.3 per cent) almost to its 1947 level.

Allowing for the problems created by non-enumeration of the non-municipal Lower River urban populations before 1961, only one Lower River rural Census District has a population in excess of 100 per cent of its 1947 population in 1966. The Kempsey-Beranghi Census District which includes some of the best dairyland in the study region, is close to Kempsey and had a good quality bitumen road and public transport connections with Kempsey throughout the period under survey. It is the only rural Census District to have an increase in total population throughout the period 1947 to 1966. This increase took place mainly between 1947 and 1961 (6.5 per cent) and the population has remained fairly constant since 1961. South-west Rocks-Arakoon Census Districts have a combined increase of 16.4 per cent on their 1947 population, but as the South-west Rocks Census District (1961 and 1966) had a 15.7 per cent increase in population between 1961 and 1966 and Arakoon suffered a 16.8 per cent loss in the same period it is doubtful if the rural population was increasing from 1947 to 1961. Both Gladstone-Kinchela and Smithtown-Cooroobongatti had population declines of approximately 13.0 per cent which in the main were probably losses in the rural community in the Smithtown-

Cooroobongatti Census District, and both rural and urban in the Gladstone-Kinchela Census District (Smithtown and Gladstone had losses of 2.2 per cent and 7.9 per cent of their total populations respectively between 1961 and 1966). Losses of population in the Cooroobongatti and Kinchela Census Districts as well as in the Glenrock-Belimbopinni Census District might well be attributed to farms on more marginal dairylands bordering and including shallow swampland (Glenrock soils association) which have discontinued dairy production since 1949.

#### Age group distribution

Age group data for each of the Census Districts groups also assists in the analysis of population trend patterns within the study region. In general, the age distribution pattern for the whole study region population in 1961 and 1966 (See Fig. VI-3) is very similar to those of other Valley Regions discussed in Chapter III.<sup>1</sup> However, there are marked differences among age distribution patterns for each of the Census District communities within the study region. Middle River and Tributaries Census District population in 1961 was distributed in a normal fashion with a somewhat larger proportion of the population in the under 14 age classes. The 1966 Census data indicate some changes in this distribution pattern, of which the development of a marked decrease in the proportion of the population

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Age group data for Census Districts are available for the 1961 and 1966 Censuses only. Personal communication, Mr K. Crawford, Bureau of Census and Statistics.

in the 15-24 age classes and a decline in the 0-4 age class are the most significant (See Fig. V-4). These trends are considerably more pronounced in the populations of other groups of rural Census Districts, especially those of the Lower Middle River which had less than 16 per cent of the total population in the 20-34 age classes in both Censuses.

In the Lower River Census Districts the pattern of age group distribution and variations from the N.S.W. norm are very similar to those of the Lower Middle River Census Districts. This suggests that the pattern has been developing for some time in these Census Districts and major changes in the future may not come from migration but from a decline in births resulting from loss of population in the most prolific child bearing classes, in the past and at present, progressing through succeeding age groups. Beyond these comments, it is difficult to be specific for both the Middle River and Tributaries and the Lower Middle River Census Districts have quite irregular patterns in their age group distributions. The former groups of Census Districts appear to have experienced migration of school age and young workforce age groups for only a relatively short time before 1961. The 1966 Census indicates an extension of migration into the 20-24 age class, also in the 35-39 age group.

The 35-39 age group deficiency is located more specifically among Census Districts with higher losses of population associated with abandonment of dairying. One possible explanation is that this phenomenon represents the loss of young dairymen who had taken up

dairy farms on marginal dairy land during the early 1950's, which was a period of optimism in the Australian dairy industry. The same hypothesis may also provide a partial explanation for the irregular movements around the N.S.W. norm demonstrated by age groups in the Lower Middle River Census Districts (See Fig. VI-5). Other partial explanations related to use of previously abandoned dairy farmsteads by non-primary production workforce families may also be applicable to these Census Districts, especially to the Aldavilla-Mooneba and Euroka-Kalateenee Census Districts.

Urban population age group distributions also show considerable variation both from the N.S.W. norm in the case of the non-municipal communities, and between the non-municipal populations and that of Kempsey Municipality. Kempsey population age group distribution follows a similar pattern to that of N.S.W. and there is less than 2 per cent variation for any single class from the N.S.W. norm (See Figs. VI-7 and VI-11E). As the age class providing the greatest variation was the 5-9 in 1961 and the 10-14 in 1966, it seems that Kempsey age groups patterns could well approximate the N.S.W. norm in the next census. However, the non-municipal urban populations distinguish themselves by their very notable variations from the N.S.W. norm, both singly and collectively (See Fig. VI-11F to VI-11H).

Smithtown population has an age group distribution similar to the surrounding rural centres except that trends appear exaggerated. One possible explanation for this tendency to exaggeration is the limits of workforce employment opportunities combined

with a high proportion of Roman Catholics (over 65 per cent in 1961). Employment opportunities are limited to the Smithtown condensery and concomitant services such as milk transport (factory employment provided between 71 per cent and 75 per cent of workforce employment in 1961 and 1966 respectively). This is attractive to many in the region and labour turnover is not high. In turn, this has led to the restriction of employment opportunities for new members in the workforce with consequent high migration levels in the young workforce age groups, both to Kempsey and beyond. The current factory workforce is now ageing and around 30 per cent of the total population is in the 30-54 age classes. The high proportion of Catholics in the population has ensured the high levels in the pre-school and school age groups but there is evidence that the numbers of young members in the population are declining so that future census data may reveal a more markedly ageing population until the current factory workforce reaches retiring age and factory employment opportunities are again available to younger age groups.

The age distribution pattern for South-west Rocks contrasts markedly with other non-municipal urban Census Districts and Kempsey Municipality (See Figs. VI-8 and VI-10). South-west Rocks has only 13 per cent of its population in the 20-34 age group, or almost 3 per cent more than these classes in Smithtown and 5.5 per cent less than Kempsey, and over 35 per cent of its population in the 50-74 age classes. This older population largely represents retired local farmers who in recent years have chosen this coastal centre in

preference to Kempsey, Smithtown and Gladstone, and perhaps more importantly have been in an economic position to retire, unlike their counterparts of pre-World War II days. Despite increases in tourist interest in this centre there has been insufficient tourist development to influence the age group distribution of the population. However, the centre's popularity is no longer local only, and it may continue to provide an increasing proportion of the study region's population, both old and in future years, perhaps young also.

### Industry employment

Adequate workforce/industry employment data would provide a very useful base for examining the changing influence of the dairy industry on the study region population. Unfortunately industry employment data are limited to major industry categories, e.g. Primary Production, Mining, Manufacturing etc., and are only available on a Census District basis for the 1961 and 1966 Censuses.<sup>1</sup> Index of population and workforce data graphed for three rural Census District groups and the total urban population summarise the main features of employment in the study region. Apart from the Middle River and Tributaries Census Districts in 1961 in which 46.5 per cent of the population were members of the workforce, between 32 per cent and 39 per cent of the population were gainfully employed in 1961 and 1966. In the Middle River and Tributaries Census Districts

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Personal communication with Mr K. Crawford, Bureau of Census and Statistics.

population decline has been matched by workforce decline.

In both Census years primary production accounted for between 45 per cent and 48 per cent of the total workforce employment so the decline in number of persons employed in primary production was not so marked as that of the workforce as a whole. However, the number of persons employed in service industries fell markedly by 104 persons or by 5.7 per cent of the 1961 total, and manufacturing employment declined by only 10 per cent, which represented a 6 per cent increase in the proportion of workforce engaged in manufacturing compared with 1961.

Several factors contributed to these changes, of which the decline in dairy farming noted in Chapter III and the marked improvement of communications between Bellbrook and Kempsey were the most important. Between 1961 and 1966 there was a 30 per cent decrease in the number of registered dairy farms and a 42 per cent decrease in the number of dairy cows on registered dairy farms in the Bellbrook Police District. The proportional drop in milk production was over 50 per cent between 1961 and 1966, and over 70 per cent between 1962 and 1966. There has been a long-term decline in the dairy industry in this region and the poor seasonal conditions of 1966 (See Table VI-1) forced more farmers from the industry than would normally have abandoned dairying. However, not all ex-dairymen left primary production and many turned to other activities, especially beef cattle grazing and part-time employment with the Shire Council on drought relief road work, and with the Forestry

Commission. The sharp decline in milk production in 1965-66 seriously affected the already marginal economic position of the Toorooka butter factory which laid off some of its employees and retrenched its milk collection services. From 1964 roadworks had progressively improved communications between Bellbrook and Kempsey encouraging the rural population to use Kempsey as its only service centre, by-passing the few services provided at Bellbrook and Willawarrin. Accordingly, services employment suffered at these centres.

The employment situation is somewhat different in the Lower Middle River Census Districts. Here, while total population declined, the workforce actually increased by a total of six persons. This was due to an increase in employment in manufacturing by 35 per cent, reflecting the influence of Kempsey as a growing employment centre in the study region and the increase in commuting between nearby farming districts with surplus housing and urban employment.

In the Lower River Census Districts (rural), the situation is not unlike that of the Middle River and Tributary Census Districts (See Fig. VI-12). However the pattern of employment in the Kempsey-Beranghi Census District is very similar to that of the Lower Middle River Census Districts for the same reasons described above.

The declining employment trends of the rural communities in the study region contrast with those of the urban centres including Kempsey Municipality, Smithtown, Gladstone and South-west Rocks (See Fig. VI-15). The rate of growth of workforce and employment

in manufacturing and service industries has been higher in the non-municipal centres than in Kempsey, but as the Kempsey workforce is approximately four times as large it is more useful to consider employment trends for the total urban population. Between 1961 and 1966 the total urban workforce increased by 11.8 per cent and the majority of new employment opportunities were provided by the service group of industries whose workforce increased by 12.4 per cent in this period.

Among the service industries the hotels, accommodation, amusements category demonstrated the highest workforce gain and in 1966 employed 11.8 per cent of the workforce in South-west Rocks and 9.6 per cent of the workforce in Kempsey. This reflects the strong upsurge in provision of tourist accommodation especially motels in Kempsey and embryonic development of these facilities at South-west Rocks to meet the increasing tourist interest noted above. Gains in manufacturing industries in the urban centres collectively were slight, as were they for primary production, amounting to 2.3 per cent and 2.8 per cent of the 1961 employment respectively.

Census data provide only a limited outline of the dynamics of population growth and movement in such a small area as the study region. Initial field observations and some sample farm data help in suggesting hypotheses about population dynamics in the Macleay. As this is not a population study as such, but is more concerned with the interactions of dairy industry policy on rural population, only a limited analysis of these data is attempted. It is also unfortunate that census

data are too incomplete to allow the use of trend analysis to assist prediction of short-term trends in other than subjective qualitative terms.

### Population dynamics in the study region

A descriptive model can be used to analyse the forces operating within the various communities within the study region to produce migratory movements. This model can be divided into two arbitrary stages which are part of one continuum whose extent at any point in time is limited by some function of the economic and social rewards available in a particular rural location, the economic and social rewards in alternative rural or urban locations and the extent of the development of a communications network, both physical and psychological.

Stage I (See Fig. VI-16) represents the initial migration stage. Members of the Kempsey workforce observe greater opportunities in more rapidly developing urban centres such as Newcastle and Sydney and migration of the younger, better informed and more adventurous workforce groups commences. Concurrently with improved local communications some members of local urban centre workforces, i.e. from Smithtown and Gladstone, move to the larger centre Kempsey, sometimes as permanent residents but more frequently initially as commuters, eventually finding permanent residence in the larger urban centre. In turn, rural workforce members, especially in the younger age groups, see little opportunity in remaining in rural locations and move to either the local urban centre or to Kempsey, or direct to larger external urban centres. Marginal dairymen

and those who foresee greater rewards both social and economic in urban employment may also join these migrant groups, many of them travelling from their rural location to the new site of employment until feeling sufficiently secure to abandon rural activities and residence altogether.

Stage II begins to operate when communications throughout the region involved are adequate to permit widespread appreciation of ruling rewards situations and ready movement of those inclined to change their occupation, residential location or both (See Fig. VI-17). It appears that this stage has only recently been reached in the study region and that prior to this the communications function declined rapidly up-river from Willawarrin. Adjustments of up-river communities are now reaching a peak as improved roads and knowledge of down-river opportunities are appreciated. Marginal up-river farmers are often prepared to undertake farming less rewarding down-river holdings which are nevertheless more profitable than their previous farm lands. Retired farmers are prepared to move from the farm to South-west Rocks not only because they find the new location more congenial but because they know improved communications will attract the younger members of the family now running the enterprise to visit more frequently and thus provide more opportunity for discussion of activities on the farm. Thus, this trend has also aided holiday/tourist development. The commuting population can now be divided into two groups: the new commuters who have recently become part of the urban workforce and still retain their old rural residential locations; and the

older commuters who have been unable to secure accommodation in Kempsey and have left their more distant residences to relocate in surplus rural housing vacated by some of the very early commuters now living in Kempsey, or who have moved on to larger urban centres. In addition, a new type of commuter is developing. This is the farmer commuter who reverses the normal situation and lives in either Kempsey, Smithtown/Gladstone or South-west Rocks and commutes daily to his farm. Paradoxically enough, many of the farmhouses vacated by the farmer commuter are occupied by urban workforce commuters who are unable to find closer accommodation to their places of employment.

There is no doubt that rural depopulation is occurring and it seems at increasingly rapid rates. Little is known of equilibrium situations which may develop or about the levels of economic rewards which might stem such movements and consequently about the processes by which rural depopulation may be stopped once it develops. If the process of rural depopulation continues in the study region it must have severe ramifications not only on the distribution of rural population but also upon the volume of dairy production available for manufacture and consequently upon the capacity of the dairy industry to support its present manufacturing workforce. In turn, this could have considerable effects on the total population and its employment structure of the study region.

From this point on, the study is concerned with analysis of land/dairy production relationships in order to assess the probable effects of Government dairy policy on dairy production and rural population.

## Chapter VII

SAMPLE FARM DATADistribution of rural holdings

In March 1962 there were 870 rural holdings in the study region providing approximately 610 farm units. Survey data (See Chapter V) for the study region farm population when plotted over the surface morphology demonstrated notable relationships between shape, area and use of holdings, and division of holdings into primary and subsidiary units on one hand and surface morphology/soils associations on the other. These relationships may be observed by comparing Fig. V-2 with Figs. VII-1 and VII-2.

Along the river levees of the lower floodplain holdings are strip-shaped extending from the higher levees through the lower levee frequently to the margin of swampland. These holdings are commonly between 30 and 50 acres and partly represent a pattern developed in an earlier economy (commercial maize cultivation), which preceded dairy farming in the lower Macleay. The strip-shaped holdings are most common between Glenrock and Cooroobongatti-Kinchela, and most uniform between Glenrock and Smithtown-Gladstone where the levees are wider and higher above sea level than further downstream.

