INTEGRATION OF IRRIGATION AND DRYLAND FARMING IN THE SOUTHERN MURRAY BASIN

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PART II: RESULTS OF RESEARCH IN A "FIELD STUDY AREA" 1956-58*

For Figs. 2, 3, 7, 8 and 9 see envelope inside back cover.

1. SUMMARY AND CONCLUSIONS

This article is the second of a series of studies dealing with the integration of irrigated and unirrigated land uses associated with State-sponsored irrigation projects in the southern Murray Basin where 80 per cent of Australia's irrigation is concentrated. Integration has been presented as one means of achieving a more effective use of scarce water resources, particularly to

* For the first Part of this series see John Rutherford, "The Integration of Irrigation and Dryland Farming in the Southern Murray Basin—Part I: Need for Reappraising the Concept", this *Review*, Vol. 26, No. 4 (December, 1958), pp. 227-283.

The writer is grateful to the Australian National University for the generous support it gave him during this research project. It is desired also to thank the numerous officers of Government Departments in New South Wales and Victoria who provided advice on land use in areas under their control and the farmers who were interviewed during the field work. Most of the material embodied in the present article came directly from these farmers. However, none of the aforementioned necessarily shares the views expressed in this study.

The writer is indebted to Mr. H. E. Gunther of the Australian National University for drawing Figs. 3, 7 and 9.

reduce the impact of production uncertainties in semi-arid regions. Two kinds of integration were distinguished earlier, viz. "on-farm" integration which involves the joint use of irrigated and unirrigated lands by the same farmer, and "off-farm" integration which involves exchanges of factors of production between irrigation and dryland farmers (exchange of stock feed, stock, and agistment facilities).

The present article discusses the results of a field survey of integration in the central part of the southern Murray Basin called the "field study area". Four groups of irrigation farms were examined and striking contrasts in the character of integration have been explained in terms of the kinds of products produced with irrigation and a variety of physical and cultural conditions which cause regional contrasts in the character of irrigation farming.

A study of irrigated fruit and vegetable production in the Mid-Murray Area has shown that State-sponsored closer settlements here display no forms of integration. Production is geared entirely to irrigated land and stands quite aloof from surrounding dryland economies. As an instrument of national development, the creation of fruit and vegetable settlements divorced from their hinterlands runs counter to the concept of integration. It represents resource development in limited areas at the expense of greater production stability for the economy at large.

Dairyfarming with irrigation on the Swan Hill Flats has been studied as typical of production in various State-sponsored closer settlements established by Victorian authorities in the central Murray Valley and the Goulburn, Campaspe and Loddon river valleys. It is similar also to developments on the Lower Murray in South Australia. Traditionally, dairying in these settlements has displayed a lack of integration almost as great as the fruit and vegetable industries. However, in recent years dairyfarmers at Swan Hill have shown a marked trend towards "on-farm" integration, particularly by developing various uses of unirrigated Mallee lands nearby. Their aim has been to achieve advantages which they claim integration gives by comparison with the traditional reliance on intensively watered land. There is little evidence that the newly developing integration will be of great benefit to the dryland farmer, since it is designed specifically to assist irrigators in small and compact communities. However, it does point to the possible need for adjusting past models if dairying should ever be sponsored again by closer settlement of interior lands.

A group of farms mostly concerned with sheep raising was studied in the Tragowel Plains, Calivil and Boort Irrigation Districts of Victoria. These were selected as examples of properties that have emerged over many years of "partial or extensive" irrigation where the aim has been to assist greater production stability in existing dryland economies rather than more resource development by closer settlement and exotic land uses. In principle, these three districts are comparable to the more recently-established Irrigation Districts in the Riverina of New South Wales. The study of farms in these three districts has suggested that the character of integration with "partial" irrigation is governed directly by the extent to which the grazier concentrates on fine wool production with Merino flocks as opposed to meat and coarser wool production with crossbred and "dual purpose" flocks. Farms concentrating on wool growing tended to be large and located in zones with

relatively poor water supplies and with uneven land of heavy clay soils. These conditions have encouraged active use of both irrigated land and unirrigated land, i.e., a relatively marked degree of "on-farm" integration. However, with limited irrigation facilities and self-contained breeding programmes, wool growers practised little or no "off-farm" integration and therefore contributed little to reducing production instability in surrounding dryland economies. By contrast, properties specialising in fat-lamb raising tended to be located in zones of better water supply where soils and topography are more conducive to smaller farms. They display active "on-farm" integration although there is a greater dependence on irrigated land than was the case for the wool growing specialist. The fat lamb producer in the three "partial" irrigation districts practised little more "off-farm" integration than the specialist wool grower and for similar reasons. However, he differed from the latter in his dependence on dryland areas for replacement ewes. The sale of large numbers of "First Cross" ewes to fat lamb producers in irrigated regions undoubtedly helps to promote a higher level of incomes in dryland areas than would be the case if the "winter" production of fat lambs had not been stimulated with "partial" irrigation.

A study was made of a group of sheep properties in the Rochester Irrigation District of Victoria. This has suggested that "intensive" irrigation and stock fattening in both winter and summer offers much greater scope for "off-farm" integration than a concentration on winter fat lamb breeding typical of "partial" irrigation districts where farmers irrigate only in autumn and spring. The Rochester graziers had relatively high water rights which allowed them to develop appreciable areas of permanent (summer-growing) pastures in addition to the annual (winter-growing) pastures common in "partial" irrigation districts. Light and well-drained soils also permitted more development of permanent pastures. As a result the Rochester graziers could add to the winter breeding of fat lambs and beef cattle the fattening of purchased stores (beef and lambs) obtained from climatically handicapped dryland zones. They could also provide more fodder and drought agistment for the latter.

The Rochester survey has suggested that, if integration is to be a major goal of irrigation projects, it would be best to create properties with adequate water supplies on light-textured and well-drained land so as to permit all-year-round irrigation. *So long as these farms did not engage in specialist dairying,* they could achieve much more flexibility of land use than properties in the traditional zones of "partial" irrigation. They would also present the greatest possibilities for active "off-farm" integration for assisting dryland areas, if and when this were dictated by economic and climatic circumstances. It is encouraging to note that farms of this type are being sponsored in the Murrumbidgee Valley using waters from the Snowy Scheme. However, it is significant that the demands of proximity to major sources of water supply and soils with diverse possibilities under irrigation mean that farms like the Rochester properties would tend to be located along the southern and eastern flanks of the riverine plain in the southern Murray Basin. These zones tend to be remote from interior dryland areas with the highest climatic uncertainty. Hence, some system of "spatial diversification" of non-continguous lands would be necessary if a system of "on-farm" integration were to emerge which combined flexible irrigated

land use on the outer periphery of the plains with uncertain dryland farming further inland. As mentioned in Part I, this may require a system of corporate land control if sound development of both elements of the integrated economy is to be assured.

2. INTRODUCTION

In Part I of this study, published in the December, 1958 issue of this *Review*, the concept of integration between irrigated and dryland farming was discussed with particular reference to the southern Murray Basin. Various types of integration were listed and it was stressed that integration may have a value in Australia as a means of achieving a more rational use of limited water resources. In particular, it was suggested that the value of integration as a means of combating production uncertainties seemed worthy of closer analysis than it has received so far. The present article discusses the results of field research undertaken by the writer in recent years with the aim of investigating the character of integration associated with the

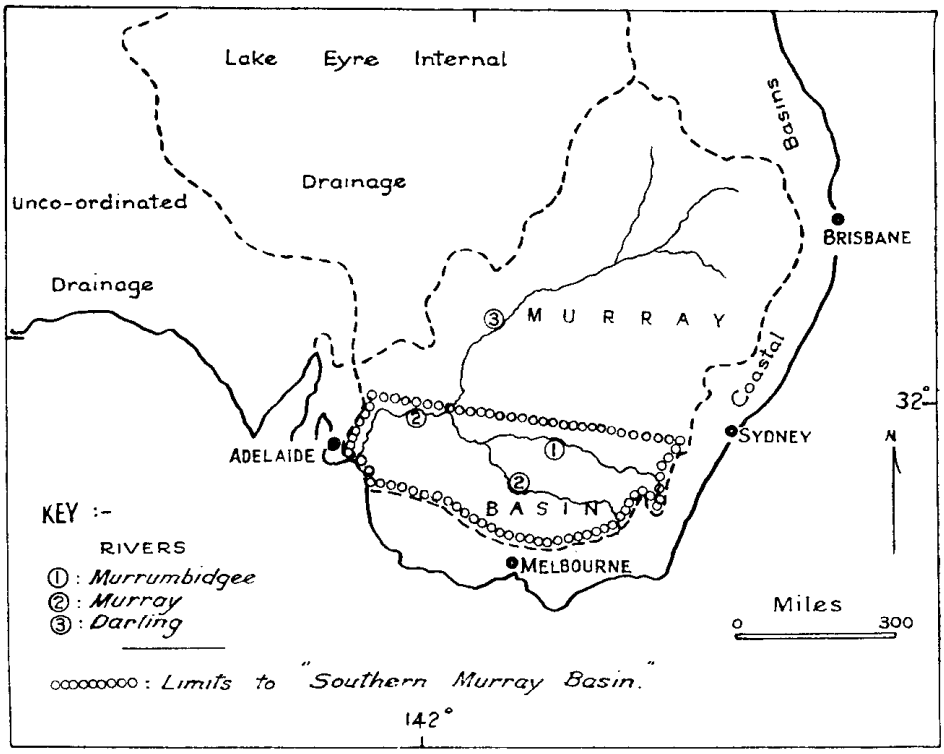

Fig. 1. Location of "Southern Murray Basin" in relation to Murray Basin and adjacent Drainage Basins

irrigation projects stimulated and controlled by State Governments in south-eastern Australia. One object of these enquiries has been to gauge whether irrigated land uses are autonomous because they do not assist or are not assisted by dryland farming or whether both interact for their mutual benefit. A number of irrigation districts has been studied by means of

surveys of samples of farms selected because they appeared to be symtomatic of development so far. The study has revealed marked differences in the pattern of integration which appear to be related to a number of physical, economic, and political factors. Regional comparisons of integration have highlighted contrasts of development which seem of particular significance to this State now embarking on large-scale promotion of irrigation in the Murrumbidgee Valley.

This article repeats the definitive and some of the cartographic information presented in Part I to provide an appreciation of the meaning of the concept of integration and the position of the areas studied in relation to the southern Murray Basin as a whole.

Definitions

The following is a definition of some of the terms used in this article.

Southern Murray Basin: The Murray Basin is shown on Fig. 1 and will be familiar to most readers. The "southern Murray Basin" comprises that portion of the Murray Basin (sometimes referred to as the Murray-Darling Basin) which lies *south* of the northernmost latitude of the Murrumbidgee Valley. The region is dominated by the Murray River and the country "drained" by its major tributaries in the winter-rainfall zone, i.e., the Murrumbidgee (N.S.W.), Goulburn, Campaspe and Loddon (Victoria), as well as the Mallee country on both sides of the Victorian and South Australian border. Portion of the lower western lands, Lachlan River and Darling River valleys are also included in New South Wales. Some 80 per cent of the irrigated land of Australia is found within the southern Murray Basin.

"Field Study Area": Figs. 2, 3, 4, 5 and 7 show the location of the "field study area" and some features of its physical geography and pattern of agricultural development. It embraces parts of the western riverine plain and the eastern Mallee country of the southern Murray Basin. Within the "field study area" occur portions of the sheep-wheat and pastoral belts (Figs. 2 and 7) developed without irrigation. The area also includes important examples of irrigation development north and south of the Murray in which the production of fruits, vegetables, dairy products, and sheep products are features.

Irrigated Lands: Irrigation in the southern Murray Basin tends to fall into two elements. First, most development is to be found in group settlements called "Irrigation Districts" or "Irrigation Areas" and, with few exceptions (notably at Mildura and Renmark), is under direct State control. Second, a minor but growing aspect of the development is undertaken by "private diverters" on a small-scale and essentially individualistic basis. Whilst this offers much promise as a means of promoting more integration this study is concerned solely with the first type of development. All reference to irrigated land is to land watered in "Districts" or "Areas".

Integration: For the purposes of this discussion, land uses are said to be integrated if:

(i) Irrigated and unirrigated lands are used by the same farm in a system of *"on-farm" integration,* and/or

(ii) Products of irrigated land use are sold to farms not irrigating and *used as factors of production* by them or *vice versa* in a system of *"off-farm" integration*. This study is not concerned with more indirect links between the two economies (such as the influence of institutions developed in "irrigation" towns).

Integration does not necessarily imply scattered water distribution for "partial" irrigation as demonstrated in the previous article (Part I).

Farm: The term "farm" is used to mean the complete business enterprise even though this might embrace a number of land units each of which could be termed a "farm" by some other definition. The land components need not be contiguous.

Types of Irrigation: The terms "intensive", "extensive" and "partial" are used in Australia to describe different systems of irrigation. In this article the last two are used as interchangeable and are distinguished from the first as follows:

"Intensive": This applies to an irrigation "district" or an irrigation "area" with a 1 in 1 or better *pro rata* water right (i.e., landholders are entitled to the supply of at least one acre-foot of water per annum for every acre considered by the supplying authority to be suitable for irrigation and commanded by the general works). Included are private group schemes or other public schemes which enjoy similar levels of water supply. In the "intensive" districts or areas most of the *productive* land is irrigated.

"Extensive or Partial": This applies to districts with lower water rights in which appreciable areas of productive land are not watered.

Dryland: This term applies to farming in country not embraced by the group irrigation projects and dependent mainly on rainfall, although some scattered irrigation is practised by "private diverters".

Method of Field Study

In its initial stages, this research project involved a reading of available literature on irrigated farming in the southern Murray Basin and the geographic and historical background to it. This was followed in 1956 by a reconnaissance survey of the irrigation districts of the area, particularly those in northern Victoria not previously visited. A large number of discussions were held with officers of Government departments and private firms with an interest in irrigation farming in the southern Murray Basin. This preliminary research led to the formulation of certain propositions which affected the design of later field enquiries. These can be summarised as follows:—

1. A detailed understanding of the character of integration in the southern Murray Basin could only be obtained by interviews with farmers in the field as the subject had never been studied before. Past surveys and censuses threw only indirect light on the problem.

2. The character of integration appeared to be influenced by a number of factors which would have to be taken into account when attempting to understand why integration differs from place to place. These factors were:—

(i) The types of goods produced with irrigation.
(ii) Conditions of irrigation water supply.
(iii) Variations in relief and soils, particularly as they affect irrigated land use.
(iv) Regional variations in rainfall as they affect the productivity of drylands and the types of agriculture practised thereon.
(v) Types of dryland production and the relative positions of irrigated and dryland economies.
(vi) Government land settlement policy, particularly the relative emphasis given to "intensive" as opposed to "extensive" forms of irrigation.

The "field study area" was chosen for detailed field research for four major reasons. First, it was compact and allowed easy comparisons between adjacent but different types of farming areas. Second, preliminary research suggested that it contained representative examples of all kinds of irrigated land settlement in the southern Murray Basin and the aforementioned six factors that impinge on the pattern of integration. Thirdly, the "field study area" was located in a strategic position astride of the margin between wheat-sheep farming and Merino wool production, *i.e.*, astride of the border between Zones B and C shown in Fig. 2. In Part I, this region was shown to be a zone of particularly high climatic certainty. Hence, the "field study area" was ideally located for integration to develop as a means of combating this uncertainty. Fourthly, the selection of the "field study area" seemed justified because the forces conducive to integration seemed to be most developed there. If integration was to evolve anywhere in the southern Murray Basin, preliminary research suggested that the "field study area" should be in the forefront of this development. Hence, a study of this area would provide a good test of a proposition which emerged from initial studies, viz., integration has not been the prime aim in Government sponsorship of many irrigation projects in the southern Murray Basin, and existing projects consequently have lacked integration at all or have developed very loose forms of little benefit to the dryland farmer.

Later in this article (sections 4 to 7) the results of field studies of four groups of irrigation farms are presented. For each area, a brief description is given for the reasons why it was selected together with a statement of the farm sampling techniques adopted. The various groups of farms studied included:—

(i) Fruit-vegetable properties in the Mid-Murray Dried Fruits Area (see Fig. 6 and western part of area shown in Fig. 7). These are similar to farms in other closer settlements further down the Murray in the "Sunraysia" and South Australian fruit areas and also in the Goulburn River Valley and the Murrumbidgee Valley. However, because of climatic and soil problems, land use in the Mid-Murray area is changing and it was decided to study this area to see whether these changes were tending to break down an apparent lack of integration in this type of settlement.

(ii) Dairying properties on the alluvial flats just north of Swan Hill. These farms are very similar to dairy farms in other closer-settled districts like the Murray Valley, Katandra, Shepparton, Tongala-Stanhope, Rochester, Dingee, and Cohuna Irrigation Districts of Victoria and the Lower Murray Swamps in South Australia. However, farms in the Swan Hill district are located closer to zones of climatic uncertainly for marginal wheat and fat lamb production and pastoral zones with wool growing without irrigation.

(iii) Farms in the Tragowel Plains, Calivil, and Boort Irrigation Districts of Victoria. These were mainly sheep farms and have benefited from long-established systems of "partial" irrigation. They are similar to those developed on the riverine plain outside the closer settlements for fruit and dairying in northern Victoria as well as in the Irrigation Districts of southern New South Wales, although water rights have been more copious in Victoria. The sheep properties in these districts are good examples of the pattern of land use that has developed over many years with limited irrigation facilities to assist the fattening of lambs and the production of wool. Here there is an emphasis on the winter production cycle typical of the parts of southern Australia with a Mediterranean type of climate where improved annual pastures have been developed.

(iv) Sheep properties in the Rochester Irrigation District of Victoria. The farms selected here were those with an acreage of permanent pasture equal to more than 90 acres or more than half the area of annual pastures. They are typical of sheep farming with relatively "intensive" irrigation techniques that have allowed stock fattening both in the summer and the winter with a much more flexible production pattern than for the majority of sheep properties in "partial" irrigation districts. Similar farms to these, but with greater land and water resources, are now being sponsored by the State Government in the Murrumbidgee Valley to use waters from the Snowy Scheme.[1] The study of the Rochester farms has given an indication of the pattern of integration that could stem from developments in the Murrumbidgee Valley.

3. GEOGRAPHY OF "FIELD STUDY AREA"

The pattern of integration between irrigated and non-irrigated use of land in the "field study area" is governed partly by physical factors of the environment and partly by the types of farming practised. The broad geographic features of the region areas follows.

Physical Features

Location

The "field study area" is centrally placed in the southern Murray Basin as indicated in Fig. 2. It lies astride of the Murray River between Echuca and Piangil and embraces parts of the farmlands of the Riverine plain and Mallee country of northern Victoria and southern New South Wales. These areas include important segments of the zone of "pioneer" settlement

[1] See *First Report of the Committee Appointed by the Minister for Conservation to Advise on the Use of Additional Water Available Within the Murrumbidgee River Upon Completion of Blowering Dam,* (Sydney: Government Printer, 1956).

in Australia and have been the scenes of social and economic hardship that have resulted from attempts to push closer settlement based on arable and livestock farming beyond the bounds of long-term climatic suitability.[2]

Climate

The "field study area" has a warm temperate climate with hot and comparatively dry (but not arid) summers and rainy winters that are relatively mild. Climatic averages for nine selected localities are shown in Table I. Winters are cool enough to cause slow plant growth between May

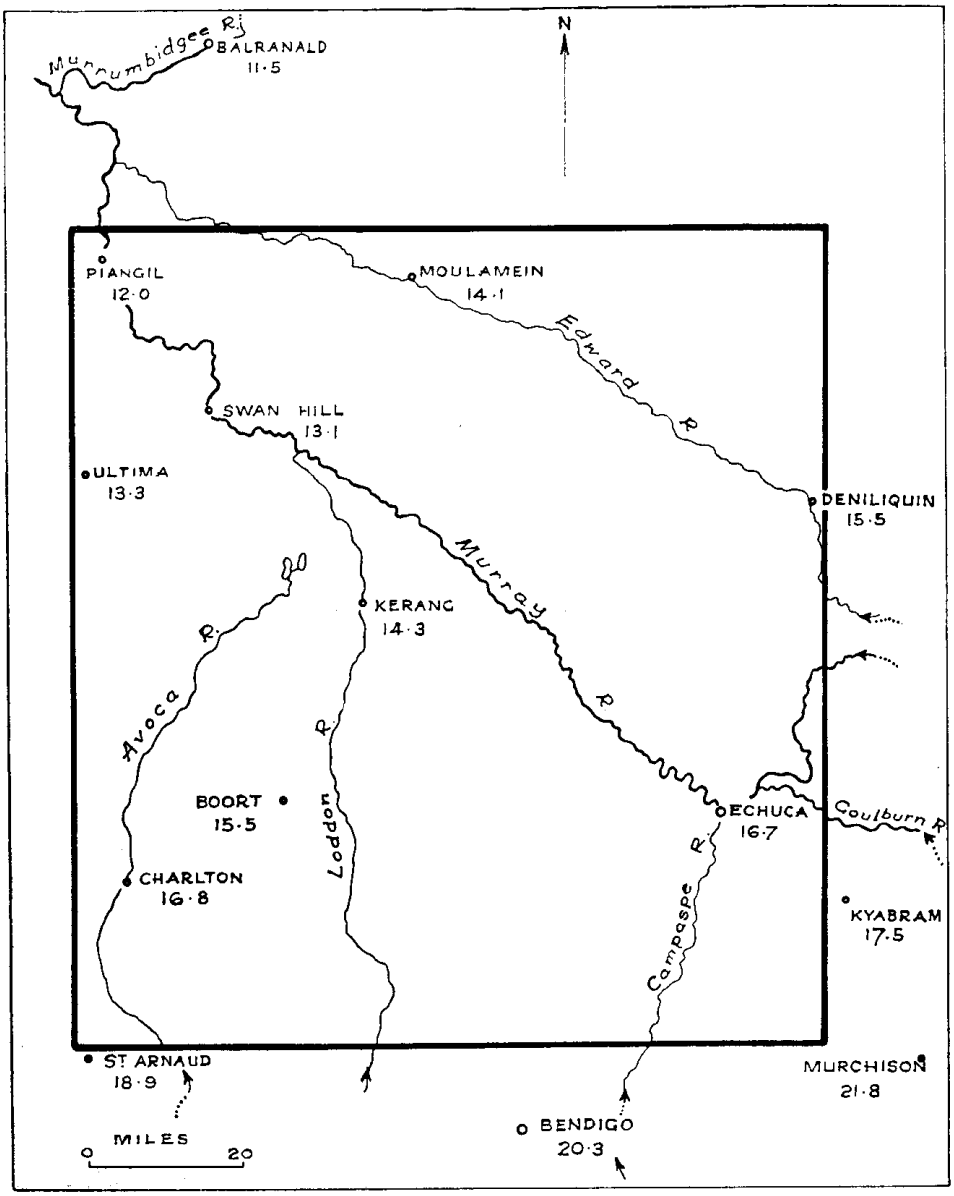

Fig. 4. Average Annual Rainfall (inches) at Selected Localities near and within "Field Study Area"

[2] Griffith Taylor, "Pioneer Belts of Australia", in *Pioneer Settlement* (New York: American Geographical Society, 1932), pp. 360-391.

and September and a large diurnal range of temperatures is characteristic, particularly in winter. In May, June and July, nocturnal radiation results in frosts sufficiently severe to damage horticultural crops in adverse locations. There are no great regional differences in temperature, partly because of the lack of marked changes in elevation and partly because the entire "field study area" traverses little more than one and one-half degrees of latitude.

Rainfall is the most critical climatic factor throughout and largely determines regional differences in dryland farming. Average annual rainfall is highest in the south (18 inches) and decreases progressively to the north-west, i.e., away from the peripheral uplands of the southern Murray Basin which determine so much of the rainfall pattern. The north-west has an average annual rainfall of about 12 inches. In southern and eastern areas, about 60 per cent of the average yearly rainfall comes in the period from April to September—the growing season for non-irrigated crops and pastures. The contribution of this period to annual totals decreases northward down to 56 per cent. Most of the rainfall in this growing season is derived from winter depressions and cyclones moving across southern Australia from the west. In the rest of the year rainfall comes partly from convectional thunderstorms (especially in the hot north-west) and weakening extra-tropical air masses from the north-east. Rainfall from April to September is more reliable than falls in the balance of the year and it is more effective for plant growth because of lower temperatures and less evaporation. Evaporation is very high during the hot months of December, January and February and average annual evaporation ranges from 50 inches in the south to 55 inches in the north-west.

Based on the relationship between rainfall and evaporation, the length of the growing season ranges from six months in the south (mid-April to mid-October) to about four months in the north-west (mid-May to mid-September).

In general terms it can be said that the "field study area" has a dry Mediterranean type of climate, which lies between the truer Mediterranean climate of Southern Australia and the interior semi-arid climate. Being in a transitional area, it experiences considerable fluctuations of weather from year to year. These fluctuations are important because a succession of years brings unpredictable changes in economic opportunity. Fluctuations in rainfall in the "field study area" impose considerable stresses and strains on the farm economies there, especially where the scope for irrigation is limited or non-existent. Such variations can be judged from statistical data published in Part I of this study.[3] See for example the annual rainfall data for Murray Downs, Boort, Deniliquin, and Echuca (Fig. 3) and the changes of wheat yields and livestock numbers for the Riverina, Northern, and Mallee Divisions (Figs, 4-8) published in the earlier study. Fluctuations in the character of rainfall during the April to September growing season affect both cereal crops and pastures. For unirrigated grazing, it is estimated that two inches of rannfall are required over the months of April and May to ensure

[3] See J. Rutherford, "Integration of Irrigation and Dryland Farming in the Southern Murray Basin, *op. cit.*, Section 4 (pp. 247-256).

TABLE I

*Climatic Averages for Selected Localities in "Field Study Area"**

Station†	Item‡	No. of Years	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Murchison (403 feet) ...	1	25	89·5	88·9	81·5	73·6	64·8	59·5	58·7	59·9	65·3	72·2	80·4	86·4	73·4
	2	21	57·9	58·0	53·3	48·2	43·1	39·7	38·5	39·3	42·2	45·6	49·9	54·8	47·5
	3	30	132	158	142	168	185	254	216	215	228	202	130	148	2,178
Bendigo (731 feet) ...	1	30	83 0	83·9	78·1	68·8	61·3	54·8	54·2	57·0	62·5	68·9	75·2	80·5	69·0
	2	30	56·5	58·3	54·0	48·2	43·7	40·7	39·4	40·2	43·0	46·7	50·9	54·9	48·0
	3	30	114	150	127	149	197	226	221	211	204	170	125	133	2,027
St. Arnaud (782 feet) ...	1	29	83·3	83·4	78·2	68·2	60·5	54·3	53·5	56·6	62·1	68·5	75·3	81·1	68·7
	2	29	55·6	56·9	53·1	47·5	43·2	40·1	38·7	39·7	42·6	45·8	49·5	53·7	47·2
	3	30	88	134	93	141	190	212	225	201	209	154	112	127	1,886
Charlton (432 feet) ...	1	30	85·3	85·9	80·1	70·8	63·2	56·7	56·2	59·0	64·2	70·3	77·6	83·4	71·1
	2	30	56·8	58·1	53·7	47·5	43·1	39·8	38·5	39·6	42·1	45·7	50·1	54·7	47·5
	3	30	74	127	100	118	160	181	185	168	192	144	105	127	1,681
Echuca (318 feet) ...	1	30	86·2	86·8	80·7	71·1	63·6	56·7	56·0	59·0	64·7	71·7	78·5	84·1	71·6
	2	30	58·9	60·1	55·9	49·3	44·5	41·3	40·2	41·2	44·3	48·6	52·7	56·9	49·5
	3	30	84	130	104	137	154	181	172	165	158	166	105	117	1,673
Boort (306 feet) ...	1	30	87·9	88·3	82·3	72·7	64·7	57·8	57·7	60·6	66·1	72·9	80·1	85·8	73·1
	2	30	58·2	59·7	55·3	48·8	44·0	40·3	38·8	40·3	43·1	47·2	51·7	56·2	48·6
	3	30	81	117	92	96	162	167	161	153	172	140	96	110	1,547
Deniliquin (311 feet) ...	1	30	88·0	88·5	82·6	72·6	65·0	58·1	57·5	60·9	66·8	73·7	80·4	85·8	73·3
	2	30	60·5	61·4	56·9	49·7	44·8	41·3	39·9	41·3	44·7	49·1	54·2	58·8	50·2
	3	30	92	112	87	112	154	178	144	148	137	146	96	140	1,546
Kerang (255 feet) ...	1	29	87·6	88·2	82·4	72·5	64·3	57·7	57·3	60·9	67·0	73·5	80·7	86·2	73·2
	2	29	57·7	59·0	54·6	48·1	43·2	40·0	39·0	40·5	44·2	47·7	52·3	56·3	48·5
	3	30	76	121	100	81	135	158	131	134	149	137	86	121	1,429
Swan Hill (230 feet) ...	1	35	89·1	89·3	83·3	73·9	65·7	58·5	58·1	61·5	67·3	74·4	82·1	87·0	74·2
	2	35	59·1	59·7	54·9	49·2	44·1	40·3	39·0	40·5	43·7	48·0	53·0	56·9	49·0
	3	30	68	113	77	79	131	146	119	129	135	128	83	101	1,309

* Commonwealth Bureau of Meteorology : *Climatic Averages for Australia* (Melbourne : 1958).
† Heights above mean sea-level shown in parantheses.
‡ Line 1 Average Daily Maximum Temperature (Degrees F).
Line 2 Average Daily Minimum Temperature (Degrees F).
Line 3 Average Monthly and Yearly Rainfall (Points).

satisfactory germination of pastures. Based on long-period rainfall records, it can be stated that the chances of receiving this minimal amount are about one in two for areas with more than 15 inches average annual rainfall. On the plains and Wimmera, this belt corresponds to the major wheat areas. Further out on the plains and Mallee in areas with between 12 and 14.9 inches average annual rainfall, the chance of receiving the minimal two inches in April and May declines to about one in three. It can be concluded that uncertain autumn rains are a great hazard for the non-irrigated grazing industry over the entire "field study area". They impose strict limits on "safe" stocking rates.

If we accept the fact that about 1½ inches of rain are needed each month over the May to October period for successful wheat growing, Table II sets out the degree of uncertainty facing this industry in the "field study area". Whilst the rainfall probability figures quoted for selected stations do not allow for important differences of soil, they indicate broadly the pattern of rainfall uncertainty for wheat growing in the area. It will be seen that stations within the present wheat belt on the plain (i.e. Wedderburn, Inglewood and Elmore) have a better than even chance of receiving 1½ inches in most months of the growing season. The other stations on the riverine plain beyond the major wheat area (i.e. Mitiamo and Kerang) display a poorer chance of receiving adequate rains. Only about one year in three would receive suitable rains and the value of rain that does fall is reduced by the heavy soils characteristic of these plains. Whilst similar degrees of uncertainty occur in the Mallee wheat areas (e.g. at Quambatook and Wycheproof), the lighter soils allow more success with limited falls of rain they occur at the correct times in the growing season.

TABLE II

*Probabilities of 1½ inches Rainfall in Each Month of Growing Season**

Station	May	June	July	August	Sept.	October
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Swan Hill	34	36	26	38	31	29
Quambatook	33	52	36	31	32	37
Kerang	41	51	31	37	33	37
Mitiamo	48	51	50	44	36	40
Boort	46	53	47	42	28	37
Wycheproof	36	54	41	33	39	36
Wedderburn	54	75	60	60	57	44
Inglewood	57	69	56	54	48	41
Elmore	55	67	59	55	48	45

* Victorian Central Planning Authority, *Resources Survey, Loddon Region* (Melbourne : Government Printer, 1952), pp. 30-31.

Topography

The topography of the "field study area" can be divided into two broad components—riverine plain and undulating Mallee. As such, it includes parts of the two components of the interior lowlands of the southern Murray Basin.[4]

[4] See C. Fenner, "The Murray Basin", *The Geographical Review*, Vol. 24 (1934), pp. 79-91.
Also: Griffith Taylor, *Australia Physiographic and Economic* (Oxford: Clarendon Press, 1919).

(i) *Riverine Plain*

This occupies most of the land surface to the north of the Murray River. South of the Murray, the riverine plain makes up all the land within and to the east of the Loddon River Valley. It has a general gradient from south to north in Victoria and from east to west in New South Wales with the Murray River providing the division between these two sloping facies. The highest part of the plain is in the south where the "field study area" comes close to the Central Uplands of Victoria. Here the general land surface is about 600 feet above sea-level. The lowest point is reached in the north-west (i.e. north of Swan Hill) where the general land surface is about 230 feet above sea-level.

