



AGDEX $\frac{400}{05}$

RUMINANT INDUSTRY RESEARCH REVIEW

**Report to the
Research Policy Advisory Committee**



**DEPARTMENT OF AGRICULTURE
SOUTH AUSTRALIA**

**Technical Report No. 59
July 1984**

RUMINANT INDUSTRY RESEARCH REVIEW

Report by a Working Party to the
Research Policy Advisory Committee
South Australian Department of Agriculture

South Australian Department of Agriculture
Box 1671 G.P.O.,
Adelaide, S.A. 5001.

ISSN-0727-601X

DEPARTMENT OF AGRICULTURE
RUMINANT INDUSTRY RESEARCH REVIEW

<u>INDEX</u>	<u>PAGE</u>
1. Summary and Recommendations	1
Significance and effectiveness of SAGRIC ruminant research	2
Provision of ruminant research in South Australia	3
Resource allocation for SAGRIC ruminant research	3
Summary of ruminant research staff recommendations	5
2. Introduction	6
Background	7
Terms of reference	7
Membership	7
3. Method of Operation	8
Consideration of terms of reference	9
Framework for review and recommendations	9
Invited resource papers	9
Canvassing of comments and submissions	10
Discussions with SAGRIC research groups	10
SAGRIC research project information	10
Other research organisations	11
4. The Significance and Effectiveness of Ruminant Research and the Resources Used	12
Overview of the ruminant industries	13
Economic value of industries	13
Resources	13
Significance and effectiveness	15
Consideration of specific ruminant industries	18
Dairy industry	18
Beef industry	20
Sheep industry	21
Goat industry	22
Other ruminant industries	23
General veterinary/animal health research	23
Pasture	24
Multi-industry, affecting ruminant industries	25
5. Other Organisation Research Relevant to South Australian Ruminant Industries	27
Other South Australian research organisations	28
Research organisations interstate	29
6. Research Priorities for the South Australian Ruminant Industries	30
Method of determining research priorities	31
Research priorities	31
Dairy industry	31
Beef industry	33
Sheep industry	34
Goat industry	36
Other ruminant industries	36
General veterinary/animal health research	36
Pasture	36

	<u>PAGE</u>
7. Resource Allocation for SAGRIC Ruminant Research	38
Manpower allocation for the ruminant industries	39
Manpower, facilities, livestock and their location	45
Dairy research	45
Beef cattle research	46
Sheep research	46
Arid zone beef and sheep research	48
Goat research	49
General veterinary/animal health research	49
Pasture research	50
8. Acknowledgements	51
9. Appendices index	52

1. SUMMARY AND RECOMMENDATIONS

The Ruminant Industry Research Review Working Party was appointed by the Research Policy Advisory Committee of the South Australian Department of Agriculture (SAGRIC) in October 1981, to "examine the present resources and effectiveness of ruminant industry research and then develop a 10 year plan for ruminant industry research in SAGRIC that could best serve South Australian agriculture".

SIGNIFICANCE AND EFFECTIVENESS OF SAGRIC RUMINANT RESEARCH

The Working Party considered the overall standard of research to be high. However, it noted certain deficiencies in the areas of:

- * problem identification and establishment of research priorities;
- * completion of research projects;
- * extension of research findings;
- * imbalance and inadequate technical support staff in some areas.

The following are the Working Party's recommendations on these issues:

Recommendation 1: Establishment of research priorities

The South Australian Department of Agriculture should adopt formal procedures for advising on research priorities and on-going assessment of research projects in each of the ruminant industries, with appropriate representatives of industry and the Department. (Page 15)

Recommendation 2: Completion of research projects

The South Australian Department of Agriculture must ensure that research projects are taken through to completion including analysis and publication. Adequate support must therefore be provided, particularly in biometrics and computing services. (Page 17)

Recommendation 3: Extension of research findings

Research developments must be effectively transferred and promoted to the rural industries by:

- * *designation of specific officers responsible for the transfer of important research developments;*
- * *active marketing of research developments to potential users.*

(Page 17)

Recommendation 4: Provision of technical support

The effective research time of professional staff should be improved by ensuring adequate technical support. A ratio of 1.0 technical per professional officer in research should be the core State-funded complement. (Page 17)

PROVISION OF RUMINANT RESEARCH IN SOUTH AUSTRALIA

The Working Party reviewed ruminant research in SAGRIC and other organisations and makes the following recommendation:

Recommendation 5: Role of SAGRIC in ruminant research

The South Australian Department of Agriculture should continue to provide the majority of the applied ruminant industry research for South Australia.
(Page 28)

RESOURCE ALLOCATION FOR SAGRIC RUMINANT RESEARCH

The Working Party assessed the overall resource requirements for SAGRIC ruminant research and considers that maximum efficiency will be achieved by provision of industry-specific research centres. It therefore makes the following recommendations:

Recommendation 6: SAGRIC resources for ruminant research

The present proportions of professional manpower and annual expenditure in SAGRIC allocated to the ruminant industries are appropriate and should be at least maintained, based on the current value of the ruminant industries relative to the other agricultural industries.
(Page 39)

Recommendation 7: Dairy research

- (a) *Dairy research should be located within a major dairying area in the Adelaide Hills. A research centre should be established, with approximately 250-300 hectares to accommodate a herd of 120-150 milking cows plus followers.*
- (b) *The professional staff for dairy research should be a total of 6.0 research officers, with equivalent technical support, working in the following disciplines: genetics and reproduction (1.0), nutrition and grazing management (2.5), veterinary/animal health (1.0), and product technology (1.5).*
- (c) *Ultimately, all dairy research in both production and technology should be located at this centre.*
(Page 45)

Recommendation 8: Beef research

- (a) *Beef cattle research should be consolidated at Struan Research Centre, with a base herd of between 600 and 800 beef cattle run on the Centre. Existing beef herds on Turretfield, Parndana and Wanbi Research Centres should be disposed of when their involvement in current research projects ceases.*
- (b) *The professional staff for beef cattle research should be a total of 4.5 research officers, with equivalent technical support, working in the following disciplines: genetics and reproduction (1.0), husbandry and livestock management (0.5), nutrition and grazing management (1.0), veterinary/animal health (1.0), and product quality/marketing (1.0).*
- (c) *Ultimately, all beef cattle research should be located at Struan Research Centre.*
(Page 46)

Recommendation 9: Sheep research

- (a) The South Australian Department of Agriculture should consolidate its sheep research resources (manpower, sheep and facilities) into two major centres: the first within the cereal/sheep zone, logically at Turretfield Research Centre, to cater for the requirements of the Merino sheep and wool industries; the second within the high rainfall area, to be centred on Struan Research Centre, primarily for research on sheepmeat production. Each centre should carry approximately 3 000 breeding ewes as the basis for the Departmental sheep research programmes.

Regional research centres, running sheep as part of normal farm management, would provide additional livestock resources for sheep research.

- (b) The professional staff for sheep research should be a total of 13.5 research officers, with equivalent technical support, working in the following disciplines: genetics and reproduction (5.0), husbandry and livestock management (1.0), nutrition and grazing management (3.0), veterinary/animal health (3.5), and product quality/marketing (1.0).
- (c) Ultimately, the allocation of resources for the sheep industry should approximate 75% to wool industry research and 25% to sheepmeat industry research. (Page 48)

Recommendation 10: Arid zone research

- (a) Arid zone research staff should be based at Northern Regional Headquarters, Port Augusta, and operate as a mobile group working on private properties.
- (b) The professional staff for arid zone ruminant research should be a total of 2.0 man years per annum, working with both cattle and sheep in the disciplines of husbandry and livestock management, and nutrition and grazing management (rangeland management).
- (c) Ultimately all arid zone research staff should be based at Port Augusta. (Page 49)

Recommendation 11: Goat research

- (a) Provision of specific SAGRIC facilities for goat research cannot be justified. The use of private co-operators' flocks is adequate for envisaged research needs.
- (b) The professional staff for goat research should amount to 0.2 man years per annum, across the disciplines of genetics and reproduction, husbandry and livestock management, nutrition and grazing management, and veterinary/animal health. Such staffing level should be achieved by utilizing research officers from appropriate disciplines in the major ruminant species. (Page 49)

Recommendation 12: General animal health research

- (a) Direct veterinary input into the major research groups for each industry should be strengthened by locating officers with veterinary research training at the respective industry research centres.
- (b) General veterinary research should be located in Adelaide in the veterinary laboratories of the Veterinary Sciences Division.
- (c) The professional staff for general veterinary research should be a total of 6.0 man years per annum. (Page 49)

Recommendation 13: Pasture research

- (a) Pasture breeding research should be located at one site, currently Northfield Research Laboratories.
- (b) The number of professional man years per annum devoted to pasture breeding should be 5.0.
- (c) Coordinated programmes between the breeding centre and staff on specialist livestock research centres should be developed to evaluate new varieties as they become available for release, for animal production systems. (Page 50)

SUMMARY OF RUMINANT RESEARCH STAFF RECOMMENDATIONS

In brief, the Working Party recommendations for the core State-funded research staff allocation to ruminant research in SAGRIC are:

Research Area/Discipline	Industry				
	Dairy	Beef	Sheep	Goat	Multi-industry
Genetics and reproduction	1.0	1.0	5.0	} 0.1	} 2.0
Husbandry and livestock management	0.1	0.5	1.0		
Nutrition and grazing management	2.4	1.0	3.0		
Veterinary/animal health	1.0	1.0	3.5	0.1	6.0
Product technology					
- quality	1.5	} 1.0	} 1.0	-	-
- processing					
Marketing	-			-	-
Pastures					5.0
TOTAL	6.0	4.5	13.5	0.2	13.0

In addition, the core State-funded staffing levels for technical and support staff should be the same as for professional (research) officers, giving a 1:1 professional : technical and support staff ratio.

2. INTRODUCTION

2.1 BACKGROUND

The Research Policy Advisory Committee was established in 1979 to provide objective advice to the South Australian Department of Agriculture (SAGRIC) on its research policies. One method it has adopted is to commission in-depth reviews of specific areas of research in SAGRIC. In October 1981, it appointed the Ruminant Industry Research Review Working Party to "examine the present resources and effectiveness of ruminant industry research and then develop a 10 year plan for ruminant industry research in SAGRIC that could best serve South Australian agriculture".

Such a review was considered necessary because the present distribution of resources both between and within each of the ruminant industries was recognised as not necessarily reflecting current industry needs and relative importance to the State's economy. This distribution of resources has been influenced by the number of original appointments made, the interest of staff in tackling the various problems of these industries, and the random attrition of staff in recent years.

2.2 TERMS OF REFERENCE

The terms of reference of the Working Party were:

1. Review the significance and effectiveness of the research being conducted by SAGRIC in each of the ruminant industries and identify the resources used in each area.
2. Identify the research carried out in the ruminant industries in other organisations in South Australia, and elsewhere in Australia which has direct relevance to S.A. ruminant industries.
3. Identify and rank the research priorities and the research resources in SAGRIC needed for the ruminant industries which would best serve the needs of South Australian agriculture for the next decade.
4. Advise on changes in staff and resource allocation in SAGRIC which would meet those identified research priorities and needs.

2.3 MEMBERSHIP

The Ruminant Industry Research Review Working Party consisted of:

J.R. Hawker, Sheep and beef cattle stud breeder, "Anama", Clare,
(Convenor);
A.A. Kuhl, Dairy/sheep/beef grazier, "Braelee Estate", Mount Gambier;
Dr. A.S. Pell, Principal Research Officer, Animal Industry Division;
N. McK. Smith, Cereal/sheep farmer, Maitland;
R.M. Steed, Assistant General Manager, Dairy Vale Metro Co-operative
Ltd., Clarence Gardens;
R.B. Wickes, Principal Officer, Research Management;
J.P. Egan, Senior Research Officer, Turretfield Research Centre
(Technical Secretary);
Consultant on Animal Health matters (appointed subsequently):
Dr. D.E. Gardner, Director, Veterinary Laboratory Services.

3. METHOD OF OPERATION

3.1 CONSIDERATION OF TERMS OF REFERENCE

For the purposes of this review, the Working Party interpreted its terms of reference as including the dairy, beef, sheep and wool and goat industries, with brief attention given to other ruminant species which could form the basis of viable industries in the next decade. Production, protection (animal health, disease, etc.) and processing research needs and activities were addressed by the Working Party within each of these industries.

The vital importance of pastures to the ruminant industries was recognised early in discussions and consequently research needs and activities in the pasture area, of relevance to the ruminant industries, were considered.

A number of other research areas and disciplines were recognised as being important to the State's ruminant industries, including soil, water, economics and marketing, but these have not been examined in depth by the Working Party.

Although the terms of reference specifically directed the Working Party to look at research needs and activities, some comment on extension needs and methods was considered desirable because extension of research findings is an important component of the effectiveness of research.

3.2 FRAMEWORK FOR REVIEW AND RECOMMENDATIONS

To provide a standard format for looking at research activities, research needs and resource allocation, the Working Party adopted an industry x discipline matrix, as used by Standing Committee on Agriculture for reporting on research and extension resource allocation at a national level for State Departments and C.S.I.R.O. The industries covered are dairy, beef, sheep, goats, multi-ruminant and pasture, in combination with the following 5 areas of research discipline:

- * General Resource, which includes agricultural chemicals, soils and fertilizers; non-commodity oriented disciplines; and agricultural engineering;
- * Production, which includes genetics and reproduction; husbandry and livestock management; and nutrition and grazing management;
- * Protection, which includes animal health; entomology; plant pathology; weeds; and vertebrate pests;
- * Product Technology, which includes harvesting and processing; and quality and quality control;
- * Extension and Economic Services, which includes extension and social factors; farm business management; and general economics and marketing.

3.3 INVITED RESOURCE PAPERS

To provide industry information to the Working Party, and as a basis for seeking comment from both within and outside SAGRIC, the Working Party invited a number of SAGRIC officers to prepare specific industry resource

papers. Nine such papers were prepared, on Dairy Cattle Production, Dairy Processing, Beef Cattle Production, Wool, Sheepmeats, Live Sheep Export, Goats, Deer, and Veterinary and Animal Health (Appendices I.1 to I.9).

3.4 CANVASSING OF COMMENTS AND SUBMISSIONS

Copies of all resource papers and of the terms of reference of the review were circulated widely throughout SAGRIC and 11 submissions were received (Appendix II.1).

Copies of the terms of reference of the review and relevant resource papers were sent to 35 organisations or associations involved with the ruminant industries in South Australia seeking their comments and views.

In addition, advertisements in the rural press invited further enquiry or written submissions from interested persons or organisations.

A total of 18 submissions were received from outside of SAGRIC, as listed in Appendix II.2.

3.5 DISCUSSIONS WITH SAGRIC RESEARCH GROUPS

In order to discuss research programmes, priorities and resource allocations for the ruminant industries, the Working Party met with research groups at:

- * Northfield Dairy Research Centre (dairy production and processing);
- * Northfield Research Laboratories (pasture research including work at Parndana Research Centre);
- * Turretfield Research Centre (beef, sheep, goats, pasture and multi-industry research);
- * Struan and Kybybolite Research Centres, and the South East Regional Veterinary Laboratory (beef, sheep, pasture and animal health/veterinary research);
- * Animal Industry Division, Grenfell Centre (sheep research, including work at Kybybolite, Minnipa, Struan and Turretfield Research Centres, and Cape Borda Research Farm);
- * Veterinary Sciences Division, Frome Road (animal health and disease research).

3.6 SAGRIC RESEARCH PROJECT INFORMATION

In addition to technical information on current research projects gained by discussions with the various research groups, information on the aims, location and resource allocation to all SAGRIC research projects was obtained from the 1982/83 Project Performance Budgeting estimates. On the basis of this information, research projects of relevance to the ruminant industries were classified in the Industry x Discipline matrix described earlier, and listed in Appendix III.1. General research management and research centre/laboratory management projects have not been included in this listing.

Resource allocation to each of the ruminant industry research areas was determined on the basis of these project classifications and the project budgeting information. Since salaries and wages constitute the major part (approximately 70%) of research expenditure, the assessment of resource allocation has concentrated mainly on the manpower allocations

to each of the industries and research disciplines (Appendices III.2, III.3, III.4 and III.5).

3.7 OTHER RESEARCH ORGANISATIONS

Information on current research programmes likely to be relevant to South Australian ruminant industries was sought from 39 organisations around Australia known or considered likely to be conducting such research (i.e. Departments of Agriculture/Primary Industry, C.S.I.R.O. Divisions, Universities and Agricultural Colleges).

Replies were received from 32 of these organisations, listed in Appendix IV.2. The information obtained from these organisations has been summarised and is available on request.

4. THE SIGNIFICANCE AND EFFECTIVENESS OF
RUMINANT RESEARCH AND THE RESOURCES USED

4.1 OVERVIEW OF RUMINANT INDUSTRIES

4.1.1 Economic value of industries

Table 4.1 shows the mean local value for each of the ruminant industries in South Australia over the five year period up to and including 1981/82. SAGRIC expenditure for research in each industry (mean of 2 years) is also given.

Table 4.1 The mean local value of the ruminant industries taken over 5 years and the expenditure by SAGRIC in each industry.

Industry	Mean Local Value [†] (1977/78 to 81/82) (\$000's)	SAGRIC Expenditure 80/81, 81/82 (\$)
Dairy and fodder production	66 456	596 095*
Beef	109 438	332 362*
Sheep	276 097	727 011*
Goats	336	1 975
Pasture (50%)	3 077	293 597
Total	455 404	1 951 040

[†] Australian Bureau of Statistics

* Includes an estimate of research expenditure in the Veterinary Sciences Division, SAGRIC.

4.1.2 Resources

Current SAGRIC research projects of relevance to the ruminant industries are listed in Appendix III.1. The current total manpower allocation to each industry in SAGRIC is summarised in Table 4.2. This table has been derived from Appendices III.2, III.3, III.4 and III.5 for professional, technical and ancillary support, and weekly paid staff respectively. This table includes manpower allocation on research centres for general livestock operations (i.e. not assigned to specific research projects), but excludes research centre management and requirements for basic farm operation. Partitioning of this manpower between industries has been made on the basis of information supplied for the Review of Research Centres, 1983 (South Australian Department of Agriculture Technical Report No. 32).

The general veterinary/animal health category shown in Table 4.2 includes those projects which do not relate to specific industries. Some of these projects are not entirely restricted to the ruminant industries, but may also have relevance to other animal industries, notably pigs and poultry. No attempt has been made in these instances to partition the resource allocation to individual industries. Where veterinary/animal health projects are specific to only one or two ruminant industries however, the resource allocation to these has been included in industry totals.

Table 4.2 Current manpower input to SAGRIC ruminant industry research (year ending June 30, 1983). State-funded man-years are given, with additional Industry-funded man-years in parentheses.

Industry	Salaried Staff			Weekly Paid Staff*	TOTAL STAFF	% OF TOTAL STATE-FUNDED RUMINANT INDUSTRIES STAFF
	Professional*	Technical*	Ancillary*			
Dairy	8.9	7.3	4.0	6.0 (0.9)	26.2 (0.9)	37.8
Beef	4.2 (0.5)	2.2 (3.0)	1.0 (0.5)	5.5 (1.0)	12.9 (5.0)	18.6
Sheep	12.2 (0.5)	2.1 (3.0)	3.1 (0.5)	3.5 (1.1)	20.9 (5.1)	30.1
Goats	0.1	0.2	0	0	0.3	0.4
General Veterinary/ Animal Health	5.5 (1.0)	3.1 (3.0)	0.5	0	9.1 (4.0)	13.1
TOTAL DIRECT RUMINANT INDUSTRIES	30.9 (2.0)	14.9 (9.0)	8.6 (1.0)	15.0 (3.0)	69.4 (15.0)	100.0
Pasture	5.2 (3.4)	5.9 (8.0)	2.3 (4.0)	8.8 (4.8)	22.2 (20.2)	
Multi-industry	27.0	13.3	9.1	1.5	50.9	

* "Professional" generally refers to research officers, or the research component of extension or veterinary staff activities;
 "Technical" generally refers to technical officers or laboratory technicians;
 "Ancillary" generally refers to field assistants;
 "Weekly Paid Staff" general hands and casual labour.

Contribution of the multi-industry research (soil, water, social science and economics) to the ruminant industries is difficult to assess. Therefore, partitioning of the manpower resource allocation to multi-industry research between ruminant industries and other livestock, agricultural and horticultural industries has not been attempted, but it is listed as a separate item in Table 4.2.

SAGRIC research facilities involved in ruminant industry research are listed in Table 4.3. Again, most of these facilities service multiple industries and a realistic partitioning of the resource allocation to each between the industries served is difficult. Most of the SAGRIC research work in the major ruminant industries (sheep, beef and dairy cattle) is conducted on Departmental research centres, or on leased properties at Cape Borda (Kangaroo Island) and Wandilo (South East). Only a few smaller scale experiments are conducted on private properties. The operation of research centres has been the subject of a separate Working Party Review recently (Review of Research Centres; South Australian Department of Agriculture, Technical Report No. 32 [1983]).

4.1.3 Significance and effectiveness

In assessing the significance and effectiveness of SAGRIC research in the ruminant industries, several key issues common to all industries and, it would appear, to rural research in general, emerged.

(i) The mechanism of determining research priorities:

The need for an on-going forum to identify producer problems and translate these into research and extension needs, potential value and priorities was identified in almost all industries, by producers, agribusiness and SAGRIC officers. Industries expected to benefit from research must be involved in the initial establishment of research priorities and proposals. The tendency for research priorities to reflect the interests of research workers rather than the needs of industries will thereby be minimised. The Working Party commended recent moves within the Department to establish formal research liaison links with the respective industries, or with distinct agricultural regions.

Recommendation 1: Establishment of research priorities

The South Australian Department of Agriculture should adopt formal procedures for advising on research priorities and on-going assessment of research projects in each of the ruminant industries, with appropriate representatives of industry and the Department.

A suitable procedure would be the formation of both Industry Research Advisory Committees and, where appropriate, Regional Research Liaison Councils. Departmental and producer representatives on these committees should have extensive industry knowledge and experience, and an appreciation of research needs. Membership should be for a renewable fixed term.

(ii) Completion of research projects:

Research work cannot be fully effective until research projects are brought to a satisfactory conclusion by scientific analysis of results and publication thereof. Currently, deficiencies are noted in the areas of

Table 4.3 SAGRIC facilities involved in ruminant industry research.