The strip pattern of holdings is also observed on the higher sections of tributary levees along Belmore River and Kinchela and Clybucca Creeks. However, in these locations as well as towards the estuary on the

main river levees there is a tendency towards compactness of holdings giving greater widths of the narrower levee per farm, for the levee is often only wide enough for the access road, farm house and other buildings as it tails off rapidly into swamp and mangrove. These holdings are consistently larger than their higher levee counterparts being between 75 and 150 acres in area.

Once in swampland, holdings increase in area markedly, with a strong tendency towards square or compact rectangular shapes. Original subdivisions in the swamps varied from 50 to 500 acre blocks. This order of variation in holdings areas remains today although there has been considerable amalgamation of holdings in the swamplands, as well as along the lower tributary levees. This situation contrasts with that of the main river levees where there has been frequent subdivision of the original holdings.

In the lower section of the middle river between Kempsey and Turners Flat the tendency towards strip holdings is again apparent. Here the strips extend from the floodplain to terraces and infrequently onto hill lands. The strips become progressively wider upstream, e.g. compare the width of holdings in the Euroka and Aldavilla areas (200-400 yards) with those of Sherwood, Mooneba and Turners Flat (400-800 yards). Further upstream, the floodplain alluvials narrow and finally disappear making old alluvial terraces the most desirable agricultural land. Single holdings frequently occupy the whole of an inside meander core and holdings are decidedly compact in shape, often in excess of 500 acres in area. On such holdings the area of cultivable

soils is often less than 50 acres confined to narrow strips of terrace bordering the shingle river bed.

In the upper tributaries, especially on the northern side of the river (Hickeys Creek and Nulla Nulla Creek) a variation of the strip pattern of holdings replaces the compact meander-core blocks. Holdings include land on both sides of the tributary streams from creek alluvials to steep hill-lands. Further upstream as the valleys narrow, the holdings again assume a more compact shape as greater distance along the streams is required to provide adequate creek alluvials in relation to hill-lands.

Away from the Macleay River and its major tributaries in the hill-lands the holdings are very large (2,000 to 5,000 acres). The more rugged and difficult of access, the larger the holdings. Single holdings may include a major part of a tributary watershed particularly in the upper valleys of Dungay, Parrabel, Warbro and Stockyard Creeks, all of which are northern-flowing tributaries.

It is evident there has been a strong tendency to adjust the size of rural holdings in relation to their potential productive capacity. Land with the highest production potential tends to be divided into the smallest holdings and that with the lowest production potential into the largest.

#### Use of holdings

The uses of holdings, as opposed to the more detailed classes of land-use, are depicted for the study

region in 1962-63 in Fig. VII-1. There are obvious areal correlations between surface morphology and patterns of holdings discussed above, and use of holdings demonstrating the importance of the physical environment in local patterns of rural activities. Holding-use was determined on the basis of income sources providing 20 per cent or more of each holding's income from verbal information provided by the owner. The only category not determined on an economic basis was flood refuge, a use which could not be equated directly with an economic reward yet was particularly important.

The outstanding features of the holdings-use pattern are:

1. Concentration of dairying holdings along the floodplain levees of the lower river (Kempsey-Cooroobong soils association), on the floodplain of the lower middle river (Euroka-Cooroobong soils association) and on the middle river and tributary holdings with significant areas of terraces and creek alluvials (Aldavilla-Sherwood soils association).
2. The ubiquity of beef cattle grazing activities which predominate on the hill-lands and swamp holdings, but have also intruded to a limited extent upon dairying activities throughout the floodplain and terrace holdings.
3. The concentration of banana growing holdings on the steeper hill-slope holdings of the Yarrahapinni district.
4. The very scattered distribution of holdings with an important commercial field-cropping component.

5. The groups of dune and hill-lands holdings used for flood refuges.

The term flood refuge is applied to those holdings used in times of flooding to hold dairy stock, especially milking cows. These holdings represent a form of flood insurance which some lower river farmers have undertaken to provide accommodation for milking cows to avoid the worst features of using roads, stock routes and other public lands during flood times. These holdings must be above flood level, close to the primary holding and of easy access for milking stock. As can be seen in Fig. VII-1, flood-refuge holdings are concentrated on the areas of high ground surrounding the floodplain, especially along access roads, e.g. the concentration of flood refuges to the south of Yarrahapinni on either side of the Pacific Highway serves farmers from Smithtown to lower Clybucca, and those in Tanban serve Bellimbopinni farmers. Holdings suitable in both location/accessibility and size are now scarce and the majority of dairymen are still dependent upon public lands with attendant problems of herd segregation, lack of milking facilities and feeding stock. Frequently dairymen possessing flood refuges attempt to defray the cost of providing this facility by grazing beef cattle. However, the time and labour involved in looking after a small beef herd some distance from the primary holding frequently offsets the advantages.

The use of subsidiary holdings is closely associated with both the location of the subsidiary holding in relation to the primary holding and the physical environment of the subsidiary holding. As may

be observed in Fig. VII-2 the lower river primary holdings are concentrated along the levees of the main river and its tributaries while most of the swamp and hill-lands are subsidiary holdings. The concentration of primary holdings along the river frontage continues up valley, but as the floodplain/terraces narrow the greater the area of land included in the holdings with a consequent decline in the number of subsidiary holdings. Away from the river, especially in the southern hill-lands, subsidiary holdings represent the inability of landholders to acquire contiguous holdings rather than the need for land of differing quality and location. In each of the upper tributaries, but especially on the southern side of the river, a large proportion of the land is controlled by the N.S.W. Forestry Commission, which issues annual grazing leases to nearby, preferably adjacent, landowners.<sup>1</sup>

In Fig. VII-3 sample farm holdings have been identified by their code numbers. Those farms possessing subsidiary holdings have the same number, and arrows point from primary and subsidiary holdings of the same farm to the other. Several usage patterns can be examined using the sample farm population as case studies. In order of decreasing interdependence of holdings three types of relationship can be distinguished in a continuum which extends from complete interdependence of holdings usage to almost complete independence of

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Under the terms of Forestry Commission grazing leases, lessees cannot improve the land for grazing or agricultural purposes by clearing.

holdings usage. Two beef cattle grazing holdings (28 and 31) exemplify those farms with a very high degree of interdependence among holdings. Both have subsidiary holdings which have production capacities similar or in excess of the primary holding. Farm 31 primary holding is a large levee/swamp holding and the subsidiaries are hill-land holdings. The subsidiary holdings are used as breeding and holding properties and stock are taken from them to the primary holding for fattening as required.<sup>1</sup> In this use, the large area of shallow swamp within the primary holding also acts as a buffer during periods of drought, for as drought progresses and hill-land pastures are depleted, swamp waters are evaporated and volunteer pastures allow additional stock to be carried. Sample farm 28 with five large subsidiary holdings requires more complex organisation for farm land includes levees, swamps and hill-lands. This farmer also breeds stock for sale as vealers as well as purchasing stores for fattening and resale as stores or fat stock according to market conditions. On this property, stock are being moved continuously as adjustments are made to market and pasture conditions.

At the other end of the holdings inter-dependency scale sample farm 25 includes two holdings which are used almost completely independent of one another. The lower river primary holding is used for dairy farming alone. The hill-land subsidiary holding

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<sup>1</sup>When stock have been purchased for fattening in the future, but fattening land is not available because the market is not considered suitable for the disposal of stock already fattened or 'finished', they must be 'held', i.e. maintained in their present condition as cheaply as possible.

is used for breeding beef stores and cannot be used as a flood refuge or to maintain dry dairy cows because of distance between the holdings and difficult access to the subsidiary. In this case it is only because the subsidiary holding is sufficiently large to be operated as a more or less independent unit whilst the primary holding is too small to provide an acceptable family income that the farmer has continued to maintain the subsidiary enterprise. Initially it was intended to regard these two holdings as completely separate enterprises, but because the farmer regarded both holdings necessary and on occasions ran young dairy stock on the subsidiary the two holdings were regarded as part of the same enterprise.

Between these two extremes are the numerous examples of floodplain dairymen (4,5,7,10,39 etc.) who possess subsidiary holdings which they use as flood refuges and in some seasons to graze dry dairy cows. There are also the upper river beef producers such as sample farmer 103 whose major holdings are hill-lands in a middle river tributary valley, but who retains a swamp holding in upper Kinchela as drought insurance. In addition, many dairymen indicated they had reciprocal agreements with middle or lower river farmers depending on the location of their own farms, by which their opposite numbers took their dairy stock during times of flood or drought and in return received all milk produced. Many such arrangements were intra-family and reflected recent in-valley migration, but most were very loose non-family arrangements.

### Sample farm data

Selected data for comparison of sample dairy farm information and Bureau of Census and Statistics dairy farm information are included in Table VII-1. This data suggests that the sample dairy farm population is not significantly different from the total dairy farm population. Unfortunately no comparable data are available to assess the representativeness of the total sample farm population.

Area of holdings data for the sample farm population (See Table VII-1) indicate the considerable range in the area of primary holdings and in the total area of all holdings. However, over 46 per cent of all sample farm primary holdings are between 50 and 149 acres and only 10.2 per cent were larger than 500 acres. The distribution of the primary holdings population is heavily skewed by the presence of a few very large primary holdings of over 1,000 acres (3.4 per cent of the total population), all of which are beef cattle grazing properties. Only 46.6 per cent of sample farms had subsidiary holdings. The distribution of this population is more heavily skewed than that of primary holdings, the modal class being 100-149 acres, whereas the mean is 547 acres. Similarly the total area of all holdings demonstrates a markedly skewed distribution.

A more useful tabulation for analysis of farm land resources is the area of each morphological class included in sample farms. This tabulation is provided in Table VII-2. As the sampling method used provided farms associated with particular morphological classes

in approximately equal proportion to the area of each morphological class occupied by primary holdings, it is obvious that the lower river floodplain is the most important morphological or land class to the farming community. Almost 70 per cent of all sample farms included one acre or more of lower river floodplain in their land class composition and on over 90 per cent of these farms the lower river floodplain is part of their primary holdings. Cleared swamp is the second most important land class in sample farm composition. Some 64.4 per cent of all sample farms have one acre or more of cleared swamp, and 45 per cent have over 50 acres, but in most cases swampland forms part of subsidiary holdings rather than primary holdings.

A more detailed examination of the distributions of lower river floodplain and swamp among farms clearly demonstrates that lower river floodplain is the most important land class of the two. Of farms which include lower river floodplain, 72 per cent have 50-99 acres of this land type ( $\bar{x} = 69.6$  acres) and 24.4 per cent have between 25 and 49 acres ( $\bar{x} = 40.6$  acres) but only 26.8 per cent of farms with swamp included between 50 and 99 acres of it and 43.7 per cent possessed less than 25 acres.

As a consequence of the limited areas of middle river floodplain and terraces relatively few farms (33.9 per cent and 16.1 per cent respectively) include these land classes. Of those sample farms possessing one acre or more of middle river floodplain, 50 per cent had less than 25 acres, and of those possessing middle river terrace 52.6 per cent had less than 25 acres of it.

Cleared and uncleared slopes and cleared swamps are more evenly distributed among sample farms. Approximately 48 per cent of all sample farms include more than one acre of each of these three land classes. Uncleared swamp is the least evenly distributed by unit area. 61.4 per cent of sample farms with this land class possessed less than 50 acres of it although the mean area per sample farm was over 71 acres. Slopes, cleared and uncleared, were moderately evenly distributed by area among sample farms. Of farms including these land classes 56 per cent and 45 per cent respectively have between 25 and 149 acres. However, the area per farm distributions for both classes is markedly skewed with means of 195 and 468 acres for cleared and uncleared slopes.

The proportions of each land class in sample farm land composition provide a further insight into the relative importance of each land class to the farming community (See Table VII-3). There is a considerable range in the proportions of different land classes included in the total areas of sample farms, but land classes may be divided into two general groups according to the proportions of farmland they commonly provide. In the first group, which includes middle river floodplain, middle river terraces, lower river terraces and cleared swamp, each land class provides less than 20 per cent of the total area of some 70 per cent of farms which include them, although the first two classes in the group are usually the most productive on farms which possess them. Cleared swamp, cleared dunes and mangrove and salt-affected floodplain also provide small proportions of the total areas of farms in which they are included.

The second group of land classes includes those which provide significantly higher proportions of the total areas of sample farms in which they are found. This group includes the most and the least productive land classes. Lower river floodplain provides over 50 per cent of the area of all farms in which it is found, but it is widely distributed among area classes and seven of the area classes used in Table VI-4 have 10 per cent or more of the farm population which includes one acre or more of lower river floodplain. Similarly, 50 per cent of farms which include one acre or more of uncleared slopes have in excess of 30 per cent of their area in this land class.

The sample farm population undertakes the variety of economic activities, i.e. activities providing 5 per cent or more of farm income in any one year, found in farm enterprises in the study region. Of the 118 sample farms, 100 were concerned with dairying at some time between 1957-66, the actual number involved varying from 100 in 1960-61 to 80 in 1965-66. In 1962-63 dairying was the dominant economic activity on 71 per cent of sample farms, and the only source of income on 39 per cent of them (See Table VI-5). Some 27 sample farmers (28 per cent of the sample farm population) were involved in pig raising as well as dairying, 19 (20 per cent) in beef cattle grazing, 6 of whom were also pig-raisers, and 16 (17 per cent) in field cropping. Although each group of activities tended to be concentrated in certain localities or groups of localities, none were as specifically located as the banana growers of the Yarrahapinni district, two of whom were also dairymen in 1962-63.

Subsidiary holdings are used in a variety of ways depending on a number of factors including area, location, use and adequacy of primary holding for that use, distance and accessibility, area and land composition of the subsidiary holding. Tables VII-6a and VII-6b tabulate the uses noted for first, second and third subsidiary holdings in 1962-63. Of the 55 first subsidiary holdings, 18 per cent were used exclusively as flood refuges, and a further 22 per cent were used as flood refuges as well as for other purposes, of which grazing dry dairy cattle was the most common. Grazing dry dairy cattle and grazing beef cattle were the next most common forms of first subsidiary holding use (33 per cent and 31 per cent respectively) and only 13 per cent were used for field cropping. Each of the 12 first subsidiary holdings used for grazing dairy cattle in milk were in the first category of Table VI-6. Second and third subsidiary holdings were most commonly employed for beef cattle grazing and were generally devoted to single uses rather than multiple activities as were the primary holdings.

Location of subsidiary holdings in relation to primary holdings is an important factor in the degree of interdependence between the two holdings. Holdings must be very close if they are to be used jointly for grazing dairy stock in milk and less than 5 per cent of all sample farm subsidiary holdings were used for this purpose in 1962-63, although 34 per cent were used for grazing dry dairy stock. Dairy cows in milk cannot be walked far from grazing to milking shed without notable production losses, hence the use of 'less than 1 mile'

as the first distance class limit in Table VI-7. In addition farm operators cannot maintain a constant check on dry stock if subsidiary holdings are more than 3-4 miles from the primary holding or if the subsidiary holding is not readily accessible. Furthermore, springing stock cannot be moved by foot more than several miles without great care.