Except for isolated outcrops of Palaeozoic bedrock, the riverine plain is composed of consolidated estuarine, lacustrine, fluviatile and wind-blown sands and clays, often hundreds of feet deep. In macro-relief, it presents a generally featureless surface but closer inspection reveals important elements of micro-relief that greatly influence the pattern of natural drainage and artificial water supplies.

The Cadell Tilt Block has greatly altered the direction of the Murray River near Echuca and it has had important repercussions on the character of minor drainage as well as irrigation channels.[5]

The low-lying plain country adjacent to present-day water courses (e.g. the Murray and Lodden rivers) is subject to frequent flooding and this type of country tends to increase in relative importance away from the uplands flanking the riverine plain, i.e., it increases to the north in Victoria and to the west in New South Wales. Streams form a braided pattern and the country becomes broken by a series of long but low ridges with intervening depressions or floodways. Locally, this type of land is often referred to as "lignum" or "black" country. Whilst it is highly fertile, liability to flooding and an uneven surface makes it difficult to develop for irrigation.

In the north-west along the eastern flank of the Mallee zone and south of the Murray (in the triangle between Boort, Kerang and Swan Hill), there is a remarkable topographic zone associated with the North-West Lakes System of Victoria. The lakes represent terminal points of an endoreic or internal drainage system, flowing from the south but unable to reach the Murray. Along the eastern shore of each lake or dry depression occurs a "lunette" described by Hills as "a crescentic ridge of silty clay or clay loam whose smooth and regular outlines, rising above the plains, at once catches the eye in otherwise monotonous landscape."[6] Where lunettes are most numerous, the land surface is quite irregular and difficult to develop for irrigation.

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[5] W. J. Harris, "The Physiography of the Echuca District", *Proc. Royal Soc. of Vic.*, Vol. 51, New Series (Part I, 1938), pp. 45-60.

[6] E. S. Hills, "The Lunette, A New Land Form of Aeolian Origin", *The Australian Geographer,* Vol. III, No. 7 (March, 1940), pp. 15-21.

Because it has evolved largely by the alluviation of a "prior stream" system as modified by the deposition of wind-blown material, the riverine plain exhibits a pattern of micro-relief associated with the location and alluviation of these streams.[7] The plain has an inward sloping gradient (north in Victoria and west in New South Wales) of about four feet per mile near the uplands and less than one foot per mile in the north-west. There is a series of low winding ridges of "high" plain trending northward in Victoria and westward in New South Wales away from the peripheral uplands of south-eastern Australia. These ridges correspond to the alluvial fans and associated high-level depressions (river beds) and levees of the old stream system. Present streams of the plains lie between these ridges in areas of "low" plain. These features of micro-relief are closely related to regional variations in soils and irrigation development.

(ii) *Undulating Mallee*

The "field study area" includes the eastern perimeter of the Mallee landscape that dominates the south-western part of the southern Murray Basin.[8] This country occurs mostly in Victoria immediately west of the Loddon River Valley and merges into the Wimmera to the south. The surface materials of the Mallee were originally deposited as limestones and marls at the bottom of a Tertiary sea (the Murravian Gulf) that invaded this part of southern Australia.[9] From late Pliocene times onwards, the bed of this sea was uplifted with two results. Firstly, the sea retreated towards the south-west, finally to assume its present position in South Australia near the Murray Mouth. The Murray was able to keep pace with the uplift and cut its way through the rising Mallee. Secondly, differential settling of the alluvial deposits of the older Murravian Gulf floor caused the formation of a series of well-pronounced ridges and broad troughs that now traverse the Mallee from south-east to north-west. Westerly winds also built a complex series of west-east sand dunes which overlie the northern

[7] B. E. Butler, "A Theory of Prior Streams as a Causal Factor of Soil Occurrence on the Riverine Plain of South-Eastern Australia", *Aust. Journ. of Agr. Res.*, Vol. 1, No. 3 (1950), pp. 231-252.

Depositional Systems of the Riverine Plain of South-Eastern Australia in Relation to Soils, CSIRO, Soils Publication No. 10, 1958.

J. K. M. Skene, *Report on the Soils of Irrigation Districts of the North West Plains and Adjoining Terricks Area* (Unpublished Report Number 25, Victorian Department of Agriculture, 1955).

Preliminary Report on the Soils of the Boort Irrigation and Water Supply District (Unpublished Report Number 13, Victorian Department of Agriculture, 1951).

H. M. Churchward, "The Soils and Land Use of the Denimein Irrigation District New South Wales", CSIRO, *Soils and Land Use Series,* No. 27 (Melbourne: 1958).

E. J. Johnston, "Soils of Deniboota Irrigation District and Their Classification for Irrigation", CSIRO, *Soils and Land Use Series* No. 5 (Melbourne: 1952).

[8] E. S. Hills, *The Physiography of Victoria* (Melbourne: Whitcombe and Tombs, 1940).

"The Physiography of North-Western Victoria", *Proc. Roy. Soc. of Vic.,* Vol. 51, Part 2 (1939), pp. 297-323.

Victorian Central Planning Authority, *Resources Survey, Mallee Region* (Melbourne: Government Printer), p. 12.

[9] T. W. E. (Sir) David, *The Geology of the Commonwealth of Australia* (London: E. Arnold, 1950), Vol. II, p. 12.

Mallee where conditions were more arid. The tortuous character of water supply channels in the Victorian Wimmera-Mallee Water Supply System bears witness to the uneven relief of the Mallee as channels seek to exploit the high land to give the greatest command over lower country.

The entrenchment of the Murray River through the Mallee zone increases downstream from Swan Hill which marks the point of entrance of the river into the Mallee. The river is flanked by cliff-like walls with terraces (or old erosion levels) down the faces of these cliffs. These have been exploited for the irrigated fruit settlements of "Sunraysia" and the South Australian Projects further downstream.[10]

The drainage pattern of the "field study area" is dominated by the Murray River, which flows generally from south-east to north-west across the centre of the area. It is Australia's finest stream in volume and reliability of flow and its impact on economic development. The character of the drainage pattern is closely related to the topography as outlined above. There is a sharp distinction between the drainage of the riverine plain and that of the Mallee.

A feature of the streams in the riverine plain of the Southern Murray Basin is the manner in which they emerge from the peripheral uplands feeding them and suddenly change to a low and decreasing gradient and break up into an array of anastomising channels of distributaries and "anabranches". The drainage network becomes more ill-defined and subject to serious flooding as the country flattens out."

A notable feature of the pattern of drainage on the riverine plain is the contrast in stream direction north and south of the Murray River which forms a remarkable division (Fig. 3).[12] The Murray and its tributaries or effluents to the north of it (notably the Edward and Wakool rivers) and the Gunbower Creek to the south of it parallel one another in a course from south-east to north-west. The streams that drain across the plain in Victoria (notably the Campaspe and Loddon rivers and Bullock Creek) flow from south to north. This pattern conforms to the major gradients of the plain noted earlier and contrasts in the direction of slope and drainage have produced concomitant contrasts in the pattern of irrigation channels as mentioned later.

The Mallee zone is a region of endoreic or internal drainage. Although the gradient of the Mallee tends to be towards the Murray, the streams that drain it never reach the main stream. They are ephemeral and end in terminal lakes. The Avoca River is the most striking example of this within the "field study area". The terminal lakes are zones of salt accumulation.

As with other streams of the southern Murray Basin, the streams of the "field study area" are characterised by great variations in flow which can be attributed directly to variations of rainfall over catchment zones. The Murray River is the most reliable because of its origins in the more

[10] J. Macdonald Holmes, *The Murray Valley* (Sydney: Angus and Robertson, 1948), pp. 85-86 and 172.

[11] T. W. E. David, *loc. cit.*

[12] Macdonald Holmes, *op. cit.*, p. 85.

copiously and reliably watered alpine areas of south-eastern Australia.[13] Flows in effluents like the Edward and Wakool rivers vary in sympathy with fluctuations in the flow of the Murrumbidgee and Murray rivers which are parent to them. The Campaspe, Loddon, and Avoca rivers have relatively low and erratic flows because of comparatively small catchments, which receive lower and less reliable rainfalls.

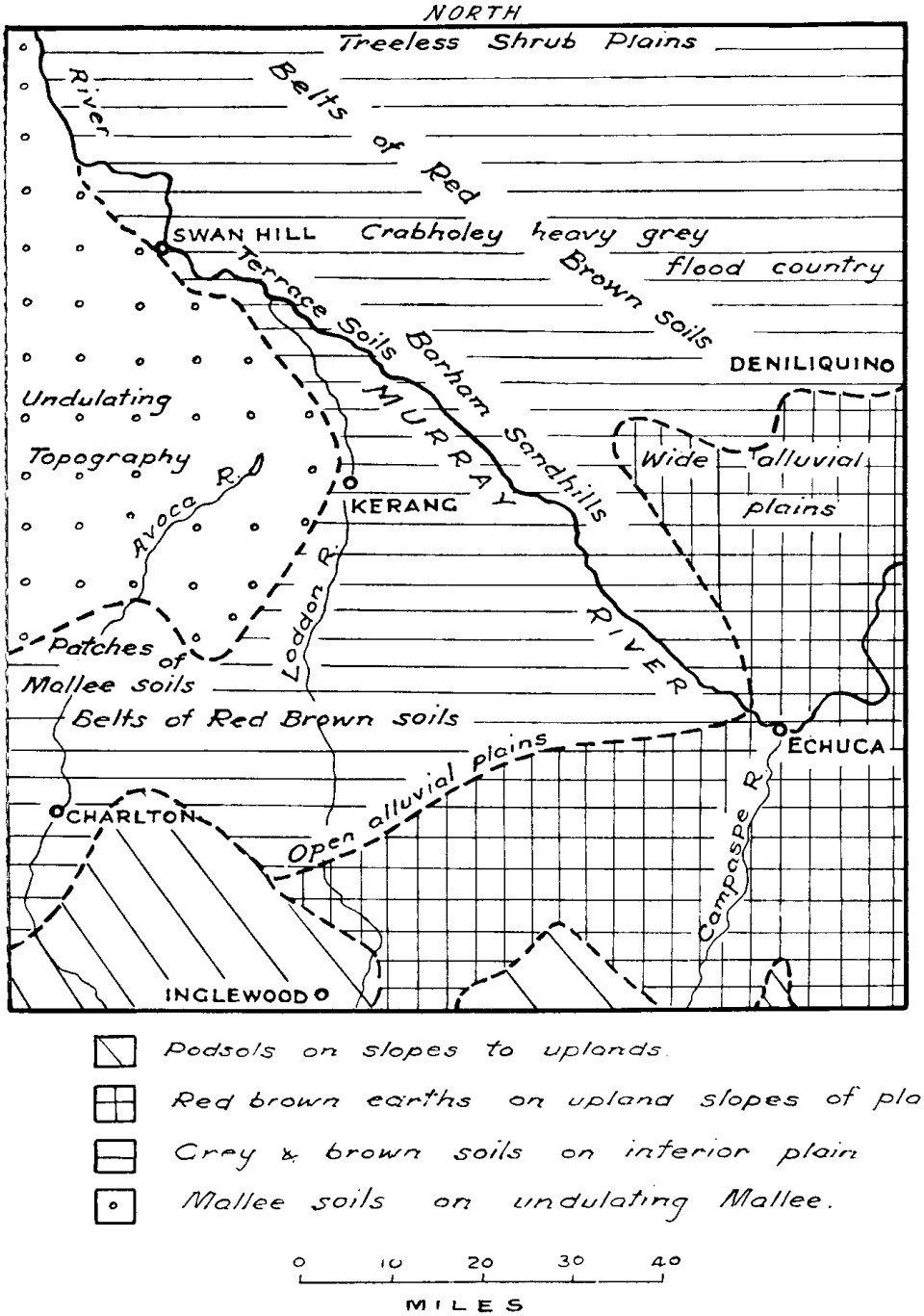

Fig. 5—A Generalised Soils Map of the "Field Study Area."

[13] Frank A. Craft, "Elementary Hydrology of South-Eastern Australia", *Proc. Linn. Soc. N.S.W.*, Vol. 64 (1939), p. 504.

Soils

In describing the soils of the "field study area" a distinction should be made between those of the riverine plain and those of the Mallee (Fig. 5). The soils of the riverine plains can be subdivided into (i) Red Brown Earths, and (ii) Grey and Brown Soils of Heavy Texture.[14] However, these two sub-groups are elements of the one riverine landscape.[15]

Red Brown Earths form pedocals in the "winter" rainfall zone of Mediterranean climate and flank the pedocals of the peripheral uplands. They are usually reddish brown sands to clay loams on the acid to neutral surface overlying reddish brown clay subsoils (alkaline).

Grey and Brown soils of Heavy Texture form uniformly fine textured soils and occur on the typically "treeless" and Box plains. They are usually soils with shallow clay loam or clay topsoil overlying heavier clays. Because of relatively low rainfall, surface horizons show relatively high lime content. They are alkaline and zones of salt accumulation. Some flooded terrace soils along the Murray have been reclaimed for irrigated improved pastures (earlier lucerne). These are typically grey loams to clay loams, but with relatively high permeability. The south-western corner of the "field study area" includes part of the Victorian Wimmera with a complex of Red and Grey soils similar to the Plians. This merges northward into the Mallee.

The Mallee land surface is made up of pedocalcic Solonized Brown (Mallee) soils on the more elevated country, with stretches of Grey Brown Soils along the major water courses (notably the Avoca and Murray Rivers). There is a characteristic association between relief and soil type. The tops of the ridges have light textured red surface soils overlying clayey soils and a zone of lime accumulation. Low rainfall has resulted in more common salt and limestone in and near surface layers than on the riverine plain. Mallee soils become heavier textured and darker in colour down the slopes from ridges and dunes on to intervening flats and near the Murray River.

Variations in micro-relief and soil type have a major influence on the suitability of the riverine plain and Mallee to irrigation farming. Soil research on the riverine plain pinpointed these relationships. In terms of Butler's study (1950), the Red Brown Earths and Grey and Brown soils of Heavy Texture are viewed as a gradation or "unbroken spectrum" of soil sediments laid down by a "prior stream" system that has built an "outwash plain of gently sloping alluvial fans which issue from the mountain masses to the south and east" of the region under review. A typical alluvial fan on the riverine plain "resembles a pitching anticline based on the foothills. It is generally observed that the present stream falls off the alluvial fan as it emerges from the foothills . . . The present rivers usually flow in the lower area between adjoining fans." The alluvial fans of the "prior streams" finger out across the plain as a series of low but well-defined

[14] As defined by J. A. Prescott, "The Soils of Australia in Relation to Vegetation and Climate", CSIRO, Aust. Bull. No. 177 (1944).

[15] The character of soils in the lowlands of the southern Murray Basin have been reported in various soil surveys carried out by the CSIRO and other Government Departments. For a general statement on the soils of the area see Department of National Development: *Report of the Murray Valley Survey Committee on Resources and Development of the Murray Valley,* Vol. 1 (Canberra: Government Printer, 1947), pp. 42-52.

"ridges" which trend more or less parallel to the present drainage, i.e., from south to north in Victoria and roughly from east to west in New South Wales. The typical high-level depression marking the bed of each "prior stream" is flanked by levee-like deposits of coarse and elevated sediments which slope away towards the present drainage lines with soil textures increasing down this slope. The differences in elevation between the fans or "high plain" and the flood plains of "prior streams" now forming "low" plain is greatest in the zone of Red Brown Earths where alluviation by "prior streams" was most active in depositing coarser sediments in a deltaic pattern. This difference in elevation diminishes out on to the plain towards the distal ends of the "prior streams" and the country becomes dominated by Grey and Brown Soils of Heavy Texture, which are derived largely from the finer flood plain sediments of the ancient stream system.[16]

In the "field study area", the southern and eastern flanks represent the zone of transition between the two great soil groups mentioned above. Tongues of "prior stream" levees are associated with soils like Yarrawolla Fine Sandy Loams, Yarrawolla Loams, and Kinypaniel loams in Victoria and the Cobram, Deniboota, Purdanima, and Conargo series in New South Wales. There are isolated dunes of aeolian origin in these regions and these are ancillary to the "prior streams". Down the slope of each alluvial fan, the soils of the Red Brown Earth group become heavier until they change to Grey and Brown soils of Heavy Texture on the flood plains of the "prior streams". In the latter zones occur soils like Kerang, Macorna, Towangur and Tragowel clays (Victoria) and Mundiwa, Riverina, Moulamein and Neimur clays in New South Wales.[17] Towards the distal ends of the "prior stream" systems (e.g., Tragowel Plains and Wakool irrigation districts), the country is dominated by these heavier soils and there is little evidence of levee formations. The major exception to this is the tongue of lighter and more elevated soils which runs parallel to the southern bank of the Murray through the eastern part of the Torrumbarry Irrigation System. Butler suggests that this was formed by "more vigorous prior streams from the Goulburn River catchment".[18]

Where "prior streams" have been most active in building alluvial fans of coarser textured deposits, i.e., on the southern and eastern flanks of the interior lowlands of the southern Murray Basin, the country presents a relatively varied scope for irrigation development based mainly on improved pastures. Not only is there a wider variety of soil textures and soil drainage conditions, but these areas generally lie closer to major channels. Thus, within the "field study area", these conditions mean that a more varied pattern of irrigation farming is possible in the southern and eastern parts (e.g., in the Rochester and Tongala-Stanhope Irrigation Districts). Northward over the plains in Victoria and westward in New South Wales, heavier soils and more low-lying topography (with poorer drainage) and greater hazards of waterlogging and "salinity" tend to dictate a less varied scope

[16] Butler (1950), *op. cit.*, pp. 236-240. Langford-Smith has criticised the use of the term "fan" and argues that the riverine deposits have deltaic formations. See T. Langford-Smith, "Deposition on the Riverine Plain of South-Eastern Australia," *Australian Journal of Science*, Vol. 22 (1959), p. 73.

[17] See Skene (1951 and 1955), *op. cit.*, Churchward (1958), *op. cit.*, and Johnston (1952), *op cit.*

[18] Butler (1950), *op. cit.*, p. 245.

for irrigation. However, the grey soils of Victoria usually present superior agronomic characteristics to their counterparts to the north of the Murray because they have been influenced more by the deposition of "parna".[19] The aforementioned tongue of higher and lighter soils along the southern bank of the Murray between Gunbower, Cohuna and Meade cuts across this pattern.

Mallee fringe soils are extensively irrigated (often by pumping) near the Murray River between Long Lake, Swan Hill and Piangil. The suitability of these soils to irrigation is closely related to differences in elevation. The higher and lighter textured soils (such as Murray sands) of the sandhills are suited to citrus, tree fruits and vines. Down the slope from these high points, the texture of soils becomes heavier and the depth of soil over clayey subsoil and zone of lime accumulation becomes progressively less. Land use suitability changes first to tree fruits (non-citrus) and vines, then to vines alone. Vegetables can be grown over most types. The heavy grey soils on the flats have little or no value for irrigated crops, unless they can be reclaimed for pasture production as at Swan Hill. Drainage and salting problems have occurred in all these Mallee fringe soils.

Vegetation

Changes in the character of natural vegetation throughout the "field study area" are related closely to differences of rainfall and soil. The natural tree cover changes from dry sclerophyl forest on the better-watered slopes of the Victorian uplands to savannah woodland then to savannah and shrub-steppe, as rainfall diminishes over the plain. These changes occur in belts which tend to parallel the rainfall isohyets as they parallel the uplands of south-eastern Australia.

The natural vegetation has been altered greatly since the land was occupied, especially since cropping first took place. Much of the natural tree cover has been cleared, particularly away from the major water courses. However, some of it remains even in areas subject to cropping. This is particularly true of the wind-breaks left around many of the cropping paddocks in the Mallee. These bear witness to the relatively thick tree cover borne originally by this area despite low rainfalls and it emphasises the manner in which the light-textured soils of the region allow plants to make good use of limited moisture. The ground cover in all areas has been altered greatly since settlement with natural perennials giving way first to a dominance by natural annuals then an intrusion of exotic and frequently less nutritious annuals like Barley grass.[20]

Pattern of Rural Development

Fig. 7 shows the pattern of land use in the "field study area" as at March, 1958. Reference should be made to Figs. 3 and 5 for the location of the natural features and towns mentioned below as well as Fig. 2 which shows the relationship between the "field study area" and the southern Murray Basin as a whole.

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[19] B. E. Butler, "Parna—An Aeolian Clay", *The Australian Journal of Science*, Vol. 18, No. 5 (April, 1956), pp. 145-151.

[20] A fuller description of the vegetation of the "field study area" appears in the various soil reports for the area (see footnote 7).

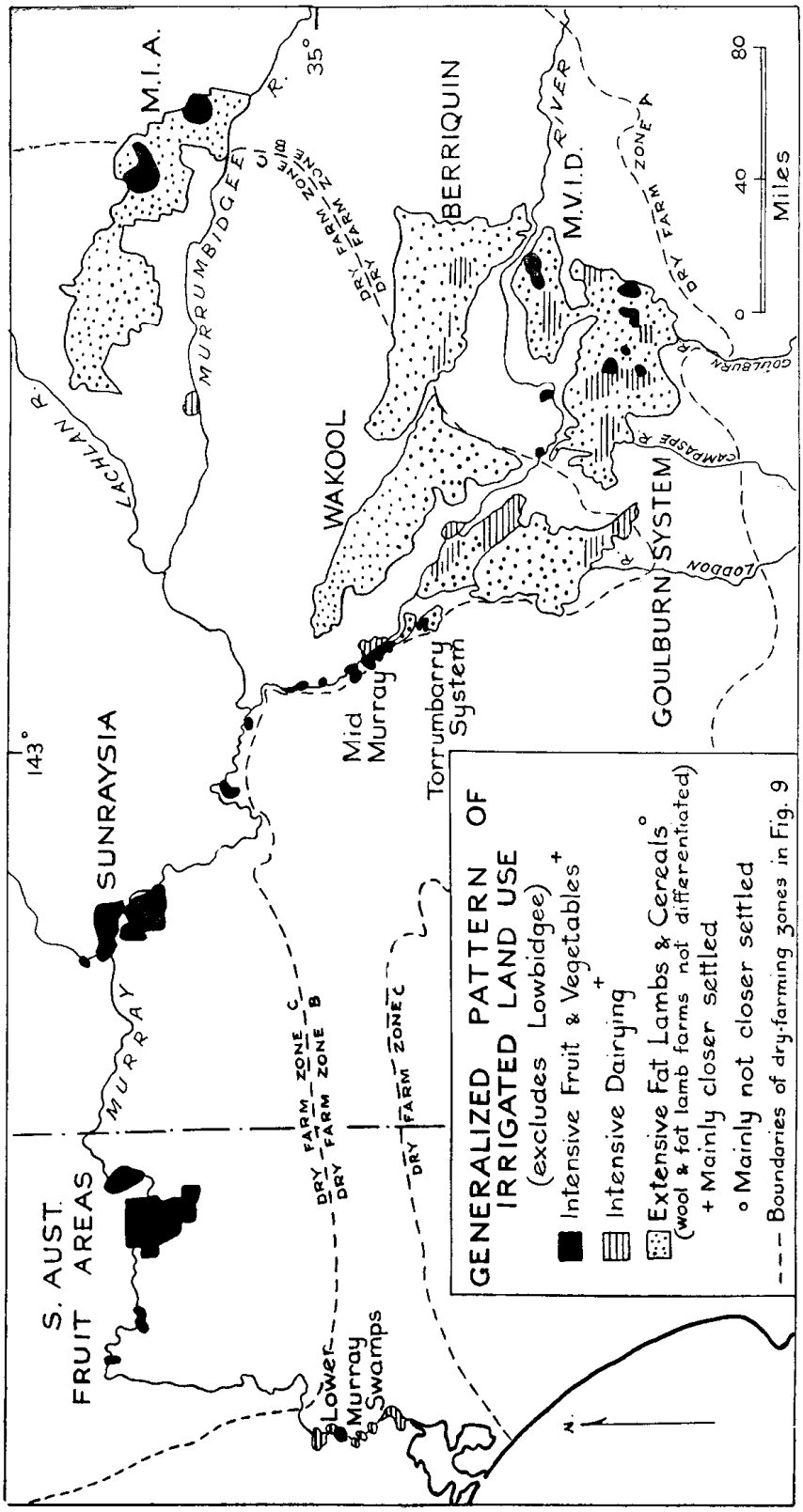

Fig. 6—Generalised Patterns of Land Use within Community Irrigation Areas and Districts of the Riverine Plains and Mallee Lands of Southern Murray Basin.

The most striking pattern shown by Fig. 7 is the contrast in intensity of land use south of the Murray River compared with developments north of the River. This applies to both irrigated and non-irrigated land uses. In non-irrigated areas, cereal growing and fat lamb raising are much more prevalent in Victoria than in southern New South Wales. In irrigated areas, the southern State shows much more emphasis on "intensive" forms of development such as fruit, vegetable, and dairy production as well as fat lamb and beef fattening. "Extensive" forms of fat lamb raising and Merino wool growing tend to be more prevalent north of the Murray. These contrasts form part of the general asymmetry of development along the Murray between New South Wales and Victoria and are a direct result of Federalism. The intensity of rural development has been affected by relative proximity to State capitals and concentrations of populations. However, other factors can be cited to explain the differences in development north and south of the Murray.

Differences between Victoria and New South Wales in regard to the gradient of the plain and proximity of irrigable land to dam sites in the uplands have made it easier and cheaper for Victoria to develop irrigation by gravity schemes.[21] The position of the "field study area" in relation to variations of micro-relief and soils discussed above (pp. 162-163) can also be cited as an explanation of differences in the intensity of irrigation development south and north of the Murray. The Victorian parts of the "field study area" include large parts of the alluvial fans laid down by "prior stream" systems and this has produced conditions ideal for most forms of "intensive" and "extensive" irrigated farming. By contrast, the areas of New South Wales that come within the "field study area" correspond more to the terminal ends of "prior stream" systems that fanned out across the Riverina. The land is dominated mostly by flood plain sediments. Consequently, the country north of the Murray is suited more to "extensive" forms of irrigation.

The Victorian elements of the "field study area" also possess superior physical conditions for dryland farming. With large areas of Wimmera-Mallee land and riverine plain composed of Red Brown Earth soils and relatively reliable and copious rainfalls in the growing season, the Victorian areas are better suited to cereal growing and fat lamb raising than the plain to the north of the Murray. In the latter areas, a relatively low and erratic rainfall compounds the effects of heavier plain soils and generally restricts non-irrigated production to extensive wool growing.

DRYLAND REGIONS

Sheep-Wheat Areas

In the southern and eastern parts of the "field study area" (Fig. 7), the sheep-wheat zone includes parts of the riverine plain with generally more than fifteen inches average annual rainfall and soils of the Red Brown Earth zone. In Victoria, the sheep-wheat belt lies in the southern parts of the Loddon and Campaspe river valleys in the "field study area" and extends into the eastern portion of New South Wales, although the latter

[21] H. L. Harris, *The Economic Resources of Australia* (Sydney: Angus and Robertson, 1934) Chapter VI.

is marginal wheat country. In the western parts of the "field study area", the sheep-wheat belt corresponds to the area dominated by undulating landforms, soils and vegetation typical of the Mallee. Successful wheat growing intrudes much further inland here than on the riverine plain and embraces areas with as little as twelve inches average annual rainfall. This is because lighter textured soils allow plants to make fuller use of low falls of rain in strategic parts of the growing season. On the riverine plain, the wheat areas experience an average of ten inches or more over the growing season from April to October, whereas in the Mallee as little as eight inches has proved sufficient.

Prior to 1860, the "field study area" was first settled during the "squatting" age by pastoralists fanning south-westward from Sydney and northward from Melbourne. They established a very extensive wool growing industry and the emphasis of settlement was along the major river systems. After the Gold Rush period of the 1850's, pressure for new farming opportunities was exerted by hundreds of aspirant settlers and the next seventy years were marked by the rise of wheat growing. In the "field study area", this occurred mainly between 1870 and 1890 on the riverine plain and Mallee areas or northern Victoria and after 1920 in the central Riverina of southern New South Wales. Early settlement for cropping pushed right out to the short-term limits imposed by runs of good seasons and was based on holdings averaging 320 acres on heavier and wetter plain country and 640 acres on lighter and drier Mallee country. The wave of dryland closer settlement was aided by a succession of State legislation [22] to promote the subdivision of the pastoral estates and by the development of a close network of railways, particularly fanning north from Melbourne. Present-day lands administration maps of the area still bear the imprint of the grid-like subdivisions made throughout the "field study area" during this process of closer settlement for wheat growing. However, the original design of 320 to 640-acres wheat blocks did not persist in practice for many years. By a process of "dummying" when selections were made, by the fact that several members of the one family were allotted blocks, and because of the impact of seasonal and economic adversity, larger farms began to emerge. To some extent, the advent of irrigation enabled the persistence of the 320 to 640-acre fram pattern in areas where the vagaries of nature could be offset by artificial water supplies.

During the early phases of development, the wheat-sheep belt was characterised by a system of monocultural farming with only limited interest in livestock. This persisted until after the First World War on the riverine plain and until the Depression years in the Mallee country. Since then, the wheat areas have been altered by the gradual evolution of a system of diversified agriculture. A "ley" farming system has emerged in which livestock raising has expanded and wheat growing has declined but with

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[22] See C. J. King, "An Outline of Closer Settlement in New South Wales, Part I, The Sequence of Land Laws 1788-1956", this *Review*, Vol. 25. Nos. 3-4 (Sept.-Dec., 1957).

Also, *The Sixty-eighth Report of the Department of Lands for year ended June*, 1947 (Sydney: Government Printer, 1947), pp. 4-8.

these enterprises complementing each other in longer rotations.[23] In many areas, the introduceiano of improved pastures has provided a nexus between the two and in others the growing of crops like oats has persisted as the basis of the emergent livestock enterprise.

The growing importance of livestock in the sheep-wheat belt over the recent decade has been encouraged by a variety of factors including declining wheat yields after years of short rotations, high relative prices for wool and sheep meats, increasing costs and labour shortages associated with cropping, and higher stocking rates possible with better pastures and a lowering of rabbit numbers as Myxomatosis has spread.[24] The trend for wider crop rotations has tended to be most marked on larger farms and in areas where natural conditions have been most conducive to pasture improvement. Therefore, it has been most pronounced within the near-upland parts of the riverine plain than further inland on the plains or in the Mallee.

Fluctuations in rainfalls during the growing season for cereals and pastures have produced wide variations in crop and livestock yields throughout the sheep-wheat zone. This is particularly the case on the inland or drier margins where average rainfalls are closer to the minimum needed for success. Thus production uncertainty tends to be less in the Wimmera and sections of the plains with Red Brown Earth Soils that it is in the Mallee and riverine plain with Grey and Brown Soils of Heavy Texture.

It has been claimed that "fat lamb production in conjunction with wheat-growing appears to make a more efficient use of both feed and labour resources than the combination of wheat and wool growing".[25] However, a number of factors have affected regional and temporal changes in the types of sheep run in conjunction with wheat growing. Fat lamb raising tends to be more important in areas where climate and soil allow the best feed to be grown, *i.e.*, in the southern Mallee to Wimmera country and on the riverine plain nearer the uplands. In drier areas of less certain feed supplies, Merinos, Comebacks, and Dual Purpose sheep are relatively more prevalent to allow graziers to achieve greater flexibility in wool and meat production. Changes in seasonal conditions and price levels over the last twenty years have also altered the emphasis given to various classes of

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[23] L. W. McLennan, "Movement in Wheat Acreages in Australia", *Quarterly Review of Agricultural Economics,* Vol. IX, No. 1 (January, 1956), pp. 22-30.

R. M. Parish, "Recent Trends in Land Use on South-western Wheat Farms", this *Review,* Vol. 20, No. 1 (March, 1952), pp. 7-52.

Bureau of Agricultural Economics, *Reconnaissance Survey of the Sheep Industry, No. 8, The Counties of Tatchera and Gunbower, Victoria* (Canberra: 1952).

[24] Sheep are the most important livestock run, but small herds of beef cattle are carried on many holdings. Many farmers in the Mallee raise pigs as a sideline in good years and some have small numbers of dairy stock mainly to supply their own requirements of milk and butter but for some vealer production.