Location	Area (ha)	Livestock Numbers*		Ruminant industry and related research areas
		Cattle	Sheep	
<u>Research Centres</u>				
Kybybolite	301	-	2684	Pasture utilisation; high rainfall sheep production.
Minnipa	1202	-	1605	Sheep management and reproduction in cereal/sheep zone.
Northfield	245	177	124	Dairy cattle management, nutrition and genetics; dairy product quality and processing technology; sheep nutrition; fodder conservation; pasture breeding.
Parafield Plant Introduction Centre	23	-	-	Screening of pasture species.
Parndana	497	94	2998	Pasture renovation and clover infertility in sheep; internal parasites in beef.
Struan	1093	574	1614	Beef management, nutrition, genetics and breeding; crossbred lamb production.
Turretfield	650	176	2079	Beef crossbreeding and production; sheep management, nutrition and genetics in cereal/sheep zone; pasture screening.
Wanbi	1424	180	610	Beef crossbreeding; sheep and cattle grazing management.
Wandilo (leased)	272	136	-	Beef crossbreeding.
Cape Borda (leased farm)	350	-	3699	High fertility Merinos on oestrogenic clover; resistance to blowfly strike.
<u>Research Laboratories</u>				
Northfield	-	-	-	Soil and water, pasture plant screening, entomology, weeds.
Veterinary Sciences Division - Frome Road and Struan (SERVL)	-	-	-	Immunology, biochemistry, pathology, microbiology, parasitology and virology investigations.
Plant Pathology Unit - Waite Agricultural Research Institute	-	-	-	Annual ryegrass toxicity.
TOTALS	6057	1337	15413	

* Livestock numbers at March 31, 1984.

statistical and computing support. This has resulted in considerable delays. Failure of research officers to see projects through to completion was recognised as a limitation to the effectiveness of some research projects in the past.

Recommendation 2: Completion of research projects

The South Australian Department of Agriculture must ensure that research projects are taken through to completion including analysis and publication. Adequate support must therefore be provided, particularly in biometrics and computing services.

(iii) Research/extension gap:

Effectiveness of research was limited in a number of cases, even after proper analysis and scientific publication, by the results having not been adopted by the end-use industries to any significant extent. SAGRIC has relied in the past on research officers to transfer their information. While this is effective in certain cases, it is not reasonable to expect all research officers trained in science to be effective marketers of information.

Recommendation 3: Extension of research findings

Research developments must be effectively transferred and promoted to the rural industries by:

- * *designation of specific officers responsible for the transfer of important research developments;*
- * *active marketing of research developments to potential users.*

(iv) Staffing imbalances and shortages:

The effectiveness of research was reduced in a number of units by a lack of technical support staff, resulting in the research staff themselves having to do much of the more routine field and laboratory work. This situation was further aggravated by the requirement for research staff to handle an increasing load of administrative and clerical duties. There had also been a loss of experienced research staff to administrative positions in recent years, due partly to limitations on the career pathways in research.

Recommendation 4: Provision of technical support

The effective research time of professional staff should be improved by ensuring adequate technical support. A ratio of 1.0 technical per professional officer in research should be the core State-funded complement.

4.2 CONSIDERATION OF SPECIFIC RUMINANT INDUSTRIES

4.2.1 Dairy industry

Resources

There are currently 8.9 professional man-years devoted to dairy research comprising 4.5 in Production research, 0.7 in Protection (mainly related to mastitis), and 3.6 in Product Technology. Technical support staff directly involved in dairy research projects amounts to a further 7.3 man-years. An additional 4.0 man-years is provided as ancillary staff, and 6.9 man-years as weekly paid staff. A total of 27.1 man-years is therefore allocated to dairy research. All dairy research positions are State-funded except for the equivalent of 0.9 man-years provided as casual labour from the Australian Dairy Research Committee.

Most of SAGRIC dairy research is conducted on the Northfield Research Centre, with a number of small experiments located on private properties (e.g. in the Lower Murray irrigated flats).

Significance and effectiveness

(i) Dairy production

South Australia has the highest average butterfat production per cow in Australia today. Research must be credited with having played a part in the State's dairy herds reaching these current high levels of production.

SAGRIC research in the dairy production area was considered to have been both significant and effective, as judged by relevant research completed over the last decade. Many of the findings are now a part of routine management on a large number of S.A. dairy farms. Achievements in this area particularly relate to dairy cow management and feeding, and to fodder production, conservation and utilisation.

The level of acceptance of much of this research may be attributable to the system of assessing the relevance and applicability of all research proposals within the dairy section, whereby research and extension staff discuss proposals prior to prescheduling. More recently, the establishment of a joint Industry/Farmer/Departmental Dairy Research Advisory Committee has the potential to allow research topics to be effectively examined in the initial stages of research priority establishment and project planning. This should allow the needs of the industry to be more accurately reflected in SAGRIC research programmes.

A major factor limiting the significance of the overall dairy production research programme is the lack of a suitable SAGRIC facility for high rainfall dairy research. While the Northfield Dairy Research Centre is well suited to conducting research on dairy cow feeding and dairy production/milk quality interaction studies, the important area of pasture production and management for dairy production in a high rainfall environment is not adequately provided for. Thus, while the relevance of the Northfield dairy husbandry research programme to the important Adelaide Hills and South East dairying areas is not doubted, the ability of SAGRIC to adequately cater for the research needs of these areas is restricted.

The effectiveness of past research has been limited to some degree by deficiencies at the interface of research and extension to the farmer. Improvement could be achieved with greater liaison between Departmental research and extension staff, and between them and the dairy farmer and industry. Steps to improve this information flow have been suggested in Recommendation 3.

(ii) Dairy technology

In the dairy technology area, SAGRIC research covers two broad areas:

- (i) product quality and quality control;
- (ii) processing technology.

Research work in the product quality and quality control area has been of direct relevance to industry and the dairy farmer. The work in the area of development of methods for rapid identification and counting of bacteria, the effect of mastitis on the manufacturing properties of milk, and mastitis within the dairy herd generally, has been widely recognised. The establishment of somatic cell counting on a regular basis with results being communicated to milk producers is evidence of the effectiveness of past research in this area, as is the current testing of the Northfield-developed rapid fluorescence method for counting bacteria in milk.

There is a need for a continuing SAGRIC role in areas of mastitis control, bacteriology and milk quality control generally. Greater emphasis on extension rather than research would yield more immediate benefits.

A limitation has been a shortfall in veterinary involvement in mastitis research. This deficiency needs to be redressed in future work in this area. In the area of mastitis research, maximum impact will be achieved by a combined team approach involving research workers, extension officers and veterinarians.

Within the dairy processing industry over recent years, there has been amalgamation of the State's dairy processing operations into a small number of large companies. Those companies have invested in their own research and development sections with a resultant decreased reliance of the industry on SAGRIC research in processing technology.

The significance of some past research to dairy processors in the State and its relevance to their needs has been questioned. A particular case is the long term study of the effect of milk protein genotype on milk protein composition and manufacturing properties. However, the recent demonstration of the quantitative improvements possible suggests that this technology has potential commercial value.

If SAGRIC is to continue to play a meaningful role in the dairy technology area, its research must become more directly oriented to industry needs and the Department must effectively extend its research activities and findings into the industry.

4.2.2 Beef industry

Resources

The current allocation of staff to beef industry research is 4.7 professional man-years (3.4 to Production research, 1.3 to Protection), 5.2 technical man-years, 1.5 ancillary man-years and 6.5 weekly paid man-years. The total allocation to beef research is therefore 17.9 man-years. Of the above totals, rural industry research funding provides for 0.5 professional, 3.0 technical, 0.5 ancillary and 1.0 weekly paid man-years. The major external source of funding for beef research is the Australian Meat Research Committee (A.M.R.C.), with one project on cattle marketing methods funded by the National Carcase Classification Supervisory Committee.

Beef research is conducted on Parndana, Struan, Turretfield and Wanbi Research Centres in the main, with some crossbreeding research on the leased property at Wandilo in the South East. Other Animal Health and Protection research is based at the Veterinary Sciences Division's Frome Road Laboratories, the South East Regional Veterinary Laboratories and at the Plant Pathology Unit at the Waite Agricultural Research Institute (annual ryegrass toxicity). A project on beef cattle marketing is conducted from within the Animal Industry Division in Grenfell Centre.

Significance and effectiveness

In assessing the significance of the current SAGRIC research programme for the State's beef industry, it was noted that the major emphasis is on improving beef production levels. No attempt is being made to determine and quantify the causes and extent of economic loss, either on-farm or in the marketing chain.

The significance of a number of SAGRIC beef research projects was questioned on the grounds of their relevance to the existing or likely future trends in beef production in this State, or through them being duplicated elsewhere. The Working Party questioned the large resource commitment to the evaluation of crossbreeding/straight breeding strategies, while growth stimulants are being extensively examined in other organisations.

SAGRIC's beef research programme was seen as lacking balance with a number of the priority research areas identified by producer organisations not adequately covered, e.g. pastoral zone beef production and management, pasture production, reproduction, and the cost effectiveness of disease control methods. This suggests that, in the past, SAGRIC has not obtained effective input from the ultimate users in setting objectives for beef research programmes.

With regard to the effectiveness of the SAGRIC research programme for the beef industry, the Working Party was concerned that some projects, although listed as being conducted, were not being undertaken effectively, if at all. This particularly relates to several projects in the area of disease information and control.

One of the prime measures of the effectiveness of the SAGRIC research programme should be the degree of adoption of research findings by producers. This was recognised as low for much of the beef research,

particularly in the most actively researched area of genetics and reproduction. Reasons for the poor adoption rate of many of the research findings include the low priority placed on cattle by farmers with mixed enterprises and a lack of active extension of research results. In the case of crossbreeding of certain breeds, despite the demonstrated benefits, market prejudices were also seen as severely restricting adoption by producers.

4.2.3 Sheep industry

Resources

Sheep industry research has an allocation of 12.7 professional man-years, 5.1 technical man-years, 3.6 ancillary staff man-years and 4.6 weekly paid man-years. Total allocation to sheep research (including casual labour) is therefore in excess of 26.0 man-years. A large proportion (5.1 man-years) of the professional manpower devoted to sheep research is in the genetics and reproduction area, with other major emphasis on nutrition and grazing management (2.6 man-years) and on animal health (3.8 man-years). Of the above manpower totals, rural industry research funds provide for 0.5 professional, 3.0 technical, 0.5 ancillary and the equivalent of about 1.1 weekly paid man-years. Major sources of external funding for sheep research are the Wool Research Trust Fund and the Australian Meat Research Committee.

Sheep research is conducted on Kybybolite, Minnipa, Northfield, Parndana, Struan, Turretfield and Wanbi Research Centres, and on the Cape Borda leased property. Several small scale experiments are run on private properties. The Animal Industry Division, Sheep Research Group, consisting of seven research officers based in Grenfell Centre, conducts research mainly on the Minnipa and Turretfield Research Centres, on Cape Borda, and on several private properties. They also make use of wool testing laboratory facilities in outside organisations. Much of the animal health and disease research of the Veterinary Sciences Division's laboratories is also directly relevant to the sheep industry, as is the annual ryegrass toxicity work of the SAGRIC Plant Pathology Unit at the Waite Agricultural Research Institute.

Significance and effectiveness

In reviewing the significance and effectiveness of SAGRIC sheep research, the Working Party considered that the overall programme of research was relevant to the needs of the S.A. sheep industry.

A strong emphasis on genetics, breeding and reproduction was regarded as important. However, a better balance between improvement in fecundity and other aspects of reproduction and management is desirable. Improvement in sheep reproduction rates by way of increased fecundity, whether by genetic or other means, is of limited relevance in the cereal and pastoral zones, because of the management problems associated with multiple births.

Sheep husbandry and management is an important area receiving only scant research attention at present. This was considered inadequate relative to the other research areas, with increased emphasis needed on pastoral zone sheep management in particular, as well as the integration of sheep and cropping enterprises on farms in the cereal zone.

In the nutrition and grazing management area, it was noted that most research was directed towards the application of nutritional principles and information under conditions of high levels of hand-feeding, with little attention to the more commonly relevant grazing situation. Strategies for grazing management under varying pasture conditions, and the effects on sheep production, were seen as areas requiring greater effort.

Much of the work on sheep health and diseases was highly significant and relevant to the problems of the industry, e.g. on internal parasites, ryegrass toxicity, trace element deficiencies. However, the interaction of sheep health and husbandry in flock management programmes was being largely ignored, and it was felt that this should receive greater emphasis. There must therefore be veterinary involvement in sheep production-oriented research.

In the marketing area, SAGRIC's involvement in the development of livestock marketing systems based on objective carcass classification methods was recognised as potentially significant for the sheepmeat industry, but currently there are major problems in implementation.

With regards to the effectiveness of SAGRIC research for the sheep industry, many of the shortcomings previously listed for ruminant research in general were noted. Most significant of these were the backlog of unpublished research results and the need for more effective promotion of research projects and results to the industry. The need to develop procedures to identify research priorities for all sectors of the sheep industry was also endorsed.

4.2.4 Goat industry

Resources

Manpower allocation to goat industry research is low, at 0.1 professional and 0.2 technical man-years. This provides for a SAGRIC research project on the genetics of mohair production on a private property in the South East, and a resource on milk goat management. SAGRIC does not own a goat flock.

Significance and effectiveness

SAGRIC research involvement in the goat industry commenced only in 1979. Any assessment of its long term significance and effectiveness may be premature.

Since the project on Angora goat genetics was initiated at the request of the industry, its relevance to industry needs can be assumed. Conduct of the project on a commercial flock is seen as an aid to eventual industry adoption of results.

In the milk goat industry, the low level of SAGRIC input does not provide for an effective research programme, but as a resource role, this level of input appears adequate.

No research is currently being supported by SAGRIC in either the cashmere or meat goat industries, but work is under consideration.

4.2.5 Other ruminant industries

No research on ruminant industries other than those listed above is being conducted by SAGRIC. The only such industry considered to currently have potential in South Australia is deer farming (see Appendix I.8), but this is still very much in its infancy.

4.2.6 General veterinary/animal health research

Resources

The manpower allocation to general veterinary/animal health research (i.e. not specific to any one ruminant industry) is 6.5 professional, 6.1 technical and 0.5 ancillary man-years. No weekly paid staff contribute directly to such research, most of which is conducted by the Veterinary Sciences Division at its Frome Road headquarters, Gilles Plains Field Station, and the South East Regional Veterinary Laboratories.

The Animal Health Division contribution to general animal health research is 0.6 professional man-years, which includes pig and poultry as well as ruminant species. Only about 0.2 man-years of this Animal Health Division total is attributable to the ruminant industries.

Of the total of 13.1 man-years for general veterinary/animal health research, rural industry research funds support 1.0 professional and 3.0 technical man-years.

Significance and effectiveness

As stated earlier, research projects on specific animal health problems have in most cases been discussed within each particular industry. The general veterinary/animal health area includes those projects of a very broad or basic nature which are relevant to all or most animal industries, including non-ruminants.

Examples are the biochemistry, microbiology, tissue pathology and parasitology research programmes of the Veterinary Sciences Division. These research activities generally operate in conjunction with the diagnostic functions of this Division and are therefore quite significant to the State's ruminant industries.

The effectiveness of veterinary input into research was limited, for several reasons:

- (i) low veterinary involvement in production research, necessary to provide the link between the basic studies and research in the field;
- (ii) overcrowding in the Frome Road laboratories and the lack of suitable facilities there for ruminant studies.

The Working Party noted that long-term aims for the relocation of the Division's facilities to Northfield with other elements of SAGRIC should remove this latter problem and contribute towards improving contact between veterinary and animal production research. This should be further facilitated by the amalgamation of Animal Health, Animal Industry and Veterinary Sciences Division into the Division of Animal Services.

4.2.7 Pasture

Resources

The current allocation of staff to pasture research is 8.6 professional, 13.9 technical, 6.3 ancillary and 13.6 weekly paid staff man-years. Casual labour adds to this weekly paid staff allocation for pasture research. Industry funds play a major role in providing staff for the pasture research programme, financing 3.4 professional man-years, 8.0 technical, 4.0 ancillary and 4.8 weekly paid staff as well as additional casual labour. Thus, slightly less than half of the total manpower allocation of 42.3 man-years to pasture research is rural industry funded, principally by the Wool Research Trust Fund, the Australian Meat Research Committee, the Wheat Industry Research Council, and the S.A. Wheat Industry Research Committee.

The main thrust of the pasture research programme is in the genetics and reproduction (plant breeding) area (5.1 professional plus 12.3 technical man-years). Pasture research is based mainly at Northfield Research Centre and Laboratories, and at Parafield Plant Introduction Centre. Programmes of a more regional nature operate from Kybybolite, Parndana and Turretfield Research Centres, often using sites on private properties or other SAGRIC centres. The medic seed storage and the aphid and disease screening facilities are both located at Northfield.

Significance and effectiveness

The Working Party recognised the key importance of pastures as the basis for viable and productive ruminant industries in this State. In the light of this, the pasture research programme in SAGRIC was seen as highly significant to the State's ruminant industries. Small improvements in pasture production were seen as leading to potentially significant gains in animal production in South Australia.

SAGRIC research work in the pasture legume area was heavily oriented towards selecting and breeding varieties to overcome problems which have arisen with the three main groups of pasture legumes, for example:

- (i) oestrogen content and clover scorch in subclovers;
- (ii) aphid and other insect pest susceptibility in lucerne and the annual medics.

The urgency of finding suitable replacements without these disabilities was endorsed by the Working Party, in order to ensure the maintenance of viable grazing livestock industries throughout much of the State.

At the same time, the need to select pasture legumes well-adapted to a wide variety of soil types and climatic conditions was recognised as a means of improving and extending the benefits of pasture production. Continuing work in SAGRIC with this aim was therefore seen as highly significant to the ruminant industries.

The importance of other work in the pasture agronomy area was also evident, for example on techniques for re-establishing lucerne on non-wetting soils in the South-east, renovating oestrogenic pastures, and the control of annual ryegrass toxicity by agronomic means.

Despite the intense activity in such areas as selecting and breeding new pasture legumes, a number of important areas in the overall pasture programme are being given inadequate attention. A particular deficiency is the lack of widespread screening of new pasture legume lines, especially in the western half of the State. In the case of medics and clovers for the cropping areas, ability to regenerate after cropping is essential. In addition, lines showing adaptation to a wide range of environmental conditions need to be evaluated in grazing systems prior to release, with attention to such factors as persistence and yield under grazing, and animal production measures.

Another gap in the programme is the absence of work on the introduction and evaluation of new pasture grasses, especially in view of the spread of annual ryegrass toxicity.

The Working Party was satisfied that SAGRIC's pasture research programme was not duplicating work being done in other States or organisations, since much of the work is of a local or regional nature. In fact, the level of co-operation and co-ordination of activities between States appeared extensive, with much exchange of genetic material between organisations. The designation of SAGRIC as the host for the *Medicago* collection for Australia and the Western Australian Department of Agriculture as host for the subterranean clover collection obviously has avoided duplication in this area.

Concerning the effectiveness of the pasture research programme for the State's ruminant industries, the registration and release of a range of new pasture legumes by SAGRIC in recent years is ample evidence of its success. As indicated earlier however, field testing and proving of new varieties has been limited, and this must necessarily restrict the effectiveness of the programme. In particular, there has been little consideration of animal production criteria during pasture variety development. There is a need to develop more rapid and cost effective methods of variety testing, involving animal production criteria, in conjunction with the Animal Services Division.

The effectiveness of pasture research has also been adversely affected by a shortage of technical support staff. The Working Party particularly noted the very heavy reliance on rural industry research funds to provide technical staff and other resources for pasture research. This makes the programme vulnerable to short-term changes in industry priorities. A higher level of core State-funded manpower for pasture research is therefore advocated to ensure continuity of this important area of research.

4.2.8 Multi-industry, affecting ruminant industries

Resources

A total of 27.0 professional man-years is allocated to multi-industry projects considered to have relevance to the ruminant industries, with a further 13.3 technical, 9.1 ancillary and 1.5 weekly paid staff man-years, for an overall total of 50.9 man-years. Most of this research effort is in the areas of General Resources Management (agricultural chemicals, soils and water, fertilizers; non-commodity oriented disciplines), Protection (entomology; weeds; vertebrate pests), and Extension and Economic Services.

Arid zone ecology, an important area of multi-industry research of particular relevance to the pastoral beef and sheep industries, has a current allocation of 1.0 professional man-years only.

Significance and effectiveness

Whilst recognising the importance of a number of these multi-industry research areas to the ruminant industries, the Working Party did not consider that it was within the terms of reference to attempt an evaluation of the research programme in each. It was considered that any such evaluation, if needed, should be left to specialist review teams with expertise in the disciplines involved. Indeed, the General Economics and Marketing area is one which has been the subject of a review completed recently for the Research Policy Advisory Committee.

5. OTHER ORGANISATION RESEARCH RELEVANT TO
SOUTH AUSTRALIAN RUMINANT INDUSTRIES

5.1 OTHER SOUTH AUSTRALIAN RESEARCH ORGANISATIONS

The only other organisation currently conducting research in South Australia relevant to the State's ruminant industries is the University of Adelaide. This research work is based at several sections of the University:

(i) Waite Agricultural Research Institute:

Projects relate to sheep, cattle and goat nutrition and grazing management, reproduction, physiology; goat breeding for meat and cashmere; sheep blowfly control; pasture ecology and management.

Major research facilities exist at the Waite Agricultural Research Institute itself, and at the Mortlock Experimental Station at Mintaro. In addition, some projects are conducted, in part, on private properties.

(ii) Botany Department:

Projects relate to arid zone ecology and management.

The Department operates the Middleback Field Centre for arid zone studies, on Middleback Station, via Whyalla. Observations are also continuing at Koonamore (North-East pastoral) and from time to time projects are conducted on other pastoral stations.

(iii) Department of Obstetrics and Gynaecology:

Projects relate to reproductive physiology and manipulation of reproduction in sheep.

This group is based at the Queen Elizabeth Hospital, Woodville, and conducts some work in conjunction with SAGRIC research officers in Animal Industry Division and at Kybybolite Research Centre, with research staff at the Waite Institute, and with private co-operators.

The Working Party, in reviewing the research conducted by the University of Adelaide, noted that it was mainly basic and innovative. Most of the application of this research work was being conducted in conjunction with officers of the Department of Agriculture.

On this basis then, the Working Party was confident that SAGRIC has a major role in providing applied ruminant industry research for South Australia.

Recommendation 5: Role of SAGRIC in ruminant research

The South Australian Department of Agriculture should continue to provide the majority of the applied ruminant industry research for South Australia.

5.2 RESEARCH ORGANISATIONS INTERSTATE

A large number of organisations in other states also conduct research programmes of varying degrees of relevance to the South Australian ruminant industries. These organisations include the various State Departments of Agriculture/Primary Industry, C.S.I.R.O. Divisions, Universities, Agricultural Colleges and several Federal Government Bureaux/Authorities.

Organisations which responded with details of research programmes of relevance to the South Australian ruminant industries are listed in Appendix IV.2.

A further report listing the research programmes/projects in these organisations considered relevant to the South Australian ruminant industries is available on request.

"Relevance to South Australian ruminant industries" was assessed from the limited information provided for each programme/project on several factors:

- * environmental similarity of the location of the research to South Australian conditions;
- * presence of similar problems/circumstances in the S.A. ruminant industries.

While these criteria proved suitable for assessing research of an applied nature, they were generally inappropriate for much of the basic research. Most of this basic research, generally conducted in Universities and C.S.I.R.O. Divisions, has been included in this listing, since it is of potential relevance, albeit indirect, to the South Australian ruminant industries.