Accessibility is equally as important as the actual distance involved, but more difficult to classify. The criteria used in Table VII-7 were the ability to get a two-wheel drive vehicle to the holding, and the ability to reach the subsidiary holding from the primary holding during low level floods. Of first subsidiary holdings, 84 per cent were readily accessible from their primary holdings and 38 per cent were both readily accessible and within one mile of the primary holding. Good accessibility is also desirable for second and third subsidiary holdings but these tend to be more distant from the primary holding than first subsidiary holdings.

A general relationship can be observed between sample farms involved in the more specialist dairy-use combinations and farm area. Of the 46 sample farms on which dairying is a specialist activity 34 (74 per cent) had primary holdings of between 50 and 149 acres and 38 (83 per cent) had a total area of core dairyland, i.e. land used for grazing dairy cows in milk, of between 25 and 99 acres (See Table VII-8).<sup>1</sup> The multiple use

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Area of core dairyland generally corresponds to areas supporting paspalum and kikuyu pastures but also includes area of improved pastures and field crops fed to dairy stock and maize/acre equivalents of purchased feeds fed to dairy stock.

combinations: dairying with pigs, dairying with beef cattle and dairying with pigs and beef cattle are associated with progressively larger areas of land, but with differing combinations of areas of primary holdings, core dairyland and total area.

Dairying with pigs is found on farms with a wide range of primary holdings areas: 44 per cent had primary holdings of between 25 and 149 acres and a further 44 per cent with primary holdings of between 200 and 399 acres. Similarly the area of core dairyland on these farms was widely distributed with a slightly higher concentration in the 50 to 149 acre classes. Of the nine farms in the category dairying with beef cattle grazing, two-thirds had primary holdings of between 100 and 199 acres, and between 25 and 149 acres of core dairyland. All had total areas in excess of 200 acres. Sample farms which combined pig-raising and beef cattle grazing with dairying tended to have larger areas of primary holdings than the two previous use-combination groups (500 acres or more), but similar areas of core dairyland.

At the other end of the land resources scale, sample farms undertaking dairying and field cropping were notably the smallest group, 92 per cent having between 25 and 99 acres of primary holding and core dairyland, and 50 per cent of these farms were in the same total area class.

Again it appears that there have been notable adjustments between land resources and forms of farming activity which could be related to quality of land resources and location to local markets.

Butterfat production

Over the period of the field survey (1957-58 to 1965-66), 69 per cent of all sample farms and 81 per cent of all sample dairy farms secured 50 per cent or more of farm income from dairying activities. Table VII-9 classifies sample farms by butterfat production for each year of the study and Table VII-10 provides mean per annum production and standard deviations for each class. These tables demonstrate the predominance of farms producing between 4,000 and 11,999 lbs of butterfat per annum in the sample, with an even distribution of farm production around the 6,000-8,999 lbs class. Cross-tabulation of mean butterfat production per sample dairy farm with dairy-use combinations (See Table VII-11), indicates the differences between groups of farms undertaking different farming activities. Specialist dairy farm production is normally distributed around 8,000 lbs of butterfat, while two-thirds of farms undertaking dairying with beef cattle grazing are above this level and 69 per cent of dairy farms undertaking dairying with pig-raising and 89 per cent of farms undertaking pig-raising and beef cattle grazing are below this level. Sample dairy farms involved in field cropping are widely distributed having one or more members in each production category from 2,000-3,999 lbs to 17,000-19,999 lbs, but 50 per cent of these farms have mean per annum production of between 4,000 and 7,999 lbs of butterfat.

Analysis of farmland composition, farm activities and butterfat production strongly suggest that relationships between farmland composition and

dairy production will not be constant throughout the study region. Correlation coefficients for a number of measures of dairy farm land resources and mean farm butterfat production for each year of the study are tabulated, with appropriate levels of significance in Table VI-12. The only measures of farm land resources consistently significant at the 0.01 level are the area of core dairyland (except in 1965-66) and the area of lower river floodplain (except in 1962-63 and 1963-64). Area of middle river floodplain and middle river terrace should logically provide poor coefficients with the whole sample dairy farm population despite their relatively high productivity because of the limited number of dairy farms possessing these land classes.

## Chapter VIII

CLASSIFICATION OF SAMPLE FARMS IN TYPE  
LOCATION FARM CHARACTERISTICS.Farm classification problems

Evidence strongly suggests that the relationship or relationships between farm land resources and dairy production are complex and are at least partly conditioned by social as well as economic considerations. In turn, there is an obvious need to classify sample farms according to farm land resources and use-activities in order to investigate the production/land relationships by appropriate farm classes. A classification suitable for this purpose must consider not only the physical characteristics of farmland resources but also those cultural features which distinguish groups of farms. In addition the classification must be formulated in such a way that resulting classes can be tested statistically to provide measures of the statistical significance of the system. Classificatory systems involve three phenomena: the individuals to be classified, the attributes by which the classification operates, and the uses for which the system is designed.<sup>1</sup> In the present context, these

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Williams, W.T. and Lance, G.N. 'Logic of computer-based intrinsic classifications.' Nature. July 1965. pp. 159-161.

terms correspond to the sample farm population, land resources and other farm inputs and production data and prediction of relationships between inputs, especially land resource inputs, and dairy production respectively.

Although the demands of the required classification system are not strictly within Kellogg's definition of land classification, his exposition of 'land' provides a suitable conceptual base for designing a farm classification for analysing land production relationships.<sup>1</sup> Concurrently, Robinson's hierarchy of functional and formal regions provides a suitable structural framework for the classification in which farms with similar land resources/cultural characteristics could be assembled for geographic analysis.<sup>2</sup>

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'Land is a term of social science. Land is property. It connotes the space within which production takes place. Besides natural qualities that influence response to management, land connotes location in relation to cultural features, property rights and boundaries and the whole collection of characteristics of place relevant to the concept and operation of the firm.'

Kellogg, C.E. 'Soil classification and land classification.' Journal of Farm Economics. 1951. p. 200.

2

Robinson, G.W.S. 'The geographical region: form and function.' Scottish Geographical Magazine. 69. pp. 49-58. 1953.

### Formal regions.

The first attempt to classify sample farms and to test the statistical significance of the resulting classes is described in 'Testing the significance of formal regions in the Macleay Valley, N.S.W.'<sup>1</sup> Each sample farm was accepted as a functional region and groups of farms possessing similar suites of landforms were classified as formal regions. Subjectively, limits were set on the proportions of various land classes permissible for farms in each formal region and the significance of the classification was tested by increasingly complex statistical techniques, culminating in the use of a multi-variate analysis of the variance statistic. A summary of formal region characteristics is provided in Table VIII-1.

This work demonstrated the statistical significance of the formal region classification but two major weaknesses in the approach were evident. The classification identified formal regions representing very small groups of farms. Some of these were too small to be useful, e.g., Seven Oaks/Broadwater formal region included a total of 19 and Temagog, 21 primary holdings, over half of which were beef cattle grazing properties (See Table VIII-2). More particularly, because a constant sampling fraction had been used throughout the study region during the sampling process,

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Laut, P. 'Testing the significance of formal regions in the Macleay Valley, N.S.W.' Australian Geographical Studies. 5. pp. 150-154, 1967. (A copy is included as Appendix V.)

formal regions were inadequately represented to justify use of the farm data for predictive purposes with any degree of statistical validity, e.g., Seven Oaks. At this stage it was impossible to resample the study region farm population, or even to supplement the sample in those formal regions inadequately represented.

Using sample farms to provide a classification for the total farm population is analogous to the problem of using a vegetation sample to classify the vegetation population in ecology discussed by Williams and Lance.<sup>1</sup> In such studies three alternatives are open to the classifier:

1. The data may be treated as a finite population with the possibility of significant inaccuracies;
2. the original classification may be applied to a new sample of the same population and the level of information tested;<sup>2</sup>
3. a genuinely probabilistic situation can be assumed and probabilities assigned to relationships used in the classification.

The last possibility is the most desirable but is beset by complex mathematical problems, so it was decided to abandon classification of the total farm

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Williams, W.T. and Lance, G.N. 'Logic of computer-based intrinsic classifications.' Nature. pp. 159-161. 1965.

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A possibility noted above as impracticable in this study.

population by a single attribute for sample farms, and to classify the sample farms as a multivariate finite population. With the limitations of the first classification and problems associated with single variate classifications for a multivariate population in mind, it was decided to:

1. Modify the formal region classification by using a number of variables;
2. limit the number of classes and ensure adequate representation in each class;
3. retain as far as possible geographic grouping of sample farms in order to identify local environment/social/economic relationships.

#### Multbet classification

The procedures employed to provide the final classification used in this study (See Fig. VIII-1) began with selection of an objective classificatory system to provide the basis for modifying formal region groupings, and to provide a level of significance benchmark against which to compare other groupings. Personal communications with Williams and later Barnes suggested the use of the MULTBET programme to secure an objective classification of sample farms, biased only by the selection of attributes to be used in the computations.<sup>1,2</sup> MULTBET executes a polythetic

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Williams, W.T. and Barnes, K., Computing Research Section, CSIRO. Canberra.

2

Lance, G.N. and Williams, W.T. 'Computer programs for classification.' Proceedings ANCCAC Conference. Canberra. May 1963. Paper 12/3

agglomerative classification using a centroid strategy on mixed data.<sup>1</sup> It is programmed for the CSIRO 3600 CD and is very time consuming, the time involved being proportional to the number of attributes classified. On the basis of cost, the number of attributes had to be reduced to less than 40. Finally, 38 sample farm attributes (24 numerical, 12 disordered multistate and 2 ordered multistate) measuring farm land resources, dairying activities, income sources and capital investments were processed (See Table VIII-3). The resulting agglomerative groups are mapped in Fig. VIII-2. At this point it was decided to use the five groups or classes provided at the 231, 228, 227, 230 and 225 levels rather than the previous level, which would provide 10 groups or classes. While this appears to be an arbitrary decision, the grouping diagram indicates by the vertical distances between the intercepts the low level of information gain prior to the 231-225 level and the high information gain required before the succeeding grouping levels are reached.

A complementary program to MULTBET is GROUPER which investigates the relationships between groups or classes provided by previous intrinsic classification. In this case the classes were provided by MULTBET, and the original attribute information on which the classes were based was analysed by MULTBET classes. For each comparison GROUPER provides attribute means and

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Lance, G.N. and Williams, W.T. 'Mixed data classificatory programs I. Agglomerative systems.' The Australian Computer Journal. pp. 1-6. 1967.

contributions to the similarity measure in descending order of contribution. These are tabulated and located and the formal region classes provided, for each sample farms in the four MULTBET groups 228, 227, 230 and 225 in Tables VIII-4 to VIII-7 and Figs VIII-3 to VIII-6. Each farm is represented by the colour symbol of the formal region classification used on Fig. VIII-7 for ready comparison of individual farms by the two classifications. Group 231 of the MULTBET classification was not included as it consists entirely of non-dairy farms.

Information provided by GROUPER is particularly useful because it indicates the relative importance of each attribute at each agglomerative level of the MULTBET classification. When the distribution of MULTBET groups is compared with that of the original formal region classification, it is possible to determine which sample farm attributes are more important than land resources in class distribution of farms and on this basis to alter the classification of particular sample farms among the formal regions. MULTBET/GROUPER information also indicated that three of the better regroupings of formal region classes would to be combine:

1. Seven Oaks/Broadwater and Kinchela regions;
2. Yarrahapinni and Euroka regions;
3. Temagog and Hickeys Creek regions;

to provide a total of five classes in the new classification. To avoid confusion between the new and the old classifications, the new formal regions were designated Type Locations ( See Fig. VIII-7).

In this way MULTBET/GROUPER programs provided a series of objective measures against which other classifications of the sample farm population could be compared. As may be noted from the figures and tables representing the MULTBET classification, these groupings cut across the formal region classification although certain similarities of areal distribution of classes between the two classifications may be noted. When sample farm attributes were used to test the level of significance of the MULTBET grouping, it was found that the IBM 360 computer did not have the capacity to invert the 38 by 118 matrix used for MULTBET. To overcome this problem it was necessary to reduce the number of attributes to be included in the multi-variate mean analysis by subjecting them to tests of multicollinearity.<sup>1</sup> The 32 numerical attributes were divided into three groups: farm land resources, dairy production and productivity measures and farm income and expenses, and tested (See Table VIII-8). Partial correlation coefficients and T statistics for these tests and attributes are listed in Tables VIII-9 to VIII-11. From the results of these tests 15 attributes were selected for use in a series of multi-variate mean computations.<sup>2</sup> (See Table VIII-12) Computations were made

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Personal communication with Mr N. Tuckwell, formerly of the Statistics Department Economics Faculty, S.G.S., A.N.U. See Appendix VI for explanation of the method.

2

Personal with Mr N. Tuckwell. See Appendix VII for explanation of the method.

for MULTBET, adjusted Formal Region and Type Location classifications with and without non-dairy farms. In addition, computations were made using land resource data only for the Formal Region and Type Location classifications. Using the 15 attributes selected following tests of multicollinearity, all classifications had chi-square statistics considerably less than the 0.005 level of probability (See Table VIII-13).

The Type Location classification provided a class population range of from 9 to 37 sample farms and from 9 to 34 sample dairy farms. The possibility of further amalgamating formal regions was considered (e.g. the Clybucca and Kinchela), but rejected as there would be additional information loss with little or no gain in statistical significance of the resulting groups, as the amalgamation of the eight Formal Regions into five Type Locations gave a notable decline in the significance level. In addition, more time had been devoted to the development of a satisfactory classification than was warranted in the context of this study.<sup>1</sup> For these reasons the five-class Type Location classification was adopted for analysis of dairy production/land resource relationships in the study region.

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Including MULTBET multivariate means analysis and tests of collinearity, the total time taken in computation was in excess of 160 minutes while the mean hours necessary to process, organise and analyse the data easily exceeded 200.

### Type Locations and Sample Farm characteristics

This section provides a brief analysis by Type Locations of some of the farm characteristics considered basic to this study. To avoid lengthy descriptions of data a series of tables have been prepared for each variable. These are complemented by a few comments concerning the distribution of each variable, or in some cases groups of variables among Type Locations in the following manner. For mean variables (1957-66) e.g., farm land resources and mean of capital investments, data are provided for each Type Location. This is followed by tables representing the results of two forms of analysis of variance. The first is the more usual form in which the mean values for each Type Location group of farms are analysed and the statistical significance of the classes represented by F values, the significance of which are indicated at  $0.05 > \underline{p} > 0.01$  and  $0.01 > \underline{p}$  levels.