[25] V. G. J. O'Neill, "Fat Lambs on Wheat Farms", *Quarterly Review of Agricultural Economics,* Vol. XI, No. 3 (July, 1958), pp. 120-126.

sheep. In the run of good seasons after 1946, there was a trend to more fat lamb raising but this was temporarily checked in favour of finer wool growing by the high wool prices ruling in the early 1950's.[26]

Pastoral Areas

Inland from the sheep-wheat belt and outside the group irrigation projects, the country is dominated by woolgrowing using Merino flocks which graze "native" pastures on the drier Mallee and treeless riverine plain. In many respects the landscape of to-day differs very little from that which emerged as a result of pioneer settlement by the squatters, although the country bears the effects of long exploitation. In the "field study area", the pastoral zone makes up the non-irrigated parts of the Riverina to the north of the Murray (*i.e.*, to the north of the Edward River and to the south of the Wakool River). In Victoria, it covers non-irrigated parts of the central Murray Valley (the Patho and Torrumbarry Plains) and sweeps across parts of the Campaspe and Loddon river valleys. Near to the present sheep-wheat zone, it includes lands where closer settlement for wheat growing was once tried without long-term success. Here, heavier soils and low and erratic rainfalls forced many cereal farms to be abandoned and encouraged a return to more extensive grazing. This trend was accentuated by periods of economic depression.

Settlement throughout the pastoral zone is on a relatively extensive basis with an almost complete reliance on sheep raising. Merino wool production provides most income on the majority of non-irrigated holdings to the north of the Murray although some wheat is grown, particularly on isolated Mallee rises, and small beef cattle herds are run, especially on properties with river frontages. The scope for improvement throughout this zone lies mostly in better subdivision and improved water supplies. South of the Murray where rainfall is higher and feed conditions better, many properties run dual purpose sheep for breeding fat lambs in good years and wool production in all years. The long run of good seasons between 1946 and 1956 provided an incentive for the development of the stock fattening industries here.

Variations in rainfall have caused sharp fluctuations in the numbers of stock carried throughout the pastoral belt. Drought losses of incomes are severe and result from a combination of the following factors:—[27]

(i) Deaths by starvation.

(ii) Cost of fodder to keep stock alive.

(iii) Cost of sending stock to other areas on agistment.

(iv) Loss of lambs through death of breeding flocks and shortage of feed for breeding ewes.

(v) Differences between ordinary costs of breeding stock and the high costs incurred after droughts when holdings must be restocked.

[26] H. G. McConnell, "Trends in Farm Incomes in the Wheat-Sheep Zone of Victoria", *Quarterly Review of Agricultural Economics,* Vol. X, No. 1 (January, 1957), pp. 12-16.

K. Suters, "Movements in Australian Sheep Numbers since 1943", same *Review,* Vol. XI, No. 4 (October, 1958), pp. 185-192.

[27] *Report of the Board Appointed Under the Provisions of the Water Act,* 1912-1930, *Proposed Wakool Domestic and Stock Water Supply and Irrigation District* (Sydney: Government Printer, 1932), p. 20.

(vi) Permanent understocking below the stocking rates possible in normal years as a result of the impact of drought years.

(vii) Loss of wool in both quantity and quality.

(viii) Losses of income because of forced sale of stock.

Improved water supplies and feed during the last 20 years have reduced the likely impact of these losses during a future drought. However, because of the large build-up in stock rates during the last decade, only a future major drought will provide an indication of how much losses of earlier droughts will recur.

IRRIGATION PROJECTS

The group irrigation schemes in the "field study area" were largely created by State government action and they are now administered by two State bodies—the Water Conservation and Irrigation Commission in New South Wales and the State Rivers and Water Supply Commission in Victoria. The former was constituted in 1912 by the *Irrigation Act* of that year. The latter was constituted by the *Water Act,* 1905, and began to function in 1906. Irrigation works directly affecting the Murray River itself are controlled by the River Murray Commission set up by the *River Murray Agreement* of 1915. This Commission consists of four members one from each of the three States of New South Wales, Victoria and South Australia, and a Commonwealth Government representative member as chairman. It is not a corporate body or Constructing Authority.[28]

Irrigation Works

Water supply for the group irrigation projects within the "field study area" in New South Wales comes from the Murray River as regulated first by the Hume Dam and downstream by Yarrawonga Weir.[29] The latter regulates the flow of the Murray River so that water can be diverted by gravity into the Mulwala Canal to serve the Berriquin, Denimein and Deniboota Irrigation Districts and part of the Wakool District.[30] Most of the Wakool District and also the Tullakool Area relies on water diverted from the Edward River (an effluent of the Murray) using Steven's Weir. Water was first made available to the Wakool District in 1935 but the District was not constituted until 1941. The Tullakool Irrigation Area was constituted in 1947 and excised from the Wakool District. It first received water in 1948 and was created for the purpose of promoting soldier settlement. The Denimein Irrigation District was constituted in 1946. Irrigation water was made available to landholders in 1951 by the extension of supply channels from the Berriquin District. The Deniboota Irrigation District lies to the south-west of Deniliquin and was constituted in 1938, but was not officially opened until 1955.

[28] A. F. Ronalds (as revised by G. L. Harrison), *R.M.C., The Work of the River Murray Commission* (Melbourne: Government Printer, 1954).

[29] Water is also diverted south of the Murray to supply the Murray Valley Irrigation District to the west of Cobram.

[30] They are described in *Water Conservation and Irrigation in New South Wales,* compiled by the Water Conservation and Irrigation Commission (Sydney: Government Printer, 1958).

Along the Murray River there are several small Trust districts including Bama, Bringan, Glenview, Bungunyah-Koraleigh and Goodnight Water Trust Districts which receive water from the Murray River. Unlike the Irrigation Areas and Districts, they are administered by trustees after the State has constructed the necessary works.[31]

The distinction between the Wakool, Denimein and Deniboota Irrigation Districts on the one hand and the Tullakool Irrigation Area on the other is a basic one characteristic of development in New South Wales.

> "Irrigation Districts represent the extensive system of irrigation development under which water supply works are constructed to serve farm holdings without disturbance of land tenures by the State. Areas of holdings may vary from a few hundred acres to some thousands of acres. Water is supplied to irrigate about 33⅓ per cent. of each of the smaller holdings and about 4 per cent. of each of the larger holdings on the basis of a water usage of one acre-foot to one acre of land. In practice water usage varies from about one acre-foot to three acre-feet per acre of land according to seasonal conditions, the nature of the soils and the class of crop irrigated.
>
> "Irrigation Areas represent the intensive system of irrigation development. Lands to be included in such schemes are resumed for subdivision if not already held by the Crown. Subdivision provides for horticultural farms of from 25 to 50 acres of irrigable land according to quality and about 550 acres of irrigable land for large-area or mixed farming holdings. Water is supplied for practically 100 per cent. irrigation.
>
> "The difference between the two types of development is important and the form to be generally adopted is a matter of high policy." [32]

As noted later, the main lines of production in the Tullakool Irrigation Area have been sheep raising and cereal growing (rice and wheat) on "large-area" farms. Whilst the development of the Wakool, Denimein and Deniboota Irrigation Districts has followed the lines mentioned above, there has been some subdivision of various estates for State-controlled closer settlement as a modification of the overall principle of water supply to pre-irrigation holdings. Within the State-controlled irrigation districts of New South Wales the basic supply of water for irrigation is made on the basis of "water rights". These are attached to the land itself and based on the assessed area that is "commanded and suited to irrigation". In Wakool and Deniboota Districts the overall basis for allocating water rights is 1 in 5, *i.e.*, one acre-foot per annum for every five acres assessed as "commanded and suited to irrigation". In the Denimein District, the basis is 1 in 10. In all three districts there is a maximum of 200 acre-feet per holding. However, where dairy blocks have been established by War Service Land Settlement more copious rights have been allotted. In the Tullakool Irrigation Area, each holding has 150 "water rights" (*i.e.*, 150 acre-feet basic supply) but additional water is purchased as "excess". This also occurs in the Districts.

South of the Murray River, irrigation projects within the "field study area" are more numerous than north of the river and they are much older.[33] The Irrigation Districts of Tongala-Stanhope, Deakin, Rochester, Dingee,

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[31] *Water Conservation and Irrigation in New South Wales, op. cit.*, p. 31.

[32] *Report of Irrigation Development and Food Production Advisory Committee,* Parts I and II (Sydney: Government Printer, 1952), p. 11.

[33] For a description of these projects and their development see: Everard Brown, *Irrigation and Water Supply Development in Victoria* (Melbourne: State Rivers and Water Supply Commission, 1954) and *The Fiftieth Annual Report of the State Rivers and Water Supply Commission,* 1954-55 (Melbourne: Government Printer, 1955).

Calivil and Boort form the western part of the Goulburn River Irrigation System which is the largest scheme in Australia. It supplies water for domestic, stock and irrigation needs in the Goulburn, Campaspe, and Loddon river valleys. The major water storage for this system is Eildon Reservoir on the upper Goulburn River to the east of the "field study area". The downstream Goulburn Weir enables water to be diverted east and west from the Goulburn River. In its westward course, water is gravitated through the Goulburn Waranga Channel to Waranga Basin. From there it is taken westward by means of the Waranga Western Channel across the northern plains of Victoria and into the Mallee over a total distance of 230 miles from Waranga Basin.

The Campaspe Irrigation District lies to the south of the Waranga Western Channel and receives its supplies from the Campaspe River. Unlike the other districts it had no water rights attached to it by 1957.

The Irrigation Districts of Cohuna, Koondrook, Kerang, Third Lake, Mystic Park, Fish Point, Tresco and Swan Hill make up the Torrumbarry Irrigation System all of which lies to the south of the Murray River inside the "field study area". This system is supplied with water from the Murray River using Torrumbarry Weir 26 miles downstream from Echuca. The weir raises the summer level of the river and enables water to be mostly gravitated to these districts by a series of improved "natural" water courses, artificial channels and lakes. The Nyah Irrigation District is supplied by pumping from the Murray River.

In the Victorian Irrigation Districts, water is allotted by the State Rivers and Water Supply Commission to each holding on a *pro rata* basis according to lands classified as "commanded and suited to irrigation". The district water rights vary according to the intensity of farming sponsored by the projects. At the time of survey, the basis for apportioning water rights to the districts was by the following formula:—

District	*Basis for Apportioning Water Rights*
Nyah	2½ acre-feet per irrigable acre
Cohuna, Dingee, Koondrook, Rochester, Swan Hill and Tongala-Stanhope	1 acre-foot per irrigable acre
Third Lake	2 acre-feet per 3 irrigable acres
Fish Point	1 acre-foot per 2 irrigable acres
Kerang and Mystic Park	1 acre-foot per 3 irrigable acres
Deakin	1 acre-foot per 4 irrigable acres
Boort, Calivil, and Tragowel Plains	1 acre-foot per 5 irrigable acres.

As a result of the erection of Eildon and Cairn Curran Reservoirs (the latter on the upper Loddon River), and as channels are progressively enlarged, the intention is to increase all water rights to an overall common basis of 1 in 3 but with new assessments of the rateable lands on each holding [34] and preservation of rights now in excess of 1 in 3.

[34] L. R. East, *The Goulburn Irrigation System, Use of Eildon and Cairn Curran Waters* (Melbourne: State Rivers and Water Supply Commission, 1955).

It was noted earlier that the various irrigation projects (*i.e.* Districts and Areas) of New South Wales within the "field study area" had developed mainly during the last twenty-five years. By contrast, the Victorian districts have a much longer history and many of them first developed (usually under other names) as Irrigation Trusts in the latter part of last century, *i.e.* before the State assumed full control over development in 1905.[35]

All holdings have been allotted water rights. The owner of each block has to pay a compulsory charge each year for the water rights attached to his land, irrespective of whether he has used all the water so allotted. This long-standing principle of "compulsory water rights" is a feature of development in the irrigation districts and areas of south-eastern Australia and has been designed to encourage effective and continuous use of water so as to overcome the problems of irregular water use, with its attendant problems of supply that had arisen in earlier years when development was controlled by Irrigation Trusts in Victoria. The landholders also have to meet a "general rate", particularly for supplies of domestic and stock water. In addition to water allotted for domestic and stock purposes and as water rights, and when supplies permit, additional water can be obtained as "excess water" (New South Wales) or as "sales" (Victoria). Generally speaking, the charges for water vary according to the costs of supply and are higher for schemes depending on pumped supplies than for schemes depending on gravitated supplies. During the period of survey (1956-58) most of the irrigation districts in Victoria operated on a charge for water rights of 15s. 0d. per acre-foot and similar charges for "sales" water. However, charges in the Nyah District were 150s. 0d. for every 3 acre-feet and in the Tresco District 120s. 0d. for every 2 acre-feet because of the higher costs of pumping water in these districts. In New South Wales, charges for water rights averaged 20s. 0d. per acre-foot, with a graduated scale up to this level in the first three years of supply. Slightly lower charges were imposed for "excess" supplies.

IRRIGATED FARMING

Most of the irrigated farming of the "field study area" occurs within the group irrigation projects described above. Although some irrigation farms produce a range of products, it is more common for them to specialise in one or several cognate products. Therefore, it is both convenient and realistic to examine irrigated land use under several product headings in relation to the map of "dominant farm products" (Fig. 7).

Table III sets out the total areas of the various irrigation projects of the "field study area" and gives the total area irrigated in each during the 1956-57 and 1957-58 seasons. It will be noted that there are wide variations in the proportion irrigated. This is mainly a reflection of the closely-related factors of water supply and type of land use. All the districts where more than 35 per cent. of the land was watered in 1956-57 contain intensively developed closer settlements for dairying and/or fruit growing. They have 1 in 1 or better water rights allotted to them. The Tresco District is given over mainly to fruit growing, but had only 32.6 per cent of its land watered in 1956-57. This is because a large part of the district

[35] This applies to areas now covered by the Tragowel Plains, Cohuna, Swan Hill, Campaspe, Kerang, Boort, Koondrook, and the Tongala-Stanhope Irrigation Districts.

has gone out of production because of a deterioration of soils with high water tables and "salting". In other districts, the major form of production is sheep raising and rice is grown also in the districts of southern New South Wales. The proportion of these districts irrigated is closely related to the water rights allotted to them. The area watered in all irrigation districts changes from year to year, partly because of general development (especially in new districts like those of the Riverina) and partly because of fluctuations in rainfalls during the irrigation season which greatly affects the total acreage of irrigated cereals, native pastures, and fodder crops. Generally, short-term fluctuations in area irrigated are generally lower where irrigated fruit crops or permanent pastures are involved to any extent. Where irrigation of winter-growing crops occurs as the major industry fluctuations are more marked. This is because the former are irrigated during times of the year that are usually fairly arid and there is a persistent need for heavy irrigations to keep crops and pastures alive. Fig. 9 shows the various kinds of crops and pastures irrigated in the projects of the "field study area" in 1956-57. Districts with relatively large areas of fruits and permanent pasture have been closer-settled and "intensive" irrigation is practised. "Partial" irrigation occurs in the remainder.

Fruit and Vegetable Growing

Irrigated fruit and vegetable growing in the "field study area" is fundamentally dependent on irrigation many times the rainfall received during a production season in the warmer and drier months of the year. It is located chiefly in the western and eastern parts of the area, but small areas of pumped irrigation of tree fruit occur in various localities such as Boort and Gunbower.

In the western portion of the "field study area", spray irrigation of citrus occurs on sandhills near Barham along the Murray River in New South Wales. A similar but smaller area of spray-irrigated citrus and apples is located nearby in Victoria, in the Koondrook District. Proceeding westward, the next fruit settlement of importance is at Murrabit, in the Koondrook Irrigation District. Citrus is the main crop, but there are smaller areas of apples and stone fruits. The acreage of fruit in the Koondrook district is declining because of unsuitable heavy soils. This applies particularly to Murrabit, where heavier alluvial terrace soils have been used.

West of Murrabit, the next major fruit settlement is at Kangaroo Lake, where crops are grown on aeolian dunes. Citrus is the major crop, but there are also smaller areas of vines and pome fruits. Further west are the relatively important areas of Tresco Irrigation District and Lake Boga, which are supplied by pumping from the Lake. Although citrus and tree fruits occur on the higher Mallee fringe soils, the main crop is vines (mainly for table purposes, but some drying). In the Swan Hill Irrigation District there are several major fruitgrowing settlements supplied by the Torrumbarry Irrigation System. To the south-east of Swan Hill, there are small areas of citrus, vines (drying and table), and stone fruits. To the north-west of Swan Hill are the fruit settlements of Speewa, Beverford, Woorinen North, Woorinen, Tyntynder South, Woorinen South, and Murraydale. Some declining fruit production occurs on heavier grey alluvial soils near the Murray (e.g., Speewa), but most of the fruit is grown in

TABLE III

Area of Land Watered in Group Irrigation Projects of "Field Study Area" 1956-57 *and* 1957-58*

District	Total Area of District	Land Watered			
		1956-57		1957-58	
		Total Area Watered	Proportion of Total District Watered	Total Area Watered	Proportion of Total District Watered
	Acres	Acres	Per cent	Acres	Per cent
Tongala-Stanhope ..	76,137	42,586	55·9	45,056	59·2
Rochester	181,705	69,662	38·3	77,794	42·8
Dingee	8,826	4,319	48·9	5,196	58·9
Calivil	61,132	13,431	22·0	17,094	28·0
Tragowel Plains ..	218,441	51,368	23·5	67,151	30·7
Deakin	160 868	8,202	5·1	11,328	7·0
Boort	80,212	21,705	27·1	29,150	36·3
Cohuna	85,544	59,203	69·2	60,179	70·3
Koondrook	88,168	37,826	42·9	47,836	54·3
Swan Hill	37,200	24,224	65·1	19,404	52·2
Third Lake	11,438	3,168	27·7	3,977	34·8
Mystic Park	19,267	3,445	17·9	6,024	31·3
Tresco	4,648	1,515	32·6	1,498	32·2
Fish Point	6,327	2,000	31·6	3,221	50·9
Kerang	88,573	34,952	39·5	39,600	44·7
Nyah	3,843	2,876	74·8	3,389	88·2
Wakool	493,730	58,010	11·7	63,064	12·8
Tullakool	18,006	5,925	32·9	7,882	43·8
Deniboota	306,907	12,798	4·2	21,894	7·3†
Denimein	147,005	18,425	12·5	21,114	14·4

* *Source :* Annual reports of the State Rivers and Water Supply Commission and the Water Conservation and Irrigation Commission for these years.

† Acreage of district increased from 306,907 to 307,212 acres between two years.

the more elevated Mallee fringe areas with characteristics intermediate between the high Mallee and the riverine terraces. In all these settlements vines are the main crop, with an emphasis on drying varieties, although diversion of crops as table grapes is increasing in importance, as are deciduous fruits (apricots, plums, prunes, apples, and almonds) better suited to the climate of the mid-Murray (see p. 179).

North of the Swan Hill Irrigation District, fruit is grown in the Nyah Irrigation District (Vinifera, Nyah, Nyah West, and Nyah Extension) and also in the Piangil and Wood Wood district in Victoria, as well as at Bungunyah, Koraleigh and Goodnight, in New South Wales. Fruits are grown on Mallee fringe soils and water is supplied by pumping from the Murray. The pattern of production is similar to the Swan Hill district.

There are a number of fruit settlements in the eastern parts of the "field study area" on the riverine plain of the lower Goulburn Valley. These are located mainly in the Tongala-Stanhope Irrigation District and have developed on the lighter and more elevated soils of "prior stream" lines which run roughly from south-east to north-west through Tongala and Stanhope. A smaller but diminished area of fruit growing occurs on similar country in the Rochester Irrigation District at Bamawm and Lockington. On the northern bank of the Murray some fruit is grown on sandhills in the Bama Irrigation Trust.

The eastern fruit settlements depend mainly on gravitational supply systems which give cheaper water than by pumping in the west. In addition, the soils of the eastern zones are generally heavier than those of the Mallee fringe areas. As a result, the emphasis has been on pome and stone fruits for canning, although citrus was important in the early days. As with most of the comparable areas of northern Victoria, the initial impetus to the development of fruit growing in the eastern areas was the State-sponsored closer settlement after 1910.

Vegetable growing has increased in importance over the last twenty years in most of the fruit settlements of the "field study area". It has been aided first by the increased demands of the 1939-45 War, and later by a growing demand from Metropolitan areas for "early" vegetable crops. A post-war influx of southern European migrants into these settlements has greatly encouraged vegetable growing, as has happened in parts of the Murray and Murrumbidgee valleys (e.g., at Cobram and on the Murrumbidgee Irrigation Area). In most of the fruit settlements, problems of water logging in wet years and climatic hazards for dried vine fruits in western settlements have caused a decline in vine and tree fruit production and much of this has been replaced by the growing vegetable industry.

The "field study area" is ideally located for vegetable production with irrigation. The warm temperate climate enables all-year-round production especially for "early" crops which realise high prices in urban markets. Land and water supplies are cheaper than in rural-urban fringe areas and the large Melbourne market is readily accessible. The proximity of processing works at Bendigo and in the Goulburn Valley has also aided the development of the tomato industry for canning, pulp, and sauce.

Dairying

All the commercial dairy (and joint pig) production in the "field study area" depends on copious irrigation several times the rainfall, especially in closer settlements producing in the warmer and drier months of the year. The major dairying settlements occur in areas initially developed by State-sponsored closer settlement schemes. They are located on riverine plain country where relatively cheap gravitational water supplies have been brought to Red Brown Earth Soils and Grey and Brown Soils of Heavy Texture by the Goulburn and Torrumbarry Irrigation Systems. Most of these settlements first began to develop dairying on a major scale between 1910 and 1925 and the major concentrations of dairying occur in the following areas: Tongala-Stanhope Irrigation Districts, Rochester Irrigation District (at Nanneella, Ballendella, Bamawm, Lockington, and Bamawm Extension), Dingee Irrigation District, Cohuna Irrigation District (along

the National Channel and between Gunbower, Meade, Cohuna and Gannawarra), Koondrook Irrigation District (near the Murray between Koondrook and Murrabit), and the Swan Hill Irrigation District (north of Swan Hall at Tyntynder South, Murraydale, Tyntynder Central, Tyntynder and Speewa).

As described for the Swan Hill District (pp. 180-197), the closer-settled dairying districts are composed mainly of small "family" farms dependent on intensive irrigation of permanent pastures with calvings in late winter and early spring to take advantage of lush feed during the warmer months of the year. For the most part, these settlements have been located on the higher and better-drained soils of "prior stream" alluvial fans on the southern and eastern flanks of the plain near to major channels of the Goulburn system or on fairly permeable alluvial soils close to the Murray. Such a location has ensured good water supplies and has allowed the development of lucerne in earlier years and permanent pastures in later years.

Outside the closer-settlements, irrigated dairying has developed partly by "private diversion" from the Murray but mainly in the "partial" irrigation projects dominated by sheep raising. The dairying industry of the Loddon Valley shown on Fig. 7 in the Calivil, Boort, Pyramid, Yarrawolla, and Macorna districts is an example of this. To some extent dairying in these districts was sponsored by the State for immigrant and soldier settlers after 1918, especially at Calivil but much of it developed on a private basis.[36] This industry was more important in the past than it is today, especially in the 1920's and 1930's when it provided a "beginning" industry for emergent sheep farmers or a means of livelihood during times of economic depression. In recent years, dairying in the "partial" irrigation districts of northern Victoria has tended to decline in favour of fat lamb raising because of higher wool and sheep-meat prices.

Dairying in the "partial" irrigation districts tends to be associated with irrigated annual pastures common to the irrigated sheep zones and permanent pastures so popular in the closer settlements are not so developed here. This is a reflection of poor water supply coupled with the heavier soils of the flood plains both of which dictate fairly extensive development. The dairying industry tends to be much less stable in the "partial" irrigation districts than in the closer settlements and fluctuates according to changes in relative prices for sheep and dairy products.

Sheep-Cereal Production

The later discussion of irrigation in the Tragowel Plains, Calivil, and Boort Irrigation Districts (pp. 197-218) provides an indication of the type of sheep production found outside the "islands" of closer settlement in districts that have developed with systems of "partial" irrigation. These properties are typical of most projects in the "field study area" although it should be noted that a rice-oats-pasture rotation occurs on many of the sheep properties in the southern Riverina. Outside the rice areas, "partial" irrigation has allowed many graziers to concentate on specialised sheep

[36] Although dairying in the Calivil District is based on 1 in 5 *pro-rata* water rights, a comparatively intensive pattern of settlement is sustained by high "sales quotas" granted to each dairyfarmer.

raising with fat lambs and coarse wool the main products. This contrasts with specialised Merino woolgrowing in non-irrigated parts of the Riverina and with sheep-wheat production in non-irrigated areas of northern Victoria to the south. In most cases, irrigation has encouraged a drift away from cereal growing but the rice areas are an exception to this. The properties studied in the Rochester Irrigation District (pp. 218-233) are examples of production flexibility possible with high water rights and better drained soils in areas like Tongala-Stanhope, Rochester, Koondrook, and Swan Hill.

Various physical and economic factors effect regional and temporal variations in the emphasis given to crossbred meat and wool growing as opposed to Merino wool growing. However, it is clear that "partial' irrigation has caused the pattern of sheep raising to differ from that of surrounding dryland areas insofar as it has allowed smaller properties with higher carrying capacities, earlier and safer production of sheep meats, and a more flexible production pattern. Developments in high water right areas like Rochester represent the extreme of this contrast and irrigationists have been able to develop a wide range of stock fattening enterprises and alter the seasonal pattern of production according to changing economic and climatic circumstance.

4. INTEGRATION AND IRRIGATED FRUIT AND VEGETABLE GROWING IN MID-MURRAY AREA (N.S.W. AND VICTORIA)

The Mid-Murray Dried Fruits Area includes the fruit settlements of the following irrigation projects: Nyah (at Nyah, Nyah West, Vinifera, and Nyah Extension), Swan Hill (at Woorinen, Beverford, Speewa, Tyntynder, Murrawee, and Rangott's Land), Tresco (at Tresco and Tresco West), and Long Lake. All these districts are in Victoria within a radius of 18 miles of Swan Hill on the Murray River. The Mid-Murray Area also includes the adjacent projects in New South Wales at Goodnight, Koraleigh and Bungunyah. These various settlements are shown on the northwestern part of the "field study area" as indicated in Fig. 7 except Goodnight which lies to the north of the area under review.

The major expansion of fruit growing took place in the Mid-Murray Area immediately before and after the First World War and the development is shown for the Swan Hill District in Fig. 10. Growth of irrigated fruit growing in these areas was greatly stimulated by State-sponsored closer settlement (both civilian and soldier) which occurred between 1910 and 1925.

During 1957, the writer undertook a reconnaissance study of fruit farms in the Mid-Murray Area, properties being selected at random along the major roads in the various settlements. Information gleaned from fruit growers has provided a clear indication of the pattern of integration in these areas and this has been confirmed by official census data and advice from local officers of the Victorian Department of Agriculture. *The survey showed that irrigated fruit and vegetable growing in this part of the southern Murray Basin involves no forms of integration between irrigated and non-irrigated land uses.* An official census over the years 1951-54

showed that most horticultural properties in the Mid-Murray Area specialise in the production of fruits and vegetables.[37] Irrigated land is the basis of all farm production and the products of unirrigated land are of no value in this process.

Many of the fruit properties in the Mid-Murray Area have appreciable areas of non-irrigated land, despite the fact that few properties exceed 30 acres and most are between 10 and 25 acres. Unirrigated areas are used partly as headlands to allow turning of implements, and for laneways, channels and building sites (houses, sheds and drying racks). Also many farms possess land once used for fruit growing but now unproductive because of high water tables and "salting". Whilst much of the non-irrigated land was of some value to farm production it was not cropped and was therefore not used in a system of "on-farm" integration. The survey of the Mid-Murray Area showed that fruit growers did not sell factors of production to dryland farmers nor were products of dryland farms used as factors of production by the fruit growers. In this important sense, irrigated fruit and vegetable growing lacked any forms of "off-farm" integration and *was divorced from neighbouring dryland uses.*

In the Mid-Murray Fruits Area, the main crops on most holdings were drying grapes, including Sultanas (by far the major crop), Walthams, Gordos, Currants, and other grapes. In the 1951-54 period, the census of this area showed that 85 per cent of the grape crop was dried. Tree fruits, like apricots and citrus, were generally minor crops, although some areas like Lake Boga and Long Lake grew more tree fruits than grapes. The Mid-Murray Fruits Area is at a climatic disadvantage for dried vine fruits compared with areas further down the Murray between Robinvale in Victoria and Cadell in South Australia—i.e. the "Sunraysia" and South Australian fruit areas of the Mallee-Murray. Being in a lower latitude and closer to the influence of the uplands of south-eastern Australia, the Mid-Murray Area experiences a greater incidence of damaging rains in spring and autumn, and a shorter and later growing season with less solar heat than the other areas. As a result, serious crop losses have been suffered and there has been an increasing trend for a high proportion of the grape crop to be diverted to wineries or sold as fresh fruit. Some vine areas have gone out of production altogether and there has been a significant increase in plantings of tree fruits better adapted to climatic conditions. Some vine growers have taken up dairying but a major trend has been an increased emphasis on vegetable production, assisted by the same kind of post-war influx of southern European migrants as occurred on the Murrumbidgee Irrigation Areas.

Whilst land use on fruit farms in the Mid-Murray Area is still in a state of flux, it appears that dried vine fruits and associated tree fruits will remain the major form of land use. There are no indications that the traditional lack of integration with surrounding dryland economies is being broken down. This is quite significant because, if such a change is to occur in any of the irrigated fruit areas of the southern Murray Basin, one could reasonably expect it to occur first in the Mid-Murray Area.

[37] Orchard Census conducted by the Victorian Department of Agriculture, 1951-54.

5. INTEGRATION AND IRRIGATED DAIRYING IN SWAN HILL DISTRICT (VICTORIA)

During 1957 a detailed survey was made of thirty-three dairyfarms in the Swan Hill Irrigation District of Victoria. (See Fig. 8). These were selected as a random sample (28 per cent) of the commercial dairies on the alluvial flats to the north of Swan Hill, adjacent to the Murray River in localities such as Tyntynder, Tyntynder North, Tyntynder South, Murraydaye and Speewa. Because of the proportion of the total farms studied and in the light of information collected from various local experts, it is considered that the details for these 33 properties reflects reasonably well conditions on the 116 farms from which they were chosen.

The following discussion of the pattern of integration on the thirty-three dairyfarms surveyed in the Swan Hill district deals first with the types of integration occurring on the flats and second with the factors that have assisted or hindered the development of integration. At each point a distinction is made between "on-farm" integration (i.e. the joint use of irrigated and dry lands) and "off-farm" integration (i.e. exchanges of feed, stock, and stock agistment between irrigators and dryland farmers).

"On-farm" Integration of Land Resources

Land Resources

Table IV and Table V set out the area of the dairyfarms surveyed on the Swan Hill Flats. Table IV gives the general pattern of land use on the farms. The average area of the farms surveyed on the Flats was 83.6 acres and 23 farms (70 per cent) were within 40 and 99 acres. This pattern of farm size is typical of the intensive dairying settlements established under closer settlement on the plains of northern Victoria. All farms possessed small areas of unirrigated land on the Flats used mostly as laneways, channels, and for building sites (houses, sheds, etc.). Most of the productive lands on the Flats was irrigated, chiefly developed as improved permanent or summer-type pastures (typically Paspalum and white clovers, with small but declining areas of lucerne). Only two farms had appreciable areas of improved annual or winter-type pastures under irrigation—i.e. the kind more common in irrigated sheep districts (see page 203). A heavy reliance on irrigated summer pastures is a feature of the closer-settled dairying areas of the southern Murray Basin. Irrigated natural pastures and fodder crops are of much less importance nowadays than they were in the earlier years of development and there has been a decline of irrigated lucerne. These trends are summarised for the Swan Hill Irrigation District as a whole in Fig. 10 and they are similar to trends in other closer-settled dairying areas in northern Victoria as well. The present farms on the Swan Hill Flats are somewhat larger than was the case when the district was first closer settled for dairying in the early part of this century. The typical farm then was 40 to 60 acres but this tended to prove too small for a "home maintenance" area and a gradual build up of farm size occurred.