The information obtained was helpful in making judgements on the relevance of SAGRIC research and the duplication between SAGRIC and other states. This is further discussed in Section 6.2.

6. RESEARCH PRIORITIES FOR
THE SOUTH AUSTRALIAN RUMINANT INDUSTRIES

6.1 METHOD OF DETERMINING RESEARCH PRIORITIES

Priority research areas for the State's ruminant industries for the next ten years were assessed on the basis of submissions made to the Working Party via:

- (i) invited resource papers;
- (ii) Departmental, industry and individual submissions;
- (iii) discussions with the respective SAGRIC ruminant research groups.

In defining priority areas, it was decided that these should be kept broad, in order to allow research management and specific Industry Advisory Committees flexibility in more closely defining research priorities within each industry. This was seen as being especially important in view of the likelihood of changing problems and priorities over the next decade. However, within each of these broad research areas, examples of specific present and perceived future problems currently identified as warranting research attention are listed.

6.2 RESEARCH PRIORITIES

Priorities are assessed in each of the six general research areas for each of the ruminant industries in turn, with comment on the relative importance of future research in that area, along with examples of current and perceived future topics of priority for research attention. In addition, the areas of pasture and general veterinary/animal health research, and several other areas common to all ruminant industries, are similarly considered.

6.2.1 Dairy Industry

The Department of Agriculture is the only organisation in South Australia conducting dairy research. Interstate centres in Victoria conduct complementary work that is relevant to the dairying areas of the South East of South Australia. Dairy technology research is conducted by C.S.I.R.O., the Victorian Department of Agriculture and the Queensland Department of Primary Industry. Additionally, research and development are undertaken by industry itself.

Genetics and reproduction:

This represents an important area for continuing research involvement. Research projects associated with the Australian Dairy Herd Improvement Scheme involve the areas of cow population structure, definition of breeding objectives, herd recording services, artificial breeding, and sire and cow evaluation. Research in South Australia is, and should continue to be, involved with such programmes, and in the development and application to local herd recording and management programmes. These areas make extensive use of the systems modelling approach.

Husbandry and livestock management:

These are areas for limited research involvement, for example in those aspects of livestock management which relate to fertility and mastitis control.

Nutrition and grazing management (including pasture management and utilisation):

These are areas of major importance for research activity. The important pasture research component incorporates agronomic and economic evaluation of new pasture species appropriate to the dairying areas of the State and grazing strategies and their effect on pasture composition and on dairy cow intake and performance.

Important continuing priority is attached to dairy nutrition, current emphasis including replacement heifer nutrition and evaluation of the role of grain legumes and fodder crops in dairy cow feeding programmes. Feeding strategies aimed at high performance per cow require continuing research, particularly in relation to seasonality of pasture growth and of calving pattern. The important components of fertility and metabolic disorder require continuing investigation within the dairy nutrition research area.

Product technology:

Research resources allocated to this area in the future should be reduced, with research priorities being related to problems of direct relevance to the South Australian dairy processing industry. Recent research elucidating milk protein genotypes favourable for cheesemaking should be completed with demonstration of the commercial benefits and application of the important findings.

The dairy processing industry in Australia is strongly serviced with research centres including those of the C.S.I.R.O. Dairy Research Laboratory, the Gilbert Chandler Institute of Dairy Technology, Victoria, and the Otto Madsen Dairy Research Laboratory, Queensland. The industry itself is increasingly conducting its own research relevant to its specific processing requirements.

Research priority areas relevant to the local South Australian manufacturing industry include those relating to the quality of milk and milk products, to cheese manufacture, to the investigation of non-cheddar cheese chemistry, microbiology and technology, and to the development of techniques for rapid measurement of compositional and microbiological quality of milk and milk products.

Marketing:

No research resources can be justified in this area, the topic being adequately covered by the industry itself.

Veterinary/animal health:

This area can justify increased research emphasis. Research priority areas include the development and evaluation of dairy herd health and production programmes, with particular emphasis on mastitis and its control, fertility and metabolic disorders. There is a continuing research priority in the area of mastitis control, bacteriology and milk quality control generally.

The determination of the distribution and significance of dairy cattle disease and nutrient deficiency is seen as an important priority and as a preliminary to further research in those areas.

6.2.2 Beef Industry

SAGRIC conducts most of the applied beef research work in South Australia. Some related work has been conducted at Waite Agricultural Research Institute by post-graduate students working in nutrition and more recently reproduction. This does not impinge on the need for SAGRIC to remain the major resource for applied beef cattle research in South Australia. Interstate beef research centres, particularly of the Victorian Department of Agriculture, have similar research programmes. The complementarity of these programmes is maintained by frequent meetings between officers, particularly between Hamilton and Struan Research Centres.

Genetics and reproduction:

This has been an area of vigorous activity in the past, especially on genetics and breeding, but future research involvement in this area should be limited. Emphasis in the future needs to be given to application of research results by way of formulation of breeding plans and techniques for minimising reproductive wastage/improving reproductive performance.

Husbandry and livestock management:

There is a need to define the problems requiring research relating to the management and husbandry of beef cattle in the arid pastoral zone, where some 20-25% of the State's beef cattle are normally run. This is an area which has been largely neglected in past research.

Attention also needs to be given to assessing the causes and extent of losses in the beef production and marketing chain, as a prelude to research aimed at minimising such sources of economic wastage.

Nutrition and grazing management:

An increased research emphasis on nutrition and grazing management is advocated, with particular attention to pasture management and utilization for beef production in the high rainfall zone. While the principles of nutrition are well researched and understood, the application of such knowledge via nutritional management strategies needs to be improved. The effects of various feeding and management strategies on overall production in the beef herd, with special attention to the interaction between nutrition and reproduction, require further study.

Product technology and marketing:

These two areas are considered jointly, since the specific areas where SAGRIC research is considered justifiable fall into common territory between the two. Continued SAGRIC involvement on a limited scale is needed to develop and evaluate objective marketing methods for beef cattle. The success of such a scheme will depend on the demonstration of advantages of objective marketing methods and the acceptance of these advantages by producers and buyers of cattle.

Veterinary/animal health:

This is seen as an important area for research for the beef cattle industry. Identification of significant animal health problems resulting

in economic loss in beef cattle herds on-farm is required. Problem areas currently recognised include internal parasites, metabolic diseases, trace element and vitamin deficiencies, and plant toxicities. Aspects of several of these problems are common to all extensive ruminant industries, and need to be examined in a multi-industry/multi-disciplinary approach.

Development and evaluation of herd health and production programmes for beef cattle should be given attention. Closer links between animal health and production research also need to be encouraged, preferably by locating veterinary research officers with the production research groups.

6.2.3 Sheep Industry

The sheep research programme of SAGRIC is the major on-going commitment to sheep research in this State, although sheep research is also conducted by the Waite Agricultural Research Institute, mainly in association with post-graduate training. Research into the sheep industry in other States is extensive, and needs to be used to the fullest extent possible in South Australia. Most sheep research programmes in South Australia receive substantial financial support from the Australian Wool Research Trust Fund and the Australian Meat Research Committee. These funds provide some measure of co-ordination of sheep research on a national level.

Genetics and reproduction:

This should continue to be an important area of SAGRIC research for the sheep and wool industries, particularly for the South Australian Merino. Genetic improvement, with emphasis on parameters of reproductive rate, body and wool growth, efficiency, quality, and disease and parasite resistance is an area of prime importance. Means of applying this information, for example by way of selection indices and the formulation of breeding plans, should feature in the Department's research efforts in this regard.

In the area of reproduction, causes of reproductive inefficiency in sheep flocks need to be identified and research into minimising these losses initiated. Priority should also be given to adapting and evaluating improved breeding techniques appropriate to South Australian sheep production conditions.

Husbandry and livestock management:

Research in this area is of low priority, with the exception of the evaluation of husbandry and management practices for sheep grazing in the semi-arid pastoral lands. Here the aim should be to define those practices which will enable optimum sustainable production levels to be achieved without long-term damage to the pastoral resource.

Nutrition and grazing management:

The area of greatest need is seen as pasture management and utilisation for sheep production. Allied to this is the development and evaluation of grazing/feeding management strategies based on sound nutritional principles, with particular emphasis on lambing, weaner sheep and drought management alternatives.

Since almost half of the State's sheep are found in the cereal zone, information on the integration of sheep production and cropping, and optimum enterprise mixes, would be valuable to producers on mixed farms. Systems analysis may be an important research tool in this and other grazing management/pasture utilisation studies.

Management strategies for high fertility sheep is a specific area of research need, to ensure that the genetic potential of such breeds or strains can be realised.

Another specific area of current research need is in the interaction of nutrition, management, health and welfare of sheep in the live sheep export trade.

Product technology:

Only limited SAGRIC research involvement is justified in the area of product technology for the sheep and wool industries, in view of national effort in this area. SAGRIC should confine its attention to the effects of local on-farm practices or factors on product quality. Examples of such research are the evaluation of factors leading to pigmented fibre contamination in white wool, effect of selection criteria on wool quality parameters, and the effect of management and breeding on carcase characteristics in sheepmeat production.

Marketing:

Similarly, SAGRIC involvement in marketing research for the sheep industry should be limited. Areas where SAGRIC research is justified include the development and evaluation of marketing methods for sheepmeats based on objective measurement, and the comparison of existing marketing options for wool and sheepmeats.

Veterinary/animal health:

This is an area of high priority for SAGRIC research. The currently recognised major problems for sheep production, including internal parasites, fleece rot and flystrike, footrot, and reproductive disorders of bacterial origin should receive continued research attention.

Disorders common to all extensive livestock industries, such as nutrient deficiencies, parasitism and toxicities require multi-industry/multi-disciplinary research.

Development and evaluation of flock health and production programmes for the various sheep enterprises should be given high priority. Veterinary involvement in production research programmes needs to be encouraged and facilitated.

Future research priorities need to be determined on the basis of objective information on the extent and causes of on-farm losses in sheep flocks.

6.2.4 Goat Industry

In general, the Working Party considers that SAGRIC research for the goat industry is justifiable only on a very limited scale at this stage. SAGRIC should continue to monitor developments and progress and provide a limited resource role using officers with relevant expertise from other ruminant industries.

Possible areas for Angora/Cashmere goat research are in genetics and reproduction (e.g. genetic improvement of production characteristics) and in animal health (goat health problems with significance for human health or sheep production). Marketing of mohair and goat meat may also justify some research input to establish a firm basis for the industry.

6.2.5 Other Ruminant Industries

The deer industry is the only other ruminant industry which currently offers some potential for development in South Australia. In view of its low potential for expansion in this State, due to the very limited market for its end-products venison and velvet, no SAGRIC research into the deer industry is warranted. However, SAGRIC should continue to monitor the industry's progress, and provide a limited resource role through research and advisory staff with relevant expertise in the major ruminant industries.

6.2.6 General Veterinary/Animal Health Research

SAGRIC is the main organisation conducting veterinary research in South Australia. Both the Queen Elizabeth Hospital and Waite Agricultural Research Institute are involved in reproductive physiology research work in collaboration with SAGRIC officers. Consequently SAGRIC should be providing a focus for veterinary research in S.A.

The Working Party considers that substantial gains can be achieved in the short term by minimising losses in animal production. Research into animal health and disease problems is therefore seen as an area of high priority for the ruminant industries. Specific priorities for research in this area need to be determined on the basis of sound, objective data on the causes of economic loss in each of the ruminant industries.

A number of animal health and disease problem areas currently recognised as justifying research attention have already been listed within the respective industries. Many of these are common to all extensive livestock industries, and in some instances to other forms of livestock or agricultural production as well, thus necessitating a multi-industry/multi-disciplinary approach. Veterinary research officer involvement in all phases of production research should therefore be encouraged and facilitated.

Animal welfare issues, such as the evaluation of stress in ruminant livestock production, should be considered for research.

6.2.7 Pasture

Pasture research in this State is conducted mainly by SAGRIC, although the Waite Agricultural Research Institute has a research project on the management of pastures and pasture/animal relationships. Consequently

SAGRIC should maintain the major pasture breeding and evaluation programme for South Australia. Pasture research has been co-ordinated nationally through the Plant Production Committee of Standing Committee on Agriculture, with South Australia being identified as the national centre for *Medicago* research.

The maintenance and improvement of pasture production and quality is recognised as the basis for the continuing profitability of the ruminant animal industries in South Australia. In view of the difficulties which have become apparent in maintaining the State's pastures in the last decade in particular, the Working Party ranks pasture research as being of very high priority.

Pasture research is obviously of benefit to both the extensive livestock and the cropping industries of this State. However, the Working Party has restricted its assessment of the pasture area to the viewpoint of benefits to the ruminant livestock industries only.

Within the pasture research area, continued high priority needs to be given to the introduction, breeding, evaluation and release of pasture plants.

Emphasis in such programmes should be on agronomic characters and resistance/tolerance to insect pests and diseases. Pasture legume varieties need to be developed for a number of specific problem situations, such as the low rainfall cropping zone, alkaline and hard-setting red-brown earths, and water-logged soils. Pasture grasses also warrant research attention, in order to improve livestock production from mixed swards. The role of fodder crops in meeting seasonal feed deficiencies should be researched.

Pasture management/grazing management/pasture utilisation are related areas of importance, especially to this Review. Possible research areas include pasture renovation techniques, fertilizer and trace element responses, weed and insect control, and grazing strategies. Re-establishment of lucerne stands on non-wetting soils is one particular problem of high significance to the ruminant industries.

One of the difficulties of pasture research is the time, cost and effort involved in conventional field evaluation of new pasture lines or varieties under grazing conditions. There is an urgent need to develop more rapid and cost-effective evaluation methods for new pasture plants prior to release.

7. RESOURCE ALLOCATION FOR SAGRIC RUMINANT RESEARCH

7.1 MANPOWER ALLOCATION FOR THE RUMINANT INDUSTRIES

To determine the levels of staffing recommended for SAGRIC ruminant research, the Working Party required a comparison with other industries. This was made by determining the total expenditure by SAGRIC in research in each industry and comparing these relative expenditures with the contribution of these industries to the economy of South Australia. Table 7.1 provides the five year mean local value of the major industries (Australian Bureau of Statistics) and a mean of two years of research expenditure from State funds in South Australia. The research intensity index (State research expenditure/local value x 100) provides a basis for comparisons between industries. The following factors were then taken into account in assessing the research intensity currently applied to the ruminant industries:

- (i) size and value of the industry;
- (ii) prospects for growth (or decline) in each industry over the next decade;
- (iii) social and environmental issues.

The value of the ruminant industries represents approximately 40 per cent of the total value of rural production in South Australia (Table 7.1). The ruminant industries are reliant on overseas markets to sell a large proportion of the meat, fibre and dairy products produced. This demand is likely to increase in the 1980's (Anon. 1983a). It is expected that the beef cattle numbers in Australia over the next five years will gradually increase, meat sheep numbers increase, and the dairy and wool industries stabilize (Anon. 1983b).

Consequently, to maintain efficient and stable ruminant industries, there is a need to maintain ruminant research intensity at least at its current level. There are no social or environmental factors within the ruminant industries which warrant significant adjustments to this research intensity.

Recommendation 6: SAGRIC resources for ruminant research

The present proportions of professional manpower and annual expenditure in SAGRIC allocated to the ruminant industries are appropriate and should be at least maintained, based on the current value of the ruminant industries relative to the other agricultural industries.

The Working Party then considered how research staff should be allocated between the respective ruminant industries and research areas/disciplines (see Table 7.3). Research resource allocation recommendations are such as to allow research managers flexibility in allocating resources to priority projects within the broad research areas. No attempt has been made to suggest the levels of resource allocation to specific projects, since this can be best decided by the respective research managers. The aim of the Working Party therefore was to define a core research capability or complement for the defined areas of SAGRIC ruminant research.

Factors taken into consideration in arriving at this statement of the core (State-funded) staffing allocation for ruminant industry research were:

- (i) size and value of each industry as given in Table 7.2;

- (ii) prospects for growth (or decline) in each industry over the next decade;
- (iii) extent of problems and scope for improvements in each industry as a consequence of continuing research;
- (iv) costs and likelihood of successful outcome to research in each industry;
- (v) environmental and social factors pertinent to respective industries.

Allocation of manpower to the various research disciplines within each of the industries was determined by assessment of the relative priority attached to future research within that discipline, as given in Chapter 6.

These proposed staffing levels in the case of professional officers are shown in Table 7.3. "Recommended" levels referred to represent the core level of State-funded staffing.

Table 7.4 shows the current and suggested staffing levels for technical officers in ruminant research in a similar manner. To arrive at the "Recommended" levels, a desirable professional officer to technical support staff ratio of 1:1 was adopted.

Table 7.1 The level of State-funded research resource allocation for the major industry groups in South Australia.

Industry Group	Local Value of Industry (mean of 77/78 to 81/82) (\$000's) (A)†	State Government Research Expenditure (mean of 80/81, 81/82) (\$) (B)*	Research Intensity ($\frac{B}{A} \times 100$)
Ruminant Industries	455 404	1 951 040	0.43
Intensive Industries	170 000	412 646	0.24
Horticultural Crops	167 756	994 085	0.59
Field Crops	354 644	1 362 215	0.38
Apiary	3 036	-	-
SUBTOTAL	1 150 840	4 719 986	0.41
Multi-disciplinary	-	1 185 461	-
TOTAL	1 150 840	5 905 447	0.51

* State Government expenditure includes an estimate of research expenditure by the Veterinary Sciences Division and also expenditure by other organisations on field crop improvement funded from State sources.

Note: Expenditure on pasture research has been divided equally between ruminant industries and field crops since both gain from pasture production.

(†Source - Australian Bureau of Statistics)

Table 7.2 The mean local value of the ruminant industries taken over 5 years and the expenditure by SAGRIC in each industry.

Industry	Mean Local Value 77/78 to 81/82 (\$000's) (A)	SAGRIC Expenditure '80/81, 81/82 (\$) (B)	Research Intensity Index $\frac{B}{A} \times 100$
Dairy and fodder production	66 456	596 095*	0.90
Beef	109 438	332 362*	0.30
Sheep	276 097	727 011*	0.26
Goats	336	1 975	0.59
Pasture (50%)	3 077	293 597	not applicable
TOTAL	455 404	1 951 040	0.43

* Includes an estimate of research expenditure in the Veterinary Sciences Division, SAGRIC.

Table 7.3 Present and proposed allocation of research staff to ruminant industry research areas:
Professional Officers*

Research Area/Discipline	Industry									
	Dairy		Beef		Sheep		Goats		Multi-ruminant industry**	
	Current	Recom- mended	Current	Recom- mended	Current	Recom- mended	Current	Recom- mended	Current	Recom- mended
Genetics & Reproduction	1.0	1.0	2.1	1.0	5.1	5.0				
Husbandry & Livestock Management	0.4	0.1	0.5	0.5	-	1.0	0.1	0.1	1.0	2.0
Nutrition & Grazing Management	3.1	2.4	0.8	1.0	2.6	3.0				
Veterinary/Animal Health	0.7	1.0	0.8 (0.5)	1.0	3.3 (0.5)	3.5	-	0.1	5.5 (1.0)	6.0
Product Technology - Quality - Processing	3.6	1.5	-	1.0	1.0	1.0	-	-	-	-
Marketing	-	-	-		0.2		-	-	-	-
Pastures									5.2 (3.4)	5.0
Miscellaneous†	0.1	-	-	-	-	-	-	-	-	-
TOTAL	8.9	6.0	4.2 (0.5)	4.5	12.2 (0.5)	13.5	0.1	0.2	11.7 (4.4)	13.0
TOTAL: ALL RUMINANT INDUSTRIES										
			Current	37.1 (5.4)						
			Recommended	37.2						

* Core State-funded positions, with additional industry-funded positions shown in parentheses.

** Research areas not specific to any one ruminant industry but to several, e.g. arid zone ecology and management is provided for in the allocation to the Genetics & Reproduction, Husbandry & Livestock Management and Nutrition & Grazing Management Disciplines under Multi-ruminant Industry. Similarly for general Veterinary/Animal Health and Pasture research.

† Not specific to any one research area/discipline.

Table 7.4 Present and proposed allocation of research staff to ruminant industry research areas:
Technical Support Staff*

Research Area/Discipline	Industry									
	Dairy		Beef		Sheep		Goats		Multi-ruminant industry**	
	Current	Recom- mended	Current	Recom- mended	Current	Recom- mended	Current	Recom- mended	Current	Recom- mended
Genetics & Reproduction	-	1.0	1.5 (1.0)	1.0	2.8 (1.0)	5.0	}	}	}	}
Husbandry & Livestock Management	0.5	0.1	-	0.5	-	1.0				
Nutrition & Grazing Management	3.7	2.4	0.3	1.0	0.5	3.0				
Veterinary/Animal Health	3.5	1.0	1.1 (1.5)	1.0	1.3 (2.5)	3.5	-	0.1	3.6 (3.0)	6.0
Product Technology - Quality - Processing	2.8	1.5	-	} 1.0	0.3	} 1.0	-	-	-	-
Marketing	-	-	(1.0)		-		-	-	-	-
Pastures									8.1 (12.0)	5.0
Miscellaneous†	0.8	-	0.3	-	0.3	-	-	-	-	-
TOTAL	11.3	6.0	3.2 (3.5)	4.5	5.2 (3.5)	13.5	0.2	0.2	11.7 (15.0)	13.0
TOTAL: ALL RUMINANT INDUSTRIES										
	Current	31.5 (22.0)								
	Recommended	37.2								

* Core State-funded positions, with additional industry-funded positions shown in parentheses. Technical Officers, Technicians and Field Assistants.

** Research areas not specific to any one ruminant industry but to several, e.g. arid zone ecology and management is provided for in the allocation to the Genetics & Reproduction, Husbandry & Livestock Management and Nutrition & Grazing Management Disciplines under Multi-ruminant Industry. Similarly for general Veterinary/Animal Health and Pasture research.

† Not specific to any one research area/discipline.

7.2 MANPOWER, FACILITIES, LIVESTOCK AND THEIR LOCATION

It is a feature of much livestock research that full control over, and close observation of, experimental animals is highly desirable. Such control and opportunity for observation are generally best provided by having experimental flocks or herds on SAGRIC research centres, as is predominantly the situation at present. Therefore the Working Party endorses the need for SAGRIC research centres to provide the major livestock resource and carrying capacity required to enable the identified priority areas to be adequately researched in the coming decade. Any proposed changes in the size, location or function of SAGRIC-operated research centres should consider the implications for ruminant industry research.

7.2.1 Dairy research

The Working Party considered that research facilities at the Northfield Dairy Research Centre are adequate and appropriate for research in most of the identified priority areas, but that the important priority area of pasture management and utilisation is not adequately catered for. Northfield Research Centre's location in a dryland farming area is not representative of the majority of the State's dairy farming environments.