The second type of analysis of variance used is Duncan's Multiple Range Test. This form of analysis provides ranking and grouping of Type Locations at the  $0.05 > \underline{p} > 0.01$  level of significance demonstrating which Type Locations possess mean values significantly different from the others. For example in Table VIII-18(a) only Type Location 5 sample dairy farms have a mean area of primary holdings significantly different from those of other Type Locations. In contrast there is considerable overlap among Type Location groupings for area of cleared swamp (Table VIII-18(g)). The mean area of cleared swamp per farm is largest for Type Location 3 and smallest in Type Location 4 sample dairy farms. The area of this

land class for Type Location 3 is not significantly greater than that of Type Location 2, but greater than that of Type Location 1. The mean area for Type Location 2 is not significantly greater than for Type Location 1, but is significantly greater than those of Type Locations 5 and 4. Type Location 1 mean area of cleared swamp on the other hand is not significantly greater than those Type Locations 4 and 5. Type Locations 1, 4 and 5 together provide the third grouping.

For annual farm variables, e.g., mean butterfat production and farm cash-costs, there are two variations in the method of table presentation listed above. For these variables, data for each Type Location group of sample farms are tabulated for each year of the study period and for the mean 1957-66, and the number of sample dairy farms involved noted. In addition the Duncan's Multiple Range Test is applied by years as well as by Type Locations. In Table VII-21 mean butterfat production per farm for each Type Location is analysed, ranked and grouped by each year of the survey as above. It is supplemented by Table VIII-22 in which mean butterfat production per farm for each year is analysed for each of the Type Locations to provide statistical evidence of annual/seasonal variations of this variable for each Type Location group of sample farms within the study period. For example, Table VIII-21(a) demonstrates that for mean butterfat production per farm from 1957-58 to 1965-66 Type Location 2 sample dairy farms had significantly higher mean production than farms of Type Locations 4 and 3. While there is no significant difference between the mean values for this variable for

Type Locations 4 and 3, there is between 4 and 1, so that for this variable Type Location 3 farms overlap with Type Locations 4 and 1 and similarly, Type Location 1 group overlaps with 3 and 5 Type Locations. In the same way the three groups provided by Duncan's Multiple Range Test for the same data analysed by years indicate that years 5 (1961-62), 9 (1965-66), 2 (1958-59), 1 (1957-58), 3 (1959-60), 4 (1960-61) and 8 (1964-65) have mean per farm butterfat production data which are not significantly different. Similarly, years, 9, 2, 1, 3, 4, 8 and 6 form the second group of years in which butterfat production per farm does not vary significantly and years 1, 3, 4, 8, 6 and 7 form the third such group. In each case the sixth and fifth year which overlap with other groups respectively demonstrating that the only years in which butterfat production data are significantly different are year 5 (1961-62), year 6 (1962-63) and year 7 (1963-64). These differences can be accounted for readily in terms of flood losses.

In this way it is possible to demonstrate the significance of the Type Location classification of sample dairy farms for certain farm characteristics, as well as to indicate the range of these characteristics for all sample farms and for each Type Location group of sample farms throughout the period of the survey. The farm characteristics treated include:

1. Farm land resources.
2. Butterfat production per farm.
3. Mean size of dairy herds.
4. Mean butterfat production per milking cow.

5. Mean butterfat production per acre of land used for grazing cows in milk.
6. Farm receipts.
7. Proportion of farm receipts from milk sales.
8. Proportion of farm receipts from cattle sales.
9. Proportion of farm receipts from pig sales.
10. Farm cash costs.
11. Mean of capital investments.

These particular measures were chosen because they represented the more important measures of dairy industry activities.

1. Farm land resources (Tables VIII-14 to VIII-18).

- (a) Eight of the thirteen land class measures for which analysis of variance was computed had  $F$  values at or above  $0.01 > p$  level of significance, and the remaining five had  $F$  values at the  $0.05 > p > 0.01$  and  $0.01 > p$  levels of significance. The area of primary holdings is statistically significant ( $0.01 > p$  level) among Type Locations, but total area of all holdings is only significant at the  $0.05 > p > 0.01$  level. Among the land classes, area of lower river floodplain, area of mangrove and salt-affected floodplain, area of cleared slopes, area of middle river terrace, area of cleared swamp,

area of middle river floodplain and area of uncleared swamp (in descending order of F value) all have F values significant at the  $0.01 > p$  level.

- (b) Type Location 5 sample dairy farms have the highest ranking area of primary holdings and total area of holdings, both of which are significantly larger than other Type Location groups of farms which together form the second group. The importance of land classes to the Type Location classification is clearly reflected in the results of the Duncan's Multiple Range Test for land classes by Type Locations (Table VIII-18).

2. Butterfat production per farm (Tables VIII-18 to VIII-22):

- (a) Analysis of variance for butterfat production per farm by Type Locations indicates that mean values for this variable are significantly different among Type Locations ( $0.01 > p$  level). However, mean production for all sample farms for the study period is not significantly different from year to year, i.e., seasonal conditions do not appear to have a statistically significant effect on total annual production.
- (b) For each year of the study period except 1963, mean butterfat production per farm values for Type Locations were significantly different. Type Location 2 group of sample

farms had the highest mean production in each year of the survey although mean production for this group was significantly higher than that of any other Type Location, i.e., it forms a separate group in only two years of the survey period. During the drier years (early and late years) of the survey, mean values for this variable were second highest for Type Location 3 group of sample dairy farms, but during the wetter years of the survey (mid survey period) Type Location 4 replaced Type Location 3 in second ranking. Range Test results for mean per farm production from 1957-58 to 1965-66 (Table VIII-21(a)) indicate that there are four significant Type Location groupings with overlap between Type Location 4 and 3, 3 and 1 and 1 and 5.

- (c) Contrasting with Range Test results for Type Locations, Range Test results for years indicate no significant variations among means for per farm butterfat production at the  $0.01 > \underline{p}$  level. However, at the  $0.05 > \underline{p} > 0.01$  level of significance, Type Location groups 1 and 3 demonstrate significant annual variations with three groupings of years. Even so, no one year had significantly higher butterfat production per farm than all other years in any Type Location.

3. Mean size of dairy herds (Tables VII-23 to VII-26):

- (a) Although the F value for analysis of variance for number of cows in milk per farm by Type Location groups for 1957-66 is significant at the  $0.01 > p$  level, analysis of annual data indicate the mean values were significant at this level only in 1964-65 and at the  $0.05 > p > 0.01$  level in three other years.
- (b) In all years of the survey, Type Location 2 group of sample dairy farms rank highest for the number of cows in milk, but this Type Location was only significantly different ( $0.05 > p > 0.01$ ) from all other Type Locations in 1958-59 and 1961-62. Type Locations 3 and 4 rank second and third or vice versa for most years.
- (c) Range Test results for this variable by years indicate that there were significant annual variations only for Type Location 1 and only one year, 1963-64, was significantly different from all other years.

4. Butterfat production per cow (Tables VIII-27 to VIII-30):

- (a) Analysis of variance for this variable indicates significant differences among means for both Type Locations and years. However, the F value is considerably higher (X7) for Type Locations. Similarly, means for Type Locations groups for this variable are significant at the  $0.01 > p$  level for

six of the nine years of the study period and at the  $0.05 > \underline{p} > 0.01$  level for a further year. On the other hand, Type Location 3 is the only Type Location group of sample dairy farms for which there is a significant annual variation in butterfat production per cow at the  $0.01 > \underline{p}$  level. Type Locations 1 and 2 have annual variations significant at the  $0.05 > \underline{p} > 0.01$  level.

- (b) The Range Test indicates that Type Location 2 has a significantly higher butterfat production per cow ( $0.05 > \underline{p} > 0.01$ ) than all other Type Locations for mean 1957-66 values. Range Tests for annual data indicate that while Type Location 2 group of sample dairy farms ranks highest for this variable in seven of the nine years of the survey, the means for this Type Location are not significantly greater than those of several other Type Locations of which 4 and 3 are thenext highest ranking.
- (c) When the Range Test is applied to annual data from Butterfat production per cow for all sample farms, four groupings are provided, but there is considerable overlap among groups. Similarly, data for Type Location groups 1 and 3 provide several groups of years in which there is considerable overlap and Type Locations 2 and 5 have two groupings of years which overlap for all but the first and last.

5. Butterfat production per acre of land used for grazing cows in milk. (Tables VII-31 to VII-34):

- (a) Analysis of variance and Range Test values for this
- (b) variable are of the same order as those of the previous
- (c) variable, butterfat production per milking cow.

6. Farm receipts (Tables VIII-35 to VIII-38):

- (a) F values for analysis of variance for this variable by Type Location groups of sample dairy farms for 1957-66 indicate there are significant differences among Type Location means at the  $0.01 > p$  level of significance. However, annual means for all sample dairy farms provide no significant differences among years. Annual analyses of Type Location means of farm receipts are not consistently significantly different and F values reach the  $0.01 > p$  level for only four of the nine years of the survey. One further year reaches the  $0.05 > p > 0.01$  level.
- (b) Farm receipt means for Type Locations 2 and 4 rank highest in the Range Test, but no single Type Location has a significantly higher or lower mean for any year than all other Type Locations. However, annual data for this variable indicate that Type Locations may be divided

into three distinct groups: Type Locations 1 and 3 for which there are four and three groupings of years respectively. Type Locations 4 and 5 for which mean data for all years are statistically similar, and Type Location 2 in which only years 5 (1961-62) and 7 (1963-64), having the highest and lowest farm receipts respectively, are significantly different from one another. These annual variations in farm receipts in lower river Type Location groups of sample dairy farms are very closely associated with flooding in the very wet years 1962-64.

7. Proportion of farm receipts from milk sales (Tables VIII-39 to VIII-42):
8. Proportion of farm receipts from cattle sales (Tables VIII-43 to VIII-46):
9. Proportion of farm receipts from pig sales (Tables VIII-47 to VIII-50):

(a) These three variables are to a large extent complementary comprising as they do over 95% of farm receipts for all sample dairy farms. The proportion of farm receipts from pig sales and the proportion of farm receipts from milk sales demonstrate very high F values well above the  $0.01 > p$  level of significance for variance among Type Locations for all years of the survey, whereas the proportion of farm receipts from cattle sales is similar

among all Type Location groups of sample dairy farms. None of these variables provide significant levels of variance for annual data either for all sample farms or for individual Type Locations. This strongly suggests the static nature of the farm economies within the study region between 1957-58 and 1965-66 despite marked variations in the physical environments during this period.

- (b) The strong locational influence on dairy farming activities noted in the previous chapter is amply demonstrated by the groupings provided by the Multiple Range Test when applied to proportion of farm income from milk sales and proportion of farm income from pig sales. There are strong grouping tendencies for both these variables for all years ( $0.05 > p > 0.01$ ) with reverse ranking of Type Locations i.e., the first of these variables ranks Type Locations upstream, the second ranks them downstream. In contrast, the proportion of farm receipts from cattle sales demonstrates very poor grouping tendencies although Type Location 5 is consistently ranked highest, followed by Type Locations 3 and/or 4
- (c) None of these variables demonstrates significant annual variations nor do any particular years receive highest or lowest

ranking consistently among Type Location groups of sample dairy farms.

10. Farm cash costs (Tables VIII-51 to VIII-54):

- (a) Farm cash costs vary significantly ( $0.01 > p$ ) among years and Type Location groups of sample dairy farms. Variance among Type Locations for each year of the survey are more significant than for among years for each Type Location.
- (b) Results of the Multiple Range Test for all Type Locations for the whole survey period indicate that only Type Locations 2 and 3 could be grouped at the  $0.05 > p > 0.01$  level of significance. Each of the other three Type Locations have mean values significantly different from all other Type Locations at this level. Ranking of Type Location groups indicates that farm cash costs are highest for Type Locations 4 and 5 and least in 1 and 3. While ranking of Type Locations remains much the same for each year of the study period, grouping of Type Locations at the  $0.05 > p > 0.01$  level is less marked.
- (c) There is very little annual variation for farm cash costs within most Type Location groups of sample farms. Type Location 2 group provides the major exception with three significant year groupings. These groupings overlap a great deal, but

indicate that the later years of the survey were associated with high farm cash costs, and the early years with low farm cash costs. Undoubtedly, a considerable proportion of these costs result from seasonal conditions, especially floods, but an increasing proportion is attributable to improved management techniques.

11. Mean of capital investments (Tables VIII-54 to VIII-56):

- (a) Of these measures, unimproved capital investment (U.C.V.) improved capital investment (I.C.V.) and mean total of capital investment were significantly different among Type Location groups of sample dairy farms at the  $0.01 > p$  level and mean annual capital investment in livestock was significantly different among Type Locations at the  $0.05 > p > 0.01$  level.
- (b) Ranking and grouping by the Multiple Range Test indicated that at the  $0.05 > p > 0.01$  level of significance, Type Location 2 formed a separate group from other Type Locations for UCV but combined with 4 to provide an overlapping group (Type Locations 4, 5, 3) for ICV Type Location 5, ranked highest for mean capital investment in livestock, was grouped with Type Location 2 to form the first group for this variable. Ranking and grouping of Type Locations for mean of

total capital investment data was similar to that of ICV except there were only two groupings.

These data demonstrate there are considerable variations in the significance of the distributions of the variables analysed among Type Locations. (Table VIII-57 provides a summary of Analysis of Variance results for Type Locations). They also demonstrate the relative unimportance (statistically) of annual variations for the majority of the same variables. However, the two forms of analysis of variance used do indicate that the Type Location classification provides a statistically satisfactory basis for classification of all but one of the variables treated, i.e., proportion of farm income from cattle sales, as well as for the combined group of variables used in the multivariate means analysis.

It is not considered necessary to examine all variables which may be treated in the following chapter by analysis of variance. It is anticipated that many of these variables are randomly distributed among Type Locations and their relationships with butterfat production will not be determined by their distributions among Type Location groups of sample dairy farms. However, where particular farm variables are closely associated with individual Type Locations, it is expected that this will affect the relationships between these particular variables and butterfat production and provide further evidence of the character of individual Type Locations. In either case, the additional tabular and accompanying descriptive/analytical material would tend to hinder rather than clarify the exposition.

## Chapter IX

LAND RESOURCES/DAIRY PRODUCTION  
RELATIONSHIPS

Once the patterns of land resource division among farms and use of these resources are known, it is possible to explore those relationships which exist between farm land resources and agricultural production. Given the range of technology available to a particular form of agriculture, the economic circumstances governing its organisation and the social environment, it is the inherent energy of the land resources available to the agriculturalist which determines what levels of agricultural production can be achieved from particular land resources. If an agricultural industry used land of one particular quality only, relationships between land resources and production could be more readily analysed than the more typical situation in which a range of land classes of varying potential productivity are used for the same purposes. Similarly, social circumstances are not identical in all farm units, so that farm operator responses to the land resources, to available technology and to changes in economic conditions vary considerably. Major changes in the economic structure of an agricultural industry affect all producers within that industry to some extent, but some respond more rapidly either because of the economic marginality of their enterprise or because of social conditions which make them more perceptive of economic change and its consequences.