TABLE IV

Farm Size and Land Use for Thirty-three Sample Dairyfarms, Swan Hill District, 1957

Number	A. Land Resources Wholly or Partly in Irrigation District*							B. Land Resources Outside Irrigation District			Grand Total Area
		Irrigated Land					Non-Irrigated Land				
	Total Area	Improved Permanent Pasture	Improved Annual Pasture	"Natural" Pasture	Fodder Crops	Commercial Crops, etc.	"Natural" Pasture, Lanes, Channels, Building Sites, etc.	Commercial Crops	Fodder Crops	"Natural" Pasture, etc.	
No.	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
1	23½	22½	...	...	...	...	1	...	...	...	23½
2	36	31	...	...	...	2†	3	...	...	...	36
3	38	31	...	...	...	...	7	...	...	...	38
4	43	40	...	...	...	...	3	...	...	...	43
5	50	48	...	...	...	...	2	...	...	...	50
6	50	47	...	...	...	...	3	...	...	50	100
7	53	42	8	...	...	...	3	...	...	600	653
8	56	50	...	...	5‡	...	1	...	...	...	56
9	56	39	8	...	4§	...	5	...	...	...	56
10	60	55	...	...	...	...	5	...	180	376	616
11	60	55	...	...	...	...	5	...	...	...	60
12	60	...	...	36½	...	10‖ 12¶ ½**	1	...	...	...	60
13	60	55	...	...	...	...	5	...	...	...	60
14	60	56	...	...	...	...	4	...	...	1,400	1,460
15	67	40	20	...	...	...	7	...	...	...	67
16	69	66	...	...	...	...	3	...	...	...	69
17	72	65	...	5††	...	...	2	800	50	1,850	2,772
18	75	67	...	...	...	...	8	...	...	...	75
19	78	76	...	...	...	...	2	...	...	...	78
20	79	78	...	...	...	...	1	...	...	...	79
21	82	67	12	...	...	...	3	...	...	...	82
22	84	43	32	...	7§	...	2	...	...	...	84
23	88	80	...	...	...	...	8	50	100	97	335
24	92	66	16	...	...	...	10	100	50	170	412
25	94	76	...	...	16‡	...	2	...	...	...	94
26	96	26	52	...	5‡‡	...	13	...	...	...	96
27	100	84	...	...	...	14‖	2	...	...	...	100
28	113	108	...	...	...	...	5	...	...	...	113
29	119	114	...	...	...	...	5	...	...	...	119
30	130	115	...	...	...	...	15	...	...	1,400	1,530
31	136	106	24	...	...	1§§	5	150	150	600	1,036
32	198	168	10	...	10§	...	10	...	...	...	198
33	280	126	147	...	...	...	7	...	...	...	280
Average ...	83·6	66·9	...	...	...	...	4·8	...	...	...	331·2

* Lands actually contiguous with irrigated land in the district. † Grapes. ‡ Oats as cover crop to improved pasture. § Lucerne
‖ Vegetables. ¶ Share grapes. ** Tree fruits. †† Dead vine crop. ‡‡ Rye corn. §§ House garden.

"On-farm" Integration

It is clear then that the characteristic dairyfarm established by closer settlement in the Swan Hill district is a small property with all its productive land under intensive irrigation and with a specialist interest in dairying.

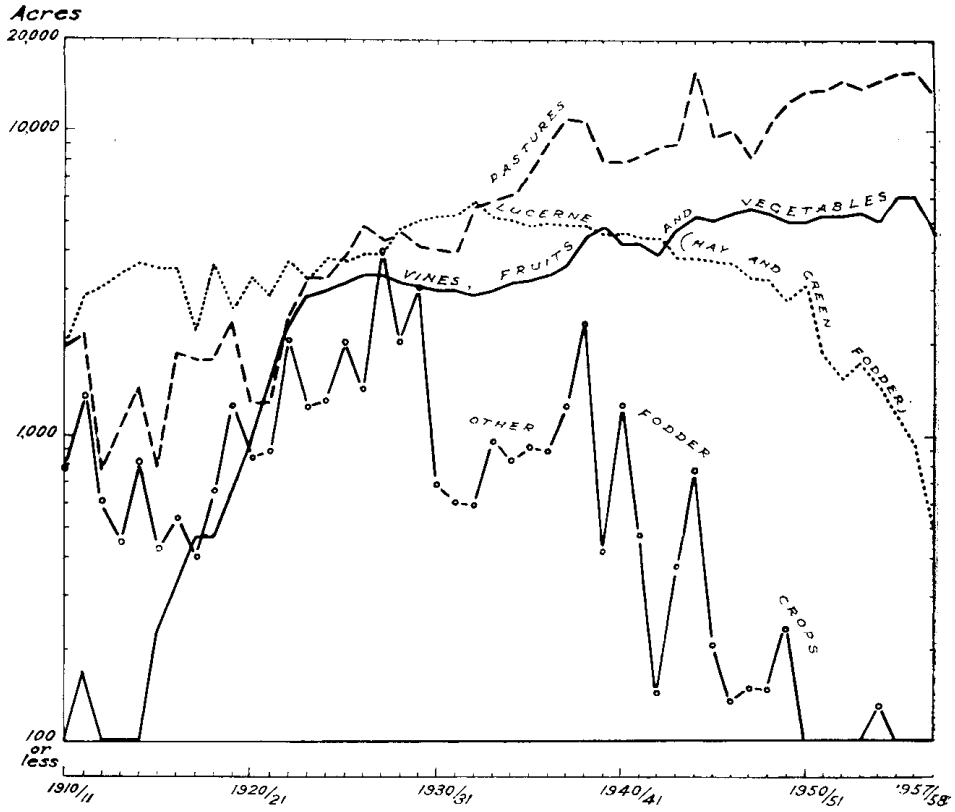


Fig. 10—Trends in Areas Watered in Swan Hill Irrigation District 1910-11 to 1957-58. State-sponsored closer settlement led to rapid development in the early phase. Note how irrigated pastures have taken over from irrigated lucerne and fodder crops.

and pig raising as a joint enterprise. This type of farm can be likened to the fruit farms described earlier in that little "on-farm" integration or joint use of irrigated and unirrigated lands has been practised in the last 50 years. However, the field study of the Swan Hill district revealed that dairyfarms there were developing interesting modifications to this traditional pattern and "on-farm" integration is increasing in importance. This trend is occurring in other dairying districts of northern Victoria. To the extent that intensive dairying might play a part in future developmental programmes (given a more attractive market outlook than prevails at this juncture) certain adjustments might need to be made to the model adopted by governments in earlier closer settlement projects.

The survey showed that it is the custom of many dairyfarmers to practise "on-farm" integration whether or not they own the unirrigated land used in conjunction with their irrigated land. Although all of the thirty-

three farmers had their headquarters (households and milking plants and irrigated feed supplies) on the Swan Hill Flats, many of them directed part of their efforts to a stocking and, sometimes, a cropping programme on unirrigated land located mostly in the nearby Victorian Mallee but in some cases over the Murray River in New South Wales. Nine of the thirty-three farmers owned unirrigated land which was actively integrated with their irrigated dairy block. Table VI sets out certain details of these unirrigated blocks. In only two cases was the enterprise (cropping and/or stocking) on the unirrigated block more than a mere supplement to the dairy enterprise. Only a minority of the dairyfarmers owning unirrigated land possessed it before they bought their irrigated blocks.

TABLE V

*The Pattern of Farm Sizes for 33 Dairyfarms Surveyed on the Swan Hill Flats, 1957**

Size Group (acres)	Number of Farms
Less than 40	3
40 to 59	6
60 to 79	11
80 to 99	6
100 to 119	3
120 to 139	2
140 to 159	Nil
160 to 179	Nil
180 to 199	1
200 to 249	Nil
250 or more	1
Average size	83·6 acres
Smallest size	22·5 acres
Largest size	280·0 acres

* These figures refer only to the Swan Hill Flats. Nine of the 33 farms also possessed areas of unirrigated country as shown in Table IV.

Of the twenty-four farmers who did not own unirrigated country, eighteen made a regular practice of agisting dairy stock on unirrigated country away from the Swan Hill Flats. In most cases, this involved agisting young stock as soon as they could be taken away from the constant care of the "home" farm and until they calved. Milking cows were commonly agisted during their annual "dry" spell in winter. In most cases, stock agistment was obtained by paying a rental charge to the dry farmer.

The geographic pattern of "on-farm" integration in the Swan Hill district is an interesting one. Unirrigated lands integrated with the irrigated blocks on the flats were located mostly in the nearby Victoria Mallee; few farmers were using land over the Murray River in New South Wales. The explanation for this is that the Mallee country is better adapted to the kinds of stock agistment and cropping of interest to the dairyfarmers (see p. 190). Lands rented for agistment were scattered over a wider area than most of the unirrigated land owned by nine of the dairyfarmers. The main reason for this is that the farmers who had acquired dry country sought land

TABLE VI

Unirrigated Blocks Worked by Nine Dairyfarmers in Conjunction with Dairy Blocks on the Swan Hill Flats, 1957

Farm Number	Unirrigated Block		Distance of Unirrigated Block from Dairyfarm	Uses of the Unirrigated Block			
	Area	Location		Cropping for Sale	Fodder Crops for Dairyfarm	Agistment of Dairy Stock	Independent Sheep Enterprise
	Acres		Miles				
6	50	Victorian Mallee	4	None	Oats	Yes	None.
7	600	N S.W. Plains	17	None	None	Yes	Yes.
10	556	Victorian Mallee	10	None	Wheat Oats. Barley.	Yes	None.
14*	1,400	Victorian Mallee-Murray fringe.	40	None	None	Yes	Yes,
17	2,700	Victorian Mallee	25	Wheat Oats. Barley.	Oats	Yes	Yes.
23	247	Victorian Mallee	Nil	Barley	Oats Barley.	Yes	None.
24	320	Victorian Mallee	9	Wheat Oats.	Wheat Oats.	Yes	None.
30*	1,400	Victorian Mallee-Murray fringe.	40	None	None	Yes	Yes.
31	900	Victorian Mallee	9	Wheat Oats. Barley.	Wheat Oats. Barley	Yes	None.

* These properties were worked by brothers who operated a dry property jointly.

TABLE VII

Extent of Agistment of Stock on Dry Country by 27 Dairyfarmers in Swan Hill District, 1957

Type of Farm	Agistment Practised				Location of Agistment			
	Agistment of Milking Herd for Several Months in Winter		Agistment of Young Dairy Stock for Non-productive period		Victorian Mallee		Riverine Plain in New South Wales	
	Regularly	1956* Only	Regularly	1956 Only	Regularly	1956 Only	Regularly	1956 Only
	No.	No.	No.	No.	No.	No.	No.	No.
A. *Nine* farms owning dry lands ..	9	..	9	..	8	..	1	..
B. *Eighteen* farms without own dry lands	14	4	12	1	11	4		..

* This was an extremely wet year for the Swan Hill District.

fairly close to their "home" farm because this allowed them to develop it easily, especially for cropping, without interfering with their irrigation activities on the alluvial Flats. By contrast, farmers seeking rented agistment for stock were prepared to go much further afield since close supervision of cattle on unirrigated land was not needed. However, two of the nine farmers possessed dry country 40 miles from their irrigated blocks. A sealed highway linked their lands so they did not regard the distance as excessive.

Dryfarmers Use of Irrigated Land

During the interviews with the dairyfarmers on the Swan Hill Flats, enquiries were made about the prevalence of agistment of stock from drylands farms on the irrigated Flats. It was clear from the information obtained that this was quite rare. Only two of the thirty-three farmers interviewed ever made a practice of allowing dryfarmers to place stock on his irrigation land. In these cases, one or two paddocks were made available for short periods to hold stock moving into or out of the sales at Swan Hill. The dairyfarmers were prepared to do this to "clean up" rough pasture not ideal for intensive dairying. Reasons for the general opposition of the dairyfarmers to permitting stock from unirrigated country on their lands are given later. General enquiries in the Swan Hill district suggested that, of the 120 farms located on the alluvial Flats north of Swan Hill, only twelve properties (including some sheep farms) ever carried stock from unirrigated areas. In only a few cases was this done as a regular practice. It usually occurred only during major droughts when special lines of stock were agisted, as in the droughts of the 1940's. *It can be concluded, therefore, that the type of intensively managed dairyfarm that has been developed under closer settlement on the Swan Hill Flats does not provide any relief to unirrigated grazing lands in the surrounding country during periods of drought.* In very few cases had dairyfarmers sold their herds during severe droughts and engaged in the then profitable agistment of drought-affected stock from unirrigated areas.

"Off-farm" Integration of Livestock Operations

Livestock Enterprises

Table VIII lists the numbers and kinds of livestock managed by the thirty-three dairyfarmers interviewed on the Swan Hill Flats. All but five of the farmers ran pigs as a sideline to dairying. These five farmers included two undertaking dairying as a joint enterprise with fruit growing and three keeping stud dairy stock and using surplus milk to raise them. Despite considerable variations, the pig enterprise was a substantial one on all farms with pigs. None of the farms raised beef cattle as a speciality although one dairy bred stud Shorthorn stock and sold progeny to beef producers in other areas.

Sheep were raised by only five of the thirty-three farmers. In one case these were run on the irrigated Flats; in the other four cases, the sheep enterprise was located on unirrigated blocks away from the Flats.

TABLE VIII

*Number of Livestock on 33 Dairyfarms Surveyed in Swan Hill District 1957**

Farm Number	Dairy Stock		Pigs				Sheep			
	Milkers	Non-Milkers	Boars	Sows	Porkers	Baconers	Ewes	Rams	Young Sheep	Wethers
1	22	7	1	3	..	25	..	..	..	..
2	9	4	..	..	..	..	..	..	..	..
3	12	8	..	..	..	10	..	..	..	..
4	28	4	1	4	60	..	..	..	..	..
5	35	15	..	..	50	..	..	..	..	..
6	42	16	1	3	40	..	..	..	..	..
7	30	19	1	4	32	..	140	6	92	47
8	41	20	2	6	62	..	100	3	80	..
9	31	18	1	3	..	40	..	..	..	..
10	50	28	3	15	240	..	..	..	..	..
11	46	20	1	6	..	100	..	..	..	..
12	7	3	..	..	..	..	..	..	..	..
13	38	12	1	6	..	78	..	..	..	..
14	50	24	1	3	..	45	300	3	240	110
15	33	20	1	8	128	..	..	..	..	..
16	40	20	1	5	..	80	..	..	..	..
17	50	40	..	..	..	..	500	6	450	..
18	50	40	2	10	160	..	..	..	..	..
19	50	32	1	5	80	..	..	..	..	..
20	50	30	1	6	120	..	..	..	..	..
21	52	21	1	5	..	50	..	..	..	..
22	29	16	1	6	35	60	..	..	..	..
23	46	20	1	4	..	35	..	..	..	..
24	42	36	1	5	30	..	..	..	..	..
25	56	24	1	8	100	..	..	..	..	..
26	45	20	1	4	70	..	..	..	..	..
27	46	28	1	4	..	32	..	..	..	..
28	50	40	1	2	..	36	..	..	..	..
29	80	40	1	8	..	110	..	..	..	..
30†	60	20	..	..	..	50	300	3	240	110
31	100	57	1	12	..	120	..	..	..	..
32	85	75	..	..	..	..	..	..	..	..
33	70	150	..	..	..	..	..	..	..	..

* Refers to total numbers carried during 1956-57 year, including any stock bred and/or sold in that year. † See footnote to Table VI.

Livestock Purchases

It was customary for the dairyfarmers to breed all or most of their own dairy replacement stock except bulls which were purchased from studs over a wide area of Australia. None of the farms ever purchased dairy stock from unirrigated farms in the interior lowlands of the southern Murray Basin. Most of the farmers raising pigs bred all their stock except breeding replacements that were bought from other irrigators. However, ten of the farmers purchased store pigs for fattening. Most of these came from neighbouring irrigation farms but some came from unirrigated Mallee country in Victoria where pigs are raised as a small sideline to wheat farming. The number of pigs absorbed by irrigation farms on the Flats was not enough to constitute an important influence on the market for pigs from unirrigated Mallee areas.

Of the five farmers with sheep, only one ever used irrigated land in conjunction with dryland, although a recurrence of droughts might encourage the practice. All of the five farmers running sheep carried crossbreds and bought considerable numbers of replacements. Most of these came from the unirrigated country of the southern Murray Basin.[38] However, this could not be classed as an example of integration since the sheep enterprise was virtually quite separate from dairying activities on the irrigated Flats. None of the farmers ever bought beef stock for fattening.

Livestock Sales

Twenty-six of the thirty-three farmers interviewed ran "grade" herds and sold only culls, usually for slaughter but sometimes to other dairyfarmers. The numbers of stock sold per annum were small. Only the stud breeder of Dairy Shorthorn stock ever sold cows to farmers in non-irrigated areas. Some of these went to wheat-sheep farmers in the Victorian Mallee who kept small dairy herds for "home" milk supplies and for raising small numbers of vealers.

The survey emphasised that the traditional closer settlement dairyfarm of the Swan Hill Flats does not practise integration through stock sales with non-irrigated areas. Hence, in terms of stock sales and purchases, *it can be concluded that this intensive dairying district is more or less divorced from the dryland economy surrounding it, except for a small exchange of store pigs.* Farmers were questioned on probable changes in livestock operations. Whilst many of them expressed a desire to acquire dry grazing country, few stated that they wanted this to assist any alteration in their stock programme other than a general build-up of stocking rates which a combination of irrigated and non-irrigated land would allow.

"Off-farm" Integration of Feeding Programmes

Source of Feed

Although irrigated summer pastures provided the bulk of the feed used on most of the thirty-three dairyfarms (both for grazing and hay), some farmers make a practice of buying supplementary fodders. Most of the farmers bought small quantities of concentrates (bran, crushed oats, hay and other "meals") which they fed to milking cows twice daily in the bails.

[38] As mentioned later (p. 217) farmers raising sheep in the non-irrigated semi-arid areas generally have an aversion to purchasing sheep from irrigated areas.

Except for stud breeders, few of the farmers considered that this played a significant role in increasing milk production. However, supplements fed with milk to young stock on most farms had a greater value. Many pig producers regularly fed grains bought from dryland areas to their pigs, particularly if they were being raised to baconer stage. However, only small quantities of pig feed were purchased by most farmers.

Seven farmers raised stud stock and they regularly fed considerable quantities of supplements to maximise the production performance and the sales value of their stock. Supplements were fed both in winter and during the summer milking season. Pasture hay was used in addition to oaten hay, crushed oats and other grains. Apart from pasture hay, much of the supplementary feed was purchased and a great amount of it came from the nearby Victorian Mallee wheat areas, directly or through agencies. Oats had tended to displace bran in popularity because of its relative cheapness.

Although stud breeding is quite popular in the Swan Hill district, the survey emphasised the heavy reliance of most farmers there on irrigated pastures and, *with regard to stock feed, the industry was almost completely independent from production on unirrigated country.*

Feed Sales

Although all the dairyfarmers regularly cut hay from the spring pasture flush, few of them ever sold hay to other farmers. *Feed production on most of the farms closely reflected the general autonomy of dairying and there was no doubt that the industry in the Swan Hill district played little part in assisting production stability in surrounding areas.* It was not possible to collect statistics to show the actual volume of feed moving out of the area as a whole. However, all inquiries reinforced the conviction that most dairy farmers tended to cut only enough hay to meet the needs of their own farm from one year to the next.

Advice from local officers of the Victorian Department of Agriculture suggested that many farmers did not make full use of the irrigated feed produced on their farms. It seems that farmers in a district like Swan Hill could cut more hay and run more stock than they do, given a significant improvement in farming techniques. To this extent, it could not be argued that there is no potential for more active integration with neighbouring dryland areas through feed exchanges. However, this was not being practised by most producers during and prior to 1957.

Factors Affecting the Character of Integration in the Swan Hill Dairying Industry

During the survey of the thirty-three dairyfarms on the Swan Hill Flats, an attempt was made to assess the factors that have assisted or hindered the development of integration there. Conclusions derived in this study are summarised below.

"On-farm" Integration

Each of the nine farmers owning drylands away from the Swan Hill Flats was asked why he had purchased this land, and all thirty-three farmers interviewed were questioned about the merits of "on-farm" integration, particularly the agistment of stock on dry country. As shown earlier,

most of the dairy farmers had small blocks on the irrigated Flats reflecting their development as units of a closer settlement scheme which began in the first decade of this century. They had been established as small "family" farms and given copious water supplies so as to encourage intensive irrigation practices and a heavy reliance on watered land. An early emphasis on lucerne growing and fodder cropping has since been displaced for agronomic reasons by almost a complete reliance on irrigated permanent or summer-growing improved pastures, which are grazed intensively from spring to autumn and used for making hay for winter feeding. Since early settlement, there has been a gradual trend towards bigger farms, but the traditional emphasis on intensively managed irrigation land has persisted to the present day. Because of high land value and the tendency for non-irrigated land to become "salted", most of the productive land on the Flats has always been watered and practically no "on-farm" integration has been possible on this land alone.[39] However, in recent years there has been a noticeable trend for dairy farmers to "reach out into dry lands" in search of unirrigated country to integrate with their irrigated lands. This has been the result of agronomic and economic factors.

Particularly during the wet years from 1946 to 1956, most of the dairy farms on the Swan Hill Flats suffered from waterlogging during the winter months.[40] Wet and cold conditions have presented considerable problems of maintaining the health of stock and heavy stocking rates have caused serious damage to valuable improved pastures during the "off-season". These problems reached a peak as a result of local flooding in 1956. For these reasons, most of the farmers considered that it was desirable to agist milking stock away from the Flats for several months in winter. Their opinions of the merits of this agistment are summarised in Table IX. Aside from giving relief to irrigated pastures, agistment provided a change of grazing for stock, both young and mature. Most farmers preferred to employ Victorian Mallee country because they believed it provided superior grazing conditions for their purposes. They claimed that the more elevated and undulating Mallee gave better shelter and drier grazing during the winters than did flatter riverine plain country over the Murray River in New South Wales. The Mallee country also had the advantage of providing more crop stubble for grazing and this provided "hard" feed to balance the protein-enriched diet on the Flats. Another factor which helped to explain the preference for the Mallee country is that most of the dryland farmers there combined cereal growing with sheep raising. They were less interested in specialist stock raising than were graziers north of them in New South Wales and they were therefore more keen to have stock brought to their properties for agistment so as to use crop stubbles. Graziers in New South Wales concentrated more on sheep raising and their blocks were normally more heavily stocked with their own flocks.

Agistment of milking herds away from the Flats had the additional merit of reducing the need to cut large quantities of pasture hay during the spring months for winter feeding. Apart from reducing one of the major tasks

[39] This results from the high water tables in this district and high rates of evaporation during the hot summer months.

[40] This resulted from the heavy local rains on top of heavy summer irrigations of relatively impervious soils. It was aggravated by the low-lying character of the alluvial flats.

on the dairyfarms, it enabled more heavy stocking during the summer months. Some farmers claimed that reduced hay cutting had the added merit of providing more humus to the soil.

TABLE IX

Farmers' Opinions of the Merits of "On-farm" Integration, Swan Hill Dairy Farm Survey, 1957

Value of Using Unirrigated Land	Number of Farmers Referring to this Point*		
	Those Owning Unirrigated Land	Those not Owning Unirrigated Land	All Farmers
	No.	No.	No.
1. Placing of the milking stock on unirrigated country during the winter months is "like a holiday" for them and they produce better in the following production period	7	13	20
2. More milking stock can be carried on the irrigated pasture by agisting young stock on unirrigated areas	9	4	13
3. Agistment of stock during the winter months allows the irrigated pasture to recover from intensive stocking and allows more production during the following irrigation season	4	12	16
4. The farm on the Swan Hill Flats is too small for it to support replacement stock as well as milking cows ..	2	5	7
5. Young stock develop better on unirrigated country (providing the season is not poor) than they do on irrigated land alone	2	5	7
6. Agistment of stock on unirrigated areas reduces the need for a heavy fodder conservation and hand feeding programme	1	..	1
7. To grow cheap feed for pigs ..	5	..	5
8. To grow oaten hay and grain for cows	5	..	5
9. To increase farm income	5	..	5

* Some farmers indicated that "on-farm" integration was of value for several of the reasons listed.

In keeping with the tradition of most dairyfarmers in Australia, the thirty-three farmers carried large numbers of replacement stock. It had become the practice for an increasing number of farmers to agist replace-

ment stock away from the Flats as soon as this could be done and until heifers were ready for calving. There were several reasons for this. Firstly, it allowed a significant increase in the number of milkers that could be run on irrigated land during the summer months without any concomitant increase in the effectiveness of management of this land. An analysis of the numbers of milkers carried on the thirty-three farms in 1957 showed that the average stocking rate by farmers who agisted stock away from the Flats (2.07 milkers per acre) was significantly higher than the average for those not practising agistment (1.38 milkers per acre).[41] There was no evidence to support the view that the higher numbers of milkers had resulted in lower production per acre and per cow. The nine farmers owning thier own dry country were better placed than the rest of those interviewed because they had a surer basis of agistment. Twenty-four farmers had to run the risk that agistment might not be available when most needed. In wet years (such as those between 1946 and 1956) when dryland farming was fairly successful, dairyfarmers on the Swan Hill Flats had no trouble in finding dryland agistment. However, in a drier year like 1957, it was more difficult to find, although there was a correspondingly lower need for it.

According to several farmers, an additional merit in agisting young replacement stock away from the irrigated Flats was that this encouraged better animal development, provided feed was good enough to maintain continuous growth. This tends to support the theory advanced in Part I that a better use of irrigated land can be achieved if stock are first bred on unirrigated lands and then brought on to the irrigated lands at a stage from which they can begin to make the most effective use of high-priced irrigated feed.[42] However, this may apply more to beef raising than to dairying.

Some of the nine farmers who owned dry country had an advantage over other dairyfarmers in that they could use it to grow cash cereal crops and, in some cases, to run a sheep enterprise as well. In several instances, the dry country had been acquired expressly to allow greater incomes than could be derived by specialist dairying. Even though the dryland enterprise was risky, it provided a cheaper sources of additional income than the alternative of acquiring more high-priced irrigation land for an increase in the scale of dairying. Ownership of the dry country also provided a more assured and cheaper source of supplementary grains regularly required for pig raising. This was important because the fortunes of the pig-raising industry on the Swan Hill Flats were closely geared to the availability and cost of grains considered in relation to the profitability of raising pigs for bacon instead of pork. "On-farm" integration had similar advantages for the stud producers who found it economic to buy relatively large quantities of grains and hay for feeding to dairy stock.

Some dairyfarmers claimed that agistment of stock off the irrigated land during the winter months allowed it to recover better from intensive irrigation and grazing during the spring to autum period and gave the dairyfarmer more chance to attend to necessary maintenance work in the winter.

[41] These stocking rates were computed on the assumption that an acre of permanent pasture was equal to 2 acres of annual pasture.

[42] See J. Rutherford, this *Review*, Vol. 26, No. 4 (December, 1958), p. 246.

It was suggested to the writer by several extension officers based on Swan Hill that local dairyfarmers had considerable scope for improving the level of productivity of their irrigated land by better management. According to this view, the trend towards use of dry country reflected the farmer's preference for taking an "easier" course. Comparisons between the 33 farmers interviewed tended to support the view that many of them could attain higher levels of production with more careful attention to the management of irrigated land. In the time available it was not possible to ascertain the relative economic merits of this compared with the more common course of developing integration with surrounding dryland areas. However, it is worth noting that most of the nine farmers who owned their own dry country claimed that they could grow necessary supplementary feed on their Mallee land more economically than by attempting to build up feed supplies from irrigation land. In addition, they claimed that it was not possible for them to produce necessary "hard" feeds on their irrigation land.

A number of conditions have hindered the development of "on-farm" integration as it affects the dairying industry on the Swan Hill Flats. Of the farmers who had agisted stock on dry country four did so for the first time during the wet conditions of 1956 but they were normally averse to the practice. In one case, the farmer preferred to put his stock on other irrigated farms. In two cases, the dairyfarmers were operating large properties that were relatively lightly stocked and they were not pressed to look for agistment away from the Flats. Another farmer expressed opposition to stock agistment because of the poor fences in the Mallee which allowed uncontrolled movement and breeding of stock.

Six farmers had never agisted dairy stock away from the irrigated Flats. In three instances, they were breeding stud stock and were opposed to agistment because of the risk of uncontrolled breeding in cereal growing areas where dryland farmers had not developed good fences. Another dairyfarmer supplied wholemilk to Swan Hill and kept milking the year round.

Table X sets out various factors mentioned by the 33 dairyfarmers as inhibiting "on-farm" integration. The following are brief elaborations of the major points raised.

(*i*) *Availability of Dryland*

For various reasons, some irrigators had found difficulty in acquiring dryland. Between 1946 and 1956, good seasons for wheat growing and stock raising in unirrigated Mallee country had made many dry farmers reluctant to sell blocks to irrigators. Land offered for sale was either too expensive or in lots too large for the irrigator. Dairyfarmers also had to face the problem of distance between irrigated and dryland blocks. Country close to Swan Hill was in keen demand both by irrigators and dry farmers because of the advantages of living close to a major urban centre. Hence, many dairyfarmers, in attempting to develop "on-farm" integration by acquiring dry blocks, had to go further afield than was desirable. A further difficulty was a lack of capital for land purchase which aggravated the impact of rising land values in non-irrigated areas.

TABLE X

Farmers' Opinions on Problems of Developing "On-farm" Integration

Problem	Number of Farmers Stating Problem		
	Among Those Who Owned Dry Country	Among Those Who did not Own Dry Country	All Farmers
	No.	No.	No.
1. Problems of labour and plant arising from fact that Mallee land needs to be periodically cultivated for effective management	1	2	3
2. Difficulty of securing dry country in lots small enough to meet the needs of the dairyfarmer	2	5	7
3. The "run" of good seasons to 1957 and the resultant increase in values of dry land	6	9	15
4. Difficult to secure dry land close enough to the irrigated farm for ease of management	3	4	7
5. The "run" of good seasons to 1957 made dry farmers averse to selling land	3	2	5
6. Lack of capital	1	5	6
7. Stock agistment gives problems of poor fencing in Mallee areas with uncontrolled stock movement and breeding	..	4	4
8. The pattern of land use in unirrigated areas of New South Wales made it difficult to secure agistment	..	2	2
9. Lack of river crossings made it difficult to send stock to dry areas in New South Wales	..	2	2

(ii) Problems of Managing Non-Irrigated Country

Reasons have been advanced earlier for a general preference by irrigators for using Mallee land in combination with their alluvial flats. Many farmers expressed the view that Mallee country required regular cultivation for sound management, especially to combat weeds. Some irrigators contended that it was not practicable for the average dairyfarmer to give adequate attention to this problem and carefully manage irrigated land as well. This was particularly the case on "one-man" farms. It is of interest to note that all of the nine dairyfarmers who owned unirrigated country had at least one adult male working with them as a full-time assistant (or

partner). There seems no doubt that lack of labour is an important deterrent to effective development of "on-farm" integration, especially if non-contiguous land units are involved. Closely related to this question is the fact that cultivation of Mallee land requires special machinery not of much direct value in the management of irrigation land on the Flats. Where the irrigator was interested in growing unirrigated cereal crops for sale, this problem could be met by employing a sharefarmer with plant for the cash cropping. However, where only small quantities of fodder crops were required, the problem of cropping was more formidable.

(iii) Problems of Stock Agistment

The Victorian Mallee country presented a problem of inadequate fencing for those farmers who wanted to agist stock there. This was a reflection of the aforementioned fact that most Mallee farmers have tended to concentrate more on cereal growing with sheep raising as a sideline. This has reduced the need for good fences of the type required for the raising of dairy and beef stock. Sand drifts have also reduced the effectiveness of fencing. This problem arose especially for the breeder of stud dairy stock who could not afford to allow his animals to be agisted on country where breeding was not strictly controlled.

Using the riverine plain country in New South Wales as a source of agistment presented several problems to the irrigator on the Swan Hill Flats. As mentioned earlier, this country tends to be stocked more heavily than Mallee land and farmers there rely more on sheep raising. This means that there is less "hard" feed available to the irrigator in the form of crop stubble and dryland graziers are less prone to lease agistment since they require all pasture for their own needs. A less important deterrent to movement of stock from the Swan Hill Flats into the riverine plains in New South Wales was the limited number of crossings over the Murray River.

Particularly for those farmers who only seek stock agistment, "on-farm" integration has been deterred by the production uncertainties facing dryland areas. Although reliance on irrigated land alone tends to be more labour consuming and expensive than using dryland in conjunction with irrigated land, it is preferred by some irrigators because the quality of grazing in unirrigated areas surrounding the Swan Hill Flats is subject to violent and unpredictable fluctuations. However, some irrigators had met this problem by using their dry land only as a source of long-term fodder reserves or by treating the non-irrigated enterprises as risky ventures not to be relied upon.

"Off-farm" Integration

It was shown earlier that little "off-farm" integration had developed as part of irrigated dairying on the Swan Hill Flats. This contrasts with the development of "on-farm" integration of benefit to the irrigator and with various kinds of "off-farm" integration displayed by the sheep properties discussed later in this article. Reasons for this lack of "off-farm" integration are given below.