It is recommended therefore that a distinct SAGRIC research facility be provided within a major dairying area, preferably in the Adelaide Hills. Such a facility would constitute SAGRIC's dairy research centre, and an important focus for pasture research in this high rainfall environment. For effective research to be carried out, the Working Party considered that a dairy herd of between 120-150 milking cows, with 30-40 young replacement stock, would be required. Land area required for such a herd, together with provision of pasture research requirements, would approximate 250-300 hectares.

The Working Party recommends that ultimately all dairy research personnel, including those in the dairy technology and dairy veterinary/animal health research areas, should work from the research centre in order to provide an integrated approach to solution of dairy industry problems. Location of extension personnel, where feasible, at the research centre would also serve to improve the extension of dairy research findings and improved management practices to dairy producers.

Recommendation 7: Dairy research

- (a) *Dairy research should be located within a major dairying area in the Adelaide Hills. A research centre should be established, with approximately 250-300 hectares to accommodate a herd of 120-150 milking cows plus followers.*
- (b) *The professional staff for dairy research should be a total of 6.0 research officers, with equivalent technical support, working in the following disciplines: genetics and reproduction (1.0), nutrition and grazing management (2.5), veterinary/animal health (1.0), and product technology (1.5).*
- (c) *Ultimately, all dairy research in both production and technology should be located at this centre.*

7.2.2 Beef cattle research

Facilities for beef cattle research in SAGRIC are considered excessive, with cattle herds on research centres at Parndana, Turretfield, Wanbi and Struan, and on the leased property at Wandilo. The need for SAGRIC to operate two high rainfall beef cattle research facilities (i.e. at Parndana and Struan) is questioned. Advantages and efficiencies can be seen in concentrating beef research at the one location. This would ideally be at Struan Research Centre, which is situated in the major beef production area of the State. Concentration of beef research staff and facilities at Struan would also benefit extension of results to the industry.

Beef research at Turretfield and Wanbi Research Centres beyond completion of existing beef cattle projects is also not favoured by the Working Party, in view of the declining importance of beef cattle in the cereal zone over recent years.

It is proposed that SAGRIC carry between 600 and 800 beef cattle for research purposes and have access to cattle on private properties.

Any development of pastoral zone beef management research will require some means of access to beef herds in this zone, most likely through use of private herds. The need for other facilities for such research will obviously depend on the nature of investigations to be undertaken. Initially, however, it is envisaged that such research would mainly involve data collection or on-farm research activities and therefore little need for facilities beyond those required for normal station cattle management.

Recommendation 8: Beef research

- (a) *Beef cattle research should be consolidated at Struan Research Centre, with a base herd of between 600 and 800 beef cattle run on the Centre. Existing beef herds on Turretfield, Parndana and Wanbi Research Centres should be disposed of when their involvement in current research projects ceases.*
- (b) *The professional staff for beef cattle research should be a total of 4.5 research officers, with equivalent technical support, working in the following disciplines: genetics and reproduction (1.0), husbandry and livestock management (0.5), nutrition and grazing management (1.0), veterinary/animal health (1.0), and product quality/marketing (1.0).*
- (c) *Ultimately, all beef cattle research should be located at Struan Research Centre.*

7.2.3 Sheep research

In total, facilities and livestock numbers for sheep research were seen as adequate, although their geographical location is not representative of the distribution of the sheep industry across the State.

Sheep research facilities appeared unduly fragmented and widely scattered, with experimental flocks on SAGRIC research centres at Kybybolite, Minnipa, Northfield, Parndana, Struan, Turretfield and Wanbi Research Centres, on the leased farm at Cape Borda and on various private properties. This situation was seen as contributing to inefficiency of

servicing the overall sheep research effort, reduced effectiveness of research officer time, inefficient use of technical and field support staff and difficulties in overall research co-ordination.

The need for separate sheep research facilities on Parndana, Wanbi and Northfield Research Centres is not evident. Nor is the need to conduct sheep research on both Struan and Kybybolite Research Centres in the high rainfall South East of the State.

There is a need therefore for consolidation of sheep research facilities and research staff into fewer, larger centres. Given the importance of the Merino sheep, and wool in particular, to the State's economy, there is a strong case for the establishment of a specific Sheep Research Centre to service this important industry. The Working Party favours a site within the cereal/sheep zone (currently Turretfield Research Centre) for such a Centre. It notes that the majority of sheep research work is not site specific and that research findings would be widely applicable over the industry.

Research for the important high rainfall areas of the sheep industry should be centred at Struan Research Centre and would concentrate on problems of the sheepmeat industry.

In support of the establishment of specialist sheep research centres, the Working Party notes that specific livestock research centres already operate within this State for the dairy, pig and poultry industries, and also recommends the consolidation of beef research at the Struan Research Centre. The approach has been successfully adopted interstate, with examples including the Western Australian Department of Agriculture Centre at Katanning; the Queensland Department of Primary Industry's Toorak Field Station, at Julia Creek; and the Trangie Research Centre operated by the New South Wales Department of Agriculture.

Numbers of sheep on SAGRIC research centres, including the Cape Borda leased property, at June 1981, totalled approximately 13 200 adult sheep, including an estimated 7 500 breeding ewes. In addition, sheep being used in projects run on private properties at that time totalled approximately 2 000 adult sheep, including approximately 1 200 breeding ewes. Of this overall total of approximately 15 000 adult sheep, including 8 500 breeding ewes, about 85% were in active use in research programmes.

Future sheep resources required depend largely on the research disciplines to be followed over the next decade and on research staff resources to be committed to those research areas. The Working Party has recommended (Table 7.3) that the allocation of research staff to sheep research increase from a present level of 12.2 research officers to a proposed minimum level of 13.5 research officers, with a similar number of technical and support staff. The recommendations in Table 7.3 further indicate that the distribution of staff resources across the important research disciplines should not change substantially.

In the light of these recommendations, it is reasonable to expect that total livestock requirements for research should not fall below the 1981 figures quoted above.

Therefore it is proposed that a more effective sheep research function will be achieved by consolidating sheep research into two major centres,

one based in the cereal/sheep zone, the other in the high rainfall area of the South East. Each centre should carry approximately 3 000 breeding ewes as the basis of the Department's sheep research programmes.

Regional research centres, running sheep flocks as part of normal farm management on the centre, would logically provide important additional livestock resources for sheep research.

As indicated earlier, the Working Party regards an increased level of direct veterinary involvement in research projects as very important in SAGRIC's future sheep research programme. For high rainfall sheep research, facilities at the Regional Veterinary Laboratory at Struan are adequate and ideally situated to result in a high level of veterinary involvement. Ultimately there also needs to be a strong veterinary involvement at the Merino research facility.

Recommendation 9: Sheep research

- (a) *The South Australian Department of Agriculture should consolidate its sheep research resources (manpower, sheep and facilities) into two major centres: the first within the cereal/sheep zone, logically at Turretfield Research Centre, to cater for the requirements of the Merino sheep and wool industries; the second within the high rainfall area, to be centred on Struan Research Centre, primarily for research on sheepmeat production. Each centre should carry approximately 3 000 breeding ewes as the basis for the Departmental sheep research programmes.*

Regional research centres, running sheep as part of normal farm management, would provide additional livestock resources for sheep research.

- (b) *The professional staff for sheep research should be a total of 13.5 research officers, with equivalent technical support, working in the following disciplines: genetics and reproduction (5.0), husbandry and livestock management (1.0), nutrition and grazing management (3.0), veterinary/animal health (3.5), and product quality/marketing (1.0).*
- (c) *Ultimately, the allocation of resources for the sheep industry should approximate 75% to wool industry research and 25% to sheepmeat industry research.*

7.2.4 Arid zone beef and sheep research

No SAGRIC research facility exists for arid zone animal husbandry, management and disease research. However, it is envisaged that at least the initial stages of such research programmes would involve mainly data collection on co-operators' properties. There may be scope for some use of the facilities for arid zone research of other organisations by SAGRIC research staff in the future. The University of Adelaide Botany Department's Middleback Field Station (near Whyalla) and the University of New South Wales' Fowlers Gap Research Station (near Broken Hill, relevant to the State's North East pastoral areas) are two such possibilities. This would need to be negotiated with the respective organisations.

Recommendation 10: Arid zone research

- (a) Arid zone research staff should be based at Northern Regional Headquarters, Port Augusta, and operate as a mobile group working on private properties.
- (b) The professional staff for arid zone ruminant research should be a total of 2.0 man years per annum, working with both cattle and sheep in the disciplines of husbandry and livestock management, and nutrition and grazing management (rangeland management).
- (c) Ultimately all arid zone research staff should be based at Port Augusta.

7.2.5 Goat research

The level of research activity proposed for the goat industry does not warrant SAGRIC running its own goat herd. The use of goat herds and facilities of co-operating producers should continue to be adequate for the research envisaged.

Recommendation 11: Goat research

- (a) Provision of specific SAGRIC facilities for goat research cannot be justified. The use of private co-operators' flocks is adequate for envisaged research needs.
- (b) The professional staff for goat research should amount to 0.2 man years per annum, across the disciplines of genetics and reproduction husbandry and livestock management, nutrition and grazing management, and veterinary/animal health. Such staffing level should be achieved by utilizing research officers from appropriate disciplines in the major ruminant species.

7.2.6 General veterinary/animal health research

Much of the current veterinary/animal health research is conducted by the Veterinary Sciences Division. The Animal Health Division has not provided effective research in the ruminant industries in the past. The Working Party saw a need to increase the veterinary input into the major research groups for each industry by locating officers with veterinary research training at the animal research centres.

The Working Party also established that there is a need for a central diagnostic facility at which research into diagnostic techniques, and specialist support to the research centres and regional research staff, is provided. This specialist activity is provided by the Veterinary Sciences Division and should be facilitated by having veterinary research scientists based in research teams in the various industries.

Recommendation 12: General animal health research

- (a) Direct veterinary input into the major research groups for each industry should be strengthened by locating officers with veterinary research training at the respective industry research centres.

- (b) *General veterinary research should be located in Adelaide in the veterinary laboratories of the Veterinary Sciences Division.*
- (c) *The professional staff for general veterinary research should be a total of 6.0 man years per annum.*

7.2.7 Pasture research

The Working Party has concluded that pasture research is of high priority and requires an increase in core State funding of research and support staff to stabilize the current programme.

The pasture research programme is seen by the Working Party to require a central research group based at Northfield Research Laboratories that provides plant genetic material and conducts a State-wide plant breeding programme. The current resources in medic seed storage, glasshouse and laboratory facilities are sub-standard and require upgrading. It is hoped that these can be provided in the proposed upgrading of the Northfield Research Laboratories. This should make provision for increasing the research staff to include work on pasture grasses as well as the clovers and medics.

The work in the industry research groups should change in emphasis to evaluate pasture species, particularly new lines from the plant breeding and selection programmes. The Working Party does not envisage that the same methodology should be used as that instituted to evaluate Trikkala subterranean clover (estimated to cost \$500 000), but smaller scale trial work to evaluate persistence under grazing, digestible yield during the season and methods of grazing management to provide optimal animal production.

Recommendation 13: Pasture research

- (a) *Pasture breeding research should be located at one site, currently Northfield Research Laboratories.*
- (b) *The number of professional man years per annum devoted to pasture breeding should be 5.0.*
- (c) *Coordinated programmes between the breeding centre and staff on specialist livestock research centres should be developed to evaluate new varieties as they become available for release, for animal production systems.*

REFERENCES

- Anon. (1983a). SAGRIC 84-87. Planning of Department of Agriculture Services for South Australians. D.J. Woolman: South Australia. 63 pp.
- Anon. (1983b). In *Quarterly Review of the Rural Economy* 5 (1). Australian Government Publishing Service: Canberra.

ACKNOWLEDGEMENTS

Many individuals, groups and organisations provided information and viewpoints to the Working Party to make this Review possible. Their co-operation is gratefully acknowledged.

These contributors are listed in the relevant Appendices.

APPENDICES

TO

RUMINANT INDUSTRY RESEARCH REVIEW

	<u>Page</u>
APPENDIX I : INVITED RESOURCE PAPERS	53
I.1 : Dairy cattle production research (S.C. Valentine)	54
I.2 : Dairy processing research (S.J. Rice)	62
I.3 : Beef cattle research (M.P. Deland)	72
I.4 : Wool industry research (M.R. Fleet)	80
I.5 : Sheepmeats research (J.P. Egan)	103
I.6 : Live sheep exports (A.S. Pell)	120
I.7 : Goat research (D. Phillips)	124
I.8 : Deer research (D.W. Russell)	133
I.9 : Veterinary research for the ruminant industries (D.N. Mackie)	136
APPENDIX II : SUBMISSIONS TO RUMINANT INDUSTRY RESEARCH REVIEW	141
II.1 : From within SAGRIC	142
II.2 : From outside SAGRIC	143
APPENDIX III : SAGRIC RUMINANT RESEARCH AND RESOURCE ALLOCATION	145
III.1: Listing of current SAGRIC ruminant research projects	146
III.2: Current manpower allocation to SAGRIC ruminant research	158
- professional officers	
III.3: Current manpower allocation to SAGRIC ruminant research	159
- technical officers	
III.4: Current manpower allocation to SAGRIC ruminant research	160
- ancillary staff	
III.5: Current manpower allocation to SAGRIC ruminant research	161
- weekly paid staff	
APPENDIX IV : RESEARCH IN OTHER ORGANISATIONS RELEVANT TO SOUTH AUSTRALIAN RUMINANT INDUSTRIES	162
IV.1 : Other South Australian organisations	163
IV.2 : Interstate organisations (list only*)	167

* Note that a full listing of summaries of research projects/programmes supplied by interstate organisations and considered relevant to the South Australian ruminant industries is available on request.

APPENDIX I
INVITED RESOURCE PAPERS

APPENDIX I.1

DAIRY CATTLE PRODUCTION RESEARCH:

INVITED RESOURCE PAPER FOR RUMINANT INDUSTRY RESEARCH REVIEW

S.C. Valentine,
Senior Research Officer,
Northfield Dairy Research Centre

1. Historical Perspective

Although the greatest period of expansion of the dairy industry in South Australia was before the end of last century, a major period of development occurred between 1930 and 1950 following the establishment of irrigation areas along the Murray Swamps and the extension of dairying into the south-eastern areas of the State around Naracoorte and Mount Gambier. During this period, dairy cow numbers increased from 110 000 in 1930 to a peak of 175 000 in 1950. Since 1950, dairy cow numbers in South Australia have shown a steady decrease from 154 000 in 1960, 143 000 in 1970 and 101 000 in 1980. Milk production in South Australia over the last 30 years has increased from 410 megalitres in 1950 to a peak of 483 megalitres in 1970 and declined to 326 megalitres in 1981.

Figures 1, 2 and 4 indicate the general decline in numbers of cows, annual milk production and number of licenced dairy farms in South Australia over the last decade. Figure 5 shows the general increase in the number of dairy cows per farm in the Metropolitan Milk Board (M.M.B.) area from 46 in 1970 to 73 in 1981. Herd size is approximately the same on dairy farms in the M.M.B. area and in the South-East of the State and smaller in the Mid-North region.

Organization of herd recording in South Australia commenced in 1920. In 1977, herd recording was transferred from the Department of Agriculture to a private co-operative, Herd Improvement Services Co-operative Limited (HISCOL), but the Department is responsible for the computer processing of production records.

2. Current Situation

There are four major dairying regions in South Australia - the Adelaide Hills, the Murray Swamps and Lakes District, the South-East and the Mid-North. Most of the production from the Adelaide Hills and Murray Swamps enters the Adelaide Metropolitan area whole milk supply, the surplus being used for cheese-making. The milk produced in the South-East is used mainly for cheese-making. Approximately 13% of the State's milk is used for butter production, 47% for cheese production and 40% consumed as whole-milk and other processed products.

Currently, there are 160 000 dairy cattle in South Australia of which 101 000 are dairy cows in milk or dry. Approximately 68% of the dairy cows are Friesian, 25% Jersey, 3% Guernsey, 3% A.I.S. and 1% Ayrshire. Forty-three per cent of the dairy cattle population is located in the Adelaide Hills, 25% in the Murray Swamps, 24% in the South-East and 8% in the Mid-North.

The State's production for 1980/81 was 326 megalitres of milk or 13 793 000 kg fat. Based on a price of \$4.00 per kg fat the value of the production for 1980/81 was approximately \$55 million.

At present, approximately 45 000 cows (45% of the adult dairy cow population) are tested under the herd recording scheme operated by HISCOL.

3. Interactions with Other Industries

The dairy industry interacts to some degree with the beef industry and farmers may move from one industry to the other depending on the relative profitabilities. During the period 1971-76, a period of over supply of milk and subsequent low returns, many dairy farmers moved from the dairy industry to the more profitable beef industry. However, at present the number of farmers involved in the beef and dairy industries are relatively stable.

Income derived from the sale of cull cows and bobby calves is probably the most variable part of the income of dairy farmers and may have a significant influence on profitability.

Part of the income of many dairy farmers is derived from other agricultural enterprises, including cereal, potato and grape growing, wool production and rearing of pigs, and consequently the profitability of dairy farmers may be dependent to a small degree on the economics of these industries.

Profitability of the dairy industry is partly dependent on the costs of cereal and pasture hay and of cereal and legume grains for feeding direct to dairy cows or for use in proprietary concentrate mixtures. Broad interactions with the dairy industry occur with other industries such as feed and seed merchants, and chemical and drug companies.

4. Future Prospects of the Industry

It appears that the future of the dairy industry is basically sound although farmers have shown only small improvements in return in recent years. Although there is still a decline in the number of dairy farms and number of cows, this is proceeding at a much slower rate. It is anticipated that provided increases in milk and milk product prices can be at least maintained with the rate of inflation and costs kept to a minimum, the profitability of the remaining dairy farmers will be increased with a greater proportion of milk products sold on the more stable local market. The potential for increased productivity will be attained from use of the Australian Dairy Herd Improvement Scheme, the rate of genetic gain being estimated at 1.5 to 2.0% per year or an annual increase in fat yield of 2.4 kg per cow.

5. Identified Major Industry Problems

(1) Viability of Dairy Farmers

A dairy farmer survey carried out for the years 1974/75 to 1976/77 showed that the average return to capital for dairy farmers in South Australia was -1%. Since this time the number of dairy farms has declined from about 2 700 to 1 700 and cow numbers have decreased from about 141 000 to 101 000. Although the decline in the number of dairy farms has resulted in increased returns to the remaining dairy farmers, current estimated returns to capital are only of the order of 1-2%. This poor return to capital may be offset to some degree by capital gains. The small improvement in returns has not prevented farmers leaving the dairy industry although the rate of decline has lessened. The retention of dairy farmers in the industry will be dependent on widening the gap between costs and returns.

(2) Level of Milk Production

Although the reduction in the number of dairy farms has been offset to some extent by an improvement in production per cow (Figure 3) and increased numbers of cows per farm, declining milk production will result in a greater proportion of milk sold on the more stable local market with less milk available to meet the demand for export products. While means to facilitate an increase in the number of dairy farms would assist dairy product manufacturers to meet product demand, the viability of dairy farmers would not be improved.

The viability of dairy farmers must be improved by reducing costs and increasing the efficiency of production. Continued research is needed to identify technological improvements in farm management to improve per farm production.

6. Future Research Priorities

Future research priorities in the dairy industry should aim to improve the viability of dairy farmers by increasing the efficiency of the industry in the areas of management and feeding the dairy herd.

With the trend towards seasonal calving and higher production per cow, an area of research which should be developed is that of feeding the high producing dairy cow in early lactation. Seasonal calving coincides with the beginning of pasture growth, but the feed available is generally insufficient to maximise milk production in early lactation, the period most likely to influence total lactation production. In order to economically assess various feeding strategies in early lactation, consideration should also be given to the nutritional requirements of the cow in relation to such factors as fertility and metabolic disease.

Another priority in dairy production research is in pasture research. There is a need for agronomic evaluation of new pasture species for milk production under various climatic and soil conditions. Research in this area should also consider the effects of grazing strategies on the quality and botanical composition of dairy pastures and the influence of these factors on intake of pastures and subsequent milk production in relation to stage of lactation.

Economic evaluation is needed of various types of concentrates in relation to the seasonal calving pattern in South Australia and the need to reduce liveweight loss to maintain fertility.

With the demand to increase production per hectare, evaluation of fodder crops producing high yields of digestible dry matter per hectare and used to fill the 'feed gap' in autumn and early winter should continue particularly in relation to their management and assessment of nutritive value for milk production.

In the field of fertility and disease control, more research is needed on the effects of level of production and nutrition on fertility and metabolic diseases such as acetonemia.

It has been estimated that in South Australia the annual economic loss due to mastitis is in excess of \$3 million per annum. Consequently, mastitis must be considered a research priority in the dairy industry. Some specified areas of research priority include:

- a) Field studies on the effect of selective dry cow therapy on new infection rate.
- b) Studies on the effects and efficacy of alternative methods of administration of intramammary drugs.
- c) Investigation of the effects of milking systems on the incidence of new infection and spread of mastitis.
- d) Evaluation of management techniques in the prevention and control of mastitis e.g. drying off methods.

In the area of herd recording there is a requirement for research:

- a) To assist centralization by evaluation of new equipment and computer programmes for herd recording and herd management.
- b) On selection programmes within a herd.

There are currently several interstate research projects associated with the Australian Dairy Herd Improvement Scheme being carried out in the areas of cow population structure, gene flows, herd recording services, artificial breeding and sire and cow evaluation. Research in South Australia needs to supply information to these projects and to conduct research in some of the uncommitted areas.

7. Resources Required

A major part of the dairy husbandry research work carried out at Northfield has related to the fields of supplementary feeding of dairy cows, calf feeding and management techniques, herd management, calf growth and development and mastitis control. There are many advantages of Northfield in its present location for the conduct of dairy husbandry research. These advantages include:

- . Close to good library facilities - both within and outside of the Department.
- . Allows close liaison and joint research work to be conducted with the dairy technology section.
- . Allows easy interaction with research and extension staff of other Divisions at Northfield and at Grenfell Centre and with research scientists and staff from the Institute of Medical and Veterinary Science, C.S.I.R.O., Waite Agricultural Research Institute and Department of Services and Supply (Division of Chemistry).
- . Permits the sharing of equipment with other Divisions at Northfield.
- . Allows maximum opportunity for contact with interstate and overseas research workers visiting Adelaide.
- . Allows farmers travelling to Adelaide to visit the centre to obtain information and discuss problems.
- . Being situated in the metropolitan area, servicing of equipment and obtaining of spares is simplified resulting in minimal disruption to research programs.

- . Opportunity of staff to undertake study courses to improve their knowledge or skills.

Research conducted at Northfield has been applicable to the dairy industry in all areas of the State since the environment has in general had little influence on the results obtained. However, Northfield is located in an area of relatively low rainfall and with poorly structured soils compared to the major dairying regions of the State. Consequently, the pasture species which grow successfully are atypical of the dairying areas, and a shorter growing season renders growth of pastures less reliable. The absence of a research centre located in a dairying area has limited research into many aspects of pasture management and pasture utilization, an area of research which is particularly relevant to the dairy industry.