The foregoing chapters of this section have sought to describe and to analyse the variety of circumstances under which dairying is carried on within the study region, and to demonstrate that there are areal patterns of dairying and related activities by which farms may be classified to help understand the relationships which exist between the various inputs, especially land resource inputs, and dairy production. Had land resources used for dairying and social and economic circumstances been identical throughout the study region, it may have been possible to establish a production function between land resources and dairy production. The variety of land resources, social conditions and local economic circumstances observed in the dairy industry of the study region do not suggest that the relationship between land and dairy production will be direct or particularly strong and will not constitute a production function. However, it may be possible to establish multivariable relationships between resource inputs and dairy production using regression analysis. Such relationships could then be used in the same manner as a production function for predictive purposes within the limits of the sample farm data, i.e. by interpolation but not by extrapolation. This approach would fulfill the requirements of the second stage of the model outlined in Chapter IV, but only within the limits of the data from which the relationships were derived.

The use of regression analysis to establish multivariable input/production relationships quantitatively involves three sets of problems:

selection of variables which will provide a high degree of statistical explanation of production variance; finding the most suitable measures of these variables; and allowing for variations in the inter-action among variables in different production units. Type Location groups of sample farms which were described and tested in the previous chapter provide a useful framework for initial testing of inter-action among variables. The limited sample farm populations of the smaller groups and the types of variables and variable measures made it necessary to reduce the number of groups for predictive purposes at a later stage. However, selection and measurement of variables provided more fundamental difficulties which had to be explored by both logical and experimental means.

#### Selection of variables

The selection of a measure for farm production proved less difficult than determining the most useful measures for resource inputs. The choice lay between the physical measure of dairy production (i.e. lbs of butterfat) or some measure of farm income. Neither is perfectly satisfactory for the purposes of the present study. Dairy production data are closely related to farm receipts in the three lower river Type Locations, but not in the middle river and tributary locations (Appendix VIII provides correlation coefficients and regression equations between dairy production and farm income data) so use of this measure neglects alternative forms of production.

The use of some measure of farm income, while accounting for non-dairying production, brings into play a variety of alternative forms of land use. Many of these are not represented sufficiently frequently to provide valid statistical assessment. In addition, analysis of resource input/production relationships for a variety of activities involves a wider spectrum of land classes, many of which can be excluded from the analysis if dairy production alone is considered. In order to preserve as simple a situation as possible it was decided to limit quantitative analysis to dairy production and to those resource inputs devoted directly to dairy production and by so doing reduce both axes of the input/output matrix.

The choice of resource input variables and measures was undertaken in two steps. In the first, input variables were grouped into three groups: land resource inputs, management inputs (as reflected by farming practices) and farmer inputs (as measured by farmer characteristics). In the second, each group of variables was tested using correlation coefficients with butterfat production to determine which demonstrated sufficiently significant relationships with butterfat production to warrant inclusion in multiple regression computations. In some cases variables were measured in several ways to determine which measure might prove the most useful, e.g. improved pastures measures include actual area, this area as a proportion of total dairy-land and the proportion of farm cash costs provided by seed, fodder and fertilizer.

The choice of which measure of land resources would be used in multiple regression computations proved the most difficult of all resource inputs. Measures of land can be usefully divided into two groups: those which measure the area of land and those which measure land quality (i.e. potential productivity under given economic and technological assumptions) as well as area, usually by imputing a value. Area measures of land classes proved to be of limited utility for explaining land production relationships as may be measured by correlation coefficients of these measures and butterfat production (See Table IX-1 to IX-6), especially for Type Locations 1, 3 and 4. These correlations indicate the importance of lower and middle river floodplain in dairy farming in Type Locations 2 and 5 respectively but suggest that the variety of land resources used for dairying in other Type Locations make further analysis using area of land class data unnecessary. It should be noted that the small populations of Type Location 1 and perhaps of 4 and 5 also could well be preventing more definitive relationships being evident for these groups.

Use of imputed land values as measures of land resources posed a number of conceptual problems. Theoretically land value is determined by the potential productive capacity of a given land resource in relation to prevailing economic and technological conditions. In practice, imperfect knowledge and social constraints limited the usefulness of the land value concept. In this particular study the problem of what is being measured is also important, as the aim is to assess

relationships between land and production. The source and consequent basis of appraisal of available valuations for the study region also present some difficulties.

In 1962-63 the N.S.W. Valuer-General's Department completed the first comprehensive valuation survey of land resources of the study region. Valuations are determined for each legal holding by a team of valuers. Land values are based on current market values of land and improvements as observed in the most recent sales prior to and at times during the valuation survey. The valuations are based on land-user appraisal rather than on any measure of inherent productivity and consequently reflect a variety of non-economic as well as economic judgements. Valuation data include two measures, unimproved capital value (U.C.V.) and improved capital value (I.C.V.). Unimproved capital value is an hypothetical measure of the value of the land in its undisturbed state and is used for calculating local government rates. It is therefore of great significance to land holders at all times. Improved capital value is a measure of both the land in its unimproved state and all the improvements in the form of fixed capital items such as clearing, fencing, buildings, man-made water supply and so on. This value is directly related to current market prices.

There are both advantages and disadvantages in using Valuer-General's Department valuation data for studies such as this. The advantages are clearly related to the availability of a broadly uniform appraisal fixed at some point in time and related to

local landowner appraisal.<sup>1,2</sup> The disadvantages are both conceptual and practical. As noted above, these valuations are based on local landowner appraisal which frequently includes non-economic or imperfect understanding of economic considerations. For example, a farm sale in the Belimbopinni district in 1963 resulted in two potential purchasers who were farmers with very limited land resources located on either side of the farm for auction, bidding approximately 25 per cent higher per acre of farmland than other sales of similar quality land. This sale was used in establishing MacLeay Shire valuations. Closely tied to this problem of use of landowner appraisal is the minute size of the farm sample (case study might be a better description) used by valuers to define valuation bases. The third conceptual disadvantage is related to use of the U.C.V. concept which leads to a practical disadvantage related to the processes by which the U.C.V. is derived. At very best the U.C.V. is an hypothetical concept which would require detailed land classification and productivity assessment to be adequately applied. However, in the present context, U.C.V. is the result of a series of highly subjective judgements which are

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1

Landowner viewpoints on V.G. values change quite remarkably. Following valuation and re-rating of land, these values are argued to be uniformly too high, but at times of land sales and more especially when land is acquired by Governments, these same values are uniformly too low.

2

The valuation data were made available by permission of the N.S.W. Valuer-General and by the District Valuer of the Port Macquarie Valuer-General's Office.

made in the following manner:

- (i) Farm sales are appraised;
- (ii) I.C.V.'s are fixed in relation to recent sales;
- (iii) Values of fixed capital items are established;
- (iv) The residue is termed U.C.V.  
((iii) and (iv) may be reversed or calculated concurrently.)
- (v) The land area is arbitrarily divided by descriptive classes and the I.C.V. appropriately divided in terms of assumed relative productive capacity.

Usefulness of V.G. data to land/production studies is severely restricted by step (v) for there is seldom a scientific basis for the land classes used by valuers. Individual valuers use differing and often incompatible land classificatory systems and area assessments are frequently highly erratic. For example a typical V.G. valuation for a sample farm holding is:

- (a) 30 acres of higher flats - £35 per acre.
  - (b) 20 acres of lower flats - £15 per acre.
  - (c) 35 acres of low flats, wet - £5 per acre.
- U.C.V. £1,525      clearing £1,350      I.C.V. £4,500

whereas a land class description after detailed farm survey for the same holdings read:

- (a) 5 acres of low levee (Kempsey-Cooroobong soils association).
- (b) 35 acres of low alluvium along the toe of the levee (Glenrock soils association).
- (c) 7 acres of (a) and (b) intermixed.

- (d) 34 acres of deep swamp (Loftus/Broadwater soils association).
- (e) 4 acres of open water lagoon.

Despite these shortcomings valuation data were used directly and indirectly as measures of land resources in land/dairy production regression analysis and later in land/management/dairy production regression analysis. These measures included:

1. U.C.V. of primary holdings (this measure partly compensated for variations in inherent land quality).
2. I.C.V. of primary holdings.
3. U.C.V. of core dairyland (i.e. of land used for grazing milking cows).
4. I.C.V. of core dairyland.
5. V.G. values assumed for land classes and land class areas as measured by field survey of primary holdings.
6. V.G. values and land classes (as for 5) for core dairyland.
7. Generalised V.G. values (i.e. means of sample farm values) for land classes for core dairyland.

In addition, an attempt was made to provide an objective measure of land resources against which value measures could be compared. This was done by using Beta weights derived from multiple regressions involving all classes of farm land resources on dairy production. The Beta weights used were for all sample farms and for each Type Location group of sample farms and were applied using negative values and ignoring negative values for individual land classes.

Together, fourteen measures of land resources were used in the first stage of correlation/regression analysis with mean butterfat production (1957-66) for each Type Location group of sample farms and for all sample farms (See Table IX-7). Of these, two value measures of farm land resources consistently provided more significant relationships with mean butterfat production than all others. These were I.C.V. of core dairyland (4 above) and Valuer-General values by land classes for core dairyland (6 above). The former was somewhat more consistent in significance levels for all groupings ( $r^2$  range from 0.207 to 0.497 with 0.469 for the whole sample dairy farm population) than the latter ( $r^2$  range from 0.111 to 0.559 with 0.440 for the whole sample dairy farm population). However, the Improved Capital Value is a less useful measure of land resources because it includes a variety of capital items many of which, such as houses and garages, are not concerned with dairy production, while the latter is closely tied to readily defined land classes which would be more useful in practical application of the approach demonstrated by this study in the field by external agencies.

It was expected that farmland would provide only a limited explanation of butterfat production and the ranges of  $r^2$  noted above were within the ranges expected. However, the  $r^2$  values of both measures for Type Location 3 sample dairy farms were very low providing some justification for the viewpoint that much of the shallow swampland is over-valued by both farmers and valuers, especially during very wet years.

Figs. IX-1 to IX-8 are scatter diagrams with best fit regression lines for Valuer-General values by land classes for core dairyland for each Type Location and lower and middle valley groups of sample dairy farms. The confidence limits (1.96x standard error of estimate) are very wide in all cases except for Type Location 1, emphasising the relatively dispersed type distribution of these values in relation to butterfat production. This is especially so for Type Locations 3 and 4. The Lower and Middle valley sample farm groups generally demonstrate more useful dispersal patterns around the regression line, but even here there are occasional sample farms beyond the confidence limits.

The second stage in correlation/regression analysis was concerned with computation and examination of correlation coefficient tables to assess the effects of other variables on butterfat production. These tables were for three groups of variables:

1. Number of milking cows and productivity measures (per acre of core dairyland and per cow).
2. Management practices, some of which could be recorded in numerical form, while others could only be ranked (ordered multistate) variables and a few had to be treated by arbitrarily ranking (disordered multistate variables). For ranked variables, rank correlation coefficients were used and for disordered multistate an in/out correlation procedure was used.<sup>1</sup>

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<sup>1</sup> Provided by N. Tuckwell, formerly of the Department of Statistics, S.G.S., A.N.U.

3. Social factors. This group of variables were intended to reflect social factors and individual farmer characteristics which might affect farmer attitudes to management processes and desire to achieve maximum production/income from the available farm resources. These variables also included some numerical, some ordered multistate and some disordered multistate variables.

For the first group of variables annual data were used to calculate correlation coefficients and regression equations for each Type Location and for all sample farms. The second and third group of variables were used for calculating correlation coefficients only using mean data (1957-66) for each Type Location and for all sample dairy farms.

#### Herd size and productivity measures

The first group of variables (number of milking cows, butterfat production per cow and butterfat production per acre) were included to allow analysis of the emphasis in farmer use of stock and land in dairy production. During the field survey it was observed that the majority of sample farmers were inclined to measure productivity in terms of per cow production (i.e. when productivity measures were considered at all) and to this end tended to graze fewer cows than might profitably be the case on their holdings. This attitude was justified by the argument that it was easier (i.e. required less labour) to milk a smaller number of higher producing cows than vice versa. In

most cases this argument was spurious because the labour supply for the farm was under-employed to some extent.

Few sample farmers were concerned with production per acre and the effects of maximising this productivity measure on total returns. (No sample farmer had ever bothered to calculate economic returns and less than 50 per cent could tell accurately their farm receipts for the previous year when questioned during field survey.) The correlation coefficient tables of these variables with annual butterfat production (See Tables IX-8 to IX-10) indicate that butterfat production per cow was significantly correlated with butterfat production for most years in all Type Locations except 1 and 5, but butterfat production per acre of core dairyland was significantly correlated with butterfat production in all years only for Type Location 3. The relationships between number of milking cows and butterfat production were between those of the two productivity relationships except for Type Location 1 which demonstrated no statistical relationship between number of milking cows and butterfat production.

Correlation coefficient tables place the earlier observation that sample farmers tended to negate the importance of land resource/dairy production relations by emphasising production per cow on a more useful basis. To establish this hypothesis regressions were calculated using mean data (1957-66) for each of the three variables on butterfat production for each of the locations which are graphed in Figs. IX-9 to IX-16. Apart from the negative relationship between

butterfat per cow and butterfat production in Type Location 1, the regression lines for butterfat per cow and butterfat production clearly demonstrate farmer emphasis on production per cow over production per acre. The tendency towards parallel regression lines for butterfat production per acre of core dairyland and butterfat production and number of milking cows per acre and butterfat production and their angle of slope in relation to those for butterfat per cow and butterfat production are also significant. This suggests that both milking cow stocking rates and productivity per acre are considerably below the optimum for all Type Location groups except 1. By increasing the number of milking cows this would simultaneously increase production per acre, but lower production per cow. When all three curves are parallel and the regressions for butterfat per cow and butterfat production and butterfat per acre and butterfat production are identical then stocking rates would be optimal under current management practices.

#### Butterfat production and farm management/farmer information variables

Few of the farm management variables used in the correlation analysis demonstrated significant relationships with mean butterfat production (1957-66). Of those which did, total area of sown pastures and field crops and maize/acre equivalents of externally derived feeds fed to dairy stock was the most important, explaining over 35 per cent of the variance in butterfat production of sample dairy farms in Type Locations 3 and 4. The dairy-use combination employed by sample

dairymen (a disordered multistate variable ranked according to the mean proportion of farm receipts derived from dairy production) also indicated strong relationships with butterfat production, especially for Type Locations 2, 3 and 4 (See Table IX-11).