Stock Sales and Purchases

A major reason why irrigated dairying and dryland farming were not greatly integrated through stock sales by irrigators is that most of the dairy-farmers bred dairy stock for their own use. Any stock sold from the

majority of farms were disposed of as culls for slaughter, although some of the cows sold could theoretically have been purchased by dry farmers for breeding vealers. However, as most stock bred on the Swan Hill Flats were Jerseys and other typical dairy breeds, they had a limited value in this context. Similarily, most of the dairyfarmers running pigs concentrated on breeding porkers and baconers for slaughter and sold few stores that could find their way into dry farming areas.

The raising of pigs as a sideline to cereal growing and sheep raising has developed on many Mallee farms in recent years. In good seasons such as those from 1946 to 1956, most of the dryland farmers were able to sell the progeny as fats for slaughter. However, in poorer years, such as 1957, many pigs had to be sold as stores and some of these were absorbed by irrigators on the Swan Hill Flats. This applied particularly to the dairyfarmer with limited labour who preferred to buy stores for fattening rather than breed his own stock. However, the number of pigs that could be absorbed from dryland areas was small and made only a minor contribution to the economy of dryland farming. None of the 33 dairyfarmers interviewed in the Swan Hill district was interested in buying dairy or beef stock from dryland regions.

The general autonomy of dairying on the Swan Hill Flats greatly inhibited the contribution that the area made to the stability of production in dryland areas by means of providing agistment facilities. Even where it might have been economic to do so, few of the dairyfarmers expressed interest in adjusting their stocking programmes to cater for the needs of dryland farmers in periods of emergency. Theoretically, in a period of deep and prolonged drought when the demand for agistment is high, it might pay a dairyman to sell his herd and engage in stock agistment. However, because of the high costs of dairying under irrigation and an interest in long-term maximisation of yields per cow and per irrigated acre, *the average dairyfarmer is forced to devote his attentions almost exclusively to his own dairying enterprise and he is not concerned with adopting a more flexible programme to cater for the needs of the dryland farmer.*

Feed Sales and Purchases

Production on the 33 dairyfarms studied in the Swan Hill district was geared fundamentally to irrigated improved pasture with peak output in the spring to autumn period. With copious water rights and highly improved pastures, there was little call for feedstuffs from outside sources except by the minority of stud producers. Most farmers running "grade" cows bought small quanties of supplements (indirectly from dryland areas) but these did not make a major contribution to production there. Where the farmer was producing cream for butter, he generally regarded supplementary feeding as of doubtful economic value ; its merit lay mainly in "keeping stock quiet in the bails during milking". However, as indicated in Table XI, purchased supplements were valued by a minority of farmers for other reasons. On some farms supplements provided a means of filling gaps in pasture growth in the winter months or when pastures were being irrigated.

For some stud producers, the purchase of relatively large quantities of "hard" feeds from dryland areas (cereal grains and hay) was regarded as economically worthwhile because the producer aimed to maximise the production performance of his stock even at high costs as this led to higher

returns from stud stock sold to other farms in Australia. However, although stud production is fairly important in the Swan Hill district compared with other dairying areas, it is a minor element of the local dairying industry and the feed absorbed by local stud producers does not constitute a vital contribution to the income of the dryland farmers who produce it.

Apart from the price obtained for different classes of pigs, a major factor affecting the economy of pig raising is the price and availability of grains from dryland areas. The Swan Hill district is better-placed than some other dairying areas because of its close proximity to the Mallee—one of Victoria's leading cereal growing areas. However, purchased grains only supplement local milk production and the volume of this feed absorbed from dryland areas is not great enough to materially alter the market outlook for cereal growers there.

In theory, a district like Swan Hill, with its copious water supplies should be in a position to grow feed for use by dryland farmers. Especially with better management of irrigated land, a spring flush of irrigated pastures occurs in most years which is not absorbed entirely on the farm. However, there were several reasons why the production of feed for sale to dryland farmers was not very general on the Swan Hill Flats. These were:—

(i) There was an *irregular demand* for feed by dryland farmers. Before 1957, the last serious drought which led to a heavy demand for feed was in 1945, although a frequent series of droughts occurred between 1938 and 1945.

(ii) The *cost of fodder conservation* on irrigation farms was high.

TABLE XI

Swan Hill Dairyfarmers' Attitudes Towards Feed Purchases for Dairy Stock

Value	Number of Farmers Giving this Opinion
Cheaper to buy oaten hay then grow own irrigated pasture hay for winter feeding	4
Small quantities of purchased supplements keep cows quiet whilst milking	10
Increase carrying capacity on small farms	5
Fills in gaps in pasture growth in winter and whilst irrigating ..	13
Greatly improved efficiency of stud production	3
Facilitates production of high-quality cream	1
Helps control of bloat	2
No value	7

(iii) There was *limited labour* available on most dairyfarms which meant that attention had to be focussed on conserving fodder for on-farm use. With good water supplies, most of the dairyfarmers aimed to conserve only enough fodder to meet the needs of the following winter.

(iv) The *prevalence of small "family" farms* on the Swan Hill Flats encouraged an autonomous system of production and such farms are a direct product of State-sponsored closer settlement.

6. INTEGRATION AND IRRIGATED FARMING IN TRAGOWEL PLAINS, CALIVIL, AND BOORT DISTRICTS (VICTORIA)

During 1957 a detailed survey was made of 45 farms in the Tragowel Plains, Calivil, and Boort Irrigation districts of Victoria (see Fig. 8). These were selected as an approximate ten per cent. random sample of the farms in these irrigation districts revealed from a study of records of the State Rivers and Water Supply Commission.[43]

To a large extent, the farmland in these three districts has not been subject to State-sponsored closer settlement, although improved water supplies for irrigation have encouraged greater intensity of land use than could persist with rainfall alone (see pp. 212). The Boort and Tragowel Plains districts have a very long history of irrigation, one of the oldest in Australia. Between 1880 and 1900, much of the present-day Tragowel Plains and Boort Irrigation districts formed parts of Trusts developed in northern Victoria as a result of State legislation passed in 1886. In those days, irrigation depended on relatively unreliable supplies from the Loddon River, the most westerly stream in northern Victoria to empty into the Murray River. The Loddon has never proved suited to large-scale water conservation because of a relatively low and highly variable run-off from its catchment.[44]

Since the control of water conservation and irrigation in Victoria was vested in the State Rivers and Water Supply Commission in 1905, the Loddon Valley has come gradually to benefit from supplies from the giant Goulburn Irrigation System, based on Victoria's finest stream, the Goulburn River in the east. This is now controlled by the Eildon Weir which is the largest structure of its kind in Australia. Water supply reaches the Loddon Valley by means of the Waranga Western Channel, being diverted from the Goulburn River at Goulburn Weir and through the Waranga Basin. The Calivil Irrigation district (and the Dingee district south of it) were developed after 1913, *i.e.*, after the change-over to the Goulburn River as the major source of water supply.

Whilst some State-sponsored closer settlement occurred in the Calivil Irrigation district after 1928 (and to a lesser extent in the Tragowel Plains district in the same period) the major role of irrigation in the three districts under discussion has been to provide facilities for pre-existing dryland

[43] *i.e.*, separate farms, not individual holdings in cases where several holdings were operated by the same farmer. Although steps were taken to avoid it, the sample may be biassed to some degree in favour of larger properties. To this extent, the discussion of these three districts may over-emphasise the significance of wool type properties and their pattern of integration.

[44] The recently erected Cairn Curran reservoir has improved water supplies in the Loddon Valley.

farming. Prior to 1850, the lands covered by these districts were taken up by "squatters" for sheep raising on an extensive scale. With the closer settlement of the northern plains of Victoria for wheat growing after 1860, much of this country became subdivided into 320 to 640 acre blocks, for monocultural wheat growing. A run of droughts in the late 1870's and early 1880's resulted in pressure for better water supplies and this culminated in the formation of various Trusts to achieve this end. These were State approved, but locally elected, bodies which relied on State financial aid, particularly for the erection of "National Headworks". Much of the present irrigation works in the Tragowel Plains and Boort districts have been grafted onto, or have grown from, works carried out by these early Trusts. Water supplies have always been on a relatively "extensive" basis and for many years the three districts have had a *pro rata* water right allocation of 1 in 5.[45] Thus, a typical system of "partial" irrigation has been in vogue. In essence, this system can be likened to that developed at a much later date in the southern Riverina of New South Wales in the Berriquin, Denimein, Deniboota, and Wakool Irrigation districts. One important difference between the two States is that pre-irrigation settlement was more intensive in Victoria than it was in New South Wales. Farms have always tended to be smaller during the phase of irrigation in the former State than in the latter State.[46] In parts of the Calivil Irrigation district, some closer settlement for dairying was deliberately encouraged by the allocation of relatively good water supplies in the form of the basic 1 in 5 water right plus a liberal "sales quota".

"On-farm" Integration of Land Resources

Land Resources

Table XII sets out the areas of the forty-five farms surveyed in the Tragowel Plains, Calivil and Boort Irrigation Districts and indicates how they were used in 1957. In six cases, the total farm area embraced lands outside the irrigation district. Although the average total farm area was 1,410 acres, there was a very wide range of from 113 acres to 14,850 acres. Thus the pattern of farm size was very different to that encountered on the Swan Hill Flats and described earlier. This contract reflects differences in the abundance of water supplies for irrigation and the consequent pattern of land use. The three districts under review contain no intensive dairying of the kind encountered on the Swan Hill Flats. Most of the land is used for relatively extensive sheep raising; a declining dairying industry occurs with farming on a scale much more extensive than that typical of closer settlements like Swan Hill. This is the result of poorer water supplies, a greater dependence on the autumn to spring production cycle and economic conditions that have given sheep raising an advantage over dairying.

[45] Because of the erection of the Cairn Curran and New Eildon Weirs and when channels have been enlarged, these three districts will enjoy a water right of 1 in 3. (See pp. 172.)

[46] Increases in property size have occurred in these areas as a result of seasonal and economic adversity particularly in the 1870's, 1880's and 1930's. Thus the average farm is much larger than that which was developed for wheat growing with 320 acres the basic unit of initial closer settlement.

TABLE XII

Farm Size and Land Use for 45 Sample Properties—Tragowel Plains, Calivil, and Boort Irrigation Districts, 1957

Farm Number	A. Land Resources Wholly or Partly in Irrigation District*							B. Dry Land Resources Outside Irrigation District			Grand Total Area
	Total Area	Irrigated Land					Non-irrigated Land	Fodder Crops	Commercial Crops	"Natural" Pasture, etc.	
		Improved Permanent Pasture	Improved Annual Pasture	"Natural" Pasture	Fodder Crops	Commercial Crops, etc.					
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
1	113	..	25	12	..	..	76	30	150	1,800	2,093
2	260	..	40	30	..	..	190	..	..	..	260
3	262	60	173	20	8	..	1	..	..	..	262
4	300	145	133	..	20	..	2	..	..	..	300
5	320	..	..	40	..	..	280	..	..	..	320
6	320	85	65	..	30	..	140	..	..	..	320
7	322	20	..	50	..	..	252	..	..	..	322
8	328	..	188	..	50	..	90	..	..	..	328
9	418	30	307	..	..	..	81	..	..	..	418
10	447	20	320	100	..	..	7	..	..	..	447
11	470	75	120	162	110	..	3	..	..	..	470
12	506	70	120	..	120	..	196	..	..	..	506
13	526	..	150	183	30	45	118	..	..	..	526
14	575	..	250	188	..	..	137	..	..	..	575
15	600	..	180	393	..	..	27	..	..	..	600

* Within or contiguous with the irrigated district.

TABLE XII—*continued.*

Farm Size and Land Use for 45 Sample Properties—Tragowel Plains, Calivil, and Boort Irrigation Districts, 1957

Farm Number	A. Land Resources Wholly or Partly in Irrigation District*							B. Dry Land Resources Outside Irrigation District			Grand Total Area
	Total Area	Irrigated Land					Non-irrigated Land	Fodder Crops	Commercial Crops	"Natural" Pasture, etc.	
		Improved Permanent Pasture	Improved Annual Pasture	"Natural" Pasture	Fodder Crops	Commercial Crops, etc.					
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
16	610	25	300	150	60	..	75	..	..	..	610
17	614	..	200	..	80	..	334	..	..	..	614
18	620	25	150	..	50	25	370	..	..	..	620
19	623	25	415	..	..	..	183	..	..	..	623
20	640	..	250	200	170	..	20	..	..	..	640
21	700	5	150	250	..	..	295	..	..	..	700
22	950	60	300	145	..	..	445	..	..	..	950
23	974	89	360	522	..	..	3	..	..	..	974
24	985	15	20	..	..	..	950	..	..	..	985
25	1,000	50	70	100	..	120	660	..	..	..	1,000
26	1,140	20	730	236	..	..	154	..	900	6,000	8,040
27	1,140	..	150	450	55	385	100	..	..	..	1,140
28	1,170	20	800	..	100	..	250	..	..	1,197	2,367
29	1,197	16	484	100	100	..	497	..	..	..	1,197
30	1,236	52	150	70	..	..	964	..	..	..	1,236

* Within or contiguous with the irrigated district.

TABLE XII—*continued.*

Farm Size and Land Use for 45 Sample Properties—Tragowel Plains, Calivil, and Boort Irrigation Districts, 1957

Farm Number	A. Land Resources Wholly or Partly in Irrigation District*							B. Dry Land Resources Outside Irrigation District			Grand Total Area
	Total Area	Irrigated Land					Non-irrigated Land	Fodder Crops	Commercial Crops	"Natural" Pasture, etc.	
		Improved Permanent Pasture	Improved Annual Pasture	"Natural" Pasture	Fodder Crops	Commercial Crops, etc.					
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
31	1,244	30	130	140	260	..	684	..	..	..	1,244
32	1,250	50	350	50	..	..	800	..	..	1,150	2,400
33	1,400	10	100	300	60	20	910	..	..	..	1,400
34	1,680	..	580	..	55	160	885	..	..	..	1,680
35	1,700	..	130	400	..	200	970	..	..	..	1,700
36	1,743	..	150	300	85	..	1,208	..	..	..	1,743
37	1,800	..	..	..	..	..	1,800	..	..	..	1,800
38	1,890	..	380	30	..	..	1,480	..	..	..	1,890
39	1,932	20	600	690	..	..	622	..	600	460	2,992
40	2,000	30	300	..	240	..	1,430	1,000	..	1,500	4,500
41	2,000	40	260	260	..	..	1,440	..	..	..	2,000
42	2,600	..	120	..	..	..	2,480	..	..	..	2,600
43	3,200	..	100	325	20	..	2,755	..	..	..	3,200
44	4,800	..	1,580	..	256	..	2,964	..	..	..	4,800
45	14,850	†	†	†	†	†	†	†	†	†	14,850
Average	1,410	..	..	..	..	..	..	..	..	..	1,740

* Within or contiguous with the irrigation districts.

† Because of its unusual size, this property is readily identifiable. Therefore details of its land use cannot be published.

TABLE XIII

*The Pattern of Farm Sizes for 45 Properties Tragowel Plains, Calivil and Boort Irrigation Districts 1957**

Size Group	Number of Farms
Acres	
Less than 250	1
250—499	10
500—749	10
750—999	3
1,000—1,249	7
1,250—1,499	2
1,500—1,749	3
1,750—1,999	3
2,000—3,999	4
4,000 or more	2
Average size	1,410 acres.
Smallest size	113 acres.
Largest size	14,850 acres.

* These figures refer only to the land within or contiguous with the irrigation districts. As shown in Table XII, six graziers had land outside the district as well.

The types of pastures and crops irrigated on the forty-five farms in the "partial" irrigation districts is directly explained by the conditions of water supply.[47] Although twenty-six properties (57.7 per cent) had some irrigated permanent pasture of the kind popular on the Swan Hill Flats, only relatively small areas were involved. There was an expected association between the development of this pasture type and the kind of stock enterprise.[48] Irrigated permanent pasture occurred on seven dairyfarms (100 per cent of this type studied), eleven fat lamb farms (91.7 per cent), and fourteen wool growing farms (53.8 per cent). Water supplies in the three districts are geared to an emphasis on irrigation in the autumn and spring months, a pattern typical of the irrigated sheep raising areas of south-eastern Australia. Hence, even dairyfarms in these areas tend to irrigate during the cooler seasons and avoid much development of summer-growing pastures, any large promotion of which would require copious waterings beyond the capacity of these irrigation projects. Nevertheless, most farmers in the "partial" irrigation districts aim to grow some green feed in summer to provide a "green pick" for stock when winter-growing pastures have dried off, particularly for weaner lambs and rams. Some of the graziers stated that they had increased their acreage of irrigated permanent pasture so as to reduce their dependence on the autumn months when water is keenly demanded for annual pastures and problems of water shortage are more likely to embarrass production.

Irrigated annual pastures (notably Subterranean clover and Wimmera Rye grass) were developed on forty-two (93.3 per cent) of the farms studied in the Tragowel Plains, Calivil, and Boort Irrigation districts. They provided the mainstay of grazing on all the farms. These pastures are well-

[47] One property was nominally in the Calivil District but had no water right or irrigated land.

[48] See p. 207 for definition of stock enterprises.

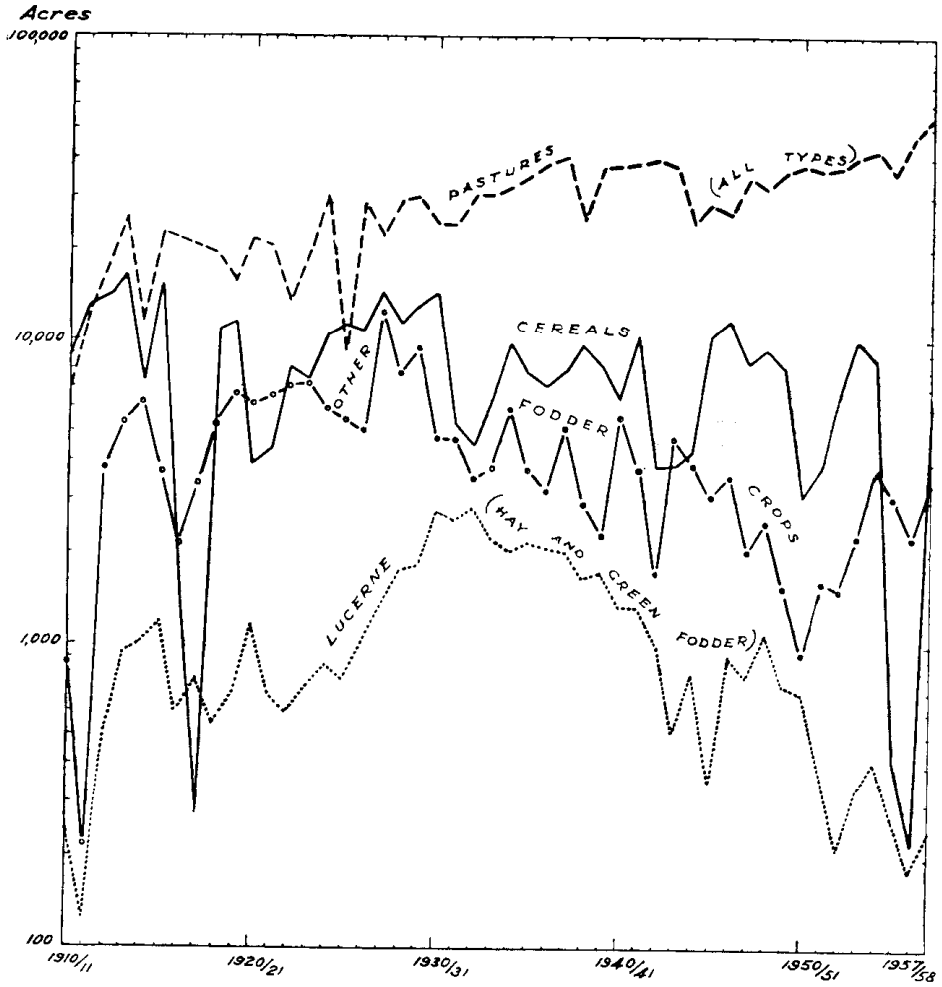


Fig. 11—Trends in Areas Watered in Tragowel Plains Irrigation District 1910-11 to 1957-58. Note how irrigated pastures have replaced an earlier emphasis on fodder crops, cereals, and lucerne.

suited to the Mediterranean environment here and their development under irrigation has extended and improved the plane of nutrition of a grazing industry geared to an autumn-winter-spring rainfall cycle. Similar pastures have been developed inland of the highlands in south-eastern Australia, mainly in regions with more than 17 inches average annual rainfall. However, irrigators have an advantage over non-irrigators because lush pasture growth and lambing can be started earlier and prolonged later in the season and fattening of stock achieved more surely and rapidly.

Irrigation of so-called "native" pastures was common practice in most of the older "partial" irrigation districts, especially from the early stages of development to the late 1920's when a "pasture revolution" with improved species first began in earnest.[49] Fairly large areas of watered "native" pastures still occur in districts like those under review, where farmers have

[49] The so-called "native" pastures are usually not composed entirely of plant species native to the area. However, whilst they are often improved by periodical cultivation, the pastures are distinguished from "improved" pastures mainly by the fact that they have not been sown and are not topdressed.

tended to be slower in adopting improved methods, partly because they have been hindered by poorer soils and water supply. Thirty of the forty-five farms surveyed had some irrigated "native" pastures. Generally these were watered in a very crude fashion and often only with water left over after improved pastures had been irrigated.

The growing of fodder crops is a fairly common if declining feature of the "partial" irrigation districts, as indicated in Table XII, which shows that twenty-two (48.8 per cent) of the farms studied were irrigating fodder crops. The main crops watered were oats and barley and lesser crops were Japanese millet, lucerne, and grain sorghum. Eight farmers were irrigating cash crops, mainly oats and barley, but one farmer grew Sunflowers (for seed) and Field Peas. Whilst the autumn fallow irrigation of wheat has increased along the Waranga Western Channel to the west of the Boort Irrigation District, it is fairly rare in the three irrigation districts under review, mainly because their Grey and Brown soils of Heavy Texture do not lend themselves as well to the crop as do lighter Mallee soils further west. These soils are naturally better suited to barley and oats which were commonly grown in earlier years.

It should not be inferred from Table XII that the areas irrigated on the forty-five farms were as stable as the irrigated areas of the dairyfarms in the Swan Hill District. The irrigation of "native" pastures and fodder crops (particularly if grown in the cooler months) is purely supplementary to the rainfall and may not be carried out in years of normal or better rainfall. To a lesser extent, the same applies to the irrigation of improved annual pastures, although fluctuations in rainfall tend more to alter the number and depth of irrigations rather than the overall area actually watered in the year. However, some farmers tend to gamble with their water supplies by spreading it over a larger area than can be adequately watered in a dry year, when supply may be restricted closer to the water right. To this extent, the autumn-to-spring irrigation programmes in vogue in these districts tended to be much more elastic than those operating in the closer-settled fruit and dairying areas described earlier. Because cool-season irrigation tends to supplement rainfall rather than shift the emphasis of production into the seasonally hot and dry period, both the dependence on irrigation as such and the absolute size of the area watered tends to fluctuate from year to year with variations in rainfall. (See Fig. 11.)

In keeping with the system of "partial" irrigation thirty-nine of the forty-five farms studied (86.7 per cent) did not water a fluctuating proportion of their productive lands. This was mostly "native" pasture country, although small areas of unirrigated commercial crops were grown, particularly where the farmer could exploit country suited to grain crops. The latter was more common in areas like the Mallee fringe areas along the western edge of the Boort District, also on the slopes of the Terricks Range on the eastern edge of the Tragowel Plains District, and Red Brown Earth soils in the Calivil district. Every farm had some area of non-productive land occupied by buildings, channels, etc. The largest area of unwatered country occurred on the bigger holdings and was made up chiefly of country unsuited or poorly endowed for irrigation because of its unevenness, liability to flooding, or because it was not commanded from the major channels. However, on six farms much of the unwatered land was completely outside the irrigation district.

"On-farm" Integration

The survey showed that the joint use of both irrigated and unirrigated lands within the same farm unit was a characteristic and long-standing feature of the Tragowel Plains, Calivil, and Boort Irrigation districts. This contrasts sharply with the position in closer settled dairying and fruit growing areas like those described earlier. However, unlike many dairy-farmers in the Swan Hill district, few farmers (dairymen or sheep farmers alike) in the three "partial" irrigation districts had "reached out into the dry country" to develop integration.

Most graziers expressed a preference for some dry land in conjunction with irrigated land. The reasons they gave are discussed later (see pp. 212-214). As water supplies increase in these three districts, it might be expected that farmers will place more reliance on irrigated land and less reliance on unirrigated land and irrigation should be less supplementary in form. However, as later discussion shows, there is no reason to believe that this will mean a complete breakdown in "on-farm" integration so characteristic of these districts at the time of survey.[50]

The forty-five irrigators interviewed in the Loddon Valley projects were asked if they ever agisted stock on dry land outside the irrigation districts along the lines described for dairying in the Swan Hill district. They were questioned also about the value and general prevalence of this practice in their district. Only five graziers (11.1 per cent of the sample) stated that they had ever done this. They included one dairyfarmer and four sheep raisers. Opinions expressed by all graziers showed that this agistment is quite rare in these areas and there was no evidence that it would increase significantly with the changeover from 1 in 5 to 1 in 3 water rights.

In a later article in this study, a mail survey of dryland properties will be discussed and an indication given of the extent to which dryland farmers in country surroundings the three irrigation districts have made use of irrigated land in the district either by acquiring it or agisting stock on it. Viewing the matter at this stage from the standpoint of the irrigators, the following points can be made:

(i) The leasing of agistment by irrigators to other farmers was quite rare. Only four irrigators (11.8 per cent) of the thirty-four interviewed in the Tragowel Plains and Calivil districts had ever engaged in the practice.[51] One farmer had done it only more because he was short of finance but he was opposed to the practice as a rule. In one other case, an irrigator had rented to a dry farmer a dry block he owned outside the irrigation district. In the other two cases, agistment had been offered only to other irrigators affected by waterlogging problems. Advice from the irrigators interviewed emphasised that "partial" irrigation facilities in the three districts had resulted in very little agistment to dryland farmers and this had occurred only in major droughts. The opinion was expressed by many farmers that

[50] See p. 212.

[51] This practice and several others mentioned below were not discussed with irrigators interviewed in the Boort district.

little agistment would be available in any future drought and it would be limited to small numbers of stock (e.g. special lines of stud sheep warranting the payment of high prices for agistment).

(ii) It was the opinion of many of the farmers interviewed in the Tragowel Plains and Calivil districts that "on-farm" integration had developed as a result of dry farmers acquiring irrigation blocks to work in conjunction with their dry blocks. Irrigators suggested that dryland farmers had tended to acquire irrigation blocks in the more intensively settled parts where available blocks were smaller and more suited to integration. An area like Yando in the Boort district was one example of this. It was said that this practice had increased after the 1938-45 droughts but had tended to fall off as the period of good seasons extended after 1946. However, judging from the history of the farmers interviewed, this type of "on-farm" integration was not common. Only six out of thirty-four farmers interviewed in the Tragowel Plains and Calivil districts (17.6 per cent) had owned dry farms outside the irrigation districts before acquiring irrigation land as a means to greater security. Thus there is some conflict between the experience of the sample farmers and their opinions about the history of other farmers.

"Off-farm" Integration of Livestock Enterprises

Livestock Enterprises

Table XIV lists the numbers and kinds of livestock managed by the forty-five graziers interviewed in the Tragowel Plains, Calivil and Boort Irrigation districts during the 1956-57 year. The farms have been classified into types listed in this Table on the basis of the stock enterprise which gave the most gross income in that year. Seven were classified as "dairying", twelve as "fat lamb raising", and twenty-six as "fine wool growing". The distinction between the latter two was made on the basis of the type of sheep run. "Wool growing" properties were those running sheep mainly for finer wool. "Fat lamb raising" properties raised fat lambs and sold coarser wools. It will be noted that four farms classified as "wool growing" used fat lamb type rams. They could be classified more correctly as "dual purpose" properties.

It will be seen from Table XIV, that appreciable numbers of dairy stock were run on two sheep properties. Pig raising was a common sideline on most dairyfarms and most sheep properties ran a small herd of beef cattle as a sideline. However, on seven properties more than fifty head of beef were run. Beef raising has increased in popularity in most irrigated sheep areas over recent years. Very often, the chief motive in running beef has been to use the cattle as a means of controlling pasture too rank for sheep and so to improve the country for sheep. Fat lamb producers tended to keep only breeding ewes and a small percentage of rams, whereas wethers were also run on many of the wool properties. Notwithstanding the above classification of sheep properties, it should be remembered that, in

TABLE XIV

Numbers of Livestock on 45 Farms Surveyed in Tragowel Plains, Calivil, and Boort Irrigation Districts in 1957

Farm Number	Sheep						Dairy Stock		Pigs				Beef Cattle	Classification of Holding by Dominant Stock Enterprise*
	Ewes		Rams		Young Sheep	Wethers	Milkers	Non-milkers	Boars	Sows	Porkers	Young Baconers		
	Wool Type	Fat Lamb Type	Wool Type	Fat Lamb Type										
1	250	5	...	75	...	350	...	...	...	...	...	...	20	W
2	...	...	...	...	...	...	33	26	...	...	...	4	6	D
3	100	...	...	4	90	4	40	33	1	4	...	60	...	D
4	...	...	...	...	...	...	100	80	1	5	100	40	...	D
5	...	...	...	...	...	150	...	...	...	...	...	...	21	W
6	...	...	...	...	...	...	45	27	1	5	...	93	...	D
7	...	...	...	...	...	...	7	32	...	...	15	...	...	D
8	400	...	10	...	400	20	...	...	...	...	...	2	15	W
9	...	550	...	16	550	...	...	...	...	...	...	...	6	FL
10	...	240	...	5	250	...	40	80	1	8	...	100	...	D
11	300	...	3	...	250	300	...	...	...	...	...	...	50	W
12	...	...	...	...	...	...	70	40	1	6	...	90	...	D
13	150	...	5	...	80	300	...	...	...	...	...	...	16	W
14	400	...	8	...	32	600	...	...	...	...	...	...	6	W
15	600	...	12	...	800	180	...	...	...	...	...	...	6	W
16	...	600	...	18	480	...	...	...	...	...	...	...	60	FL
17	...	500	...	12	400	...	...	...	...	...	...	...	12	FL
18	550	...	...	12	520	250	...	...	...	...	...	...	4	FL
19	300	...	6	...	450	400	...	...	...	...	...	...	25	W
20	350	...	7	...	310	200	...	...	...	...	...	...	3	W
21	400	...	...	8	300	...	...	...	...	...	...	...	26	W
22	600	...	12	...	480	...	35	30	1	4	...	60	...	W
23	200	550	...	14	600	...	...	...	...	...	...	...	100	FL
24	...	300	...	6	250	100	...	...	...	...	...	3	60	FL

* Classified according to enterprise giving the greatest gross income.
D—Dairying.
FL—Fat Lamb Raising.
W—Fine Wool Growing.

TABLE XIV—*continued*

Numbers of Livestock on 45 Farms Surveyed in Tragowel Plains, Calivil, and Boort Irrigation Districts in 1957—continued

Farm Number	Sheep						Dairy Stock		Pigs				Beef Cattle	Classification of Holding by Dominant Stock Enterprise*
	Ewes		Rams		Young Sheep	Wethers	Milkers	Non-milkers	Boars	Sows	Porkers	Young Baconers		
	Wool Type	Fat Lamb Type	Wool Type	Fat Lamb Type										
25	300	...	4	...	310	...	...	...	...	...	...	...	18	W
26	1,100	...	25	...	1,300	1,000	...	...	...	...	...	...	...	W
27	1,200	...	10	...	800	...	...	...	...	...	...	...	20	W
28	1,300	...	26	...	1,127	300	...	...	...	...	...	...	41	W
29	1,000	...	34	...	660	250	...	...	...	...	...	...	25	W
30	650	...	25	...	500	500	...	...	...	...	...	...	12	W
31	...	350	...	7	300	30	...	...	1	2	20	...	25	FL
32	...	1,300	...	26	1,100	500	...	...	...	...	...	...	16	FL
33	...	900	...	20	200	...	...	...	...	...	...	...	...	FL
34	1,000	...	30	...	950	...	...	...	...	...	...	...	12	W
35	1,500	...	...	18	1,200	...	...	...	...	...	...	...	60	W
36	1,100	...	26	...	750	...	2	...	...	...	...	...	...	W
37	...	1,350	...	27	817	...	...	...	...	...	...	...	...	FL
38	950	...	20	...	800	700	...	...	...	...	...	...	...	W
39	...	1,200	...	24	960	6	30	20	...	...	...	...	11	FL
40	...	2,000	...	85	1,500	3	...	...	...	...	...	3	100	FL
41	1,000	...	20	...	900	500	...	...	...	...	...	...	40	W
42	460	300	8	6	...	800	...	...	...	...	...	...	...	W
43	700	...	70	...	560	400	...	...	...	...	...	...	80	W
44	2,500	...	110	...	200	...	...	...	...	...	...	...	300	W
45	†	†	†	†	†	†	†	†	†	†	†	†	†	W

* Classified according to enterprise giving the greatest gross income.
D—Dairying.
FL—Fat Lamb raising.
W—Fine Wool Growing.
† Details for this property cannot be published. See footnote under same symbol for Table XII.

the years immediately prior to survey, all the sheep properties earned more income from wool than from other products, because of the high wool prices ruling in those years.