The use of private or leased properties and location of regional research officers in dairying areas would allow more flexibility in the type of research which could be carried out. However, the Department would need complete control of the land and herd to avoid difficulties in determining compensation for lost milk production and inconvenience to milking, feeding and breeding programmes. In order to carry out effective research on private or leased properties facilities such as libraries, laboratories and equipment maintenance workshops need to be located at a convenient, permanent site.

A research centre located in a dairying area would require facilities in terms of equipment and staff and buildings (including a library) equivalent to that presently located at Northfield. More effective research on herd fertility and disease control could be conducted if a veterinary officer was located permanently at the research centre.

A major operating expense of dairy cattle research at Northfield is the cost of purchase of livestock feeds. These feedstuffs are at present purchased with research funds, but much more flexibility in the research programme could be obtained if the income from sales of milk could be used for the purchase of livestock feeds.

8. Significance and Effectiveness of Current Research

In the last 10 years the dairy husbandry research section at Northfield has developed or contributed to the development of the following technologies which have been adopted by South Australian agriculture:-

- Early weaning of calves
- Use of Friesian calves for beef production
- Easy identification of dairy cattle
- Mechanization of hay handling and storage
- Role of large hay packages in short and long term storage of hay
- Suitability of various pasture and cereal species for fodder conservation
- Optimum time of cutting hay to maximize yield
- Role of wilted silage in dairy cow feeding
- Suitability of dried citrus pulp as an ingredient of dairy rations
- Establishment of maximum rates of molasses feeding for dairy cows
- Role of nutrition on the freezing point of milk
- Time of harvest and planting density to maximize fodder production from maize under irrigation
- Use of late flowering sorghums as standing fodder crops in autumn and winter
- Role of grain legumes in dairy cow rations.

In the last 5 years, research carried out by the dairy husbandry research group at Northfield has resulted in the publication of 26 research papers, 8 short research communications and 6 technical bulletins and fact sheets.

The relevance and applicability of all research proposals are discussed between research and extension officers prior to the writing of research preschedules. Research preschedules are then closely scrutinized and discussed between research and extension officers involved in ruminant research and reviewed by research management to ensure their effectiveness as research projects.

The acceptability of research results is always greater if the research is carried out in the particular dairying region in which it is applicable. Consequently, extension of research findings could be improved by location of research centres in dairying regions or by the conduct of research on leased or private properties.

Extension of research findings is achieved through publication of technical bulletins and fact sheets and by publication of articles in the rural press (Stock Journal, Farmer and Stockowner, National Farmer, South Australian Dairymen's Association Journal). Research results are also extended to the rural community through rural radio programmes and at dairy farmer field days and seminars. Improving contact with the rural press and radio will increase the effectiveness of extension programmes.

9. Areas of Research Adequately Covered by Other Organizations

The two major interstate dairy husbandry research centres are located in Victoria at Ellinbank in the Gippsland region, an area of approximately 900 mm annual rainfall, and at Kyabram, located in an irrigation area. Research at these centres is concentrated in the areas of:

- 1) Effects of grazing intensity, quality and composition of pastures under irrigation on subsequent milk production.
- 2) Intake of pasture in relation to pasture quality, pasture species (in particular white clover and perennial ryegrass) and pasture availability and the effects on milk production.
- 3) Effects of nutrition and body condition pre- and post-calving on subsequent milk production.
- 4) Comparative production and economic evaluation of supplements fed to grazing dairy cows as affected by stage of lactation and pasture quality and quantity.
- 5) Development and evaluation of fodder crops for milk production.

Although some data obtained from research projects at these centres is applicable to the S.A. dairy industry, there is a need for some input in these areas of research to obtain data of direct relevance to the S.A. dairying regions of different climatic and environmental structure to the dairying regions of Victoria.

Adequate research on evaluation of milking systems and the effects of milking management on prevention and control of mastitis is carried out at the Milking Research Centre at Werribee in Victoria.

10. Areas of Research Not Adequately Serviced by Other Organizations

These areas of research include:

- 1) Feeding of the dairy cow in early lactation in relation to the seasonal calving pattern in South Australia.
- 2) Effects of level of production and nutrition on fertility and metabolic diseases such as acetonemia.
- 3) The role of grain legumes in nutrition of the dairy cow when pasture quality and/or quantity is low.
- 4) Development and evaluation of new pasture species for milk production under various climatic and soil conditions.
- 5) Improving the efficiency of conservation and utilisation of conserved forages including: 1. Evaluation of annual legumes e.g. vetches and shaftal clover to increase the metabolisable energy and protein content of conserved crops; 2. Development of more efficient and economic methods of storage of conserved crops.
- 6) Evaluation of selective dry cow therapy, and methods of administration of intramammary drugs on prevention and control of mastitis.
- 7) Evaluation of the effects of grazing strategies on the quality and botanical composition of dairy pastures and the influence of these factors on intake and milk production.
- 8) Genetic research on associations between milk, blood and enzyme polymorphisms, and disease (including mastitis), production and evaluation of bulls.

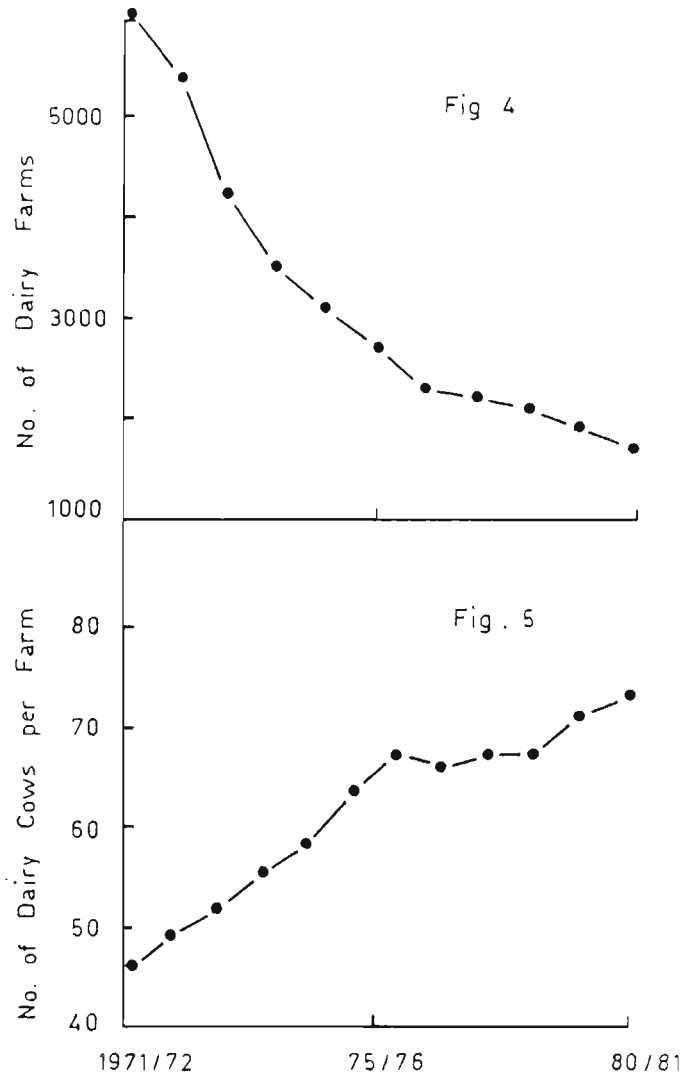
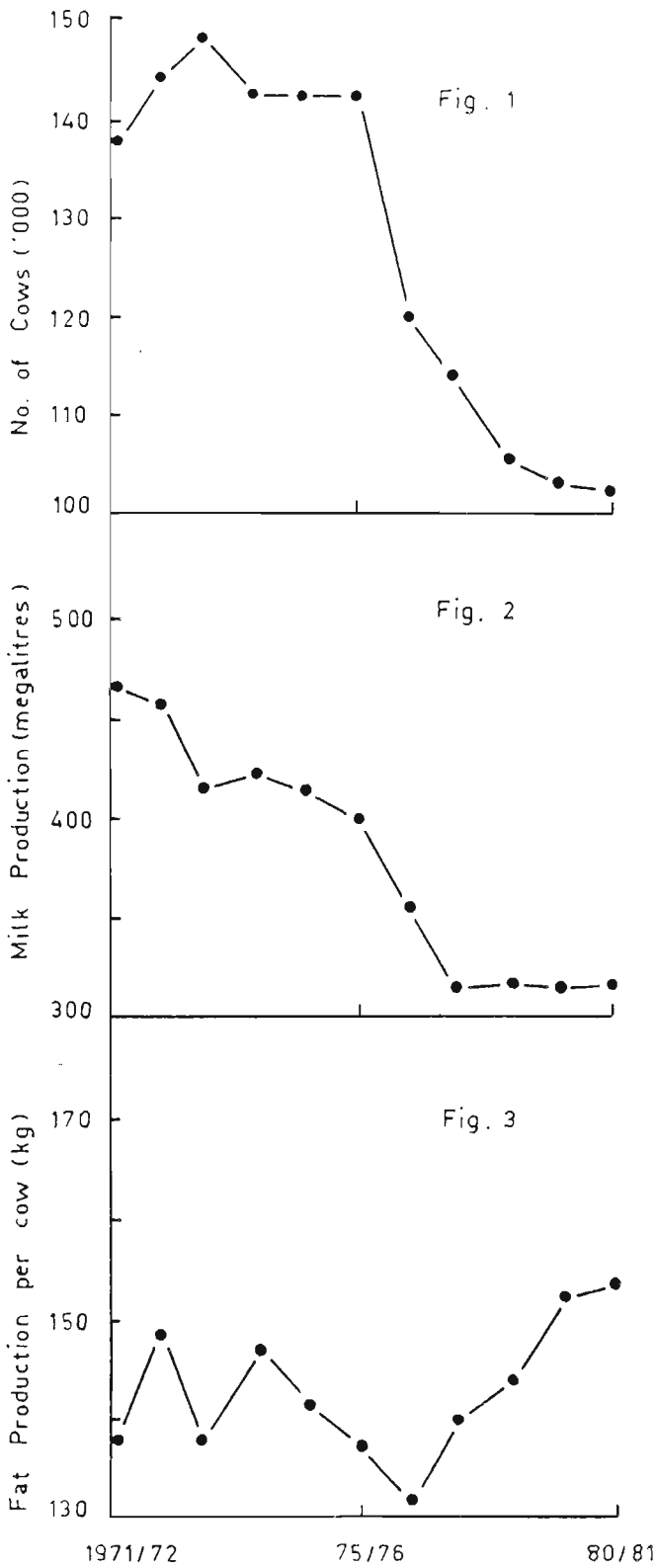


Fig. 1 Number of cows (in milk and dry) in S.A.
 Fig. 2 Milk production in S.A.
 Fig. 3 Fat production per cow in M.M.B. area.
 Fig. 4 Number of licensed dairy farms in S.A.
 Fig. 5 Average number of dairy cows per farm in M.M.B. area.

APPENDIX I.2

DAIRY PROCESSING RESEARCH:

INVITED RESOURCE PAPER FOR RUMINANT INDUSTRY RESEARCH REVIEW

S.J. Rice,
Senior Dairy Adviser,
Animal Industry Division

1. Historical Perspective (S.A. Processing Industry)

Historically the S.A. dairy farming industry developed to supply a need for liquid milk in various regions throughout the State. In addition to the supply of liquid milk, farmers also catered for consumers' needs for dairy products, particularly butter and cheese. As manufacture of milk surplus to liquid milk requirements moved from the farm to the local dairy factory, export markets in the United Kingdom established a demand that allowed for the expansion of milk production. Small farmer co-operatives developed alongside Proprietary Companies and larger companies were formed by amalgamation.

South Australian milk production reached a peak of 483 million litres in 1969-70 (B.A.E. 1980). Production has since declined to 319 million litres in 1980-81 (A.B.S. 1981). South Australian butter production declined from a peak of 9 390 tonnes in 1946-47, to 6 617 tonnes in 1970-71, to 2 177 tonnes in 1980-81. Cheese production increased from approximately 10 000 tonnes in the 1940's and 1950's to a peak of 19 288 tonnes in 1974-75 and has decreased to 16 992 tonnes in 1980-81.

This period of increasing cheese production and decreasing butter production was brought about by conversion of cream collection and can milk collection to refrigerated bulk milk collection and changing consumer preferences for products. With these changes in milk collection, larger factories were built, as evidenced by the following changes in licences issued by this Department under the Dairy Industry Act. Milk depot and creamery collection points have closed with these changes.

<u>Number of Licences</u>				
<u>Year</u>	<u>No. of Companies</u>	<u>Factories</u>	<u>Milk Depots</u>	<u>Creameries</u>
1962/63	26	45	28	15
1970/71	-	40	21	8
1980/81	13	24	11	Nil

Other changes that have occurred during this period are an expansion in the range of fresh milk products, increased supermarket sales of dairy products and an increase in milk carton sales from 8.3% (1971) to 65.4% of total liquid sales in 1981, at the expense of bottled milk. Per capita consumption of butter has decreased and cheese consumption has increased. Licensed milk vendors in the metropolitan area have decreased from 474 in 1971 to 402 in 1981 (Metropolitan Milk Board 1981).

2. S.A. Dairy Processing Industry (Current Situation)

Our major dairying areas are the Adelaide Hills (Central and Southern), River Murray Swamps, Lakes irrigation areas and the South East. The Adelaide Hills, River Murray Swamps and Lakes irrigation areas constitute the Metropolitan Milk Production Area. Our minor dairying areas, where dairying is mostly carried on as a side line to other farming pursuits, are the Mid North, Eyre Peninsula and Riverland Regions. Figures 1 and 1a indicate the existing dairy factories in S.A. and the regions they service.

Along the River Murray at Murray Bridge and Jervois two large factories make cheddar cheese and supply liquid milk to the processing plants in Adelaide. Most of the whey from cheesemaking is used by pig farmers in the area. Whey products are to be manufactured in 1982.

The Adelaide Hills area has three factories. Milk powder and non cheddar cheese are made at Mount Compass, non cheddar cheese at Mount Barker, and cheese is matured and packed at Meadows. These products are produced from milk surplus to Adelaide market milk requirements.

Located in Adelaide are two icecream factories (Freesia and Amscol), three small cheese factories and a larger food company, Alaska Foods Ltd., which manufactures yoghurt, cottage cheese, flavoured milk, custard, cheese cakes, crumpets, etc.

The South East uses most of its milk (approximately 95%) for cheese manufacture and supplies local towns with liquid milk, flavoured milk and cream. Kraft Foods Ltd. dominate the milk supply with cheddar factories at Moorak and Mil Lel and a cream cheese plant at Suttontown. Non cheddar cheese is also being made at Moorak and Kraft also have under contract the purchase of all cheese manufactured by Mount Gambier Co-op. Dairy Products Ltd. A small number of Dairy Vale suppliers at Bordertown supply milk for local sale to Bordertown Milk Vendors and the remainder is transported to Mount Gambier. The Eight Mile Creek Cheese Company in Mount Gambier manufactures a wide range of non cheddar cheese including fetta, haloumi, mozzarella, provolone and romano.

Three smaller dairying districts are located in our main agricultural or cereal growing areas of the State. The main use of milk in these areas is for the liquid milk market. From these drier inland areas, cream for butter manufacture is also received and sent to the butter factory at Gawler. Golden North Dairies, with factories at Port Pirie, Clare and Laura services the liquid milk and ice cream requirements of a very large area extending through the Barossa Valley to Port Augusta, Whyalla and the West Coast as far as Ceduna and to the North as far as Alice Springs. In addition the Mid North Region is the main supplier of liquid milk to Broken Hill. Other fresh and frozen foods and fruit juices are distributed with dairy products.

The Eyre Peninsula and Riverland areas are supplied with liquid milk and cream by their small dairy industries centred on Port Lincoln and Renmark respectively. G.W. Falland and Co. at Renmark also package fruit juice products.

South Australia's 319 million litres of milk production represents 5.8% of Australia's total milk production. Approximately 38% of the milk is used for liquid milk and 45% is cheese manufacture. South Australia manufactures 13% of Australia's cheese production. Other products manufactured are:

<u>Product</u>	<u>Approximate Manufacture</u>
Flavoured milk	10 480 000 litres
Cream	3 120 000 kg
Icecream mix	5 190 000 kg
Custard	350 000 kg
Yoghurt	2 750 000 kg

Other products manufactured by only one or two companies are skim milk powder, full cream milk powder, bakers powder, cultured buttermilk, cultured cream and butter oil. (Statistics cannot be released.)

The gross value of whole milk is estimated as \$58 m for South Australia in 1980/81 and \$832 m for Australia (A.B.S. 1981). The average total number of factory employees within the Industry is estimated as 1 242 for South Australia in 1979/80 and 19 044 for Australia (A.B.S. 1981).

3. Dairy Industry Marketing - Australia

The markets which relate to the Australian dairy industry consist of two broad sectors; a liquid milk sector which supplies milk and cream for household consumption and a manufacturing sector which processes milk into dairy products such as cheese and butter.

Marketing arrangements for the two sectors are different, although producers often supply both liquid and manufacture milk. In some States producers have a quota or contract to supply to the liquid milk market, and milk in excess of the quota can be supplied for manufacture. The liquid milk farmers receive the highest per unit price.

(a) Liquid Milk

The liquid milk market is controlled by State Government Milk Boards or Authorities in each State. The liquid milk market includes pasteurised milk, skim milk, cream, UHT milk products. In some States flavoured milk and yoghurt are also included. Regulatory controls govern milk quotas and supply, pricing, milk and product quality, treatment and sale.

The sale of liquid milk and cream in South Australia is characterised by 5 regional schemes designed to equalise the returns from liquid milk among all dairy farmers participating in the scheme.

The largest scheme for market milk price equalisation is that conducted by the Metropolitan Milk Equalisation Committee in the Metropolitan Milk Supply Area. The scheme is designed to equalise market milk and manufacturing milk returns and to ensure adequate supplies of liquid milk for the Adelaide Metropolitan Area.

The Metropolitan Milk Equalisation Scheme achieves equalisation of three variables for all producers participating in the scheme.

1. The price per kg fat paid to producers for market milk is the same for all producers in a given month.
2. The scheme equalises in proportion to the amount of fat produced, each producer's share of the total metropolitan sales of market milk by the two companies in the area.

3. The scheme involves equalisation of the price paid for manufacturing milk.

Other schemes operate in the South East, Mid North, Riverland and Port Lincoln regions. South East producers only receive a small liquid milk market share.

(b) Manufacture Milk

Until recently marketing arrangements for manufactured products were operated by the Commonwealth Dairy Produce Equalisation Committee Ltd. The C.D.P.E.C.L. operated separate price equalisation pools for butter, cheese, skim milk powder and casein.

The Inquiries Assistance Commission held two dairy industry enquiries as follows:-

- Dairy Industry, 23rd October, 1975
- Dairy Industry Marketing Arrangements, 9th September, 1976.

The second report recommended changes to marketing arrangements to be introduced in 3 stages over a 5 year period. Stage I was introduced in July 1977 with administration by the Australian Dairy Corporation.

Stage I involved a compulsory levy and disbursement scheme for prescribed products (butter, skim milk powder, casein, cheddar and gouda cheese). It is aimed at protecting the domestic market price structure by equalising export and domestic market returns.

In lieu of the I.A.C. Stage II proposals the Commonwealth introduced a system of selective underwriting for prescribed products on 1st July, 1978. Stage I continued to operate. By this scheme production in excess of set production ceilings for certain products, only received the average export price.

Since the 1979/80 season the Commonwealth Government has underwritten all production with no limits. The Stage I Marketing Arrangements continue to operate. Selective underwriting has been abandoned because export surpluses are no longer a problem.

Longer term guarantees are being built into the scheme, similar to the wheat stabilisation scheme, with a floor price based on 95% of a 3 year moving average of gross returns. It is unlikely that the Government will contribute to underwriting over the next two years as returns will be higher than the underwritten value.

Industry prospects therefore appear good, with export prices moving closer towards domestic prices.

4. Processing Industry Developments

- (1) A significant rationalisation of dairy factories occurred in the 1970's.
- (2) Decreasing milk supply has presented throughput problems in some cheese factories at certain times of the year.

- (3) A greater emphasis on milk protein in dairy products, as opposed to milk fat has occurred. Payment systems for farm milk may be changed to better reflect the true value of the components.
- (4) The cost of transporting milk and dairy products has increased significantly, resulting in amalgamation of bulk milk collection rounds and product distribution systems and a diversification of products distributed. Some dairy companies distribute a wide range of dairy products, fruit juices and frozen foods.
- (5) Trends to warehousing, palletising and supermarket distribution have occurred and as for other food products the use of non returnable containers has increased. The role of the milk vendor has however remained very strong.
- (6) Investment in automated milk and cheese equipment has been high. Some investment in complex equipment for whey utilisation will occur in 1982. Computer technology will be increasingly important.
- (7) The technology for recombined dairy products has been widely researched and will become increasingly important.
- (8) The development of UHT long life milk products is proceeding in the Eastern States. Its impact on South Australia needs to be closely monitored.
- (9) Rapid test methods for microorganisms and milk components will be increasingly important.
- (10) More sophisticated education and training programs will be needed in the 1980's, e.g. computer technology.

5. Identification of Areas Needing Research

Over the last two years the South Australian industry has been consulted by this Department on what research should be done. The industry has strongly suggested that they want more short term rather than long term basic research. Suggested areas of work have included:-

- (1) How to further improve milk quality and storage life on the farm.
- (2) Improved rapid methods for testing milk and fresh milk products for chemical composition, total plate count, coliforms, psychrotrophs and predicting shelf life.
- (3) Research on iodine in milk.
- (4) The development of new fresh milk products.
- (5) Research on stabilisers and flavours for ice cream, and flavoured milks.
- (6) The problem of low SNF in milk.
- (7) Non cheddar cheese technology, including properties affecting its use, e.g. slicing and heating properties of mozzarella.
- (8) The use of milk concentrates and recombined milk for cheesemaking, e.g. its effect on stretch curd cheese.

- (9) Pre-processing concentration of milk.
- (10) Whey utilisation.
- (11) Milk frothing in coffee vending machines.
- (12) The need for a testing service to test the accuracy and reproducibility of new equipment.
- (13) Lipolysis and associated flavour problems in milk and milk products.

Unfortunately many of the above projects may not attract finance from the Australian Dairy Research Committee because work in this field is being carried out elsewhere in Australia, or the problems are too local in nature. Work on flavours and stabilisers is mainly carried out by the supplying companies and would be a difficult field to enter.

The South Australian Dairy Research Advisory Committee was formed in 1981 and has representation from the Department, manufacturers and producers. The terms of reference of the Committee are:-

- (1) Identify research needs within the dairy industry and recommend priorities in the development of research programs taking into account the quantification of likely commercial benefits.
- (2) Determine the extent to which SAGRIC is meeting these research needs, and extending the research findings into industry and recommend action as required.