Among farmer information variables, form of farm tenure and number of changes of farmer provided the closest relationships with butterfat production (See Table IX-12). Tenure was ranked farmer-owner to share-farmer (inversely to the proportion of farm income received by the farmer), and the number of changes of farmer were numerical values 0-3. Both provided correlation coefficients with butterfat production significant at the 0.01 level of probability and were highly correlated with each other demonstrating auto-correlation among permanency and ownership and production. This situation, i.e. the concentration of share-farming on low production farms is one of the major problems of the dairy industry. Too frequently farm owners of small holding appreciate the inadequacy of their land resource, leave the industry themselves and then share the farm income with a share farmer. Another common situation among sample farms was the division of the farm land among two family members to create two much smaller production units but retaining ownership among a larger number of family members, with consequent division of the total farm income among a number of families. Among other reasons for poor performance by most share farmers is the local custom of the study region by which share-farmers provide all dairy stock which are commonly of poor quality because of the limited capital-raising

opportunities available to share-dairymen. The marked turnover of share dairymen is the result of two workforce movements. The first represents the movement of the farmers on marginal farms in the lower valley from the dairy industry, the second the movement of dairymen from more marginal middle valley and tributary farms to marginal lower valley farms to replace the group leaving the industry.

The number of children in the farmer's family was included in the correlation analysis to examine the effects of family demand as a stimulus to productive activity. Correlations of this variable with butterfat production reached the 0.01 level of significance in Type Locations 2 and 5 and for the total sample dairy farm population. As another family variable age of the oldest child did not provide significant correlations with butterfat production, it can be assumed that this relationship was more a response to family demand than to availability of an additional labour force. Neither time the farmer has been on the farm or employed in agricultural industries, nor farmer's or farmer's wife's education qualifications provided linear statistical relationships with butterfat production (See Table IX-12). It is appreciated that there may be non-linear relationships between butterfat production and some farmer information variables. For example, one would expect the relationship between butterfat production and farmer age to provide an inverted first degree polynomial curve. In the earliest stages the young farmer tends to lack capital and vocational skills, albeit he may partly compensate with enthusiasm and energy. As he

gains skill and acquires capital in his 30's and early 40's he is at the peak of his productive period. By his early 50's, despite accumulation of capital in the form of quality dairy stock and a relatively high degree of expertise, economic necessity is less pressing and consequent incentive lacking. However, linear relationships have been sought in order to provide multivariable relationships for predictive purposes without unduly complicating the mathematics involved. This is not an unrealistic approach providing prediction is confined within the limits of the data set as noted earlier in this Chapter.

#### Multiple correlations

From these data it was evident that no single variable available accounted for a greater level of explanation of butterfat production variance for each of the Type Locations and for the total sample dairy farm population than V.G. values by land classes of core dairyland. As a result, this variable provided the first independent variable for a series of controlled step-wise multiple regressions among farm variables and mean butterfat production (1957-66) which comprise the third stage of the correlation/regression analysis. In this process, selection of second, third and fourth independent variables for each Type Location and for Lower and Middle valley sample farm groups and the total sample farm population was based on a progression of multiple regressions in which a number of farm management and farmer information variables were used as the second independent variable. The one which gave the highest

level of explanation of variance of butterfat production in conjunction with V.G. values by land classes of core dairyland for all Type Locations, Lower and Middle Farm groups and the total sample farm population became the second independent variable. The process was repeated until a compromise was reached between the level of statistical explanation of variance and the number of independent variables. At each stage numerical variables which could be most readily obtained and which could be used for predictive purposes by external agencies were given preference over others.

In the first step of this stage V.G. values by land classes of core dairyland was the first independent variable and 27 management and farmer variables were used as the second independent variable in multiple correlation with mean butterfat production (1957-66). Table IX-13 provides  $r$  and  $r^2$  values for these multiple correlations. These data indicate that total acreage of sown pastures, field crops and externally derived feeds fed to dairy stock provides the best second independent variable for Type Locations 2, 4, 5, Lower Valley and total sample farm population, and variations of this measure provided the best second independent variable for Type Location 1 (best second independent variable: Seed, fodder and fertilizer as a proportion of Farm Receipts), Type Location 3 (best second independent variable: Total acreage of sown pastures, field crops and externally derived feeds fed to dairy stock as a proportion of core dairyland) and Middle Valley (best second independent variable: Acreage of sown pastures and field crops fed to dairy

stock). Adoption of this variable increased the level of statistical explanation of butterfat production to between 56.6 per cent and 90.9 per cent for the Type Location and Middle and Lower valley groups of sample dairy farms and to almost 70 per cent for the total sample dairy farm population (See Figure IX-17).

Multiple correlation coefficients were then computed using the first and second independent variables noted above, and 22 other management and other farmer information variables as the third independent variables. The multiple correlation coefficients provided by this step (See Table IX-14) indicated that two variables, Capital value of dairy stock and income from milk as a proportion of Farm Receipts provided very similar levels of statistical explanation of butterfat production. Capital value of stock was chosen as the third independent variable because it is a measure which could be readily applied by an external agency for industry or individual farm development. The third independent variable did not add significantly to the level of statistical explanation of variance of butterfat production for Type Location groups 4 and 5 and Middle valley sample dairy farms (See Fig. IX-17). However, the fourth step in the multiple correlation analysis indicated that Income from milk as a proportion of farm receipts (Milk as percentage of farm receipts) added significantly to the level of explanation in all but Type Location groups 1 and 4. When the third and fourth independent variables were interchanged and the multiple correlations again completed, a similar pattern between levels of explanation for third and fourth independent variables

was apparent and the same total level of explanation was achieved by the use of the four independent variables (See Table IX-15 and Fig. IX-17).

At this stage, levels of statistical explanation of variance of butterfat production varied from 59.8 per cent to 92.7 per cent for the Type Location, Lower Valley and Middle Valley groups and 79.4 per cent for all sample dairy farms. The levels of explanation were notably higher for Middle Valley Type Locations than for those of the Lower Valley but relatively similar for Type Location groups within each Valley group. Further multiple correlation equations using five independent variables did not provide any significant increases in the overall levels of explanation of butterfat production and it was decided to abandon multiple correlation activities. Multiple regressions on mean butterfat production (1957-66) using the four independent variables selected by multiple correlation analysis were computed (See Table IX-16) and the Beta weights for each independent variable were compared among Type Location groups. Beta weights (partial correlation coefficients) also suggest that Type Locations could be usefully grouped into Lower Valley and Middle Valley groups for practical purposes.

#### Multiple regression analysis

The levels of statistical explanation of variance of butterfat production are sufficiently high to allow the use of corresponding regression equations for prediction purposes, much the same as production functions. Tables IX-17 to IX-24 indicate some

approaches to using these equations. Section (i) of each Table uses mean sample farm data for the Type Location or Valley group to provide solutions. These solutions demonstrate the possibility of predicting the approximate level of butterfat production using particular levels of each variable for given farm situations. Section (ii) assumes two levels of production and the mean combination of variable inputs associated with each group of sample farms to demonstrate the composition of variable inputs required to achieve these levels of butterfat production.

These data are graphed in Figs. IX-18 and IX-19 for the Lower Valley and Middle Valley sample farms. They provide graphic evidence of the quantities of first, second and third independent variables (the fourth variable has been held constant at the mean level for each Valley group of sample farms) necessary to achieve a given level of butterfat production. For example, to achieve a long-term butterfat production of approximately 8,000 lbs per annum under similar seasonal conditions similar to those prevailing during the period of the survey a suitable combination of independent variable inputs would consist of core dairyland to the value of approximately \$5,800A. (£2,900A. on graph), 18 to 18.5 acres of improved pasture and dairy stock valued at approximately \$4,800A. (£2,400A. on graph). N.B. The values quoted are for 1962 (land) and 1963-64 (dairy stock). Similarly, to achieve a butterfat production of approximately 10,000 per annum, a suitable combination of independent variable inputs would consist of core dairyland \$7,200A., 23 acres of improved pasture

and dairy stock valued at \$6,000A. These are not optimal solutions, but solutions which would be commonly applicable given similar distribution of resource inputs management techniques and farmer characteristics to those noted during the field survey of sample dairy farms.

Section (iii) provides some measure of the effects of substitution of each of the independent variables (excluding the fourth independent variable) while the others are held constant. This information is graphed for Lower Valley and Middle Valley sample farms in Figs. IX-20 and IX-21. These diagrams offer opportunities for interpretation of the effects of changing the relative proportions of each of the independent variable inputs on butterfat production. However, the usefulness of these diagrams is limited to within the range sample farm data, and application of information from the graphs, or other arithmetically derived data to individual farm situations might be met by constraints which made them impossible to fulfill, e.g. the total acreage of sown pastures and field crops on Middle Valley farms is frequently limited by the area of land classes suitable for cultivation.

The problem of substitution of inputs and optimal combination solutions is one of linear programming and is not particularly relevant to the present study. However, graphic evidence does suggest the effects of substituting higher proportions of independent variable inputs on butterfat production compared with input combinations. For example, in both Lower and Middle Valley groups of sample dairy farms investment in improved pasture appears to provide for

greater increases in productivity per unit than either increases in value of core dairyland or dairy stock. When production curves for each of the independent variables is based on per annum costs, i.e.,  $x_1$  = rent,  $x_3$  = replacement cost, represented by variables  $x_{1a}$ ,  $x_{2a}$  and  $x_{3a}$ , more accurate interpretation is possible.

Under the common levels of management, and within the range of social factors operating, Lower Valley sample farms would gain greatest production returns from investments in additional core dairyland only when production is below approximately 8,500 lbs of butterfat. Above this level additional dairy stock would achieve greatest output per unit of investment. For example an additional investment of £500 in dairy stock holding other input variables at the mean level would theoretically result in an additional output of approximately 9,500 lbs of butterfat if the relationship is strictly linear. The corresponding output for £500 additional investment in improved pastures would be in the vicinity of 3,500 lbs of butterfat and for similar additional investments in land only approximately 2,000 lbs butterfat. Plotting standard error of estimate on this data reduces the clarity of the diagram considerably but it should be noted that for the regression equation for Lower River sample dairy farms it is 1,770 lbs. When the standard error of estimate is taken into consideration,  $x_{3a}$  and  $x_{2a}$  overlap, but both are significantly more profitable investments than  $x_{1a}$ . From this it could be concluded that the value of core dairyland is generally higher than necessary for the corresponding inputs of dairy stock and area of improved pasture and feed crops.

Graphic analysis of the effects of partial substitution of independent variables reveals a quite different situation for Middle Valley sample dairy farms. Although additional inputs of improved pasture/field crops and of dairy stock provide greater returns than investment in core dairyland, the comparative rates for all three independent variables are very similar. When the standard error of estimate for the multiple regression equation upon which this graphic analysis is based is considered the range of responses to increases in all three variables overlap and it would be incautious to suggest that proportional increases in any one of these variables is likely to achieve increases significantly greater than for any other of the three independent variables under consideration. For this group of sample farms it appears desirable to increase all resource inputs in the same relative proportions as for mean conditions.

By comparing the slopes of  $\frac{x}{1a}$ ,  $\frac{x}{2a}$  and  $\frac{x}{3a}$  for Lower and Middle Valley sample dairy farms it is possible to draw some conclusions as to the relative profitability of investments in each of these groups in terms of increased butterfat production. It seems that additional investment in Lower River locations will provide greater butterfat production per unit of investment than Middle River locations, but that investment in additional core dairyland resources leads to proportionally greater increases in butterfat production in Middle Valley than in the Lower Valley. Overall it is marginally more profitable per unit of investment in dairy stock and in improved pastures in

the Lower Valley than in the Middle Valley group of sample farms, whereas with land, additional investments are more profitable in the Middle Valley group of sample farms.

#### Part D. Conclusions

The design of the study has been to move from the general (Part B.) to the particular (Part C.). In this section, the probable effects of hypothetical Government dairy policies on dairy farming activities and rural population in the Macleay Valley are examined. This is done by adapting the model for farm dairy production postulated in Chapter IX to assess the number of dairy farms which could be supported by the Lower and Middle valley regions at given mean levels of dairy production. As farm population in the study region is a function of the number of farms it is possible to suggest the probable effects of the two types of Government policies on the number of dairy farms, and consequently on the farm family population of the study region. More general conclusions are reached concerning the probable effects of these policies on the rural population of the N.S.W. Milk Solids Region.

## Chapter X

CONCLUSIONSIntroduction

The design of Government policy for any particular agricultural industry must be related to a variety of economic, social and political factors many of which may not be directly concerned with the organization of the industry in question. Among these considerations are levels of farm production, income and efficiency within the industry in question, attitudes to rural population distribution and regional development and decentralization, market opportunities for future production of the industry in relation to trends in the cost structure, the possible effects of indirect and direct assistance to the industry, not only on the industry in question, but also on other agricultural industries and in turn to their demands for favourable Governmental policy, as well as to the political problem of assisting one section without alienating the electorate at large. In the present study, the probable effects of Government policy are examined only in relation to farm production, regional production and rural population distribution. Ramifications of particular policy on total industry production and markets and political questions are regarded as beyond the scope of the study.

Government agricultural policies whose aims are to increase per farm income may be divided into those aimed at increasing the farm input base, and those designed to

increase the efficiency of current farm inputs in the production process. These are not mutually exclusive, and the second are often a concomitant of the first as a result of increasing scale of activities. However, in an industry where management levels vary considerably but are commonly low, it is not easy to design a common policy which achieves the desired effect without notable variation from the mean desired result. This is especially so in the Australian dairy industry where it is left to the individual farmer to take advantage of opportunities made available by Government policy. The design of policy becomes significantly more difficult where there is notable regional variation in the quality of the land resource base which is critical to the level of production efficiency which can be achieved. The problem is further complicated where land of suitable quality is commonly intermixed with land of less than the critical minimum quality within the one farm and suitable measures of productive capacity of land classes are not available.

The previous sections of this study have been designed to provide a limited quantitative basis for estimating the effects of changes in farm inputs on production in one valley region within the N.S.W. Milk Solids Region. Part C demonstrates the variety of land resources used by farms which constitute the dairy industry in the Macleay Valley. It indicates the variety of activities associated with dairy farming and the general relationships between farm land resources and farming activities. It also provides functional relationships between selected farm inputs and outputs

for the Middle and Lower Macleay sample farms which may be regarded as representative of the two major sections of the dairy industry within the study region, i.e. that which includes a variety of other activities besides dairying and that which is dependent almost exclusively upon dairying in the farm economy.