There was a close relationship between the type of stock enterprise and the pattern of stock purchases. As was the case on the Swan Hill Flats, all the dairyfarmers bred their own replacement cows and were independent of other farms in this respect. Purchased replacement bulls usually came from other dairies, in irrigation districts or high rainfall areas of south-eastern Australia. Except for occasional purchases of rams and wethers, most wool properties bred their own sheep. They contrasted sharply with fat lamb producers most of whom had to buy large numbers of replacement ewes to maintain their breeding flocks. It was the custom to buy these ewes from dryland areas, particularly Merino-type country in southern New South Wales, such as the western Riverina. Reasons for this are given later. Thousands of Merino "First Cross" ewes came from the station properties of the Riverina into "special sale" at Echuca and Rochester. In dry years like 1957, the movement of replacement ewes from dryland farms onto irrigation farms may take place in two stages. In years of feed shortages, the dryfarmer may not be able to raise ewes to one and a half year olds and may have to sell them as a "special one line" to an irrigationist at six months of age. The latter may then keep the ewes until they are $1\frac{1}{2}$ years old and then sell them to other irrigationists (or dryland farmers further south) who want them as ewe replacements. Irrigation farmers in districts like Rochester with irrigated permanent pasture are in a better position than their counterparts in the Loddon Valley to practise as intermediaries between the dryland farmer and the fat-lamb raiser. Farming in the Rochester district is discussed in Section 7.

Although beef-cattle raising was not a major enterprise on most holdings, it formed a common sideline and most graziers preferred to breed their own stock rather than fatten purchased stores. Replacement cows were bought on occasions from neighbouring irrigation districts. However, two of the large beef raisers bought considerable numbers of store stock from the Alpine country of south-eastern Australia.

With regard to their purchase of stock, it can be concluded that the properties surveyed in the three "partial" irrigation districts were not greatly integrated with surrounding dryland areas. Inward movement of replacement ewes to fat-lamb farms was the major exception to this pattern. However, it seems that the purchase of breeding ewes constitutes an important source of income to dryland farmers, especially those in the semi-arid Merino country north of the Murray River. *It can be concluded that the general autonomy of stock breeding on the irrigation farms means that they contributed comparatively little to production stability in many dryland areas,* particularly cereal-growing areas like the Victorian Mallee. There appears to be a general absence of dealing in store sheep, and the "partial" irrigation districts could not be regarded as fattening zones for stock bred on dry country, as are parts of North America. Reasons for this lack of integration are given later (see pp. 216-217).

Livestock Sales

With regard to the pattern of their stock sales, the forty-five properties studied in the three "partial" irrigation districts displayed even less integration. Stock sold from the seven dairy farms (and similar enterprises on farms running dairies as sideline) were disposed of, either as fat pigs or

culled pigs and dairy stock, usually for slaughter. Similarly, beef enterprises were all geared to the sale of fats for slaughter. The production of "baby beef" was common and stock were sold chiefly in Bendigo and Melbourne. Wool properties sold cast-for-age ewes and wethers, normally as fats for slaughter (canning) and Bendigo was again the major selling point. However, several graziers sold younger ewes to fat-lamb breeders located either in local irrigation districts or in the nearby Victorian Mallee, where fat-lamb production was prevalent. Only relatively few wethers were ever sold to dryland woolgrowers. The majority of the stock sold from fat-lamb farms were fat lambs for slaughter and were sold through markets in Bendigo and Melbourne.

"Off-farm" Integration of Feeding Programmes

Sources of Feed (Home Grown and Purchased)

The grazing of irrigated pastures (especially improved annual species) supplemented by small quantities of irrigated fodder crops provided the major source of stock feed on the forty-five properties in the Tragowel Plains, Calivil, and Boort Irrigation districts. All of the farmers interviewed stated that they rarely, if ever, purchased any feed in years of average or better rainfall. However, many had bought fodder (mainly cereals) from dryland areas via storage pools during the last major drought in the mid-'forties. Since that time, the supplies of irrigation water have improved (both in volume and regularity) and there has been a development of irrigated pastures (see Fig. 11), so that the farms had become more or less autonomous in their feeding programmes by the time of survey.

Feed Sales

In theory, irrigation areas could contribute much to the stability of production in surrounding dryland areas, through sales of stock feed, especially in times of drought. However, if the forty-five properties studied in these three districts can be taken as a reliable guide to the overall position in "partial" irrigation districts, little integration of this kind has occurred. Twenty-eight of the farmers interviewed (62.2 per cent) did not sell feed at all. All of the seventeen farmers who did sell feed, disposed of only small quantities of grain to local pools or to local dairies in irrigation districts. Whilst some increase in the volume of feed sold could occur in the future, there is no reason to believe that dryland areas will benefit greatly. The management of the properties surveyed is not geared to exchanges of this kind and *most farms display a degree of autonomy akin to the closer settlement studied on the Swan Hill Flats.*

Factors Affecting the Character of Integration in the Tragowel Plans, Calivil, and Boort Irrigation Districts

After the fashion described for the Swan Hill District, an attempt was made during field interviews to assess the factors that have influenced the pattern of integration in the three "partial" irrigation districts. Conclusions derived from this study are summarised below.

"On-farm" Integration

The forty-five irrigators were questioned on the following three related problems:—

(i) How dependent was their production on irrigated land compared with the unirrigated land under their control?

(ii) What value did they place on "on-farm" integration for their systems of farming?

(iii) What effects on land use and particularly the pattern of "on-farm" integration would the projected increase in water rights have?

Although most of the irrigators had appreciable areas of unwatered country, all of them stated that they relied chiefly on irrigated land. All seven dairy farmers believed that they could not operate a commercial dairy without irrigation. All of the sheep farmers stated that "partial" irrigation had greatly reduced production uncertainties and allowed considerable increases in stocking rates compared with those possible without irrigation. Most said that irrigation had allowed them to double or treble their stocking rates and they considered that they would need from twice to three times their present acreage to make the same living. An absence of irrigation would also mean an emphasis on extensive wool growing rather than fat-lamb raising. This indicates that "partial" irrigation in the three districts is much more than a mere supplement to rainfall.

Notwithstanding their dependence on irrigated land, most of the graziers interviewed in the three districts emphasised the strategic value to them of unwatered country. The farmers' assessments of the value of dryland are summarised in Table XV. Only four farmers (8.9 per cent) said that unirrigated land was of no value to them. Given sufficient water, these farmers would attempt to irrigate all their land. A comparison between Table IX and Table XV, shows that the dairy farmers on the Swan Hill Flats and the predominantly sheep farmers in these three "partial" irrigation districts placed a different set of values on unirrigated land. This is a reflection of the differences in land use between the two regions. It was common for graziers in the "partial" irrigation districts to value dryland because it helped to control footrot, worms, and other stock diseases. In general, woolgrowers with Merino sheep seemed more impressed with the value of unirrigated land than were fat-lamb producers, but sheep farmers as a whole placed much more value on dryland than did dairy farmers. From this survey, it could not be said that dryland in the "partial" irrigation districts was an unimportant resource resulting from the inability of irrigators to obtain enough water to irrigate all their productive lands. There was ample evidence to support the view that it had a strategic role to play in effective sheep husbandry, especially when Merino-type sheep were being run.

With a gradual increase in witer supplies that will develop as a result of the changeover to 1 in 3 water rights, it might be expected that farmers will place more reliance on irrigated land and this could alter the present character of "on-farm" integration in the Loddon Valley. The 34 farmers interviewed in the Tragowel Plains and Calivil districts were questioned on the changes which could be expected as a result of better water supplies. It is clear that most of the graziers expected the better water

rights to cause an increase in the area of irrigated land and a general decline in the absolute area of unwatered land. However, there was no indication that dry land would cease to have the value expressed in Table

TABLE XV

Survey Farmers' Assessment of the Value of Dryland to the Irrigator in the Tragowel Plains, Calivil, and Boort Irrigation Districts

Value of Dryland	Number of Farmers Giving Opinion*			
	Dairy-farmers	Fat Lamb Raisers	Wool-growers	All Farmers
1. Helps control footrot, worms and other diseases	..	9	13	22
2. Provides necesssary change of diet for stock	..	5	10	15
3. To spell irrigation land in winter	2	3	9	14
4. Drier and warmer than irrigation land during winter months	1	3	2	6
5. Valuable for winter feed	..	1	4	5
6. To graze when irrigating other land	1	2	2	5
7. Necessary for Merino sheep	..	..	3	3
8. Sheep find it sweeter than irrigated land in summer	..	2	..	2
9. Lambing ewes thrive better in wet weather if dryland is grazed along with irrigated land	..	1	1	2
10. To graze stock in wet winters	..	1	1	2
11. Because of limited water right dryland necessary to boost income	1	..	1	2
12. Reduces risk of income loss if irrigated land should be flooded	..	1	..	1
13. To grow cash cereal crops	..	1	..	1
14. Encourages larger framed wethers	..	..	1	1
15. Supplies most income (cereals, etc.)	..	..	1	1
16. No comment	..	1	1	2
17. No value	2	1	1	4

* Some farmers listed more than one value.

XV. Farmers were asked: "Would you prefer to irrigate all your land at present not irrigated?" It is of interest to note that only ten (22.2 per cent) answered this question in the affirmative. To the extent that improved water rights should result in an intensification of settlement with more fat lamb raising (and dairying if the market outlook improves), farmers will probably reduce their reliance on unwatered land. This applies particularly to country now given over mainly to Merino wool production.

There were two major reasons why irrigators in the three "partial" irrigation districts were much less interested than dairyfarmers in the Swan Hill district in developing integration by acquiring dryland beyond their district (see Table XVI). Firstly, because of "partial" irrigation, it was not possible for most to water all the area of land necessary for making a reasonable income, unless the property had acquired a "sales" quota enough to greatly boost the water allocation above the *pro-rata* water right of 1 in 5. On many properties, appreciable areas were classified as non-rateable (i.e. they were not regarded by the State Rivers and Water Supply Commission as "commanded and suitable" for irrigation) so that the water right allocation applied to only a section of the total acreage.[52] In these cases, the overall effective water right was appreciably less than 1 in 5 for the whole farm. Hence, most properties in the three districts had appreciable unirrigated areas of their own and did not have the same need as the Swan Hill dairyfarmers to go beyond their own farms to use dry country. The second factor militating against this form of "on-farm" integration was the fact that land was watered less intensively than in the closely settled dairying or fruit areas. Hence, there were not the same problems of water logging, except in areas subject to flooding. In the discussion of the Swan Hill dairying settlement, it was noted that high land values and a tendency for unwatered land to become "salted" were two reasons why most of the productive land on the Flats was heavily watered. Neither of these conditions operated in the three "partial" irrigation districts under review. With much more extensive settlement, there is not the same pressure to irrigate land, although this will tend to increase with increased water supplies. Of course, the varied character of the soils and terrain also means that much of the country was not particularly amenable to irrigation, especially areas liable to inundation from streams and heavy soils with a relative high "salting" hazard. An additional factor militating against the agistment of stock beyond the irrigation districts was the relatively long distances that would have to be traversed to find suitable ground. The close proximity of Mallee and alluvial flats was in favour of "on-farm" integration in the dairying industry at Swan Hill. However, many of the farms in the Tragowel Plains, Calivil, and Boort Irrigation districts are relatively remote from suitable Mallee-type country. This is particularly the case for farms east of the Loddon River.

[52] This arises partly because some lands were not physically suited to irrigation. However, it is due also to the fact that, when the assessment of commanded and suitable land was made early in the history of the irrigation districts, a deliberately conservative estimate was made in order to reduce the water right allocation (and therefore, the compulsory charge for water) applicable to landholders who were then not particularly enthusiastic about irrigation.

Most of the farmers interviewed in the three "partial" irrigation districts expressed the view that *it was not possible for landholders in such projects to assist dryland farmers to any extent by providing agistment facilities in times of drought.* The following reasons were given for this:—

(i) Because of low water rights, irrigators had to concentrate on their own feed programmes and could not afford to cater for the needs of others less fortunately placed. "Partial" irrigation had not permitted appreciable areas of irrigated summer feed to be grown and it was in the hot months of the year that the dryland farmer wanted assistance most.

(ii) Seasonal and economic conditions between 1946 and 1956 had reduced both the need and scope for stock agistment from dryland areas because:—

(*a*) during this period, seasonal conditions had been conducive to successful stock production on dryland farms,

TABLE XVI

*Survey Farmers' Opinions of Value of Agisting Their Stock on Dryland Beyond Irrigation District**

Merit	Numbers of Farmers with This View			
	Dairy-farmers	Fat Lamb Raisers	Wool-growers	All Farmers
	No.	No.	No.	No.
A. Favouring Agistment				
To avoid flooded land	..	1	..	1
To rest irrigation land	..	..	1	1
To spread risks of farming	..	1	..	1
B. Against Agistment				
Adequate dry land already	2	2	8	12
Too difficult to supervise stock on dry land	1	2	2	5
Irrigation land does not get wet enough ..	3	..	3	6
Lack of finance	1	..	..	1
Production uncertainty in dryland areas ..	..	..	..	1
No opinion	..	4	2	6

* Thirty-four irrigators in the Tragowel Plains and Calivil Irrigation districts.

(*b*) high prices for wool and sheep meats had encouraged irrigators to greatly increase their breeding programmes and this had greatly reduced their ability to take in stock from other areas, except replacement ewes for their own flocks.

(iii) The demand by dryland farmers for agistment was every erratic and infrequent over the long term, so irrigators had little incentive to consider it seriously when planning their own programmes.

In the past, a major deterrent to more active integration with surrounding dryland areas has been the relatively poor water supplies enjoyed by irrigators in many "partial" irrigation districts. During the last major droughts between 1938 and 1945, many irrigators were short of water for irrigation and had to struggle to cater for their own needs, let alone assist other farmers. Improved water deliveries since then and more to come in the future should reduce this problem in any coming drought of the same dimensions. However, because of the marked development of irrigated pastures in these districts during the last 20 years, much of it based on "sales" water not guaranteed in times of drought, it seems that irrigators might still be unable to assist drought striken areas, should the need arise.

It was mentioned earlier that some dryland farmers had acquired blocks in the three "partial" irrigation districts, especially after the 1945 drought. A study of the farming experience of the farmers interviewed did not suggest that the practice was very general. Nevertheless, there is undoubtedly scope for more integration of this kind, especially for dryland farms close to the irrigation projects. Although low water rights in the three districts under review reduce the value of irrigation land here, there is the advantage that the land is cheaper than it is in districts with high water rights.

"On-farm" Integration

The major factor affecting the pattern of stock purchases by irrigation was the type of stock enterprise they ran. Another factor was size of property. The reasons for lack of stock purchases by the seven dairy-farmers are similar to those given for farms on the Swan Hill Flats (see p. 196). On most sheep properties, beef raising was a minor sideline and irrigators did not engage in the large-scale fattening of purchased stores so prevalent in parts of the United States. With small enterprises and fluctuations in the price of stores and fats, they preferred to breed their own beef, with the exception of two graziers who found it profitable to buy large numbers of stores from Alpine areas. They were located on river frontage country near the Loddon River where large beef herds were of considerable value in using coarse growth of natural pastures.

The relative emphasis on wool growing as opposed to fat lamb breeding was the major factor affecting the character of stock purchases. Where the irrigator ran Merino type stock for finer wools, he tended to breed his own line of stock, buying only occasional stud rams (usually for local irrigation studs) and wethers. Occasionally ewes were also bought to maintain a satisfactory line of stock. It was usual for dryland areas, such as the semi-arid country of the Riverina and Western Division of New South Wales and upland areas of Victoria, to supply wethers and ewes to the

irrigators, because these dryland areas were running comparable lines of stock. However, the numbers of stock sold to the irrigators were small. As a rule, most stock were bought in this way by the graziers with small farms because they were less able to breed their own replacements.

Except for several large properties able to breed their own replacements, most fat lamb producers relied heavily on the regular purchase of replacement ewes. As a general rule they preferred "First Cross" Merino stock from drier country in the Riverina districts of New South Wales. Stock from irrigation areas were avoided because they were not the right type and were more subject to disease. Dryland cereal growing areas were not favoured either as a source of ewes because they mostly ran crossbred stock which did not meet the irrigators' requirements. "First Cross" Merino ewes were favoured because of their excellent constitution, freedom from disease, and good mothering qualities. As a rule, irrigators tended to prefer young ewes (about 18 months) although older cast-for-age ewes (about four to five years) were often bought if younger ones were in short supply. Some irrigators expressed the view that older ewes stood up better to irrigation conditions.

It was evident during the survey of the Tragowel Plains, Calivil, and Boort Irrigation Districts that stock breeding there was fairly autonomous. With the exception of an inward movement of breeding ewes, it was independent of dryland areas. With the long swings in seasonal conditions, especially the run of good seasons after 1945, irrigators did not favour fattening purchased stores. Their limited irrigation supplies tended to restrict stock fattening to the autumn and spring months, so they were encouraged to concentrate on their own self-contained breeding programmes. By 1957, irrigators in these "partial" irrigation districts were not in a position to absorb many drought-affected stock from dryland areas. To the extent that stocking rates are now much higher in dryland areas than they were in the period 1938 to 1945, it seems that non-irrigated areas are more vulnerable to drought than they were then, especially as "partial" irrigation districts seem less able to help them.

The general lack of integration with dryland areas through stock sales was due to two factors:—

(i) The almost universal reliance of the irrigator on fattening stock for slaughter, and

(ii) The apparent opposition of dryland graziers to buying stock from irrigation districts, because it was alleged they were associated with a high incidence of disease (*e.g.*, footrot, worms, and fluke). This opposition to irrigation stock tended to come from dryland areas with as much or less average annual rainfall as the irrigation districts, *i.e.*, from the Mallee and Riverina areas. Dryland graziers in higher rainfall districts, such as the Victorian uplands, were not so averse to buying irrigation stock, probably because their country was more prone to similar disease problems.

We have noted earlier that few of the irrigators in the three "partial" irrigation districts ever sold feed to dryland farmers. With the gradual increase in water allocations to these districts some increase in feed sales might occur, although experience gained in a high water-right project like the Rochester Irrigation District (see p. 228) suggests that the increase

in feed sales will not be great. Table XVII summarises the attitudes towards feed sales expressed by irrigators in the Tragowel Plains and Calivil districts. The most commonly expressed reason for not selling feed was that the irrigator, in the face of erratic demands from dryland areas and limited water supplies, was forced to concentrate on growing feed for his own use. Given a recurrence of the sequence of seasons that occurred prior to 1946, a decline in stocking rates on irrigation farms and an increase in feed sales to dryland areas could occur although some irrigators seemed inclined to the view that "it would pay them best to buy stores and fatten them rather than sell feed".

With an emphasis on the irrigation of annual pastures, the irrigator tends to favour his own breeding flock and is not in a position to carry addition stock from dryland areas in the warmer months when the latter are most affected by lack of rain.

TABLE XVII

*Reasons for Survey Farmers' Opposition to Selling Feed to Dryfarmers**

Reasons	Number of Irrigators
Low water rights and heavy stocking on irrigation farms allow little feed surpluses	13
Erratic demands for feed from dryland areas	11
The decline in cereal growing under irrigation has resulted in a decline in feed for sale	3
If it pays to sell feed then it pays more to buy stores and fatten them	2
Selling feed is not an economic proposition	2
Irrigator has no facilities for storing feed over-and-above his own needs	1
Slow development of machinery for fodder conservation on irrigation farms	1

* Views expressed by 33 irrigators in the Tragowel Plains and Calivil Irrigation Districts.

7. INTEGRATION AND IRRIGATED SHEEP RAISING IN THE ROCHESTER DISTRICT (VICTORIA)

During the early part of 1958, a detailed survey was made of 21 irrigation farms in the Rochester Irrigation District of Victoria (see Fig. 8). From records held by the local office of the State Rivers and Water Supply Commission, a list was compiled of properties in this district which had appreciable areas of irrigated permanent pastures and/or lucerne and were known to derive 50 per cent or more of their gross income from sheep raising. This list showed that there were 24 properties of this type in the district. Of these, 21 were visited, 3 being inaccessible during the period of survey. The sample can be regarded as a reliable guide to the farm conditions on the group of properties from which it was selected.

Unlike the three "partial" irrigation districts described above, the Rochester Irrigation District was subject to considerable closer settlement, much of it State-controlled, especially in the period from 1910 to 1925. By these means, a closely knit dairying community was established, along the lines described for the Swan Hill district with emphasis on localities such as Nanneella, Ballandella, Bamawm, Bamawm Extension, and Lockington. These were granted copious water rights as happened at Swan Hill and were fed with water from the Waranga Western Main Channel which skirts the southern boundary of the Rochester District enroute westward from the Goulburn River. Pockets of citrus and other tree fruit production were established by closer settlement in the more elevated sections of these districts during the early phase of expansion for dairying. However, fruit-growing has tended to decline as physical conditions have proved unsuitable.

Outside the "islands" of closer settlement in the Rochester District, especially in a fan to the west, north and east of them, pre-irrigation holdings benefited by a system of "partial" irrigation. Irrigation had developed to some extent in these areas before the phase of closer settlement, but it became much more active as State control over development was exercised. Whilst the sheep properties around the "islands" of closer settlement (dairying and fruit growing) have enjoyed better *pro rata* water rights (1 in 1) in recent years, compared with farmers in lesser watered areas like those aleady described in the Loddon Valley, the system of irrigation can be termed "partial". Because some areas on most properties were not originally assessed as "commanded and suitable" for irrigation, the effective water right operating on most sheep properties has been 1 in 3, *i.e.*, about one-third of each holding has had the *pro rata* water right applied to it.[53] Nevertheless, water supplies have been more copious than in a district like Berriquin operating on an overall 1 in 3 water-right allocation.

The 21 properties surveyed are not representative of sheep properties as a whole in the Rochester District. For the most part, they occur within or close to the intensively settled dairying areas and many of them were once dairyfarms. As a result, most of the sheep properties have a water right better than 1 in 3 and the ratio of irrigated to unirrigated land is much higher than on the average sheep property in the Rochester District. Therefore, the surveyed properties can be regarded as benefiting from "intensive" irrigation by contrast to the system of "partial" irrigation described for the Tragowel Plains, Calivil, and Boort Districts, a system which also operates in many other districts like Berriquin, Wakool, Denimein, and Deniboota in New South Wales.

Although it occupies the lower end of the Campaspe Valley, the Rochester Irrigation District depends chiefly on the Goulburn Irrigation System for its water supplies. Like the Loddon, the Campaspe River with a low and unreliable run off has not been exploited for major irrigation works as has the Goulburn River. The Campaspe Valley has had an agricultural history similar to that described for the sections of the Loddon Valley covered by "partial" irrigation schemes. However, because of higher rainfall and superior soils, country included within the Rochester Irrigation

[53] Appreciable areas of land were not assessed as commanded and suitable for irrigation, either because they were physically not suited or because of an attempt to reduce the area of ratable land used for assessing the compulsory charges to be levied on landholders initially averse to irrigation.

TABLE XVIII

Farm Size and Land Use for 21 Properties in Rochester Irrigation District 1958

Farm Number	A. Land Resources in Irrigation District							B. Land Outside District	Total Property
	Irrigated Land						Non-Irrigated Land	"Natural" Pastures	
	Total Area	Improved Permanent Pastures	Improved Annual Pastures	"Natural" Pastures	Fodder Crops	Commercial Crops			
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
1	34	33	..	..	..	..	1	..	34
2	54	47	..	..	3*	3†	1	..	54
3	65	40	23½	..	..	..	1·5	..	65
4	70	45	15	..	8‡	..	2	..	70
5	80	65	..	..	..	..	15	320	400
6	120	..	..	..	90*	..	30	320	440
7	121	100	..	..	16§	..	5	1,160	1,281
8	136	92	40	..	..	..	4	1,000	1,136
9	150	133	13	..	..	3	1	..	150
10	157½	57	88½	..	5*	..	7	..	157½
11	160	95	..	..	..	..	65	..	160
12	211	65	70	..	..	..	76	..	211
13	240	35	66	..	91*	..	48	..	240
14	260	254	..	..	..	..	6	3,000	3,260
15	400	270	129	..	..	..	1	800	1,200
16	550	200	200	..	..	..	150	800	1,350
17	600	100	120	..	..	..	380	400	1,000
18	695	95	190	..	..	..	410	..	695
19	750	170	380	..	..	..	200	..	750
20	925	150	200	30	30*	..	515	..	925
21	1,180	150	150	..	..	..	880	..	1,180
Averages	331	110	..	..	..	..	13	..	703

* Lucerne. † Lucerne interplanted with citrus. ‡ Oats as cover crop to improved permanent pasture. § Oats.

District has presented better scope for dryland cereal growing than the other districts described earlier. It has also proved a somewhat safer area for non-irrigated sheep raising, especially for fat lamb production. As irrigation was actively developed after 1910, the Rochester District and those to the east of it, have proved better suited to the more "intensive" lines of development than those parts of the Loddon Valley in the west that are supplied with water from the Goulburn System. This is reflected in more dairying and fruit growing by closer settlement with heavy summer irrigations. It is also reflected in a heavier reliance by sheep farmers on irrigation land in relation to non-irrigated land and a greater emphasis on irrigated permanent pasture.

TABLE XIX

*The Pattern of Farm Sizes for 21 Properties in Rochester Irrigation District 1958**

Size Group	Number of Farms
Acres	
Less than 80	4
80 to 119	1
120 to 159	5
160 to 249	3
250 to 499	2
500 to 749	3
750 to 999	2
1,000 or more	1
Average size	331 acres.
Smallest size	34 acres.
Largest size	1,180 acres.

* Land within or contiguous with Irrigation District. As shown in Table XVIII eight farmers had some land outside the District.

"On-farm" Integration of Land Resources

Land Resources

Table XVIII sets out the areas of the twenty-one farms surveyed in the Rochester Irrigation District and indicates how they were used in 1957-58. In eight cases, farm areas embraced land completely outside the irrigation district. The average farm size of 331 acres and the range in size (from 34 acres to 1,180 acres) were larger than occurred on the Swan Hill Flats but less than in the "partial" irrigation districts of Tragowel Plains, Calivil and Boort. In this respect, land settlement was intermediate in intensity between these two extremes, although it should be noted that the twenty-one sample farms are smaller on the average than the rest of the sheep properties in the Rochester District.

Because of high water rights and relatively good soils (i.e. mostly better drained Red Brown Earths with "prior stream" influences), the twenty-one properties were able to develop more irrigated permanent pasture and/or lucerne than could their counterparts in lower watered areas to the west. In the early days of development (both for sheep raising and dairying)

lucerne was the main improved summer-growing plant under irrigation. However, as shown in Fig. 12, this crop, once the "King of Fodders" has tended to decline and has given way to irrigated permanent pastures which are better suited to grazing and the character of soil and under-drainage that occurred after irrigation. The irrigated lucerne areas can be linked with the areas of improved permanent pastures as an indication of the relative importance of irrigated "summer" feed on the survey properties.

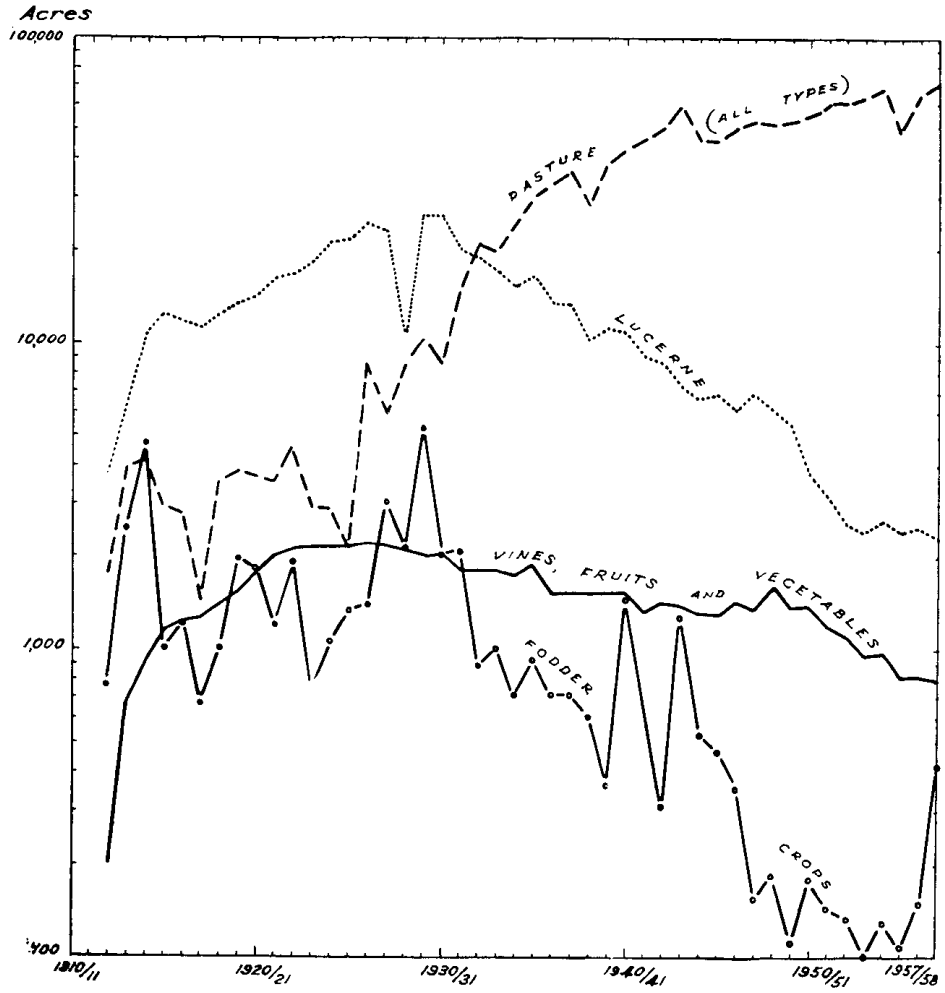


Fig. 12—Trends in Areas Watered in Rochester Irrigation District 1912-13 to 1957-58. Note decline in fruit growing and the increase of irrigated pastures at the expense of lucerne and fodder crops.

Fourteen farmers (66.7 per cent) had some areas of irrigated improved annual pastures of the kind so common in "partial" irrigation areas. Omitting lucerne, the areas of irrigated fodder crops and "natural" pastures were very small by comparison with the "partial" irrigation districts desscribed in Section 6. Similarly, non-irrigated areas within the district were relatively much smaller for this group of twenty-one farms and the area irrigated tended to fluctuate less from year to year. These comparisons reflect differences in the intensities of irrigation and land settlement as well as the more "progressive" character of farming in the Rochester Dis-

trict. The twenty-one farms are relatively well-endowed with water resources and reflect the influence of State-sponsored closer settlement. Hence they are fairly small and have generally a high proportion of their lands under irrigation. The greater emphasis given to irrigated improved pastures compared with the less productive "native" pastures and fodder crops reflects a longer history of closer settlement. It also reflects a greater awareness by farmers of the merits of improved irrigation practices than is shown by many graziers in "partial" irrigation districts further west in Victoria.

Contrary to expectations, there was no clear-cut relationship between the character of watered pastures and the type of livestock enterprise dominant on the twenty-one properties. For example, of the seven properties dependent mainly on irrigated permanent pastures, only two ran a commercial dairy. However, it should be remembered that many of the smaller properties now dominated by sheep raising were once used for dairying following closer settlement after 1910. To some extent, a heavy reliance on irrigated permanent pastures in 1957 reflected the influence of the earlier dairying. Certainly, this has enabled many graziers to build up water allocations to levels higher than those prevailing on many other sheep properties in their district and this has permitted more emphasis on summer-growing pastures.