In addition a Departmental Committee, the Milk Utilisation Group, meets three times a year to discuss dairy technology, research and extension. The Committee membership includes extension and research staff involved in dairy processing research and extension. New research needs are considered.

6. Research Priorities

It is my opinion that the following areas of research are relevant and could be investigated at Northfield. Some of this research is presently being carried out.

- (1) Improved quicker methods for testing milk and fresh milk products for composition and microbiological quality.
- (2) A small amount of research effort by Northfield Research Centre and the Australian Mineral Development Laboratory should be concentrated on iodine contamination of milk. This will involve continued monitoring of iodine levels and the source of iodine in milk.
- (3) The development of new fresh milk products, cultured products, convenience foods and frozen products may be worth investigating. Minimal research funds would be allocated by the A.D.R.C., but industry contract research and industry involvement should be developed. The industry has stated that work is needed in this area and it should be investigated. Staff training at Northfield will be necessary on some aspects and additional equipment will be necessary in the pilot plant. Alternatively, such research can be carried out in dairy factories. The confidentiality of such research can cause conflict between the research officer and the Company.

- (4) Non cheddar cheese chemistry and microbiology is an important area needing more research. Even though work is occurring elsewhere in Australia and overseas, investigation of problems particularly for Italian and Greek cheese and cottage and quarg cheese is desirable.
- (5) Investigation of the level and effect of lipolysis in South Australian milk and dairy products.
- (6) It will become increasingly important to study how to make an all year round supply of constant quality dairy products.

The use of accelerated and retarded cheese ripening to ensure the availability of high quality mature cheese all year round could be further studied. This would involve extension and research staff and would need to involve industry finance and facilities (e.g. storage rooms).

- (7) It is my opinion that milk protein payment should be introduced and that some basic genetic research should continue.

7. South Australian Research

The future research at Northfield will be conducted in a time of decreasing staff and money allocations. Projects will need to be shorter term and highly relevant to industry needs. More industry involvement and funding will therefore be necessary, as will a greater involvement of extension staff.

If product development is to be carried out, industry involvement is vital. Zadow (1981) at a recent seminar stated that:-

"to have any chance of commercial success in our market with projects having a Government R. & D. input it is vital that you tell us what you want and, preferably, be prepared to join in actively in the development stage of the work. Without such an approach, the chances of commercial success are very limited".

Because of the risk involved in product development research, investment in time, equipment and money should only occur if the South Australian industry gives full backing. Some of the larger companies (especially Kraft) have their own extensive R. & D. section and probably would not be involved.

Many of the areas for research suggested by industry need combined extension-research solutions to problems. Some information is known and further investigation in South Australia is all that is needed. Areas suggested which are in this category are lipolysis, low SNF milk, iodine in milk and cheese ripening. I see a future for continuing research-extension involvement in the dairy processing industry, but this type of problem solving work should be State funded.

I consider dairy processing industry research should continue in the areas of genetic research on efficient milk protein production, testing methods for milk and milk products and specific industry projects should be undertaken on the chemistry and microbiology of non cheddar cheese. New product development work should only be undertaken with full industry support.

Industry, extension and research staff will also have to look at South Australia's future milk supply. Seasonal milk production, low factory throughputs and a possible decreasing milk supply may present problems in the future.

The technologies of UHT milk, milk recombining, membrane processing and storage of dairy products must be carefully assessed.

Northfield dairy processing research has, in my opinion, achieved significant success in the areas of milk protein production, identification and genetics and their effects on dairy products; mastitis; dairy blend development; cheese syneresis and rapid methods for bacterial identification. Part of the milk protein work has concerned milk powders and is only relevant to one powder factory in this State and those factories using milk reconstitution. As such it has not been appreciated by some sectors of the industry.

Northfield has been one of the few research centres in which the effects of nutrition, environment and genetics on the processing properties of milk and milk products have been studied. The linkage between farm and processing research has been an important contributor to Northfield's research success. Much of the milk protein research has potential for future application in relation to efficient milk production and usage and continuing work is necessary.

In addition to research projects, Northfield has served a valuable service to industry and extension staff. Trouble shooting investigations at factory level have involved milk, milk powders and cheese in particular. Much of the investigatory work conducted by Northfield has involved sampling and testing and applying analysis results and tests to problem solutions. This service and the cheese starter service which is now dwindling have been valuable additional services provided by Northfield to industry.

I consider that such investigations should continue as a backup service to extension officers. Some analyses conducted at Northfield have been for other Government Departments (e.g. Forensic Sciences and E. & W.S.).

The future success of dairy processing research will depend on the effectiveness of the South Australian Dairy Research Advisory Committee and the Milk Utilisation Group. Projects must be well planned and have industry support. An integration of extension and research staff into our technical group may be one way of ensuring research and extension programs are better planned and integrated.

8. References

Bureau of Agricultural Economics (1980). "Statistical Handbook of the Dairy Industry." Aust. Govt. Publ. Service, Canberra.

Statistical records of the Department of Agriculture.

Metropolitan Milk Board Annual Report, 1981.

Australian Bureau of Statistics (1981). *Dairying and Dairy Products*, Australia, 1980-81.

Zadow (1981). "The Technology Transfer Concept." *Aust. J. Dairy Technol.* 36(1): 8-10.

Figure 1: Dairy factory locations in South Australia.

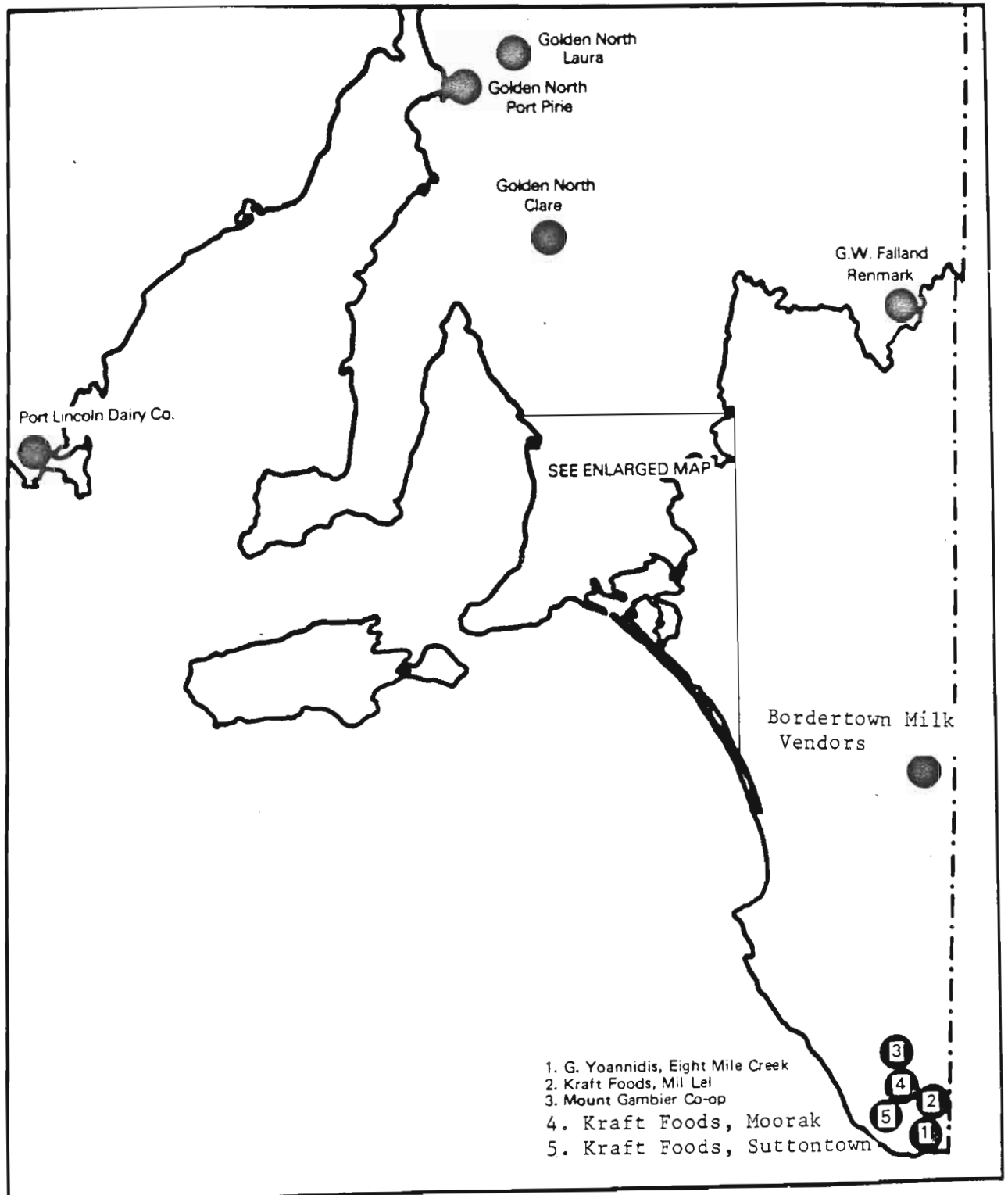
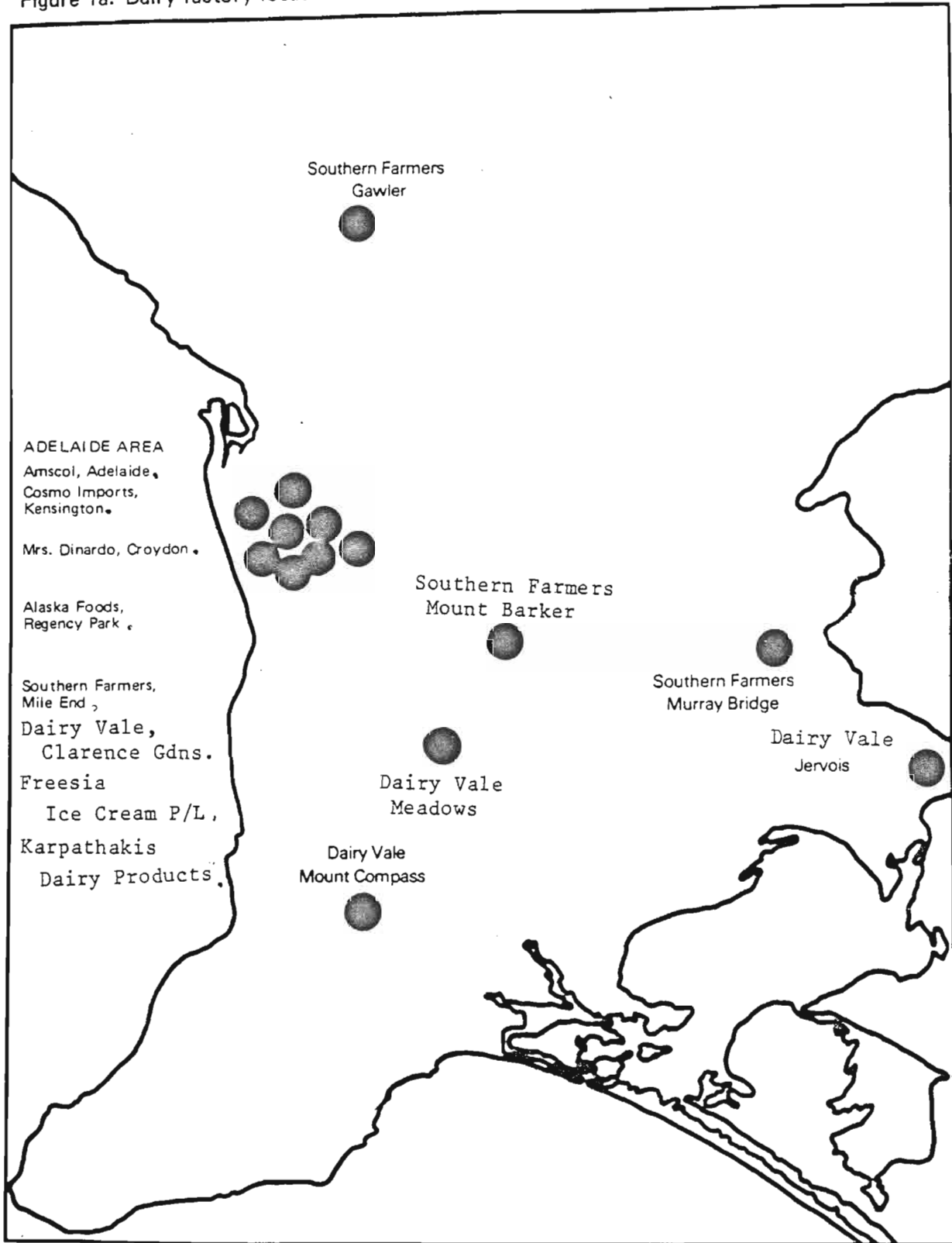


Figure 1a: Dairy factory locations in the Adelaide metropolitan milk production region.



APPENDIX I.3

BEEF CATTLE RESEARCH:

INVITED RESOURCE PAPER FOR RUMINANT INDUSTRY RESEARCH REVIEW

M.P. Deland,
Senior Research Officer,
Struan Research Centre

1. Historical Perspective of S.A. Beef Industry

Cattle were introduced by the first settlers and have been a secondary livestock enterprise to sheep production ever since. Until 1969 the British breeds, particularly the Shorthorn and their crosses with Hereford and to a lesser extent Angus formed the genetic base of the herd. Low rainfall areas including the Northern Territory and Western Queensland were a source of young cattle for fatteners in high rainfall areas of South Australia.

2. Current Situation

In recent years the development of the export trade, rapid increase in numbers (from 400 000 in 1965 to 1.9 m in 1976), and the introduction of European breeds have resulted in a greater awareness of benefits of cross-breeding and culling low performance animals. This has coincided with the employment of research officers specializing in beef cattle work and the development of experimental herds at Struan (700 cows), Turretfield (150 cows) and Wanbi (150 cows) Research Centres. Herds at Parndana and Minnipa have been maintained at comparatively low numbers (30-60 cows). Since the peak in cattle population in 1976 numbers declined to 1 m and appear to be stationary. The numbers of officers engaged in beef cattle work has also declined. Breed composition of the State herd has changed with a predominance of Herefords in the breeding herds, but a large number of crossbred cattle which involve infusions of dairy and European breed types, becoming evident in slaughter cattle presented for sale.

Distribution and production of the State's cattle has changed such that the pastoral zone with only approximately 12% of the State's cattle can no longer be regarded as the State's "cattle country". The South East, with only 3% of the State's land area has 55% of the State's beef cattle and 33% of cattle kept for milk production. The remainder are distributed in other higher rainfall areas and the wheat/sheep belt.

In 1980 cattle and calf slaughter (including export and interstate sales) grossed \$107 000 000 in comparison with sheep meat \$100 000 000, wool \$215 000 000, dairying \$42 000 000, cereals \$562 000 000, and fruit production including wines and grapes \$120 000 000.

3. Interactions with Other Ruminant Industries

Generally there has been a decline in sheep numbers as beef cattle numbers have increased over the past 10 years. Over the last two years of low cattle numbers sheep numbers have increased. Both sheep and cattle numbers declined sharply after the peak in numbers in 1976.

The State's cattle slaughtering capacity is concentrated in the Adelaide area. However, smaller works are in operation in country areas. Most of the turnoff from the South East is to buyers from Victoria although three meatworks and a number of local slaughter houses operate in the South East. The closest major works (Portland and Naracoorte) kill mainly for export and smaller works, Mt. Gambier and Mt. Schank, kill lighter cattle for local trade. Should the works at Portland close it is likely that the heavy bullock trade centred around the Millicent/Mt. Gambier areas would be most affected.

4. Future Prospects

About half of Australia's beef and veal is exported, with the U.S.A. and Japan as the main outlets. Movements in beef prices in Australia have closely followed those in the cyclical U.S. industry in recent years. As both Australia and the U.S. cattle populations are at the low part of the population cycle it is likely that prices and eventually production and value will increase.

Considerable instability has been introduced into marketing because of stockpiles of meat produced in the European Economic Community with Government subsidies, raising and lowering of trade barriers between Australia, Japan and the U.S.A., and high interest rates. This has been offset to some degree by new markets in the Middle East, Taiwan and Korea.

5. Major Factors Limiting Industry Productivity or Efficiency

(1) Management Decisions

Different markets require carcasses of different specification. In most cases specification is subjective. Fluctuating demand and hence prices on the different markets together with the long generation interval and management decision lead time are major problem areas when production objectives are reviewed. In most cases producers aim to sell "well finished" calves for local trade before the pasture dries in December-January and fatten the remainder for the export trade the following season. If prices decline during the interim considerable financial losses can be incurred. Market intelligence is poor and meat buyers prefer secrecy rather than let producers know what types of carcasses are being sought and at what prices.

(2) Social Factors

There is social pressure on beef producers from several sources. The long established breed societies and show circuits instill subjective ideals into followers which often reduce the acceptance of more economically advantageous techniques e.g. a heifer, cow or bull must be sleek and fat for show purposes. However, the intensity of feeding required for this purpose may impair the reproductive ability of the animal. Improved productivity of crossbred cows with a combination of milking breeds has been well documented. However, purebreds are more socially acceptable.

Most breed societies do not allow the inclusion of commercial animals of proven superior performance into their stud registers. This is in contrast to European breed societies and dairy breeds where minimum production standards and elite performance registers are commonplace.

(3) Genetic Factors Limiting Production Efficiency

In general, the importance of productive differences between breeds, strains and individuals has received considerable attention since the introduction of Charolais semen in the early 70's. The analysis, interpretation and practical application of this work has not been carried out although changes in the breed composition of cattle presented for slaughter, and at carcass competitions, are obvious. Producers who adhere to the traditional breeds and their crosses limit their herd productivity by at least 20% compared with those using a combination of crossbred dam with relatively high milk production and terminal sires of high growth rate.

Interest in recording of growth performance of individual straight-bred cattle has declined when compared with the late 60's. Measurement of bull serving capacity has become a standard pre-mating management technique on some properties and has increased the awareness of producers to the importance of fertility to production.

(4) Climatic Factors Limiting Production Efficiency

Differences in financial returns from cattle of similar breeding at Mt. Gambier, Struan and Wanbi have occurred. The "early-finishing" environment of the mallee and possibly other areas appears to have resulted in a 20% increase in financial returns for cattle raised at Wanbi compared with the South East. This appears to have been due to the sale of finished cattle from the mallee when prices were higher early in the season.

It is likely that marketing times should differ between regions and advisers should be aware of the differences. Time of mating may need to be looked at in each region.

(5) Nutrition as a Factor Limiting Production

Nutrition studies have been carried out at most research centres and relate to provision of supplements, feedlot studies, heifer rearing and heifer dystocia. Some mineral nutrition work has also been done particularly in relation to copper, cobalt, selenium and magnesium deficiencies.

Hay making is a major cost on most beef cattle properties but the economics of stocking rate and supplementation time and rate has not been studied to the same degree as has been the case with sheep.

Most of the information collected has not been collated, analysed, interpreted and written up although adequate nutrition at strategic times, e.g. mating, calving and finishing is obviously essential for efficient production.

(6) Disease

Most cattle are relatively free from the effects of infective diseases and high growth rates can be achieved without preventive medication. Tuberculosis and Brucellosis campaigns have been successful in reducing the incidence of these diseases to isolated herds and most other infective diseases, e.g. Vibriosis, Leptospirosis have a low incidence.

The major parasitic diseases are related to internal nematodes with Ostertagia of major concern. Most herds are given some form of anthelmintic treatment. Isolated cases of liver fluke also occur from time to time. Cattle

lice are present in most herds but their economic effects have been difficult to define.

Metabolic diseases present major problems in some areas in some years, e.g. losses of large numbers of cattle from hypomagnesia-related diseases have occurred. Toxic diseases such as annual ryegrass toxicity are not yet a major problem with cattle and appear to be related to particular areas in particular years.

6. Immediate and Future Research Priorities

Research into beef cattle in the S.A. Department of Agriculture has undergone a number of major phases. This included the identification of priority areas with producer and representative funding bodies and initiation of research programmes, development of experimental herds and research centre facilities including staff, and collection of data. These high cost phases have in most cases been undertaken without the yield phase being achieved, i.e. analysis, interpretation, extension and adoption.

First priority should therefore be to ensure a return from this investment by adequately documenting, analysing and interpreting all trial work on beef cattle which has been completed in the past 10 years together with appropriate extension publications.

Second priority should be the completion of current projects in a technically sound manner including conference presentation of interim results.

Future priorities should build on areas where economically significant leads have been found by previous and current work and which affect the majority of beef producers. These include:

- (1) Effects on lifetime productivity of nutrition during early rearing, pre-puberty and calving.
- (2) Development of commercial breeding systems which can be expected to exceed productivity of commercial straightbred herds.
- (3) Development of marketing intelligence so that producers can plan the production and marketing of appropriate classes of cattle, objectively described, produced and sold.
- (4) Development of economically sound culling policies, e.g. teeth, age, performance.
- (5) Development of economically sound selection criteria for bulls and heifers.
- (6) Development of economically sound anthelmintic programmes.

Given that there is a surplus of bulls and heifers born over requirements for breeding and that there is large variation between animals in their production potential and that of their progeny, it is clear that productivity of the breeding herd can be increased without necessarily increasing costs. Research and development of means of achieving efficiency by selection of superior animals for breeding should therefore receive high priority.

Nutritional level at critical times e.g. early rearing, pre-puberty and calving can have long term effects on lifetime productivity of females. It is clear that over-feeding can be detrimental to lifetime productivity. Completion of work initiated by Ian Johnsson and developed by D. Phillips should therefore receive high priority. In this respect the completion of analysis of samples in the U.K. while Johnsson has access to facilities should be considered as an urgent need.

There are many other areas where valuable work is indicated, e.g. helminth studies. However with the reduced staff numbers likely to be available, effort should be concentrated on those considerations which affect all beef producers; namely marketing, genetics and nutrition.

7. Resources Required

Existing physical resources together with commercial producers who have indicated willingness to participate are adequate for an effective research and development programme. Existing staffing, its supervision and deployment is totally inadequate for research, development or extension of ideas in an industry of such economic importance to the State. Of the five research officers engaged in the Department's beef cattle research programme, two are currently on study leave, one of whom (I. Johnsson) is working on nutrition and fertility, the other is working on population genetics (D. Gifford). A. Pullman is currently writing up helminth studies carried out at Parndana. David Phillips has undertaken sheep research work as well as cattle fertility and selection work and M. Deland has current breed and selection development work. It is assumed that beef production work carried out by dairy research officers will be dealt with by that section.

Of the seven extension officers with expertise in beef cattle production, only two are located in the South East where 55% of the State cattle population is concentrated and two are located where very few cattle producers are located.

There is a major need for extension officers to interpret and extend work currently on file at research centres. In this respect a research officer and an officer capable of writing extension bulletins, fact sheets, etc. could be employed for at least two years writing up material already accumulated. As most of this material is at Struan Research Centre and the major audience is concentrated in the South East these officers should be initially located at Struan Research Centre. Technical officers currently located at Turretfield (R. Lampe) and Struan (J. Rowe and J. Cooper) should be given formal training in writing extension material and assisted to do so.