The following section in this chapter examines the probable effects of each of the broad types of Government policies designed to increase farm production suggested above. First, the probable effects of increases in land and stock resources as representative of increasing capital inputs on study region dairy production and number of farms is discussed. Second, the effects of increased annual expenditure on pasture/feed crops and on nitrogen fertilizer which are representative of increased levels of management are treated in a similar manner (for the present study management is equated with production efficiency). These types of policies may be equated with two Government policies currently proposed and in operation for the dairy industry. The Dairy Farm Reconstruction Scheme as proposed by the Commonwealth Government represents the type of policy concerned with expansion of the farm resource base, and the N.S.W. State Government Feed Year Assistance Scheme, the type of policy aimed at increasing management levels through improved pasture development, i.e. increased annual expenditure.<sup>1</sup>

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Address by the Minister for Primary Industry, Hon. J.D. Anthony, Ipswich, 15 March 1968.

Land resources, levels of dairy production and number of farms

Land resources in the study region suitable for dairy farming are largely limited to the lower river floodplain, middle river floodplain and middle river terraces (including tributary floodplain). A grid dot count on the original Parish maps at a scale of 2 miles to 1 inch indicates that these three land classes provide 7.8 per cent of the total study region area (see Table X - 1). Allowing for marginal areas of shallow swampland as additional dairy land, something around 10 per cent of the study region may be regarded as suitable for dairying. Subjective field appraisal and the results of correlation analysis Tables IX-1 to IX-6 suggest that only the lower and middle river floodplains provide good quality dairy land. These land classes total 35,940 acres or 4.8 per cent of the study region, together with another 23,310 acres of middle river terrace and tributary floodplain or 3.0 per cent of total area as distinctly second class dairy land. Sample dairy farms include 6,770 acres of lower river floodplain or 20.6 per cent of the total area of this class, indicating that the 20 per cent sample of dairy farms includes a slightly higher proportion of this class than the total farm population, as would be expected. On the other hand, sample dairy farms included only 2,480 acres of middle river and tributary floodplain or 15.7 per cent of the totals of these land classes, suggesting that dairy farming does not occupy as high a proportion of these land classes as farms dependent upon other types of activities.

Valuer-General values for Lower river floodplain in 1962-63 varied from as low as £22/5/- to as high as £51 per acre with a mean of approximately £35.3 per acre for sample dairy farms. Assuming the total area of lower river floodplain were available for dairying, i.e. 32,900 acres, this would be valued at approximately £A1,161,370.<sup>1</sup> Middle river and tributary floodplain land classes were valued considerably lower than Lower river floodplain, varying from £4 to just over £40 per acre, with a mean of almost £16 per acre to give an approximate total value of £310,720 for these land classes. Of this total approximately 14,600 acres valued at £233,600 were used for dairying purposes in 1962-63, and considerably less towards the conclusion of the study period.

Problems associated with the choice of monetary or physical production measures for analytical purposes were discussed in Chapter IX. These present important issues when the effects of substitution of independent variables used in regression analysis are discussed. Again it was considered preferable to use a physical production measure, for regression analysis had not indicated that profitability was related to any of the independent variables used in the study, whereas butterfat production has demonstrated a number of strong relationships with other farm variables. Similarly, the limitations of linear correlation and regression are evident when attempting to assess the most useful

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Valuer-General values for core dairy land employed in Chapter IX are used in the following section of this Chapter to calculate the number of dairy farms which might be supported in the study region.

combinations of land resources, improved pasture and stock inputs. Subjective judgment necessarily replaced quantitative techniques when data limits (i.e. ranges of data observed for sample dairy farms) were approached.

The desirable level of butterfat production per farm set by the McCarthy Commission was an arbitrary 8,000 lbs. More recently, higher levels have been suggested as per farm production minima, of which 10,000 lbs and 12,000 lbs have been the most common. As a result, the 10,000 lbs and 12,000 lbs levels are used in the following calculations to indicate the number of dairy farms which might be accommodated in the study region. In addition, receipts for butterfat production represent varying proportions of farm receipts, so the mean level of butterfat production in the Middle valley which corresponds to 10,000 lbs production in the Lower valley has been determined by the proportion of receipts from milk sales to the total of farm receipts. This has been set at 6,500 lbs.

#### Applying the Model to Macleay Valley data

These data may be used to provide general solutions using the butterfat production model discussed in Chapter IV and the butterfat production regression equations developed in Chapter IX. In the second stage of the model for dairy farm production:

$$\text{Eq. 1} \quad P_{i_x} = f_i (L_x, C_x, M + Lb_x) .$$

where  $P_{i_x}$  = butterfat production from farm  $\underline{x}$  in region  $\underline{i}$ , and

$f_i (L_x, C_x, M + Lb_x)$  = a function of the combined resources of land capital management and labour as conditioned by local social factors and ecosystem energy inputs through land resources available at farm  $x$ . These local social factors and energy inputs are held constant within formal region  $i$ .

It follows that by summing for all  $x$  in region  $i$  :

$$\text{Eq. 2} \quad P_i = f_i (L, C, M + Lb)$$

where  $P_i$  = butterfat production from region  $i$  , and  
 $f_i (L, C, M + Lb)$  = a function of the combined resources of land capital, management and labour as conditioned by local social factors and ecosystem energy input available at region  $i$  .

Where  $P_i$  = butterfat production in region  $i$   
 $F_i$  = number of farms in region  $i$   
 $L_i$  = land resources in region  $i$  and  
 $P_d$  = desired production per farm

$$\text{Eq. 3} \quad F_i = \frac{P_i}{P_d}$$

But

$$\text{Eq. 4} \quad P_i = y, \quad (\text{where } y \text{ is butterfat production in the regression equation } y = a + bx_1 + cx_2 + dx_3 + ex_4)$$

So

$$\text{Eq. 5} \quad F_i = \frac{y_i}{P_d} = \frac{a + bx_1 + cx_2 + dx_3 + ex_4}{P_d}$$

where  $x_1$  is available land resources in region  $i$ , i.e.

$$\text{Eq. 6} \quad F_i = \frac{a + b L_i + cx_2 + dx_3 + ex_4}{P_d} .$$

A model which would allow calculation of the hypothetical number of farms which could be accommodated in a region of known land resources and which could achieve a mean butterfat production of any given level would then be

$$\text{Eq. 7} \quad L_i = A_i \times V_i \quad (\text{Area} \times \text{Value})$$

where  $L_i$  is measured in terms of values

therefore

$$\text{Eq. 8} \quad F_i = \frac{a + B A_i V_i + cx_2 + dx_3 + ex_4}{P_d}$$

where

$x_2$  = area of improved pastures, feed crops and maize/acre equivalents of externally derived feeds fed to dairy stock

$x_3$  = total value of dairy stock

$x_4$  = the proportion of farm receipts from milk sales.

Substituting values for constants  $a$ ,  $b$ ,  $c$  and  $d$  from the regression equation in Table IX - 17: (in lower river floodplain, region  $1$ )

$$\text{Eq. 9 } F_1 = \frac{-4641 + 0.28 A_1 V_1 + 109.96 x_2 + 1.55 x_3 + 78.1 x_4}{P_d}$$

It is possible to use this function to provide for variations in the desired level of mean butterfat production by converting  $x_2$ ,  $x_3$  and  $x_4$  inputs to equivalents of  $x_1$  using Equation 10

$$\text{Eq. 10 } x_1 = \frac{y - (a + cx_2 + dx_3 + ex_4)}{b}$$

So that  $\underline{x_{1m}}$  is the value of  $\frac{x_1}{P_i}$  necessary to obtain the actual mean level of  $P_i$

but actual  $x_i = A_i V_i$ ,

therefore

$$\text{Eq. 11 } F_i = \frac{A_i V_i}{x_{im}} .$$

For mean inputs and production data for Lower valley (region 1) sample dairy farms ( $P_1 = 8,315$  lbs.)

$$\begin{aligned} F_1 &= \frac{A_1 V_1}{x_{1m}} \\ &= \frac{32,900 \times 35.3}{2,805} \\ &= 414 , \end{aligned}$$

indicating that the Lower river floodplain could support a population of 414 dairy farms whose dairy production was normally distributed around a mean of 8,315 lbs p.a.

Should the desired mean level of butterfat production be higher or lower than the observed mean of

the sample dairy farms, the number of farms which could be supported at any given level of production on the Lower river floodplain is proportional to the mean desired production and the mean observed production, providing that each of the independent variables are varied by the same proportion (with the exception of  $x_4$  which is held constant as in the analysis of the previous chapter).

$$\frac{Pd}{P1} : \frac{x_1}{\bar{x}_1} : \frac{x_2}{\bar{x}_2} : \frac{x_3}{\bar{x}_3} .$$

Assuming the desired mean level of production for Lower River dairy farms to be 10,000 lbs. of butterfat per annum then:

$$F1 = \frac{32900 \times 35.3}{3773} \quad (x_1 = 3773 \approx 107 \text{ acres of lower river floodplain}).$$

$$= 344 \text{ farms}$$

and for 12,000 lbs.,  $F1 = 287$  farms.

Should the aim be to achieve the desired level of butterfat production by increasing one variable while holding others constant, two methods may be used depending upon which independent variable is under consideration. Where  $x_1$  (i.e. Value of core dairyland using Valuer-General values by land classes) is the variable to be adjusted. For example where  $Pd = 10,000$  lbs.

$$x_1 = \frac{10,000 - (-4641 + 2122 + 3840 + 6209)}{0.28}$$

$$= \frac{2470}{0.28}$$

$$= 8821 \quad (x_1 \approx 250 \text{ acres of lower river floodplain})$$

$$\text{and } F1 = \frac{32,900 \times 35.3}{8821}$$

$$= 132 \text{ farms.}$$

In the case of  $Pd = 12,000$  lbs.,  $F1 = 73$  farms.

Where  $x_2$  or  $x_3$  (total area of improved pasture, feed crops and externally derived feeds fed to dairy stock and value of dairy stock) are the variables to be adjusted, the variables must first be treated in the same way as  $x_1$  above, then the new value substituted. For example assuming  $x_2$  is to be adjusted to give  $Pd = 10,000$  lbs.

$$x_2 = \frac{10,000 - (-4641 + 785 + 3840 + 6209)}{109.96}$$

$$= \frac{3807}{109.96}$$

$$= 34.6$$

this value is then substituted as follows:

$$x_1 = \frac{10,000 - (-4641 + [34.6 \times 109.96] + 3840 + 6209)}{0.28}$$

$$= \frac{787}{0.28}$$

$$= 2810 \quad (\bar{x}_1 = 79.6 \text{ acres of lower river floodplain})$$

$$\text{and } F1 = \frac{32900 \times 35.3}{2810}$$

$$= 413 \text{ farms.}$$

(If  $Pd = 12,000$  lbs.,  $x_2 = 52.8$  and  $F1 = 413$  farms.)

Similarly, if  $x_3$  is the variable to be adjusted to give  $Pd = 10,000$  lbs.

$$\begin{aligned} x_3 &= \frac{10,000 - (-4641 + 785 + 2122 + 6209)}{1.55} \\ &= \frac{5525}{1.55} \\ &= 3565. \quad (\bar{x}_3 = 101 \text{ cows}). \end{aligned}$$

this value is substituted as follows

$$\begin{aligned} x_1 &= \frac{10,000 - (-4641 + 2122 + [3565 \times 1.55] + 6209)}{0.28} \\ &= \frac{785}{0.28} \\ &= 2804 \quad (\bar{x}_1 = 79.4 \text{ acres of lower river floodplain}) \end{aligned}$$

$$\text{and } F1 = \frac{32900 \times 35.3}{2805}$$

$$= 414 \text{ farms.}$$

(If  $Pd = 12,000$  lbs.,  $x_3 = 7825$  and  $F1 = 414$  farms.)

This type of analysis is distinctly limited in application because it is based on linear relationships. This point was discussed in the previous chapter and is equally applicable here. In addition, there are certain physical constraints which can only be applied in a general sense. While it is possible to achieve the desired level of 10,000 lbs. of butterfat production on a farm with mean land value £A2,805 = 80 acres of lower river floodplain, and it is hypothetically possible to increase mean farm's production by providing additional dairy stock, it is doubtful if many farmers could achieve

the higher desired level of butterfat production (12,000 lbs) with 79 acres of lower river floodplain, only 19 acres of improved pasture and just over 167 cows. However, the effects of improving stocking rates and quality of dairy stock are particularly important in increasing per farm production despite problems of calculating marginal returns per unit of investment of each of the independent variables using linear regressions only with sample dairy farm data.

A more useful exercise for this study is to examine the effects of given increases in variables  $x_2$  and  $x_3$  on  $x_1$  for given levels of butterfat production. Assuming mean levels for variables  $x_2$  (19.3 acres) and  $x_3$  (£A2,478), the value of  $x_1$  required to provide 10,000 lbs of butterfat production is £A8,821, which is equivalent to approximately 250 acres of lower river floodplain. This mean value of  $x_1$  (£A8,821) provides a total of 132 dairy farms in the lower valley region. However, should the mean of the desired level of butterfat production be 12,000 lbs, then the mean value of  $x_1$  is 15,964, which is equivalent to approximately 450 acres of lower river floodplain, and consequently, only 73 farms could be accommodated in the Lower Valley region.

Table X-2 provides the results of calculations assuming increasing levels of independent variables  $x_2$  and  $x_3$  and the corresponding levels of  $x_1$  required to produce means of 10,000 lbs and 12,000 lbs of butterfat per farm. These data indicate the importance of providing greater than proportional increases of variables  $x_2$  and  $x_3$  with increases in  $x_1$  from mean conditions if the number of farms is not to be severely reduced by

increasing the mean per farm level of dairy production. The last two groups of data indicate the effects of varying relative increases of  $x_2$  and  $x_3$  on the value of  $x_1$ . There is no particular significance in the choice of values adopted, although the 50 per cent increase in  $x_2$  and the 25 per cent increase in  $x_3$  may be considered as approaching the practical limits for substituting improved pasture and stock for land to achieve a level of mean per farm production of 10,000 lbs. As Lower river floodplain valued at £A1,614 (1962-63) is equivalent to almost 46 acres, the assumption of 29 acres of improved pasture must be regarded as very close to the optimum mean area which could be cultivated. Similarly, dairy stock to the value of £A3,091 (1962-63) is equivalent to approximately 69 milking cows or almost 1.5 milking cows per acre of core dairy land which may also be regarded as approaching the optimum as observed in this part of the study region. Although these data may appear optimistic, there are several sample farms which performed well above these levels throughout the survey period. The most outstanding of these was Sample Farm 62, a 34 acre farm which had a mean of 23 acres of improved pastures and field crops, carried 60 milking cows for each of the study years and achieved a mean butterfat production of 14,061 lbs. (1957-66).

The butterfat production/farm inputs regression equation for Middle Valley sample dairy farms provided in Chapter IX indicates a significantly different relationship between butterfat production and the four independent variables used. Again holding  $x_4$  constant (proportion of farm receipts from milk sales), the independent variables

can be manipulated to demonstrate the effects of increasing or decreasing inputs of each of them singly or collectively. However, as indicated in Chapter IX, Fig. IX-21 indicates that no independent variable is statistically more significant per unit of input/per unit of production than any other. For this reason it is proposed to deal with resource inputs required to produce the equivalent of 10,000 lbs of butterfat in relation to the area of middle river and tributary floodplain by proportional increases only. Taking into consideration the relative importance of dairy products to farm receipts, a mean of 6,500 lbs of butterfat per farm in the Middle Valley region is regarded as the equivalent of a mean of 10,000 lbs per farm in the Lower Valley region.