The development of appreciable areas of irrigated permanent pastures (earlier lucerne) has allowed the twenty-one sheep farmers to follow a more *flexible* stocking programme than was possible on most of the properties in the "partial" irrigation districts discussed in Section 6. Over-and-above the normal fattening of their own lambs in the autumn to spring period, they were able to engage in the following enterprises based on lush summer-growing pastures:—

(i) Breeding and fattening of vealers.
(ii) Fattening store lambs purchased from dryland areas.
(iii) Fattening carry-over weaner lambs bred on their properties but not fit for sale in spring.
(iv) Lambing in spring and fattening for sale in autumn.
(v) Fattening purchased store beef cattle.

Because of these additional activities, it was possible for some graziers to make a good living on properties much smaller than the minimum area where production is restricted solely to autumn lambing and spring fattening. In addition, the farmer could vary his stocking enterprise to take advantage of changes in economic conditions. *This type of property appears to offer a means of achieving a more rational use of scarce water resources than many irrigation farms planned in the past which have been limited to a narrower range of production possibilities.*

"On-farm" Integration

The survey emphasised that both dryland and irrigated lands were used jointly by most of the twenty-one irrigators in the Rochester Irrigation District both because of limited water supplies and because dryland had a value for the sheep raiser. The reasons for this are somewhat similar to those described for the three "partial" irrigation districts in section 6 and are listed later (see p. 229). However, the twenty-one properties

displayed a pattern of "on-farm" integration that differed from that of the forty-five properties discussed earlier. The proportion without any unirrigated land in the irrigated district (not used for buildings and channels) was 47.6 per cent and this was much higher than in the other districts. This is a reflection mainly of the fact that the Rochester properties were previously dairyfarms that had been allotted high water rights when first established. This had enabled them to be converted to sheep properties with a complete reliance an irrigated land. Eight of the twenty-one graziers (38.1 per cent) possessed land beyond the irrigation district which they used mainly for grazing ("natural" pastures) with occasional cereal crops. The dryland areas were actively integrated with the irrigation elements of each farm by using the former for stock breeding and the latter for stock fattening.

Few of the irrigators in the Rochester project ever agisted their stock on farms outside the district. Only three of the twenty-one ever did this and they included one dairyfarmer and two fat lamb raisers, all with only small areas of unirrigated land in the district.

Only six of the twenty-one irrigators (28.6 per cent) ever leased his irrigation land on agistment tc dryland farmers although this proportion was higher than was the case for the irrigators in the lesser-watered districts of the Loddon Valley described in Section 6. Only in one case was this agistment an important source of income for the irrigator ; most only agisted small numbers of sheep "to oblige a dryfarmer".

The twenty-one irrigators were asked: "In what ways do you think dryland farms outside this district ever benefit from being able to agist their stock here?" It was obvious from the information received that little agistment of this type was available in 1957 and previous years, although most irrigators emphasised that more scope for it existed prior to 1946. The reasons for this change are discussed later (see pp. 229-230).

Only one of the twenty-one irrigators (4.8 per cent) had owned a dryland property before he acquired his irrigation farm. The irrigators stated that they knew of others who had acquired irrigation blocks during and after the run of droughts between 1938 and 1945. However, the impression was gained during the survey that "on-farm" integration by this means was not a marked feature of the Rochester Irrigation District and the position seemed little different from that described for the Tragowel Plains, Calivil and Boort Irrigation Districts.

"Off-farm" Integration of Livestock Enterprises

Livestock Enterprises

Table XX lists the numbers and kinds of livestock on the twenty-one properties surveyed in the Rochester Irrigation District during the 1957-58 season. On the basis of the dominant enterprise or enterprise combination, the properties were classified into the types shown. It should be noted that, although few properties are classified as dominantly wool growing, wool sales were the main source of income on many properties in the years immediately prior to survey. The types of holdings listed are generally quite different from those encountered in "partial" irrigation districts like those discussed in Section 6. However, they are not typical of the balance of the Rochester District.

TABLE XX

Numbers of Livestock on 21 Farms Surveyed in Rochester Irrigation District in 1957-58

Farm Number	Ewes		Rams		Young Sheep Bought and Bred	Wethers	Dairy Stock		Beef Cattle	Classification of Holding by Dominant Stock Enterprise*
	Wool Type	Fat Lamb Type	Wool Type	Fat Lamb Type			Milking	Non-milking		
1	..	50†	..	..	50	..	3	..	..	DFS
2	..	200	..	4	240	..	21	15	..	FL/D
3	..	200	..	8	400	..	..	..	4	FL/DFS
4	..	300	..	6	300	..	..	..	..	FL
5	..	500	..	10	500	..	..	..	..	FL
6	..	1,130	..	8	580	..	..	..	4	FL/DFS
7	..	300	..	9	300	400	10	30	150	FL
8	..	200	6	..	400	300	..	..	100	W/B
9	..	320	..	8	360	..	..	..	145	FL
10	..	500†	..	..	500	..	..	..	40	DFS
11	..	800	..	16	1,000	..	..	..	10	FL/DFS
12	..	450	13	..	450	..	..	..	34	FL
13	..	600	..	18	900	..	..	..	24	FL/DFS
14	1,200	..	36	..	2,000	250	..	..	15	W/DFS
15	..	500†	..	..	1,500	..	..	..	178	DFS
16	..	1,500	..	60	5,650	200	..	..	120	FL/DFS
17	..	600	..	18	800	..	..	..	200	FL/DFS/B
18	..	1,020	..	31	1,920	..	2	..	..	FL/DFS
19	..	1,200	..	27	1,200	..	..	..	145	FL/B
20	..	1,000	..	30	1,000	..	70	50	6	FL/D
21	..	1,200	..	24	2,100	500	..	..	72	FL/DFS

* Classified according to enterprises giving the greatest gross income. (Symbols denote enterprises : FL — fat lamb breeding, D — dairying, DFS — dealing in sheep by fattening purchased stores, W — wool growing, B — beef raising.)

† These graziers only fattened purchased stores.

Three of the properties (14.3 per cent) ran a commercial dairy but none of these relied on dairying as the main source of income. Nine of the graziers produced fat lambs along the lines described for the other "partial" irrigation districts with an emphasis on autumn calving and a spring sale of fats. They used Merino-type "First Cross" ewes which were mated to English Shortwool rams (e.g. Dorset Horns and Southdowns). More of them lambed in spring for summer fattening than is usual in "partial" irrigation districts and this reflected the greater abundance of irrigated permanent pastures. Eight sheep properties were quite different from any encountered in the Loddon Valley because they added to their own "winter" breeding of fat lambs, the fattening of large numbers of purchased stores (mainly lambs) which were derived from dryland areas unable to sell the sheep as fats in spring. These were bought mainly in November, fattened on irrigated permanent pastures and sold next March or April for slaughter. However, only three properties specialised in dealing in store stock (often aged ewes with lambs at foot or used for one lamb crop) and graziers advised that this type of property (shown in Table XX as D.F.S.) was not common in the Rochester District.

Most of the twenty-one properties surveyed in the Rochester District ran a beef fattening enterprise as a sideline. Breeding rather than fattening purchased stores was most common but about one third of the properties fattened purchased beef. The sale of "baby beef" or vealers was characteristic. The beef fattening programmes were invariably geared to the irrigated summer pastures. On the whole, beef fattening assumed relatively greater importance on the properties surveyed in the Rochester District than it did in the "partial" irrigation districts discussed in Section 6.

None of the dairyfarms ran pigs, mainly because they used surplus skim milk in their beef fattening enterprise.

Livestock Purchases

Through their pattern of livestock purchases, the twenty-one properties in the Rochester District displayed a much more varied development of integration than did the forty-five properties studied in the Loddon Valley. Because of their relatively small size and emphasis on the breeding of fat lambs, most of them regularly purchased replacement ewes from dryland areas, preferably semi-arid Merino country in the Riverina of New South Wales. In contrast to the irrigators discussed in Section 6, most of the sixteen fat lamb breeders in the Rochester District preferred to buy relatively old ewes (four or five years) which they claimed "stood up better than young ewes to intensive irrigation conditions." It was common to retain these ewes for only one or two seasons. Hence, purchases of replacement ewes were made more regularly by the Rochester graziers than other irrigators buying young animals and retaining them longer.

Most of the irrigators bought considerable numbers of store sheep (mainly lambs but some ewes) from dryland areas. These were bought about November each year after lambs bred on the irrigation farm had been disposed of as fats. The purchased stores were fattened on irrigated permanent pastures and sold next March or April as fats for slaughter. Several graziers also bought young wethers or ewes which they retained for wool growing for several years before selling them as fats for slaughter. Because the fattening of large numbers of purchased ewes in summer was

added to the autumn to spring breeding of fat lambs, the overall stocking rates on the twenty-one properties were much higher than on "partial" irrigation properties discussed in Section 6.

One third of the graziers interviewed in the Rochester District regularly purchased store beef cattle for fattening. These usually came from upland areas to the east and south-east along the flanks of the southern Murray Basin. *The numbers of store cattle moving into the Rochester District appeared much greater than in the Tragowel Plains, Calivil, and Boort Irrigation Districts.*

Judging from advice given by the twenty-one irrigators interviewed, the purchase of replacement ewes for winter breeding and stores for summer fattening were characteristic of many other properties in the Rochester District. The latter practice was reported to be more prevalent on properties with appreciable areas of irrigated permanent pastures.

Livestock Sales

Like their counterparts in the Loddon Valley the twenty-one irrigators in the Rochester District concentrated on breeding fat stock for slaughter. Few stock went into surrounding dryland areas. Most of these stock were sold in Bendigo and Melbourne. The Rochester properties, being more heavily stocked than the other group of farms, were able to sell large numbers of stock as fats.

As mentioned earlier, because most of the properties had both irrigated winter (annual) pasture and irrigated summer (permanent) pasture, they could adopt a much more flexible stocking programme than was possible on the Loddon Valley farms geared only to irrigated winter pastures. Lambing could be undertaken in both autumn and spring to take advantage of changing markets. In addition, lambs not sold as fats in spring could be carried over more readily through the summer and sold early in autumn when prices were high, i.e. before the main peak of supplies from non-irrigated areas. Irrigated permanent pastures also allowed summer fattening of purchased store sheep and beef as well as the breeding of beef. *Irrigators in the Rochester District were less prone to problems of water* shortage in the strategic autumn season than districts where all irrigation is geared to winter-type pastures.

"Off-farm" Integration of Feeding Programmes

Sources of Feed (Home Grown and Purchased)

The twenty-one irrigators interviewed in the Rochester District displayed a heavier reliance on irrigated pastures than the forty-five irrigators in the Loddon Valley. Hence, there was a higher ratio of irrigated to non-irrigated land. The greater abundance of irrigated permanent pastures meant relatively less fodder cropping to meet green feed requirement during the spring to early autumn months. Only four irrigators (19 per cent) ever bought feed. Two occasionally bought oats from dryland areas for winter feeding of sheep and they did this only in seasons when irrigated annual pastures were at a lower ebb than usual. One grazier occasionally

purchased pasture hay from neighbouring irrigators for winter feeding of dairy stock. One grazier stated that he "found it more economic in some years to buy meadow hay (mainly from irrigators) than cut his own spring pasture because this reduced the numbers of purchased stores he could fatten in the hot months."

Feed Sales

In sharp contrast to the properties surveyed in the Tragowel Plains, Calivil and Boort Irrigation Districts, fairly large quantities of feed were sold from some of the properties surveyed in the Rochester District. Twelve of the irrigators interviewed in the latter district stated that they sold feed to other farmers. Most of the feed sold was hay cut from the spring flush growth of irrigated pastures and much of this came from irrigated permanent pastures. However, in only four cases was feed sold to dryland farmers outside the irrigation district in localities such as Bendigo, Diggora, Pine Grove, Hunter, and Mitiamo in Victoria, and Bunnalloo in New South Wales. In the other eight cases, feed was sold to local dairyfarmers, themselves on irrigated land but encountering winter feed shortages in years like 1957.

Factors Affecting the Character of Integration in the Rochester Irrigation District

The factors that influenced the character of integration displayed by the twenty-one properties studied in the Rochester District are similar to those discussed for the three "partial" irrigation districts in the Loddon Valley (Section 6). However, the more intense irrigation farming in vogue in the Rochester area resulted in less active "on-farm" integration but correspondingly more active "off-farm" integration.

"On-farm" Integration

Only two of the twenty-one irrigators interviewed in the Rochester District stated that they would prefer all their productive land to be irrigated. Nineteen farmers listed various reasons why they preferred some unwatered land and these are summarised in Table XXI. It will be noted that these reasons are similar to those given by the graziers interviewed in the Loddon Valley (see Table XV on page 213). In general, they are less diverse and relate more to problems of allowing efficient management of stock and land under "intensive" irrigation conditions. Because of more copious water supplies, the Rochester irrigators were less interested than were their counterparts in the Loddon Valley in dryland as a source of additional income in its own right. However, the fact that most of the irrigators preferred to practise some "on-farm" integration, despite relatively high water rights, supports the view expressed earlier (pp. 212-213) that the projected increase in water allocations to low water right areas will not mean a discontinuance of some "on-farm" integration as an integral part of fat lamb breeding.

TABLE XXI

Rochester Farmers' Assessment of the Value of Dryland to the Irrigator

Value	Number of Farmers Giving Opinion*
1. Helps control footrot, soft feet, worms, and other diseases	13
2. Provides necessary change of diet for stock	11
3. To spell irrigation land in winter	10
4. Fat lambs and cattle develop better with some "on-farm" integration	6
5. It is better to breed on dry land and bring stock on to irrigated land for fattening	3
6. Dryland is good for weaner lambs	2
7. To graze when irrigating land	1
8. To grow cereal crops..	1
9. No value	2

* Many farmers gave several opinions.

Despite a relatively high proportion of irrigated to non-irrigated land and heavier waterings on the 21 properties surveyed in the Rochester District, the need to look for stock agistment outside the irrigation district was much less intense than was the case for dairymen on the Swan Hill Flats. This results from: (i) lower stocking with sheep raising, (ii) generally better soil drainage and lower liability to water logging, and (iii) the existence of some relatively well-drained unirrigated land on many holdings.

Although only six of the 21 irrigators interviewed in the Rochester District ever provided agistment facilities to dryland farmers, the proportion (28.6 per cent) as much higher than applied to the farms studied in the Loddon Valley. This was undoubtedly due to the higher water rights and greater abundance or irrigated summer pastures which allowed the dry-farmer to avail himself of the benefits of irrigation at times of the year when he was most affected by shortages of green feed on his own block. Advice from the irrigators interviewed suggested that this form of "on-farm" integration had declined over the period from 1950 to 1956, especially by comparison with the 1920's and 1930's. Most farmers expressed the view that relatively little agistment facilities for the dryland farmer would exist in future drought periods, given a continuance of the stocking programmes in vogue on irrigation land in 1957. Reasons expressed for this historical change in actual and potential "on-farm" integration were:—

(i) During the earlier stages of development of the Rochester Irrigation District, irrigation properties were less heavily stocked than in the last decade and many irrigators provided agistment to dryland farmers to provide supplementary incomes. Since 1945,

high wool and meat prices had encouraged irrigators to gradually build up their stocking rates based on increases in the areas of irrigated pastures.

(ii) There had been a gradual change in the character of irrigated land use, marked by a decline in the areas of irrigated lucerne and a corresponding increase in improved permanent pastures (see Fig. 12). This had reduced the scope for fodder conservation and had also reduced the scope for agistment.

(iii) During times when dryland farmers seek agistment most (i.e. in major droughts) store stock are relatively cheap and the modern irrigator tends to prefer to buy the stores and fatten them himself rather than agist another farmer's stock. The price of agistment tends to be high in such times and it is usually only the dryfarmer with special lines of stock (e.g. stud sheep) who finds it economic to pay for agistment. Most dryland farmers find it more economic to sell their stock. In many cases, the dryland farmer finds that agistment can be obtained more readily in remote but humid areas (like Gippsland) rather than in more proximate irrigation districts.

(iv) During past droughts (i.e. before 1946), most irrigators had to face problems of water shortages as irrigation projects had tended to develop beyond the capacity of the irrigation system to supply demands for water in low rainfall years. With the completion of the larger Eildon Weir this problem should be felt much less in future droughts.

(v) Much of the past demands for agistment from dryland graziers came from areas like the Riverina of New South Wales and this region has benefited in recent decades from "extensive" irrigation projects.

On the basis of advice from the twenty-one irrigators interviewed, the main factors that have discouraged dryland farmers from acquiring irrigation blocks of their own are:—

(i) High land values in areas where the required small blocks are usually available.

(ii) The run of good seasons from 1946 to 1956 when dryland farmers had little need to look for assistance from irrigation.

(iii) The tendency for dryland farmers (especially in cereal growing areas) to sell drought-affected stock rather than attempt to save them.

(iv) The availability of cheaper agistment south of the Victorian uplands.

"Off-farm" Integration

The breeding of crossbred lambs for sale as fats is an enterprise well adapted to the intensive irrigation conditions prevalent in the Rochester Irrigation District and has been favoured by high prices ruling for lambs from irrigation projects. It is natural then that most of the irrigators interviewed in the Rochester District had made this their central enterprise

with its attendant "off-farm" integration by purchases of replacement ewes from dryland areas. However, because of their peculiar development of appreciable areas of irrigated permanent pastures, most of the graziers interviewed were able to add the additional enterprise of summer fattening of sheep and beef. Hence "off-farm" integration had been activated still more by the purchase of considerable numbers of stores from dryland areas. Proximity to dryland areas encountering seasonal difficulties in selling fat stock and the possession of sufficient water and suitable soils for summer irrigation have been pre-requisites of this. Where the grazier could develop appreciable areas of irrigated permanent pastures he could turn-off many more fat stock than he could breed on his own place. The breeding enterprise tended to be limited to the capacity of the irrigated annual pastures and, where farms were small, this limitation was often great. However, fattening purchased stores during the summer months provided a very lucrative source of additional income without the trouble of increasing the numbers of breeding ewes run.

The economy of fattening purchased stores in the Rochester District appears to be related closely to changes in seasonal conditions, as they affect the success of fattening on non-irrigated areas. Prior to 1957, a long period of good rainfalls allowed most dryland graziers to fatten many of their own lambs and the quantity of stores available to the irrigator was low and prices high. This reduced the margin of profit to be gained in the fattening enterprise. In a year like 1957, lower rainfalls resulted in greater numbers of stores being offered at lower prices and fattening them on irrigated land was economically more attractive. On the large irrigation properties, the grazier tended to alter the balance between his own winter breeding and summer fattening programmes to suit changes in the prices for purchased stores. Graziers on small holdings were less able to do this and many of them had to persist with relatively more summer fattening at lower profits. Where the irrigator possessed dryland beyond the irrigation district he could combine breeding on dry country with fattening on irrigation land and could benefit from a wider range of conditions—i.e. in times that were good for fattening on dryland he could do this as well as breed and fatten on the irrigated land. In times that were poorer for fattening on dryland he could breed there and increase the emphasis on using the irrigated land solely for fattening. This type of advantage of "on-farm" integration was discussed in Part I of this series of articles.[54]

As with the purchase of replacement ewes (typically the "First Cross" Merino), most irrigators buying store sheep for fattening tended to favour stock from semi-arid areas beyond the irrigation districts to the north of the Murray. It was claimed that lambs from these areas thrived better on intensively watered land than did lambs from cereal-growing areas.

The greater abundance of irrigated summer pastures explains why the fattening of purchased beef cattle was more prevalent on the Rochester properties than on the farms discussed in Section 6. Such pastures provided a greater bulk of rank feed better suited to beef cattle than sheep and, with relatively less irrigated annual pastures, graziers were inclined more to buy stores for summer fattening rather than breed their own beef.

[54] J. Rutherford, *op. cit.*, p. 246.

As with the Loddon Valley farms, the chief reason why few stock were sold to dryland farms from the Rochester properties was the emphasis on fattening stock for slaughter. However, because of more intense irrigation, the factor of dryland farmers' aversion to irrigation stock because of alleged disease problems tended to operate more actively against stock sales to dryland areas from the Rochester farms.

The relatively abundant irrigation feed on the Rochester properties meant that they had less need than farmers in the "partial" irrigation districts described in Section 6 to buy feed from dryland areas. Also, because they were running sheep and not dairy cattle and because of the balance between irrigated annual and irrigated permanent pastures, few of the graziers felt the same need as did the dairy farmers on the Swan Hill Flats to buy "hard" feed from dryland areas. Thus, they were relatively independent from dryland areas and practised little "off-farm" integration through feed purchases.

We have noted that the Rochester properties displayed a relatively marked development of "off-farm" integration through feed sales. This can be explained largely in terms of the more abundant water supplies and suitable soils for growing irrigated permanent pastures which produce a large amount of surplus feed in spring. Unlike the dairy farmers on the Swan Hill Flats, the irrigators interviewed in the Rochester District had less need to use all of this feed for winter feeding of stock. In addition, "off-farm" integration by feed sales appeared to be related to a number of other farm characteristics, although the sample of twenty-one properties was too small for the strength of these associations to be statistically tested. For example, it appeared that the propensity to sell feed was greatest on larger properties, since the average property size for those selling feed was 854 acres, compared with only 411 acres for those who did not sell feed. However, this association becomes less significant when it is realised that the range in property size for the sellers of feed was from 34 to 3,260 acres and that for the non-sellers of feed from 54 to 1,180 acres. Similarly (as might be expected), the sellers of feed had more irrigated permanent pastures (average area 119 acres) than the non-sellers of feed (average area

TABLE XXII

Association between Practice of Selling Feed and Fattening Purchased Store Stock—Twenty-one Survey Properties, Rochester Irrigation District, 1958

		Number of Farmers		
		Buying Stores	Not Buying Stores	Total
Number of Farmers	Selling Feed	5	7	12
	Not Selling Feed ..	7	2	9
Total		12	9	21

Applying Yates correction factor $x^2=7{\cdot}40$
Significant at 1 per cent level.

93 acres). However, the significance of this association is again reduced by the fact that the range in area of irrigated permanent pastures of the feed sellers was from 33 to 254 acres, compared with 35 to 270 acres for the non-sellers of feed.

Remembering that the twenty-one properties studied in the Rochester District was not a random sample, but covered most of the properties with similar amounts of irrigated permanent pasture, it is of some significance to note an apparent negative association between the selling of feed and the practice of buying store stock for summer fattening. (See Table XXII) This kind of association is to be expected, since the grazier who practises "off-farm" integration by fattening purchased stores during the summer would naturally be less prone to sell surplus feed (normally derived from the spring flush pasture growth) since this would tend to reduce his capacity to fatten the purchased stores during and after the harvesting time. This type of association tends to support the argument advanced by some graziers that "it pays more to buy stores for fattening yourself rather than help the dryfarmer by selling him feed."

The economy of selling feed from the Rochester farms seemed to be related somewhat to changing seasonal conditions. The demand (price) for feed was relatively low in the period from 1946 to 1956, when dryland farmers and irrigators alike were able to fatten stock on their own properties without outside assistance. However, in 1957, dry conditions greatly increased the demand for feed from irrigation farms and caused a sharp increase in the price of feed offering. As an example of this, one grazier stated that he sold hay ("standing in the paddock") for 75s. 0d. per ton in 1956 and the same feed brought 200s. 0d. per ton in 1957! However, seasons like 1957 have occurred too infrequently over the last twenty years for many irrigators to regard feed sales as more than a small sideline. Most graziers not selling feed stated that their main reason was that they did not have a surplus because their blocks had become too heavily stocked by their own breeding enterprises during the good seasonal and economic conditions ruling in the last decade. If we accept the proposition that irrigation farms like those in the Rochester District present the greatest scope for assistance to dryland areas by feed sales, then it seems fair to conclude that integration of this kind in the southern Murray Basin has been greatly reduced in the last decade by the major build-up which has occurred in stocking rates on irrigation farms which have concentrated on developing their own breeding programmes with expanding areas of improved pastures. Similar developments have tended to occur as well in the dryland sector, but the latter has tended to become much more prone to the impact of drought.

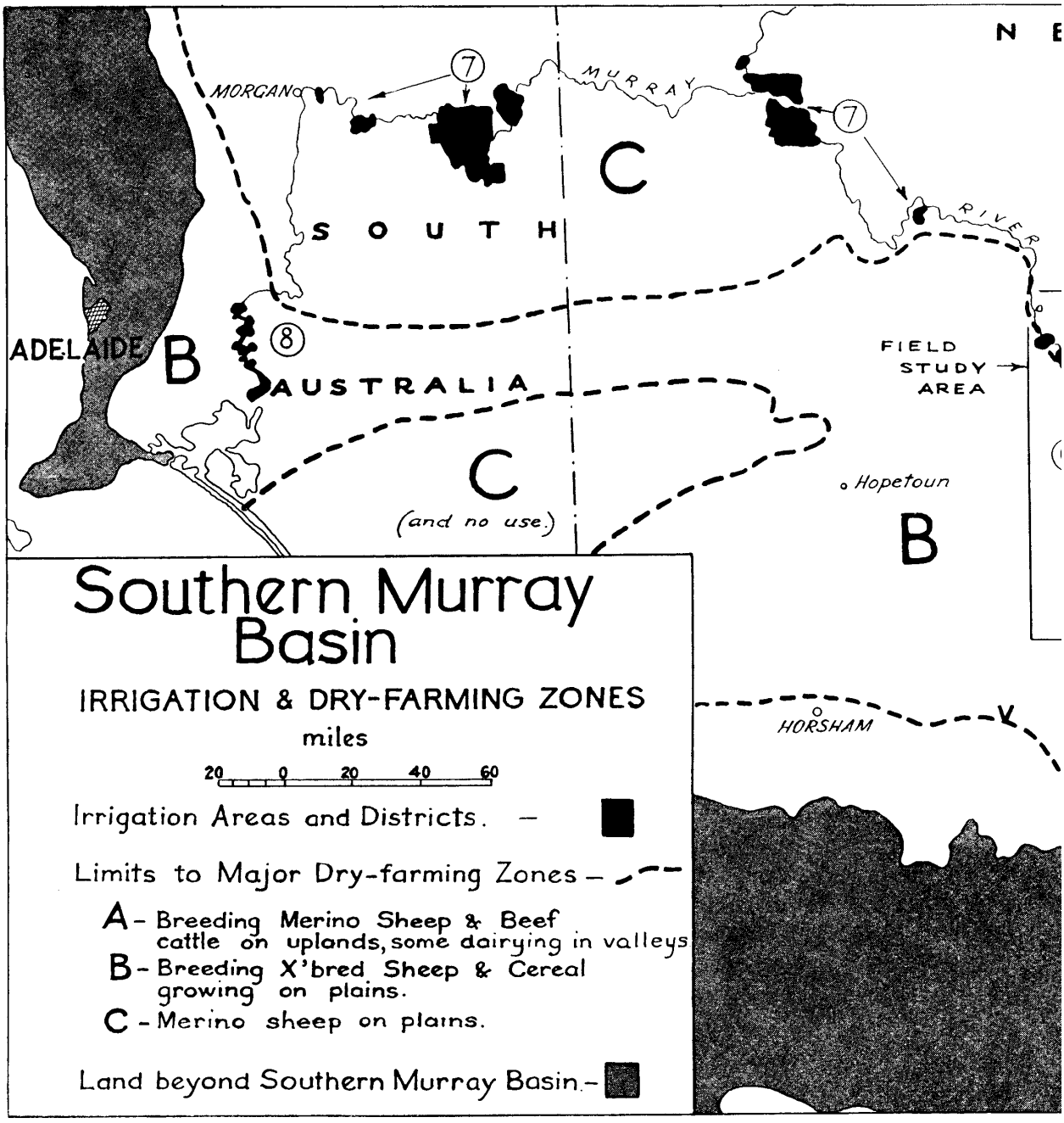


Fig. 2. Community Irrigatior

1. **Murrumbidgee Riverine Plain Projects (N.S.W.)**
   Yanco, Mirrool, Benerembah, Tabbita, Wah Wah, Hay and Lowbidgee.

2. **Murray Riverine Plain Projects (N.S.W.)**
   Berriquin, Denimein, Deniboota, Wakool and Tullakool. Map also shows Bama, Bringan, Glenview, and Bungunyah-Koraleigh along Murray.

3. **Murray Riverine Plain Project (Victoria)**
   Murray Valley.

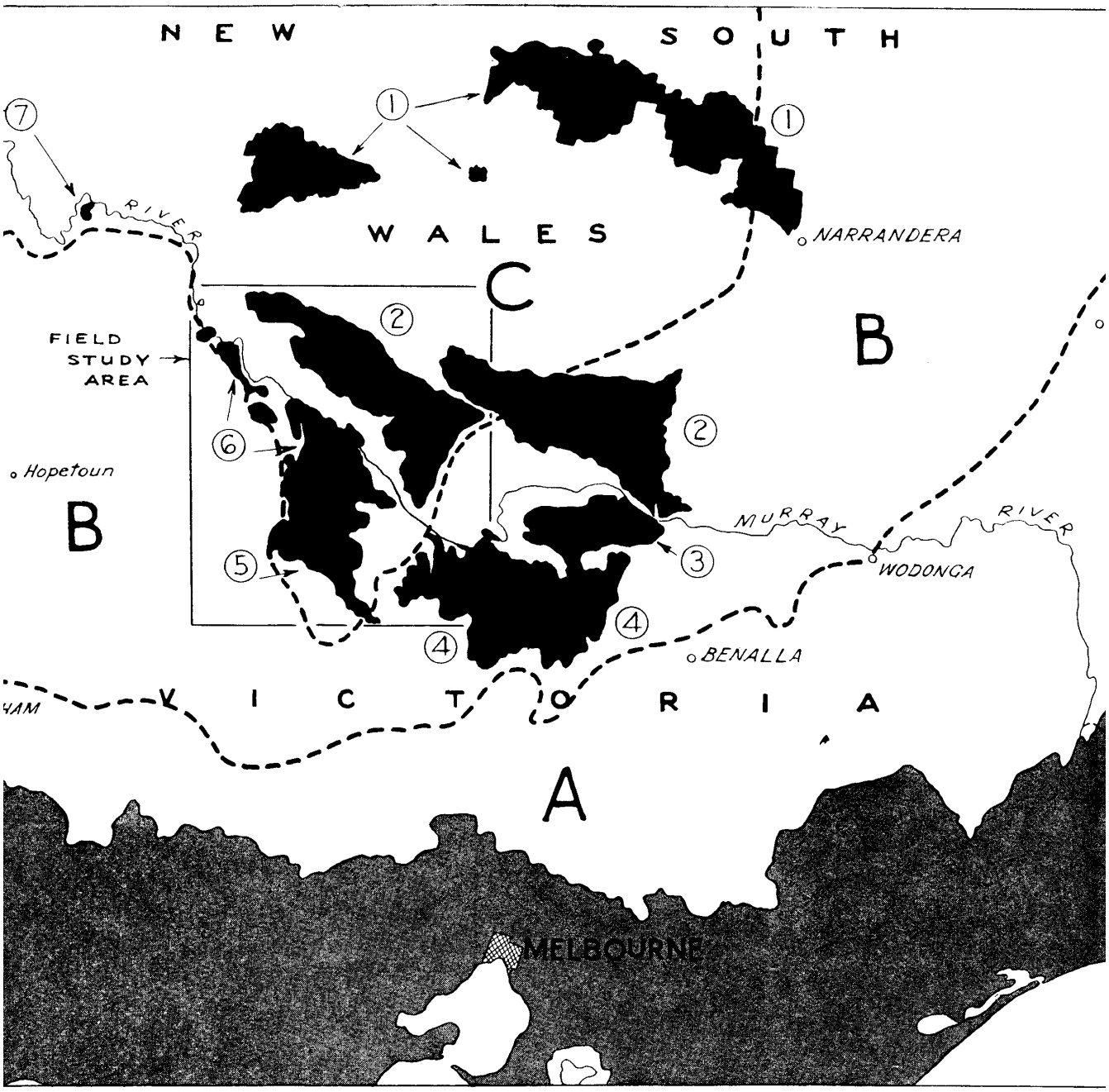


Fig. 2. Community Irrigation Projects and Dry-Farming Zones of Southern Murray Basin. Note position of "Field Study Area"

KEY TO IRRIGATION PROJECTS SHOWN

Hay and Lowbidgee.

ol. Map also shows leigh along Murray.