If additional personnel are not employed, more effective deployment of the existing staff is indicated so that staff are located close to the target audience (producers) and more effective dialogue and assistance can be generated between staff. In this respect the Callaghan plan recognised the desirability of setting up "Centres of Excellence" for particular disciplines. This has been eroded by the current deployment system.

8. Significance and Effectiveness of Current Programme

While funding bodies have written guidelines for areas of priority in funding, no similar guidelines have been given for our Department. Departmental projects have followed the priorities set by funding bodies on Australian industry requirements defined by the funding committees.

The South Australian beef cattle research programme of the last 10 years conducted by research centres compares very favourably with interstate, University and C.S.I.R.O. programmes. However, within our programme there are major areas where improvements can be made if the programme is to be effective, e.g. trials on performance recording and crossbreeding research commenced before other states and have continued. However, other states have a clear advantage in terms of statistical back-up and public awareness which complement their research work and ensure that it is interpreted and presented to the media at regular intervals.

Research officers in the South East have claimed responsibility for approximately 70 trials or investigations on many aspects of beef production over the past 10 years. However, probably less than 20 of these have reached the standard for conference proceedings and even less have been accepted for refereed journals. Of the 13 titles of leaflets, bulletins or fact sheets on the Department's current extension list only three can be regarded as extension material related to research work. Others have included some input from research officers. The major extension thrust has been directed at contact with farmers via U.F. & S., Bureau, Department of Further Education, farmer visits, school visits, press and radio. With 55% of the State's cattle population concentrated within 1 1/2 hours drive, this direct approach is probably the most effective in the South East Region. Presentations at conferences are seen as an essential means of ensuring the technical soundness of work as well as an extension and information exercise.

Officers based at Northfield, Turretfield and Adelaide offices appear to operate on one project at a time and write up the project in technotes, T.I.C.'s and journals before commencing new work. They are not subjected to the same pressure to introduce new projects to funding bodies in order to maintain the research centre and do not have the direct contact with as many producers as officers based at Struan Research Centre.

Officers from Animal Health Branch have frequently indicated responsibility for private property trial work in regions. If this work has been written up formally I have been unable to locate it.

Although there are no beef cattle research staff based at Wanbi Research Centre the local interest in the work at the centre is high as indicated by field day attendance and farmer visits. Extension material based on the experiences at Wanbi and directed at beef producers in such marginal areas would find ready acceptance as no such material is available. Advice given in the past appears to have been of doubtful value.

Clearly the different centres of research activity have different general approaches to the research undertaken and to the method of extension used.

There is no effective or formal co-ordination of activities.

There is no commitment by biometrics section to ensure sound design or analysis.

Design faults in major projects and anomalies can persist for extended periods making the final writing up unnecessarily difficult and in some cases impossible for accurate interpretations even after journal acceptance, e.g. different selection differentials used in early published carcass work in Adelaide, no replication, common grazing or stocking rates in breed comparison at Turretfield, anomalies between growth performance and reproductive performance of Struan selection work and single sire "breed" work at Northfield and Struan.

9. Areas of Research Which Need No SAGRIC Involvement

C.S.I.R.O. has virtually no beef cattle work in Southern Australia. The Universities have specialist fields of expertise in very limited areas and with limited numbers of animals. This work is decreasing rapidly with cuts in University funds with the exception of A.G.B.U. at the University of New England.

The Victorian, Western Australian, N.S.W. and New Zealand Departments of Agriculture have cattle crossbreeding projects. The South Australian programme is at the most advanced stage of development with integrated crossbreeding programmes and per hectare assessment. There may be duplication of work already done by the South Australian Department by other states but no indication that our efforts should be reduced because other institutions have undertaken similar work.

South Australian work on selection in straightbred herds was more advanced than other states. The combination of A.B.G.U., N.S.W. Department of Agriculture and N.B.R.S. effort has changed this. The training of Mr. D. Gifford in this field appears misplaced unless it is envisaged that he will document the Struan Research Centre work on his return.

Although nutrition and helminth work is being carried out elsewhere it is clear that environments specific to South Australia should be included in this work. However, an effort should be made to ensure that the work carried out is applicable to the main beef cattle raising areas of the State.

10. Areas of Research Not Being Adequately Serviced

- Major deficiencies occur in the analysis, interpretation and extension of work for which data has been and is being collected.
- Formal co-ordination and discussion of what projects have been attempted, what stage of completion they are at, what needs to be written up and who is going to do it.
- Better recording of current projects e.g. V.A.M.I.S. reporting should be considered for the whole Department as the current awareness of projects is poor.
- Research into methods of marketing is urgently required, e.g. prices received at livestock auctions may vary more than 20% for the same class and weight of animal during one market. Services provided by agents vary considerably although the commission is the same within states.

Relative costs and returns appear to vary considerably between direct selling and livestock auction dependent on whether prices generally are falling or rising. Different meatworks specialise in processing different types of stock.

Bulls are usually sold for less per kilogram than other stock yet they have higher yield of meat than other classes of stock and in New Zealand receive appropriate prices.

The requirements of individual markets are clearly specified in New Zealand and prices are paid on the basis of the suitability of stock presented and price operating on that market rather than the superficial ideals which appear to operate in our meat markets.

- Practical information on cattle marketing is being collected or could be collected every time animals are sold by the Department. Many of the queries relating to value of different classes of animals, methods of sale etc. could be answered if adequate records were kept, analysed, interpreted and extended. The minimum requirement would be date of sale, age, weight, fatscore, sex and value of each animal sold.
- The needs of the project are not considered in current criteria for attendance at conferences. In this respect many cattle projects are long term and expensive. They should receive the attention of as many critical minds as possible in the early stages so that design faults, adequacy of recording and possible anomalies are dealt with before it is too late to avoid substantial losses or embarrassment. Similar critical evaluation should also occur during the conduct of such projects. In this respect I am aware that C.S.I.R.O. staff have been instructed by chiefs to present designs or data to conferences. Victorian staff have presented designs for proposed work which have subsequently been withdrawn as a result of professional discussion at this wider level.
- As recommended by Simon Ellis (New Zealand study report) our research effort would be more effective with co-ordinated research publicity and promotion. Publicity and promotion open days at research centres with proper planning and promotion with tours of officers throughout the State to publicise new and important research findings.
- Economic evaluation of alternate enterprises on a trial basis should be carried out. Figures obtained at Wanbi Research Centre indicate that higher returns from beef cattle than sheep may be possible whilst maintaining soil stability. With development of more suitable pasture species and adequate management these returns could no doubt be increased further.
- Many differences between processing plants have been noted in the course of following trial cattle through works e.g. flow of cattle in yards, ramp design, backing gates, knocking box use, use of markers (e.g. bulls) to identify lines and individual animals etc. Considerable cost saving to the industry could be achieved by proper research in these areas. Reluctance of some processors to quote on weight and grade basis may be overcome if simple individual identification techniques were adopted. This could be more acceptable now that electronic ticketing and tallying is in use.
- Research into the use by importing countries of various grades and cuts (as is evident in New Zealand) could lead to improved packaging, producer education and returns.

APPENDIX I.4

WOOL INDUSTRY RESEARCH:

INVITED RESOURCE PAPER FOR RUMINANT INDUSTRY RESEARCH REVIEW

M.R. Fleet,
Senior Animal Industry Officer,
Animal Industry Division

1. Historical Perspective

For much of this century wool was the principal source of export revenue for Australia. In recent years exports have become more broadly based, with wool being only one of a number of significant export industries. The decline of importance of wool in terms of export value is a result of many factors, but perhaps the major influence was the development and subsequent competition from the synthetic fibre industry.

For the last 25 years wool prices have been, comparatively, at the lowest level of real value in the history of the industry (Nesti 1981). World production of non-cellulosic synthetic fibres was only 69 million kg in 1950/51 and by-passed world wool production of 1 480 million kg in 1964/65. In 1979/80 the capacity for world production of non-cellulosic synthetic fibres was 12 638 million kg, although actual production was 10 608 million kg, compared with world wool production of 1 573 million kg (Table 1).

In recent years synthetic fibre producers have suffered from over-supply, the oil crisis and low prices for products. To some extent these problems have been overcome by reducing production and the use of alternative raw materials, for example coal, natural gas. However, prices of synthetic fibres have generally increased and this has helped natural fibres recover partially.

Reduced profitability within all sectors of the wool industry (producers, marketers, shippers, processors) has necessitated vigorous promotion and numerous cost saving changes or improvements in order to maintain wool as a competitive fibre option. To a large extent the promotion, research and development for wool has been conducted by organisations such as the International Wool Secretariat (I.W.S.), and the C.S.I.R.O.

In 1970, two very significant decisions were taken for the wool industry. Firstly, the Wool Commission was founded to place Reserve Prices on the then floundering wool market and, secondly, the Australian Wool Measurement Project got underway (Young 1977). The wool market has been notoriously unstable which has had undesirable effects on the finances of both woolgrowers and wool-users. The successful establishment of the current Reserve Price scheme in 1974 has offered stability and steady improvement in wool prices. Similar, complementary schemes operate in New Zealand and South Africa. These three countries supply about 90% of exported wool.

Extensive changes have occurred to the marketing and classing of wool between 1970-1981 which stem from the research and development of the Australian Wool Measurement Project. Changes such as Sale-by-Sample and Objective Clip Preparation have meant major cost savings for the industry. In 1980-81, 99% of all bales offered at auction in South Australia were Sold-by-Sample with presale test results.

Further developments will flow from objective measurement of wool in the 1980s and beyond (Richardson 1981).

2. Current Situation

Wool production remains of major importance to the South Australian economy. The gross value and export value of wool production exceeds the values of other livestock products (Tables 2 and 3).

In 1979-80 the gross value of wool production was twice that of meat production from cattle and calves and five times that of dairy production. Wool is the principal livestock product exported from South Australia and in terms of other commodities ranks second to wheat and barley exports.

Prices and demand for wool during the second half of 1981 were depressed, although this situation should improve during the second half of the 1981-82 season. There are a number of likely reasons for the present depressed wool market, including:-

- depressed growth of world economy and textile activity,
- sustained high and unstable interest rates affecting the amounts of wool stocks that overseas users are willing to hold,
- use of raw and semi-processed wool stocks held overseas,
- exchange rate changes have generally not favoured overseas wool users,
- offerings of wool in Australia were relatively high during the first half of the 1981-82 season.

Demand for Australian wool should gradually improve during 1982 as overseas wool stocks decline. Demand could also improve as a result of more stable interest rates, a slightly lower Australian dollar and growth of consumer demand in Western Europe, Japan and other markets (Asimus 1981a).

The number of sheep in South Australia peaked at 19 747 000 in 1970. Low prices for wool and stock, drought conditions and buoyant grain prices resulted in the reduction of sheep numbers to 14 073 000 in 1978; and a steady increase since then to 17 056 000 in 1981. Australian sheep numbers seem likely to increase only gradually by about 1% per annum, from the current level of about 132 million, to reach 140-145 million by 1986-87 (Richardson 1981). About 85% of the sheep are Merino. The remaining 15% consists of a variety of fat lamb and dual purpose breeds or crossbred sheep, for example - Corriedale, Border Leicester, Dorset, Suffolk.

Sheep numbers are distributed relatively evenly through the Divisions of the State. The greatest and least number of sheep occur in the South East and Adelaide Divisions, respectively. Average fleece weights are highest in the Northern Division where the sheep are mainly Merino and are lowest in the South East and Adelaide Divisions, where a larger percentage of dual purpose and fat lamb sheep breeds are grown (Table 4). The number of agricultural establishments with sheep was 13 179, or 57% of establishments with agricultural activity, at March 31, 1980 (Australian Bureau of Statistics).

3. Interactions with Other Industries

Wool and sheep meat production are directly related and together account for about 56% (1979-80) of the gross value of livestock products to South Australia.

Income from the sale of livestock has become an important source of profitability for sheep enterprises, as a result of growth of the Middle East live sheep or meat export market. Collapse or closure of these markets could increase flock size and wool production in the short term but would subsequently cause a decline in sheep numbers and wool production, due to reduced profitability, as was the case in the early 1970s.

There will be a continued trend interstate toward a large framed Merino, such as the South Australian Merino strain. There will also be a trend toward sheep of higher reproduction rate and adoption of management techniques that minimise lamb mortality, in order to increase the numbers of surplus sheep available for sale.

Competition between grains, sheep and cattle will also be important. Grain acreage in Australia is expected to increase by as much as 0.5 million hectares per annum over the next few years, further reducing available grazing space (Richardson 1981).

Apart from woolgrowers, the wool industry provides a livelihood for shearers, classers, brokers, buyers, stock agents and an expanding local wool processing industry.

4. Future Prospects

Wool's place in a now very competitive fibre market can only be assured with continued vigorous promotion, research and development. Although wool-growers provide substantial funds through the wool levy for these purposes, the importance of wool production to the Australian economy should ensure continued funding from Commonwealth and State Governments.

In the apparel sector wool will at best maintain its share of the total fibre market as the size of the market grows slowly in the 1980s. Changes in demand for wool will include a declining proportion of Australian wool going into pure wool (Wool Mark) and increased blending with other fibres. There will be a continuous gradual shift in wool textile activity to developing countries and communist countries (COMECON block). Consumption, particularly in terms of value, will remain in the developed industrialised countries (Richardson 1981).

Synthetic fibre producers are slowly recovering from the over-production and oil crisis of the '70s and are showing greater profitability. Funding of promotion and research on synthetic fibres is now increasing. Synthetic fibre salesmen are aiming at "up-market" product areas - those areas of textile sales which can not only support raw wool prices, but offer the best prospects for increased returns to woolgrowers. In Japan the four major manufacturers of synthetic fibres were spending \$35 m a year on promotion, compared with the I.W.S. budget of \$13 m for wool (McPhee 1981).

Stimulation of demand for wool by promotion must be ongoing in view of constantly changing social, industrial, economic and political circumstances in each country that the I.W.S. operates. The success of such promotion in consumer preference for wool was seen in 1980 when total consumption of all

fibres in countries where the I.W.S. had branches fell by 2%, compared with a fall of 1% for wool (Asimus 1981).

Demand for wool can also be stimulated by developments which generate cost savings or overcome problems or restrictions in wool use, for example:-

Distribution and Transport

Shipping rates - Development of presses (e.g. dump, jumbo, tripac) that can improve storage in shipping containers by up to 72%, and lead to savings in shipping costs of over 5c per greasy kg (Asimus 1981).

Wool packs - capless packs, quality control.

Wool measurement - Sale-by-Sample with provision of accurate measurements of fibre diameter, yields and vegetable matter content and composition. Provision of additional measurements will give processors more confidence in the processing performance of wool and enable wool to compete more effectively with synthetics at a continuing price premium (Richardson 1981).

Processing

Scour effluent treatment - Lo-Flo process and Hot Acid Flocculation process.

Spinning - Siro-spun, wool processing on short stapled (cotton) machinery.

Improved dyeing and other fabric treatment techniques.

Moth proofing.

Flame proofing.

Shrink proofing - "superwash".

Felting yarns.

It is also necessary for wool production in Australia to remain profitable despite increasing costs of production and marketing. Between 1973 and 1981 average greasy wool prices increased 34 per cent, while in the same period direct costs to growers of harvesting and marketing wool increased 165 per cent (McEvoy 1977, McInerney 1981). Sale-by-Sample marketing and objective clip preparation have allowed some constraint of direct costs to growers, and further cost savings are likely to occur, in these areas, with commercial presale measurement of all important processing characteristics: termed Sale-by-Description. Although little successful development has occurred in the area of wool harvesting, a considerable amount of research is being undertaken and some areas are showing promise.

Improvement of the efficiency, quantity and quality of wool production on farms must also be an ongoing activity, and is the area in which research by State Departments of Agriculture can play a major role.

5. Funding of Wool Research

The woolgrower's tax levy of 8% on the value of his shorn wool is divided into 5% for the Market Support Fund (which in 1981 commenced to revolve and

return the funds to growers), 2 1/2% for promotion and administration, which covers a substantial portion of the activities of the I.W.S. as well as the running costs of the A.W.C., and 1/2% for research.

In 1980-81 this 1/2% for research amounted to \$7.5 million and was complemented by a grant of \$6.9 million from the Commonwealth Government. Of the \$14.4 million received by the Wool Research Trust Fund (W.R.T.F.) \$13.3 million was allocated for funding research in the following organisations:

<u>Organisation</u>	<u>W.R.T.F. Allocations 1980-81</u> millions (McKay 1981)
C.S.I.R.O.	\$7.6
Universities and Institutions	\$2.3
State Departments of Agriculture	\$1.7
Bureau of Agricultural Economics	\$0.25
Other organisations including the A.W.C.	\$0.8

These amounts form only part of the total funds spent on sheep and wool research. C.S.I.R.O. gets 40% of its wool research funds from the W.R.T.F. while 60% of its wool funds come directly from the Commonwealth. State Departments of Agriculture receive their main funds for wool and sheep research from their State Governments, while Universities and the B.A.E. supplement W.R.T.F. funds with general funds received from the Commonwealth Government (McKay 1981).

6. Major Industry Problems

At a SAGRIC Sheep Industry Meeting held in July 1979 a working party was elected to define areas of deficiency of information (problems) that impede wool and meat production (copy attached). This list is extensive and no attempt was made to set priorities, which may change with time or differ between regions of the State.

The W.R.T.F. subdivides the funding of research into different areas and has allocated research priorities to these areas (Table 6). For production research, the areas of high or medium priority are:-

- (a) The choice and genetic improvement of animals
- (b) Control of diseases and parasites
- (c) Improvement of soil fertility, plant nutrition and water use
- (d) Control of wildlife and amelioration of the environment
- (e) Reproduction and husbandry of breeding flocks
- (f) Improvement, choice and establishment of pasture species
- (g) Effect of nutrition on production and the use of forage for supplementary or drought feeding
- (h) farm management
- (i) Research facilities and training.

Study of the SAGRIC research programmes currently receiving W.R.T.F. support indicates close association with this priority list.

The following research programmes in priority areas (a) and (b) and (e), indicate major industry problems in these areas:-

(1) The choice and genetic improvement of animals

- Melanin pigmented fibres in white Merino fleece wool - SAGRIC.
- Studies on the definition of selection objectives and selection criteria for Australian Merino sheep - SAGRIC.
- Low cost near infrared spectroscopy wool measurement for sheep breeders.
- Establishment of a co-operative nucleus for high fertility Merino flocks.
- The use of recombinant DNA techniques for the isolation and characterisation of structural genes for hair and wool keratin proteins.

(2) Control of diseases and parasites

- Genetic improvement of the strong wool South Australian Merino by reduction in the incidence of body strike - SAGRIC.
- Mycotic dermatitis in sheep - prevalence and relationships to suspected causal factors - SAGRIC.
- A feasibility study of the potential of microbial agents for the suppression of the sheep blowfly.
- Responses in Merino weaner sheep to management procedures for the control of gastro-intestinal nematodes - SAGRIC.
- Control and eradication of footrot.
- Study of host-parasite relations and control of annual ryegrass toxicity.

(3) Reproduction and husbandry of breeding flocks

- Comparison of the reproductive and productive performance of Bungaree ewes and rams, with Booroola x Bungaree, Trangie fertility x Bungaree and 'T'-flock x Bungaree cross ewes and rams in South Australia - SAGRIC.
- The reproductive performance of sheep grazing a low oestrogen cultivar of *Trifolium subterraneum* sub species *Yanninicum* - SAGRIC.
- The genetic improvement of reproductive performance of flocks grazing oestrogenic pastures - SAGRIC.
- Increasing fertility and fecundity in ewes.
- Wool growth in pregnancy and lactation.
- The relationships between testes size in rams and flock fertility.

7. Future Research Priorities

It is difficult to forecast which present deficiencies of information will become important problems in the future. Ryegrass toxicity, for example, was first recognised in 1956 and remained a local problem until recent years. Ryegrass toxicity is now widely established throughout South Australia and attracting research investigation. It is likely that the importance of certain

problems will change from year to year with constantly changing seasonal, social, industrial, economic and political circumstances. Much of the research effort during the 1980s will be a continuance of present research on important industry problems which are not readily solved or require long term investigation. -

The objective measurement of wool is one area of specific interest which grew during the 1970s and will continue to grow during the 1980s. The development of instruments and standardised techniques for measuring wool characteristics has allowed radical changes in wool research, wool marketing, clip preparation, sheep selection and ram marketing. At this stage, wool is sold by representative grab sample for appraisal of non-measured characteristics and catalogued measurements for yield, fibre diameter, vegetable matter content and composition. Measurements of staple length, staple strength and position of break and unscourable colour have also been offered on a trial basis, but more efficient laboratory procedures are required before these measurements can be introduced commercially.

The measurement of the other wool characteristics of importance to wool processors, have or are being researched, for example - fibre diameter variability, coloured fibres, resistance to compression, fibre length variability, cottedness, vegetable matter distribution, staple tip. Research will also continue on improving existing commercial wool measurement techniques. For example - near infrared spectroscopy for the measurement of wool for yield and fibre diameter, offers potential cost savings in fleece testing.

The development of new and reliable methods for testing important wool characteristics will allow further research and development in areas such as:-

- (1) Sale-by-Description - marketing by measured description alone.
- (2) Centralised wool marketing.
- (3) Wool clip preparation - determining minimum requirements.
- (4) Establishing the relative importance of different wool characters to subsequent processing performance or product characteristics and quality.
- (5) Determining the heritability of newly measured wool characteristics, for example, unscourable colour, fibre diameter variability, staple strength.
- (6) Fleece testing of important wool characters and use of these measurements in sheep research, sheep selection and ram marketing.
- (7) Study of the factors affecting wool characteristics and therefore wool value.

8. Resources Required

Sheep research requires the following resources:-

- Staff - research officers, technical officers and assistants.
- Land, fencing, yards, shearing facilities, transport, water, supplementary feeding.
- Laboratory or field equipment, office and computing facilities.

- Sheep housing for intensive studies.

Resources for sheep research are now regionalised with the exception of the Animal Industry Division, which includes six research officers involved in sheep research. These officers have no technical support staff, with the exception of support from staff within the region that they are conducting research. Lack of technical support for these officers requires their undertaking many tasks that would normally be conducted by farm labour, technical officers or assistants. The activities of this group are limited by lack of support staff and by the already limited resources of regions. It is likely that resources for sheep research within each region will become more limited as a result of reduced staff and cuts in funding.

The measurement of wool in sheep research programmes and the study of factors affecting wool characteristics is growing and will continue to grow. SAGRIC has no laboratory or technical staff and little equipment to provide for wool measurements. At present experimental wool and mohair samples are sent by SAGRIC to fleece testing services such as the Australian Wool Testing Laboratory.