For mean conditions prevailing among Middle Valley sample dairy farms (mean per farm butterfat production p.a. = 6,354), and assuming the whole of the Middle river and tributary floodplain and classes are available for dairy production:

$$\begin{aligned} F_m &= \frac{A_m V_m}{x} \\ &= \frac{19420 \times 16}{1954} \\ &= 159 \text{ farms.} \end{aligned}$$

However, only approximately three-quarters of these land classes which would support some farms at this mean level were used for dairying purposes.

Assuming the desired level of production for Middle river dairy farms to be the equivalent of 10,000 lbs, i.e. 6,500 of butterfat p.a., then:

$$F_m = \frac{14568 \times 16}{2000}$$

$$= 116 \text{ farms.}$$

and the level of other independent inputs:

$$x_2 = 18.2 \text{ (acres)}$$

$$x_3 = 2357 \text{ (£A.1962-63),}$$

the fourth variable,  $x_4$ , being held constant as in the previous analysis. By doing this, it is assumed that areas of other land classes besides Middle river and tributary floodplain will be increased in proportion to provide equal opportunities for other farming activities, especially beef cattle grazing as was observed during the study period.

Some conclusions may be drawn from this analysis concerning the probable effects of the constitution of farm inputs on the total farm population in the study region, or of formal regions within the study region at given levels of production. It seems clear that within a wide range of production levels, a considerably greater farm population could be supported in the Lower valley of the study region on the Lower river floodplain land class if greater than proportional inputs of total area of improved pasture/feed crops and dairy stock to land resources are provided than were observed within this formal region group of sample farms. From observation of actual farm performance data it seems that the total area of improved pasture/feed crops input may approach the total area of core dairy land without seriously affecting marginal returns. On the other hand it is not known how

far substitution of dairy stock for other inputs can be carried. It has been shown in Chapter IX that mean farm dairy stock inputs are considerably less than optimum, even with limited mean area of improved pasture/feed crops, and mean stocking rates of two to two and one half cows per acre of core dairy land may be closer to the optimum if the area of improved pasture/feed crops is also expanded.

As demonstrated above, the Lower valley could support a much greater farm population than at present without lowering the mean level of dairy production. On the basis of a mean area of core dairy land per farm approaching 46 acres (£A1,614, 1962-63) of which around 30 acres are under improved pasture/feed crops, and with dairy stock valued at approximately £A3,100 (1963-63) per farm, just over 700 dairy farms having a mean dairy production of 10,000 lbs of butterfat p.a. could be supported on the 32,900 acres of Lower river floodplain. This compares very favourably with the mean situation observed during the survey period, when the same area of Lower river floodplain, or mean of dairy farm data would support a total of only 414 dairy farms having a mean butterfat production of 8,315 lbs p.a. and indicates that extensification of farming activities by providing more core dairy land per farm is not required to increase mean per farm production.

These data indicate not only the very low levels of management observed on most sample dairy farms but also indicate that the most useful remedial measures are associated with improvement of farm management rather than with increasing farm area in the Lower valley

region. In particular dairy stock inputs require considerable improvement, both in quality and in quantity. Concurrently feeding arrangements for dairy stock must be improved. While sample dairy farm data suggest that improved pasture/feed crops will provide the necessary feed requirements, data for kikuyu growth at the Wollongbar Agricultural Research Station have been analysed and it is suggested that very considerable gains in the production of dairy stock feed could be made by better management of volunteer pasture in this Lower valley section of the study region.

Relating Wollongbar Agricultural Research Station data to the study region was undertaken through the following procedures. Data for three rates of kikuyu growth resulting from three rates of application of nitrogen (nil, 100 lbs per acre and 200 lbs per acre) at Wollongbar (Lismore District, N.S.W.) were correlated with concurrent climatic data (see Table X-3) and a series of multiple regressions were computed for kikuyu growth rates and climatic elements. Mean climatic data for Lismore (the nearest official meteorological station to Wollongbar) were compared statistically with similar measures for West Kempsey by correlation and analysis of variance to demonstrate that these two stations were in the same climatic regime (see Table X-4). Those multiple regressions providing the highest statistical explanation of variance of kikuyu growth rates were used with mean climatic data for West Kempsey to provide the kikuyu growth rate curves graphed in Fig. X-1. The procedure did not take into account seasonal probabilities for temperature, precipitation and soil moisture in the

study region, and the overlapping hachures merely depict 1.96 times the Standard Error of Estimation for each regression equation. There is considerable overlap among the Standard Error of Estimates for three Kikuyu Growth Rates and for the months of May, June, July and August for Kikuyu Growth Rates I and II. However, as the total areas under each curve are proportional to the total volume of kikuyu produced by each of the treatments, the total production of dry matter is sufficiently great to require additional stock to take advantage of it. This is particularly the case with the highest rate of nitrogen application (Kikuyu Growth Rate III) which should support in the vicinity of two and one half to three milking cows per acre throughout the year in comparative safety. There are obvious problems in applying the results of agronomic research directly from one district to another but the evidence is strong enough to suggest that improved management of kikuyu pastures may be equally as satisfactory a means of providing additional feed for dairy stock, and be more economic than cultivating improved pastures.

This study cannot suggest which of the two pasture provision techniques, cultivation of improved pasture species or fertilizing naturalized pastures, would be the most beneficial to dairymen in the Lower Valley region. However, the evidence suggests that either would allow much greater butterfat production per acre of core dairy land in this region, providing there were corresponding increases in the numbers and quality of dairy stock converting these pastures to milk.

In sharp contrast, the volume of milk production in the Middle Valley region is closely tied to the combination of land, improved pasture and stock inputs observed on sample dairy farms. In this region, improvements in butterfat production per farm are almost directly inverse to the number of dairy farms, assuming the proportion of those land classes suitable for dairying is not increased. Paspalum is the predominant pasture grass for dairy stock in this region, and as there are no results available for fertilizer trials on these pastures, possibilities for this form of management are unknown. In addition to fertilizer/pasture unknowns, transport problems weigh heavily on the dairy industry of the Middle Valley region and amalgamation of current dairy farms may lead to more costly transport of milk between farm and factory with eventual abandonment of the more distant pick-up routes.

#### Government and rural population

This chapter has been concerned with the effects of changes in the structure of land, pasture and stock inputs and its effects on the mean level of per farm dairy production, and consequently upon the number of farms which can be accommodated in the study region at given levels of production. In the study region farm family population has been observed to be a direct function of the number of farms, and although the total rural population is somewhat greater than the total farm family population, there is a strong relationship between decline of Primary Production workforce, i.e. mainly farm workforce, and total population in the Middle

Valley region. (See Figs. VI-12 and VI-13).<sup>1</sup> It was noted in Chapter VI that in the Lower River Census Districts (Rural) decline in the Services and Manufacturing workforces was greater than for the Primary Production workforce. However, the rate of decline in the workforce employed in Services and Manufacturing is such that these employment opportunities, especially Services, are rapidly becoming unimportant in rural workforce employment. This being so, future total population will depend more heavily on Primary Production employment and consequently upon farm family population.<sup>2</sup>

It seems inevitable that the future rural population of the study region will become increasingly dependent upon the farm family population and therefore upon the number of farms in the region. It follows that Government dairy policies which affect the total farm population will therefore directly affect rural population and indirectly, through reduction in demand for some Services requirements, urban population by an unknown multiplier. In addition, where Government policies do not lead to increases in dairy production per farm in inverse proportion to the decline in number of farms, either because of withdrawal of land resources from the dairy industry or decreased production per acre of core dairy land, the resulting decline in total dairy production

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Population and workforce data are considered inadequate to calculate a multiplier between Primary Production workforce and total population.

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These assumptions are based on the only data available concerning workforce employment by Census Districts which are graphed in Figs. VI-12 to VI-15.

may lead to retrenchment in dairy Manufacturing employment with an associated multiplier effect on Services employment and total population of the whole region.

Land resources unsuitable for dairying would very likely not support different populations to those at present unless there were major changes in Government dairy policy to make dairying extremely economically attractive, thus encouraging the use of these resources for dairying. Therefore it is possible to examine the effects of hypothetical Government policies on rural population through the data presented in the previous section of this chapter.

In the Lower Valley region, sample dairy farms had mean family size of 4.4 persons. Assuming the possible number of dairy farms in this region to be 414 (as for mean conditions in Eq. 11), the total dairy farm population would be approximately 1,820, which is a realistic assumption when compared with the 1966 total rural population of 2,311 for the Lower River Census Districts which included 120 persons employed in Manufacturing, representing a family population of approximately 530 persons. (See Table Vi-1.) If a series of assumptions are made concerning the aims and methods of implementation of Government dairy policies, data provided in Table X-2 may be used to predict the levels of dairy farm family population. For example if the desired level of mean per farm butterfat production is 10,000 lbs and Government policy provides the means for dairymen to increase the area of core dairy land per farm by farm amalgamation without

corresponding increases in pasture management or dairy stock inputs, the total farm family population would decrease to approximately 580 persons, i.e. to less than one third of the dairy farm population calculated above for mean conditions. If the same assumptions are made except the desired mean level of butterfat production is raised to 12,000 lbs, this population would fall to 320 persons, or to 18 per cent of the dairy farm population calculated for observed mean conditions. On the other hand, should the approach to increased butterfat production per farm be more concerned with increasing pasture management levels and stock inputs, for example to 35 per cent above the mean of observed levels, then the total farm family population for a mean level of 10,000 lbs of butterfat would be 3,740 persons, and for 12,000 lbs approximately 600 persons. These data indicate that by improving levels of pasture management and increasing the quality of stock, and making capital available for investment in additional stock, it is possible to increase per farm production without decreasing farm family population and consequently rural population. If economic conditions in the dairy industry were more favourable, the total population in the Lower Valley region could be increased by Government dairy policies oriented in these directions.

On the other hand, the limited possibilities of profitably recombining land, pasture and stock inputs in the Middle Valley region suggest that increases in core dairy land associated with proportional increases in pasture and stock inputs make declining rural

population a concomitant of increasing per farm production.<sup>1</sup> For example, for mean of observed conditions, the Middle Valley region could support a dairy farm family population of around 715 (mean farm family membership for sample dairy farms is 4.5 persons in this region), compared with a total population of Upper River and Tributary and Lower Middle River Census Districts which include the settlements of Bellbrook and Willawarrin and Euroka-Kalateenee (See Chapter VI) of 1,550 persons. If the mean per farm production level is raised to 6,500 lbs (equivalent in terms of farm receipts to 10,000 lbs of butterfat production in the Lower Valley region) then the total farm family population which could be supported is approximately 520, which represents a 27 per cent loss of dairy farm population, and if other rural population remains constant, a 12 per cent loss of all rural population.<sup>2</sup>

#### Final comments

Allowing for limitations of both survey and Census data, it is apparent from the varying responses to management and land inputs calculated for Lower and Middle Valley sample dairy farms that the effects of Government dairy policy will vary considerably from region to region. These variations are dependent on a variety of environmental and socio-economic circumstances,

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See Figs. IX-19 and IX-21.

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This calculation does not take into account the effect of the unknown multiplier between Primary Production employment and total population.

some of which have been isolated and examined in this study. Where Government policy is based on the assumption that increasing the area of land resources per farm is the most effective method of increasing farm income, all dairy farming regions stand to lose rural population whether the land resources involved are marginal for dairying purposes or not. In regions where land resources are not physically marginal for dairying purposes such policies may be positively wasteful and dairy policies concerned with improved management are more likely to achieve the desired results, especially when associated with the provision of capital for increasing stock inputs. For example this applies to the Lower Valley of the Macleay, which possesses a physical environment far from ideal for dairy farming even in comparison with other Valley Regions in the N.S.W. Milk Solids Region.

It is not surprising that the two Governments involved with policy making in the dairy industry of the N.S.W. Milk Solids Region have developed the types of policies they have. The Commonwealth Government is concerned primarily with increasing the economic level of dairy farmers and the problems of disposing of dairy products on an over-supplied world market in competition with other highly subsidized dairy producers. Its twofold aim is to increase the level of income per farm by increasing land resources per farm, and simultaneously to reduce total production of dairy products by assisting farmers from the industry.<sup>1</sup> The N.S.W. State Government,

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<sup>1</sup>It should be noted that from the politician's point of view it is easier to provide the means to increase land  
(continued on p.203)

while equally concerned with increasing the economic level of dairy farmers, is not so directly concerned with disposal of dairy products on world markets for the majority of this State's dairy production is consumed internally. However, it is particularly concerned with problems associated with rural depopulation and the need for decentralization of manufacturing industry, and is therefore committed to maintain farm family population wherever possible. As a result, N.S.W. Government dairy policy has been dominated by the desire to improve farm management, rather than to increase farm land resources per farm although it has become involved very recently in a plan for dairy farm reconstruction similar in approach to that of the Commonwealth Government.

The aims and approaches of the two types of dairy policies put forward by the Commonwealth and State Governments are not necessarily incompatible so far as the individual dairy farmer is concerned. To obtain the greatest advantage from each, they should be applied with a clear appreciation of farm input/output relationships operating in each dairying region. This might be achieved by differing policy arrangements for regions in the case of management improvements and by individual farm appraisal in the case of dairy farm reconstruction. However, so far as regional dairy industries are concerned, Commonwealth and State policies could lead to conflicting results. One approach to solving this conflict would be to provide different

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1 (continued from p. 202)  
resources per farm through Commonwealth grants than to attempt to convince dairy farmers that their levels of management are generally low and must be raised.

regional emphases in the application of dairy policy, i.e. to have regional dairy policies related to such factors as suitability of the environment for dairying, alternative opportunities for land-use, trends in regional population distribution and the degree of dependence of regional population on dairyfarming activities. In this way, economic criteria would not be the only considerations in formulating dairy policy. It should be possible for Governments to actively promote dairying in some regions with physical environments which are marginal for dairying yet with few, or no alternative land-use opportunities if it was considered politically desirable to maintain regional population. Concurrently a more flexible dairy policy based on regional conditions could limit the development of the dairy industry in other regions where more favourable physical environments allow the industry to support farming communities at acceptable standards of living, or where suitable alternative land-use opportunities are available.

The present study has indicated that within one Valley Region of the N.S.W. Milk Solids Region, there is sufficient variation in conditions to warrant the implementation of such a policy. Additional studies of other Valley Regions would be required to prove conclusively that similar circumstances exist in each other Valley Region but trends in the dairy industries of these Valley Regions suggest that this is so.

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