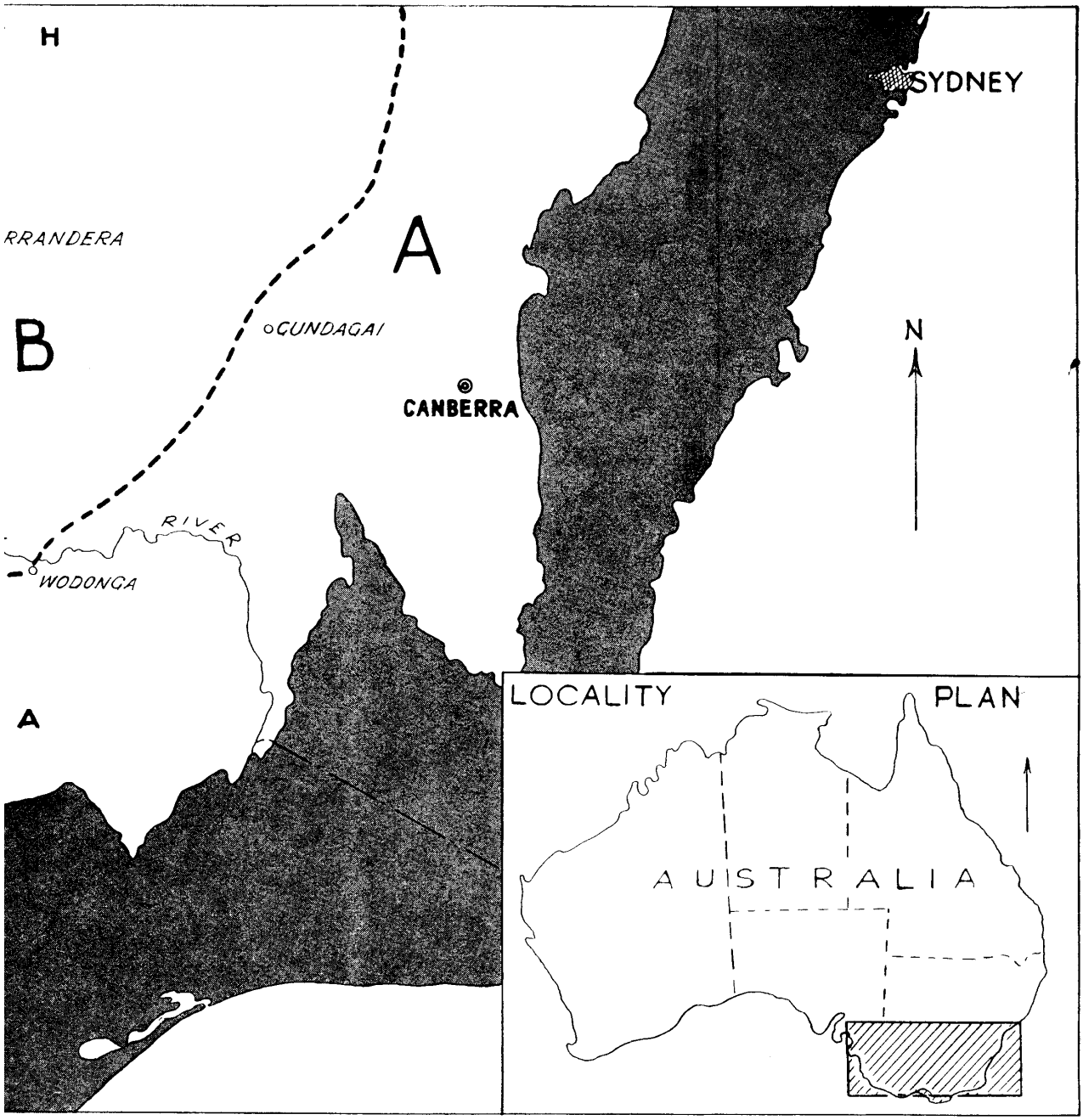
4. Eastern Goulburn Riverine Plain Projects (Victoria)
Katandra, North Shepparton, Shepparton, South Shepparton, Rodney, Tongala-Stanhope, Deakin and Rochester. (Campaspe Project on Campaspe River also shown.)

5. Western Goulburn Riverine Plain Projects (Victoria)
Dingee, Calivil, Boort, and Tragowel Plains.

6. Torrumbarry Riverine Plain Projects (Victoria) From Murray
Cohuna, Kerang, Koondrook, Third Lake, Mystic Park, Tresco, Fish Point and Swan Hill. Map also shows Nyah supplied separately from Murray.

7. Mallee-Murray Projec
Robinvale, Red Cl
Coomealla (N
N.S.W.), Chal
wood, Media,
Australia).

8. Reclaimed Swamps Lo
Cowirra, Baseby,
Burdett, Long
and Jervois.



"Field Study Area"

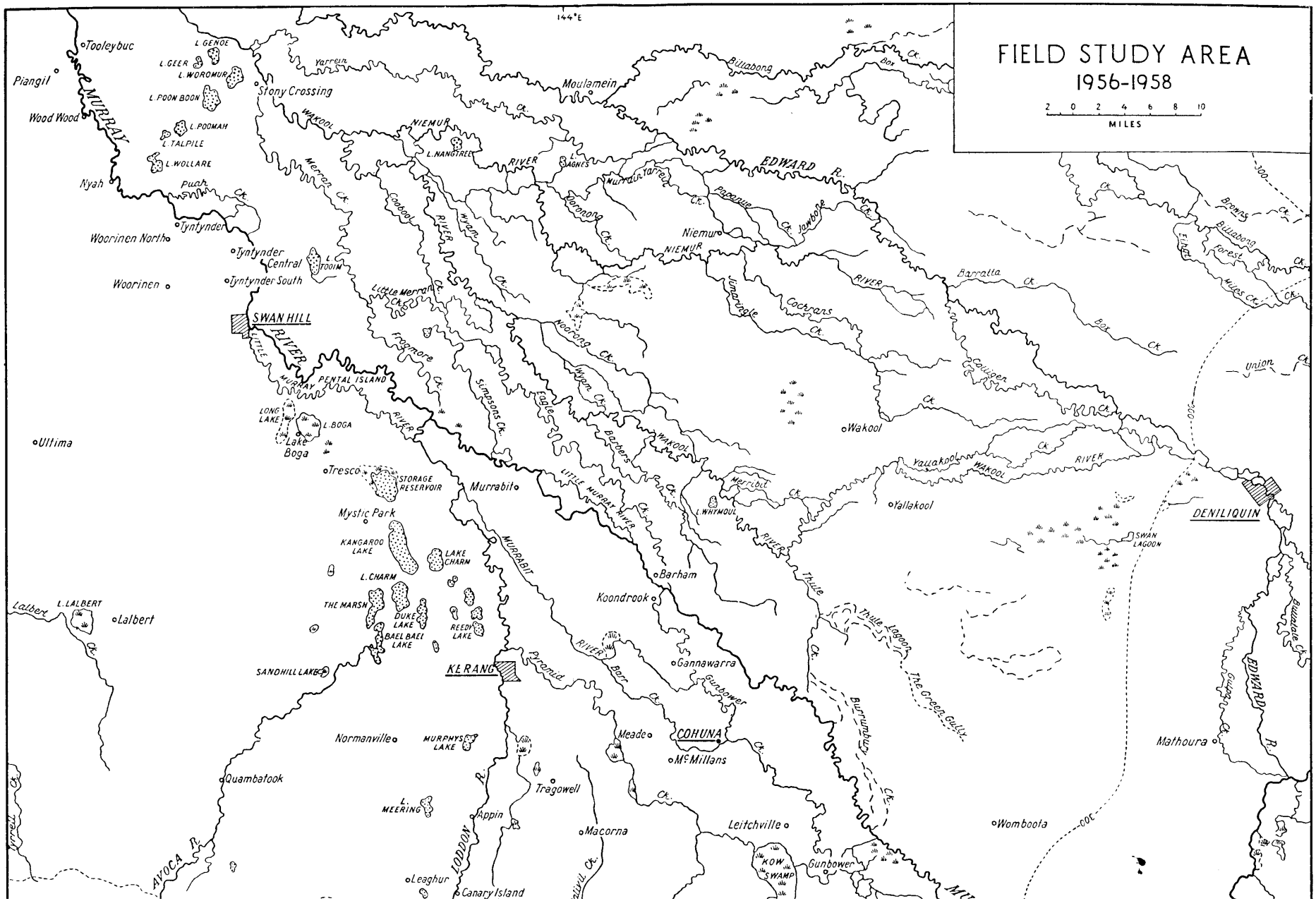
7. Mallee-Murray Projects

Robinvale, Red Cliffs, Mildura and Merbein (Victoria). Curlwaa and Coomealla (N.S.W.). Map also shows Pomona (Darling River in N.S.W.), Chaffey, Renmark, Lyrup, Berri, Cobdolga, Loxton, Sherwood, Media, Pyap, Moorook, Kingston, Waikerie, and Cadell (South Australia).

8. Reclaimed Swamps Lower Murray (South Australia)

Cowirra, Baseby, Neeta, Wall, Pompoota, Mypolonga, Murray Bridge, Burdett, Long Flat, Swan Port, River Glen, Monteith, Woods Point and Jervois.

Fig. 3.—Map of "Field Study Area" showing Localities, Streams and other Natural Features. Dotted lines show contours in feet above sea-level


FIELD STUDY AREA
1956-1958
2 0 2 4 6 8 10
MILES
144°E
Tooleybuc
L. GENOE
L. GEER
L. WOROMUR
Piangil
MURRAY
Yarrein
Stony Crossing
Billabong
Box Ck.
Moulamein
L. POON BOON
L. POOMAH
L. TALPILE
L. WOLLARE
Wood Wood
WAKOOL
NIEMUR
L. NANGTREE
RIVER
L. AGNES
EDWARD R.
Murrain Yarree Ck.
Papenue Ck.
Jambope Ck.
Nyah
Merrar Ck.
Coobool
RIVER
Myrtle Ck.
Boronong Ck.
Niemur
NIEMUR
Tyntynder
Woorinen North
Tyntynder Central
L. Trooin
Woorinen
Tyntynder South
Little Merran Ck.
Merran Ck.
Limerangle Ck.
Cochrans Ck.
RIVER
Barratta Ck.
Box Ck.
Browns Ck.
Billabong Forest
Miles Ck.
SWAN HILL
LITTLE MURRAY RIVER
PENTAL ISLAND
Fragmore Ck.
Simpsons Ck.
Eagle Ck.
Nyam Ck.
Barbers Ck.
Noorong Ck.
Couliger Ck.
Union Ck.
LONG LAKE
L. BOGA
Lake Boga
Ultima
Wakool
WAKOOL
RIVER
Yallakool
Merbit Ck.
Tresco
STORAGE RESERVOIR
Murrabit
LITTLE MURRAY RIVER
L. WHITMOUR
Yallakool
DENILIQUIN
SWAN LAGOON
Mystic Park
KANGAROO LAKE
LAKE CHARM
L. CHARM
MURRABIT
Barham
Koondrook
THE MARSH
DUKE LAKE
REEDY LAKE
BAEL BAEL LAKE
Lalbert
L. LALBERT
Lalbert Ck.
Thule
Thule Lagoon
Thule Ck.
The Creek Gully
Burrumbuzy Ck.
Gunbower Ck.
EDWARD R.
Billabong Ck.
SANDHILL LAKE
KERANG
Pyramid
RIVER
Barr Ck.
Gannawarra
Gunbower
Normanville
MURPHYS LAKE
Meade
COHUNA
McMillans
Mathoura
Quambatook
Tragowell
L. MEERING
Appin
LODDON R.
Macorna
Leitchville
Womboota
AVOCA R.
Leaghur
Canary Island
KOW SWAMP
Gunbower
MU

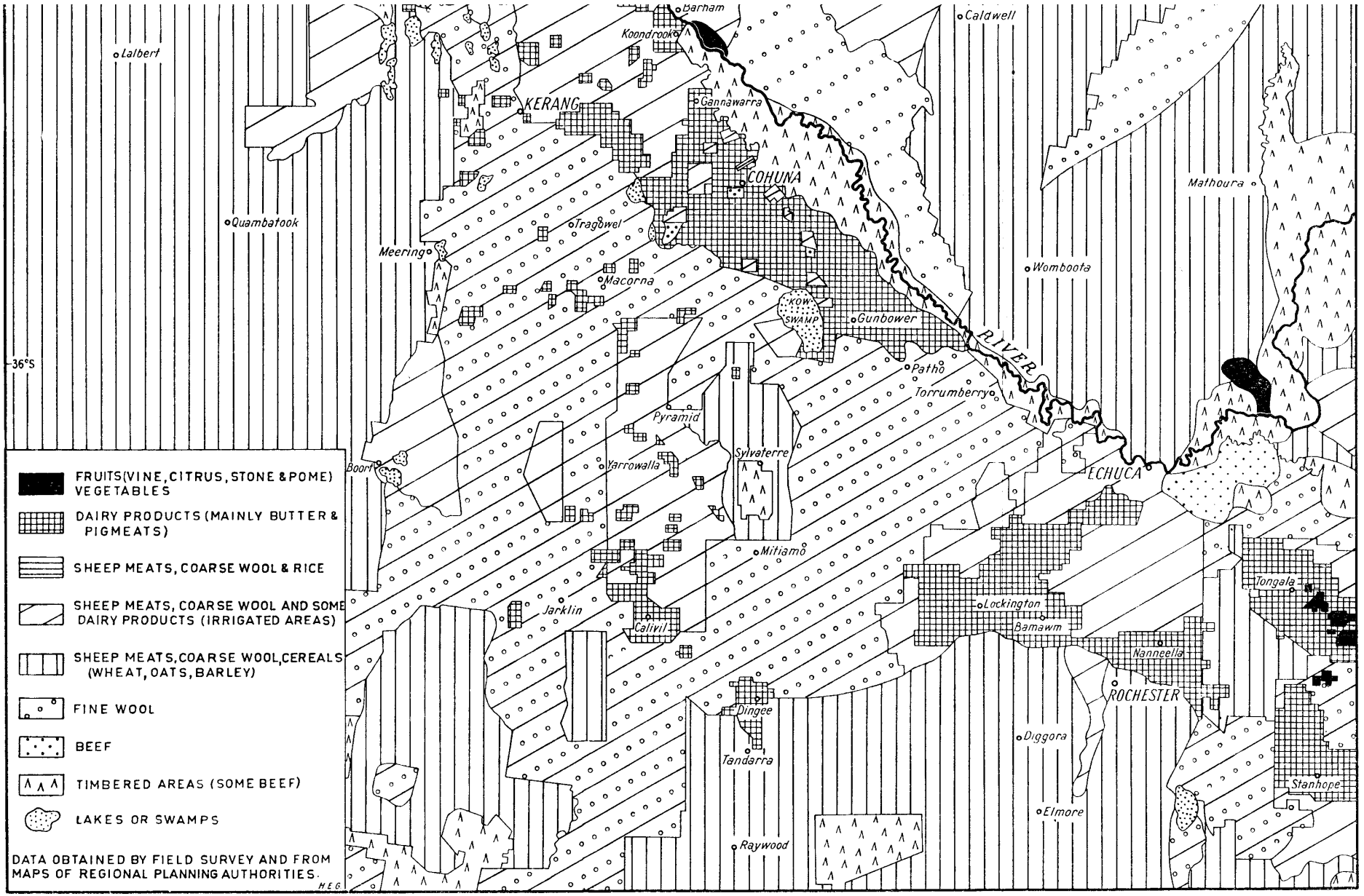
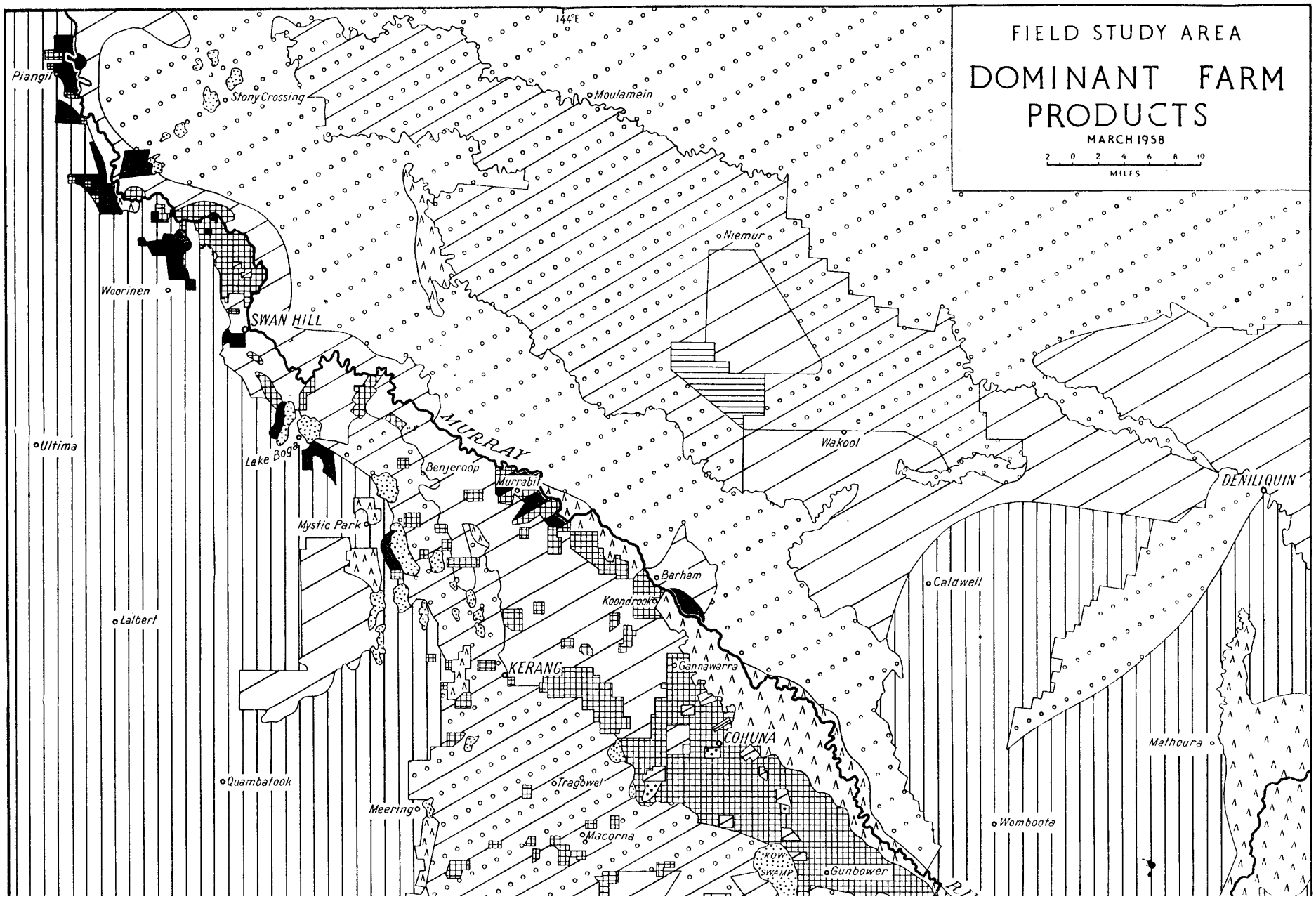


Fig. 7—Land Use in the "Field Study Area" according to Dominant Farm Products at March, 1958


FIELD STUDY AREA
DOMINANT FARM PRODUCTS
MARCH 1958
2 0 2 4 6 8 10
MILES
144°E
Piangil
Stony Crossing
Moulamein
Niemur
Woorinen
SWAN HILL
MURRAY
Ultima
Lake Boga
Benjeroop
Murrabit
Wakool
DENILIQUIN
Mystic Park
Barham
Koondrook
Caldwell
Lalbert
KERANG
Gannawarra
COHUNA
Mathoura
Quambatook
Tragowel
Meering
Macorna
Womboota
KOW SWAMP
Gunbower

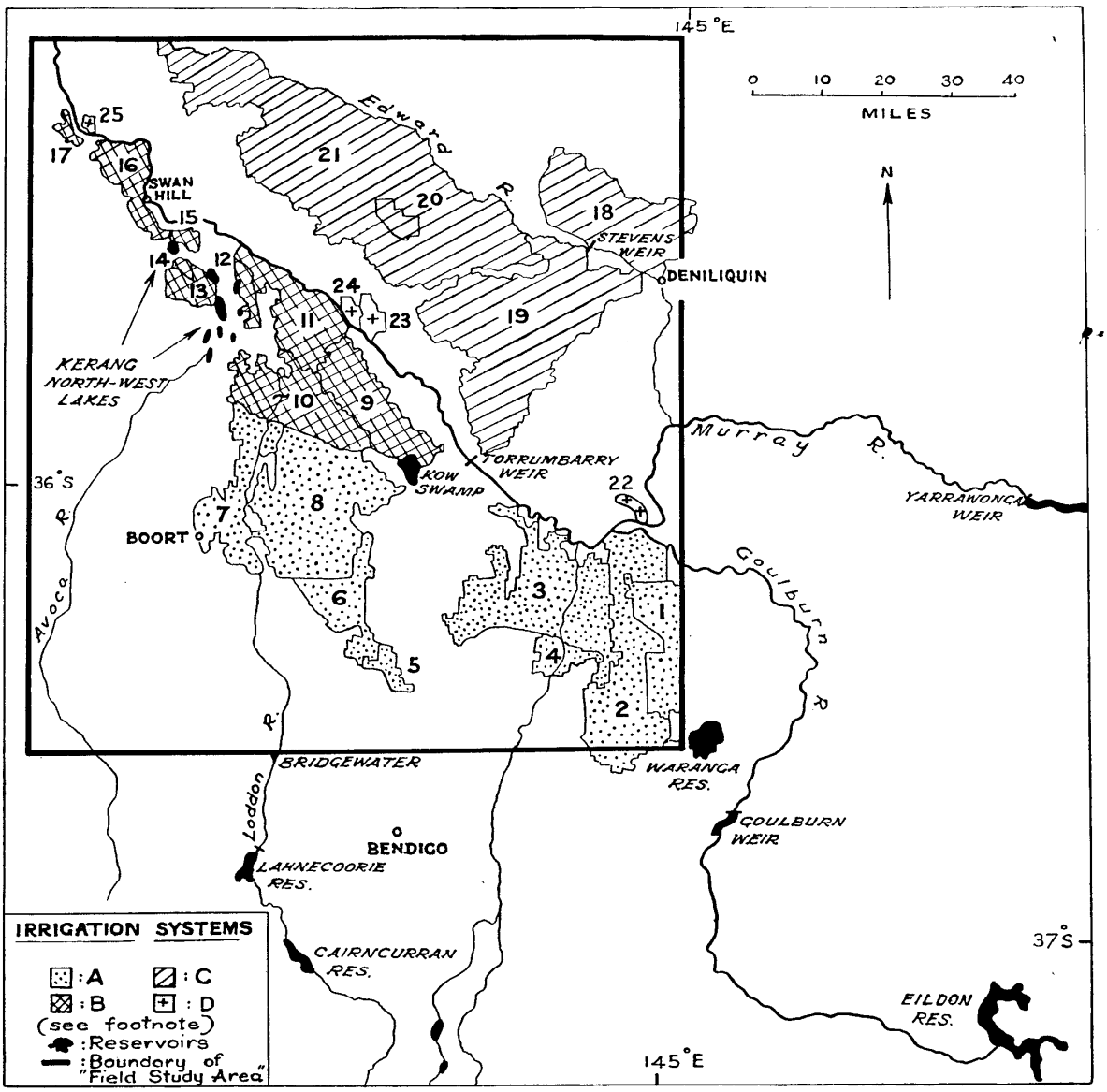


Fig. 8. Irrigation Systems serving the "Field Study Area"

A—Goulburn System: 1. *Tongala-Stanhope*, 2. *Deakin*, 3. *Rochester*, 4. *Campaspe*, 5. *Dingee*, 6 *Calivil*, 7. *Boort*, and 8. *Tragowel Plains*, *Irrigation Districts.*

B—Torrumbarry System (*Murray*): 9. *Cohuna*, 10. *Kerang*, 11. *Koondrook*, 12. *Third Lake*. 13. *Mystic Park*, 14. *Tresco*, 15. *Fish Point*, and 16. *Swan Hill*, *Irrigation Districts.*

~~*The Nyah Irrigation District* (17) *is supplied separately from the Murray.*~~

C—Riverina System (*Murray*): 18. *Denimein*, 19. *Deniboota* and 21. *Wakool*, *Irrigation Districts.*

Tullakool Irrigation Area supplied in same system (20).

D—Irrigation Trusts (*Murray*): 22. *Bama*, 23. *Bringan*, 24. *Glenview*, and 25. *Bungungah-Koraleigh.*

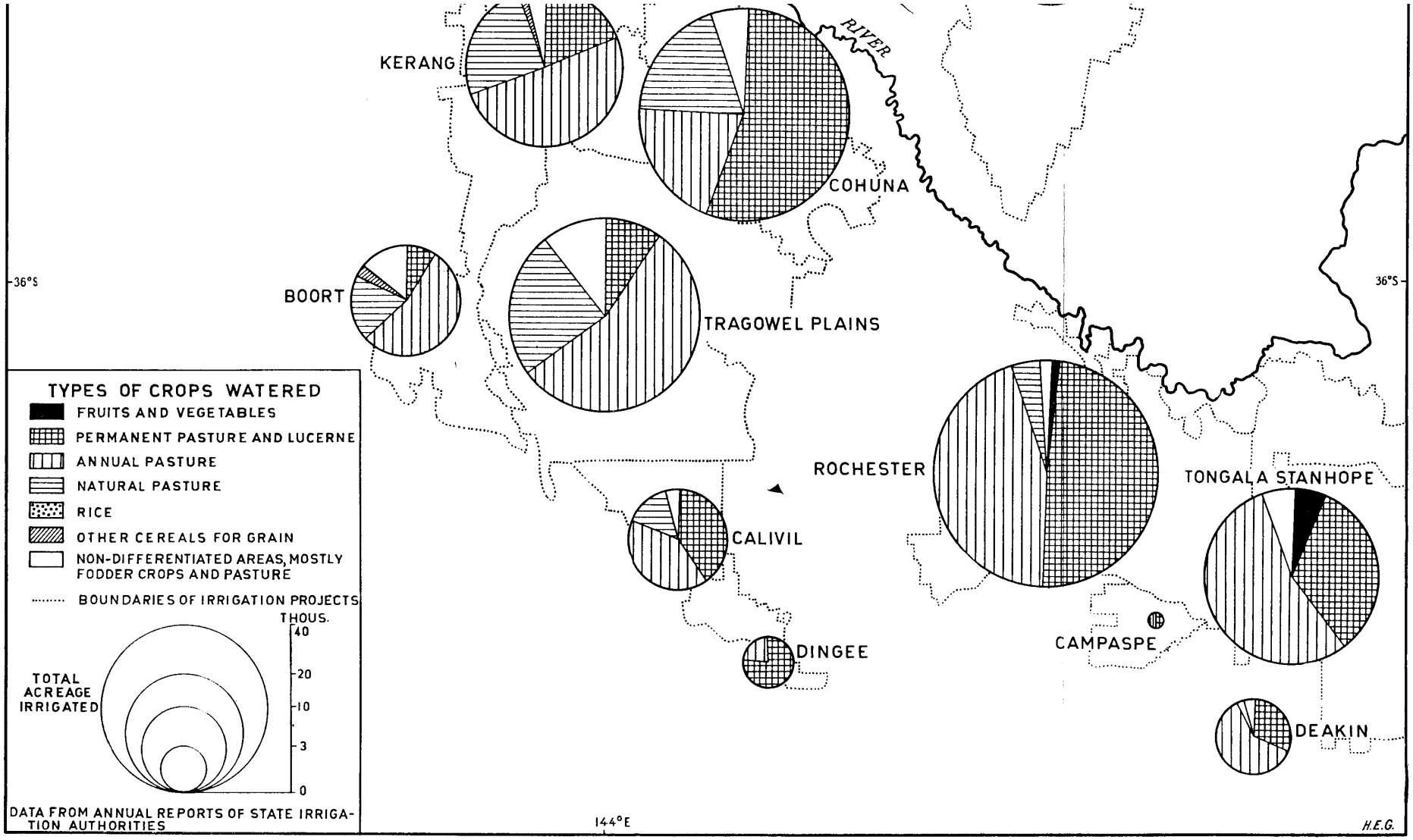
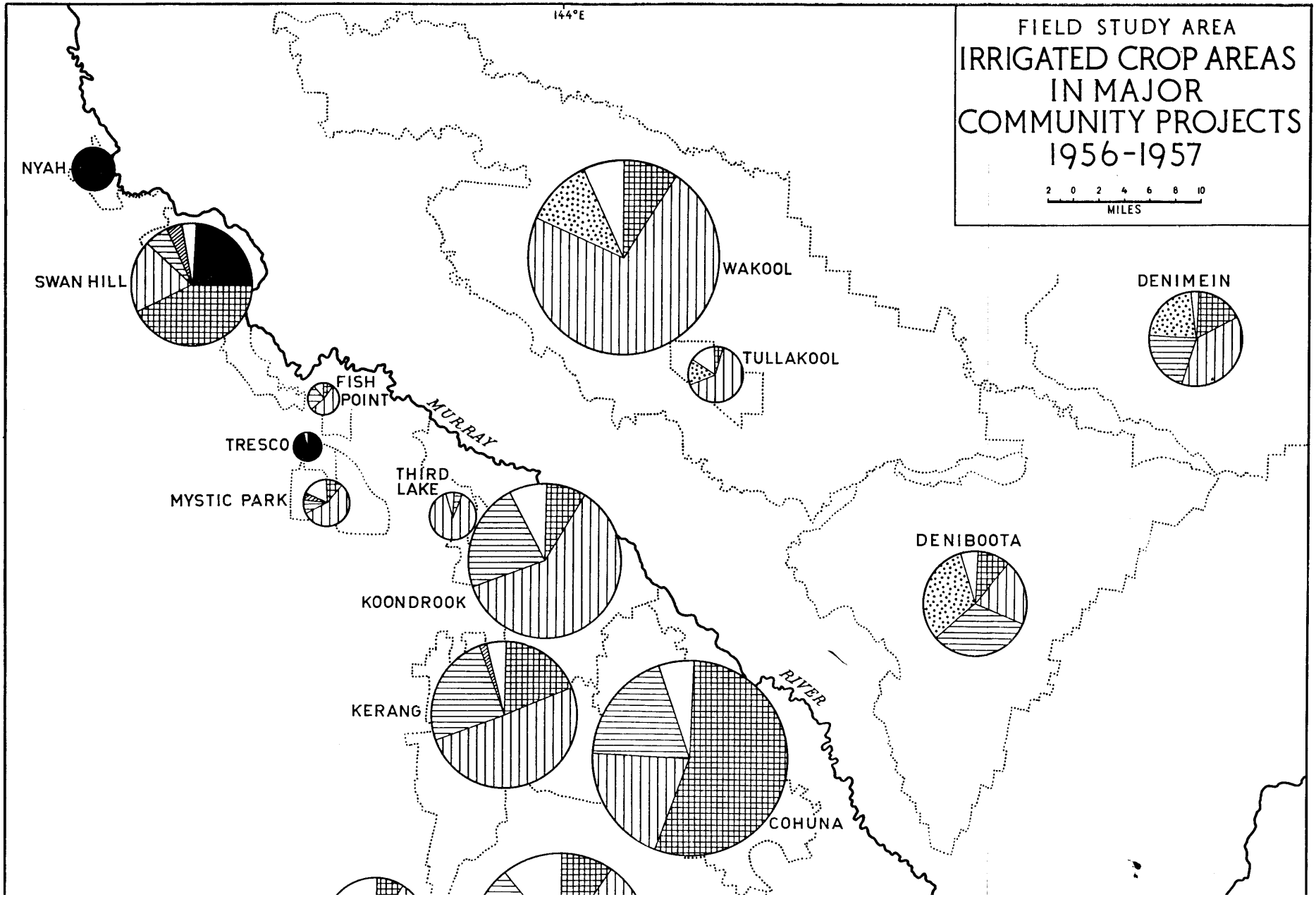


Fig. 9—Areas of Crops and Pastures Watered in "Field Study Area", 1956-57.

Note the importance of fruit and permanent pasture (dairying mainly) in the closer settlements of the Nyah, Swan Hill, Tresco, Cohuna, Calivil, Dingee, Rochester and Tongala-Stanhope irrigation districts. Improved annual and "natural" pastures are significant for sheep production in the other districts where closer settlement has not been sponsored greatly. Rice is not grown in the Victorian projects.


144°E
FIELD STUDY AREA
IRRIGATED CROP AREAS IN MAJOR COMMUNITY PROJECTS 1956-1957
2 0 2 4 6 8 10
MILES
NYAH
SWAN HILL
WAKOOL
TULLAKOOL
DENIMEIN
FISH POINT
MURRAY
TRESCO
MYSTIC PARK
THIRD LAKE
KOONDROOK
DENIBOOTA
KERANG
RIVER
COHUNA