These services offer basic tests such as washing yield and average fibre diameter at reasonable cost (\$1-60 - \$2-00 per sample). However, measurements of other wool characteristics may not be available or are available at high cost. For example, the rapid measurement of fibre diameter distribution (20 samples per hour each of 5 000 fibre counts), using the C.S.I.R.O. Fibre Fineness Distribution Analyser has been well documented, but to date has not been adopted by commercial testing services. The lack of laboratory staff and equipment in SAGRIC will limit early adoption of wool measurements or study of factors affecting wool characteristics and therefore product value.

In Queensland, New South Wales, and until recently Western Australia, the Department of Agriculture wool testing laboratories have offered low cost testing services to sheep breeders, in order to encourage the greater use of selection based on production.

9. Significance and Effectiveness of Current Research

SAGRIC memo 100 B details research philosophies and priorities. The following extracts from this memo indicate examples of guidelines that SAGRIC research officers must follow:-

- In every case research projects must be chosen on the basis that they show clearly identified prospects for increased economic and/or social benefits to the agricultural industries.
- The necessity for each research project must be established and that the required information is not available from other sources.
- Consideration must be given to the probability of gaining useful results and to successfully achieving the development, extension and adoption of the results.
- Research strategy must ensure that the maximum benefit is obtained from every project.
- All research must be related to specifically stated objectives.

- Research projects must be periodically reviewed.

These guidelines form a basis on which SAGRIC research officers can plan and specify their research intentions, in the form of a Research Preschedule Abstract. Research Preschedule Abstracts approved by the Principal Research Officer and Chief Regional Officer concerned are presented to the Research Management Committee for approval before the research programme can proceed. If industry funds are sought from the W.R.T.F. then a similar submission must be made to the A.W.C. - Research and Development Department for their consideration.

Extension officers gain knowledge of research findings in the following ways:-

- (1) Research Circulars - brief reports of preliminary results on progress.
- (2) Technical Information Circulars - report literature reviews or more detailed preliminary results.

Technical Information Circulars and Research Circulars were found very useful by sheep research and extension officers and have now been replaced by Technical Reports and Technical Papers (Research Guideline 100J).

- (3) Sheep Industry Group Meetings - a quarterly meeting of regional sheep extension/research officers with the officers of the Animal Industry Division.
- (4) Direct discussion between research officers and extension officers or woolgrowers.
- (5) Press and radio releases from research officers.
- (6) Publication of results in a scientific journal.

In summary, there are established procedures within SAGRIC which should ensure that research is both significant and effective, and that findings are extended to woolgrowers. One area of improvement could be an annual list of summaries of abstracts, on SAGRIC sheep research published in scientific journals, to be sent to all livestock extension and research officers and perhaps the media.

10. Research by Other Organisations

The areas of wool research in which SAGRIC has little activity are mainly off-farm, such as:-

- (1) Distribution research - handling and packaging of wool.
- (2) Wool harvesting research - automated mechanical shearing,
 - physical wool severance.
- (3) Textile research - increasing the efficiency and overcoming problems in wool textile processes,
 - improve or develop new performance characteristics in wool fabrics and garments,
 - explain the chemical and physical mechanisms associated with the behaviour of wool during processing or use.

- (4) Agricultural chemicals - developing improved and cheaper chemicals for the treatment of sheep diseases or parasites.

SAGRIC researchers would generally not enter the above research areas, except perhaps in a joint project with another organisation (C.S.I.R.O., A.W.C., Chemical Co.). These areas usually require research officers of different training and specialised equipment and techniques.

11. Other Areas in Need of Research

After discussion with the sheep research officers of the Animal Industry Division, the following areas were identified as not being adequately serviced. Research or development in these areas could potentially be undertaken by SAGRIC or other research organisations in the next 10 years or more.

(1) Use of recombinant DNA techniques in sire selection

It may be possible to use recombinant DNA techniques to determine the presence or absence of specific genes in breeding stock, which may be desirable or deleterious to promote. In sheep, this type of technology could be applied to simply inherited characters such as:-

<u>GENE</u>	<u>STATUS</u>	<u>EFFECT</u>
The genes for black	Recessive	Symmetrical pattern of black pigmentation
The litter size gene in the Booroola Merino (hypothetical)	Dominant	Litter size of three or more
The gene(s) for piebald (hypothetical)	Recessive	Random spotting "pattern" of pigmentation
The gene for goitre	Recessive	Goitre
The gene for cryptorchism (hypothetical)	Recessive	One or two testicles retained in the abdomen
The gene for polled	Dominant	Polledness. Heterozygous sheep not distinguishable
The gene for brown	Recessive	Symmetrical pattern of brown pigmentation
The gene for hypotrichous (hypothetical)	Recessive	Hairless on face and legs

(2) Sources of variation in fleece testing

Fleece testing laboratories provide measurements which in general are more accurate than visual assessment. However, inaccurate measurement can dramatically alter the rank of a ram, especially when few sheep are measured for the purpose of selection, for example - reserve rams. There is a need to study the sources of variation (sampling, measurement, laboratory) in fleece measurements and derive means of specifying the reliability of fleece measurement tests given standard techniques (present or improved).

(3) Male trait associated with reproduction rate

Improvement of reproduction rate in sheep is difficult for several reasons; the trait is sex limited to the female, is discrete rather than continuous and generally reproductive characters have a low heritability.

Identification of a trait, directly measurable in males, which is genetically correlated with reproduction rate in females would be very advantageous especially in Merino flocks where identification of type of birth is difficult.

(4) Categorisation of ewes bearing 0, 1, 2 lambs

Currently machines are available to classify ewes as pregnant or non-pregnant but a cheap reliable technique for classifying sheep as bearing x, y or z lambs is not available although ultra-sonic imaging looks very promising.

Having the ability to class ewes as bearing singles or multiples has potential from a management/husbandry aspect and marked implications from a breeding and genetic aspect. For example, studs could divide ewes into groups bearing 1 or 2 lambs in late pregnancy and know that all progeny of a particular group of ewes were single or twins. Such a procedure would automatically enable multiple records of reproduction rate to be accumulated on all ewes.

(5) Genetic parameters in industry flocks

The phenotypic/genetic parameters used to develop breeding programmes are based on estimates made in experimental flocks; most were obtained about 20 years ago.

Because selection changes gene frequencies, hence changing parameters, such estimates may not be applicable to stud Merino flocks. If influential studs were randomly sampled and the sires mated to random groups of ewes it would be possible to obtain more applicable parameter sets. In addition, given appropriate experimental design, it would be possible to compare the genetic merit of particular ram sources. Such information would lead to more efficient breeding programs and provide valuable information to ram buyers.

(6) Feasibility of using super-ovulation and artificial insemination in Merinos

The adoption of scientific breeding methods in the Merino industry means that the breeding value of individuals can be more accurately estimated. Within a flock it may be possible to identify groups of elite rams and ewes whose genetic potential could be exploited by super-ovulating the ewes, artificially inseminating the ova with semen from the best sires, and transferring the fertilised eggs to donor ewes.

While much of the technology is available already, modification and development of the techniques would be necessary before it was implemented at a farm level.

(7) Artificial insemination in stud breeding

Artificial insemination is widely used in the Australian Merino Society breeding programme. More recently a company in Western Australia has begun purchasing Merino rams for use in an artificial insemination programme with stud Merinos.

The implications of such a development need to be studied in terms of the amount of inbreeding "tolerable" and the development of reliable methods of identifying superior sires.

(8) Technology for exploiting the litter size of highly fecund Merinos

At Minnipa and Cape Borda Research Farm crosses of South Australian Merinos with Merino strains of high fecundity - the Trangie Fertility, the C.S.I.R.O. 'T' and the Booroola - are being conducted. Both experiments are only partially completed but early results suggest that high levels of lamb mortality will probably occur in paddock lambing situations.

Techniques which could increase survival rates in the progeny of South Australian Merino ewes and the high fecundity strains have received little attention. There are four key areas in the management of highly fecund sheep which warrant investigation. These are (i) pre-mating management, (ii) the nutritional requirements of the pregnant ewe, (iii) lambing management, and (iv) aspects of the growth of their progeny.

(9) Wool measurement

The continuing development of wool measurement for all important processing characteristics, means that breeding objectives for wool production will need to be re-assessed in response to changes in wool marketing (Sale with Additional Measurement, Sale-by-Description).

Estimation of the phenotypic, genetic and economic parameters of commercial wool measurements will be necessary. There is an increasing amount of evidence that wool characteristics such as unscourable colour, fibre diameter variability, and staple strength could be heritable. Other factors such as cottedness, coloured fibres, and tippiness may also be considered in the future.

Work will be necessary to define which wool selection criteria, measurable on the live animal, could be used to select for new objectives.

(10) Carcase classification

The development of a system of selling sheep meat by classification of the carcass means that breeding objectives for sheep meat production will need to be re-assessed as a response to changes in marketing.

Identification of traits to be included in the breeding objective and estimation of phenotypic, genetic and economic parameters will be necessary. Work will also be necessary to define which selection criteria, measurable on the live animal, could be used to select for the new objectives.

(11) 'Single gene' in the Booroola Merino

Current evidence suggests that litter size in the Booroola Merino is controlled by a single dominant gene.

If this is the case, then substantial utilisation of the gene would be enhanced if methods were available to differentiate between sheep which were LL, Ll or ll.

In addition, the 'single gene' theory means that the gene could be incorporated into other breeds by back crossing and selection. Consideration could be given, for example, to introducing the litter size gene into the Dorset and Border Leicester breeds.

(12) Sheep genetics

Several aspects of sheep genetics requiring research/development in the next decade are listed below:

- (a) Development and implementation of the National Sheep Performance Recording Scheme.
- (b) Estimation of genetic/phenotypic parameters for the Border Leicester breed.
- (c) Establishing the relative economic importance of traits such as resistance to blowfly strike and determining the most efficient method of selecting for such traits.

(13) Utilisation of 'teaser' ram effect

A better understanding of this phenomenon had led researchers to the conclusion that it may be of value in the development of more intensive lambing systems (see 14 below). Considerable work is still required in:

- (a) Identification and synthesis of pheromone(s) responsible.
- (b) The most efficient use of teaser rams/pheromone(s) in the field.

(14) Manipulation or intensification of mating and lambing systems

Research in this area is directed towards the hormonal control of many aspects of reproduction such that the frequency of lambing, early weaning and conception rates may be manipulated. The major problem remaining to be solved is the inability to obtain satisfactory conception rates immediately after weaning. This problem will attract considerable attention in the near future. Systems of intensive production will be examined.

(15) Identification of characteristics of sheep or its fleece, or development of a simple test which will give an indication of the degree of resistance of a sheep to fleece rot or body strike

There is an increasing amount of evidence that susceptibility to fleece rot and body strike is a heritable trait. For a number of reasons it is not applicable in most situations to select directly against occurrence of these disorders. Identification of characteristics of sheep which are strongly genetically correlated with fleece rot, or development of a simple test which indicates the degree of resistance of a sheep to fleece rot or body strike, would make effective selection for greater resistance much more feasible in a wide range of environments.

(16) Investigation into the mechanisms of maintenance of sheep blowfly populations in the pastoral areas

The Australian sheep blowfly *Lucilia cuprina* is responsible for approximately 90% of all blowfly strike in Australia. *Lucilia* breeds mainly

on live sheep with very few of them completing their life cycle in carcass (at least this is the case in the more temperate areas).

The *Lucilia* fly in most circumstances does not travel more than 5 km from its place of emergence. However, when conditions in the pastoral area become suitable for sheep to become fly struck, fly waves quickly develop and in bad years enormous losses can result. The mechanism by which *Lucilia* survives between these fly waves is not clear.

This would seem to be a weak link in the population cycle of *Lucilia* and knowledge of the means by which *Lucilia* survives may lead to effective control measures for these areas.

12. Speciality Wools

The South Australian climate generally does not favour the production of superfine and speciality carpet wool or wools of premium style since 98.8% of the total land area receives less than 600 mm of annual rainfall.

Production of superfine and carpet wools on pasture requires areas of relatively high rainfall and a long growing season in order that contamination and damage to wool from dust, sand, vegetable matter and ultra violet light is minimised. Therefore, production of these types of wools in South Australia is likely to be restricted to areas of high rainfall in the Adelaide Hills, Kangaroo Island and the South East.

The future production of pasture-grown superfine wool from Saxon Merino sheep is not likely to increase in the high rainfall areas unless the demand or premium prices for this type of wool increases markedly. The average fleece weight and carcass value of Saxon Merino sheep are much lower than Merino sheep of other strains.

In the case of Sharlea wool production, environmental problems are overcome by housing the sheep and a large premium (\$21 per kg) is available for this type of superfine wool. Problems which currently face intending Sharlea wool producers are:-

- High cost of shed and equipment
- High cost of feed
- Lack of suitable sheep of Saxon Merino strain in South Australia and interstate
- High cost of suitable sheep from interstate (\$50 - \$100 per head)
- Lack of an established and secure market for this wool
- Difficulty of producing premium Sharlea wool when animals are penned in groups to cut costs
- Separation from wool marketing centre in Portland, Victoria
- Lack of reserve price support from the A.W.C. and sometimes long delays in payment.

In South Australia there appears to be only two producers of Sharlea wool, both in the early stages of establishment, although there is a steady enquiry for information.

In the case of speciality carpet wool production, the four breeds in Australia which produce satisfactory speciality carpet wools will also produce good quality prime lamb. Therefore in the high rainfall areas, free of

vegetable fault, a carpet wool flock should be as profitable or more profitable than crossbreds for prime lamb production.

At present wool prices speciality carpet wool attracts a premium over crossbred wool of 30 microns or more which barely exceeds the Reserve Floor Price.

13. References:

Asimus, D.J. (1981) - Australian Wool Corporation Interim Annual Report 1980-81, A.W.C. Publ.

Asimus, D.J. (1981a) - Wool - some improvement expected. News Service 143/81, December 17, 1981, A.W.C. Publ.

McEvoy, R.I. (1977) - Harvesting, marketing and distribution costs for Australian wool - sheeps back to mill, 1970-77. *Wool Technology and Sheep Breeding* 25(4), 13-15.

McInerney, M.G. (1981) - Harvesting, marketing and distribution costs for Australian wool - sheeps backs to mill, 1981. *Wool Technology and Sheep Breeding* 29(1), 13-16.

McKay, B.H. (1981) - Important R and D programmes funded from the Wool Research Trust Fund. Proc. Australian Wool Harvesting Conf., Sydney, August 1981, A.W.C (in preparation).

McPhee, J.R. (1981) - Sizing up the synthetics. South Australian Advertiser, "On the Land". November 17, 1981.

Nesti, G. (1981) - A study on uses of superfine wools. Proceedings of Workshop on the Sharlea Industry. Victorian Department of Agriculture (in preparation).

Richardson, B. (1981) - Future market requirements for wool and their influence on breeding. Proc. of Seminar on Breeding Merinos for Future Market Needs. Clare, South Australia. Australian Association of Animal Breeding and Genetics Publ.

Young, J.C. (1977) - Fibre marketing, Working for Wool, A.W.C. Publ.

TABLE 1: WORLD PRODUCTION OF FIBRES (million kg)

Year	Natural		Man-Made		Total
	Wool (Clean basis)	Cotton	Cellulosic	Non Cellulosic	
1950/51	1 057	6 613	1 608	69	9 347
1960/61	1 463	10 113	2 608	702	13 886
1964/65	1 480	11 308	3 286	1 691	17 765
1970/71	1 602	11 784	3 431	4 701	21 518
1974/75	1 531	14 046	3 532	7 487	26 596
1977/78	1 488	13 921	3 281	9 149	27 839
1978/79 - Actual	1 528	12 973	3 318	10 034	27 853
- Capacity				12 301	
1979/80 - Actual	1 573	14 270	3 371	10 608	29 822
- Capacity				12 638	
1980/81 - Provisional	1 581	14 137	3 244	10 487	24 449

Source: Australian Wool Compendium - A.W.C.

TABLE 2: SOUTH AUSTRALIAN LIVESTOCK PRODUCTS, GROSS VALUE (\$'000)

Commodity	1978/79	1979/80
Wool (a)	161 985	215 423
Meat (b) - cattle and calves	142 852	107 295
- sheep and lambs	56 365	98 827
- non-ruminant (pigs, poultry)	54 160	67 317
Dairy (c)	37 407	42 341
Eggs	17 825	20 564
TOTAL (d)	470 594	551 767

(a) Includes dead and fellmongered wool and wool exported on skins.

(b) Includes adjustments for net exports (overseas and interstate) of live animals.

(c) Includes milk used for butter, cheese, processed milk products, human consumption and other purposes.

(d) Excludes honey and beeswax.

Source: Australian Bureau of Statistics.

TABLE 3: SOUTH AUSTRALIAN EXPORTS, VALUE OF PRINCIPAL COMMODITIES^(a) (\$'000)

Commodity	1979-80	1980-81 ^P
Wheat	375 695	303 919
Barley	191 806	156 812
Wool (b)	183 746	225 004
Lead (c)	180 458	99 717
Meat (d)	98 632	99 814
Live sheep and lambs	49 370	-
Iron and steel (e)	26 899	14 903

(p) Preliminary

(a) State of origin South Australia

(b) Greasy plus scoured, carbonised, noils and wool waste

(c) Lead and lead alloys unwrought

(d) Beef, veal, lamb and mutton: Fresh, chilled or frozen

(e) Iron and steel blooms, billets, slabs, sheet bars and prices roughly shaped by forging

Source: Australian Bureau of Statistics.

TABLE 4: SHEEP AND LAMB NUMBERS AND AVERAGE FLEECE WEIGHT, BY STATISTICAL
DIVISION - at March 31, 1980

Statistical Division	Sheep Numbers ('000)	Average Fleece Weight (kg)
Adelaide	64	3.10
Outer Adelaide	1 912	5.07
Yorke and Lower North	2 354	5.38
Murraylands	2 127	5.36
South East	4 347	4.88
Eyre	2 246	5.11
Northern	2 997	5.67
TOTAL	16 046	5.20

Source: Australian Bureau of Statistics.

TABLE 5: SUMMARY OF SUPPORT BY AREAS OF ACTIVITY 1981-82

Area of Activity	Priority	W.R.T.F. Budget \$	C.S.I.R.O. Budget \$'000	Total Budget \$'000
<u>1. Production Research</u>				
a. The choice and genetic improvement of animals	High	229 405	836.5	1 065.9
b. Control of diseases and parasites	High	946 524	693.2	1 639.7
c. Improvement of soil fertility, plant nutrition and water use	High	466 182	1 117.3	1 583.5
d. Control of wildlife and amelioration of the environment	High	27 772	581.7	609.5
e. Reproduction and husbandry of breeding flocks	Medium	391 170	-	391.2
f. Research facilities and training	Medium	377 921	-	377.9
g. Improvement, choice and establishment of pasture species	Medium	401 880	-	401.9
h. The effect of nutrition on production and use of forage for supplementary and drought feeding	Medium	405 704	467.6	873.3
i. Farm management	Medium	20 000	-	20.0
j. Extension	Medium	93 518	-	93.5
k. Grazing management	Low	84 217	299.0	313.2
l. Control of weeds, pasture pests and plant diseases	Low	82 026	-	82.0
TOTAL		3 526 319	3 925.3	7 451.6

TABLE 5 (Cont'd.)

Area of Activity	Priority	W.R.T.F. Budget \$	C.S.I.R.O. Budget \$'000	Total Budget \$'000
<u>2. Wool Harvesting Research</u>				
a. Automated mechanical shearing	Highest	371 249	-	371.2
b. Biological and chemical defleecing	Highest	197 615	895.6	1 093.2
c. Physical wool severence	High	149 470	-	149.5
d. Technology transfer	High	50 397	-	50.4
e. General	Medium	117 850	23.2	141.1
TOTAL		886 581	918.8	1 805.4
<u>3. Distribution Research</u>				
a. Raw wool specification ⁽²⁾	Higher	236 177	976.6	1 212.8 ⁽²⁾
b. Packaging	Higher	125 000 ⁽¹⁾	207.9	332.9
c. Preparation	Medium	8 000 ⁽¹⁾	-	8.0
d. Training	Medium	13 610	-	13.6
e. Extension	Lower	7 200	-	7.2
TOTAL		389 987	1 184.5	1 574.5

TABLE 5 (Cont'd.)

Area of Activity	Priority	W.R.T.F. Budget \$	C.S.I.R.O. Budget \$'000	Total Budget \$'000
<u>4. Textile Research</u>				
a. Wool processing ⁽³⁾	High	145 599	775.3	920.9
b. Colouration ⁽⁴⁾	High	81 774	486.1	567.9
c. Improvements/final products ⁽⁵⁾	High	261 056	1 917.3	2 178.3
d. Environment impact studies ⁽³⁾	High	109 395	475.6	585
e. Strategic research ⁽⁶⁾	Medium	200 583	289.7	490.3
f. Other areas		33 600	0.8	34.4
TOTAL		832 007	3 944.8	4 776.8
<u>5. Economic Research</u>				
a. Economic evaluation of research priorities and technical developments	Higher	62 905	68.4	131.3
b. Adjustment studies	Medium/ Higher	21 586	236.7	258.3
c. Demand and supply analysis	Medium	16 458	367.0	383.4
d. Training programme	Medium	36 525	-	36.5
e. Extension	Medium	6 400	-	6.4
TOTAL		143 874	672.1	815.9

(1) Projects funded by A.W.C.

(2) Total global research on raw wool specification in 1980 was \$2 024 000.

(3) Total global research in these two areas estimated in 1980 to be \$6 719 000.

- (4) Total global research on colouration estimated in 1980 to be \$1 792 000.
- (5) Total global research on improvements/final products estimated in 1980 to be \$4 573 000.
- (6) Total global research on strategic research estimated in 1980 to be \$1 489 000.

Source: Australian Wool Corporation - Research and Development Department.

APPENDIX I.5

SHEEPMEATS RESEARCH:

INVITED RESOURCE PAPER FOR RUMINANT INDUSTRY RESEARCH REVIEW

J.P. Egan,
Senior Research Officer,
Turretfield Research Centre

1. Historical Perspective

Sheep farming in South Australia has played an important role in the State's economy and development from the earliest days of settlement. Only six years after the first settlers arrived in 1836, South Australia already had 360 000 sheep, and with large imports from the earlier settled colonies of New South Wales, Victoria and Tasmania, this number reached one million by 1850. This early growth of the sheep industry was largely fostered by the ready market for fine Australian wool in the United Kingdom.

With the expansion of the settlement in the State, sheep numbers continued to rise, reaching a peak of 7.6 million in 1892, when the Australian sheep population stood at 106.4 million. Over the next 40 years however, S.A. sheep numbers declined and then fluctuated around the 5 to 6 million figure.

Numbers started to rise again in the early 1930's, as shown in Figure 1, to reach an all-time high of 19.7 million in 1970. In the decade since then, sheep numbers have declined once again, to a level of 17.1 million in 1981. A feature of this past decade has been a large fluctuation or instability in sheep numbers.

2. Current Situation

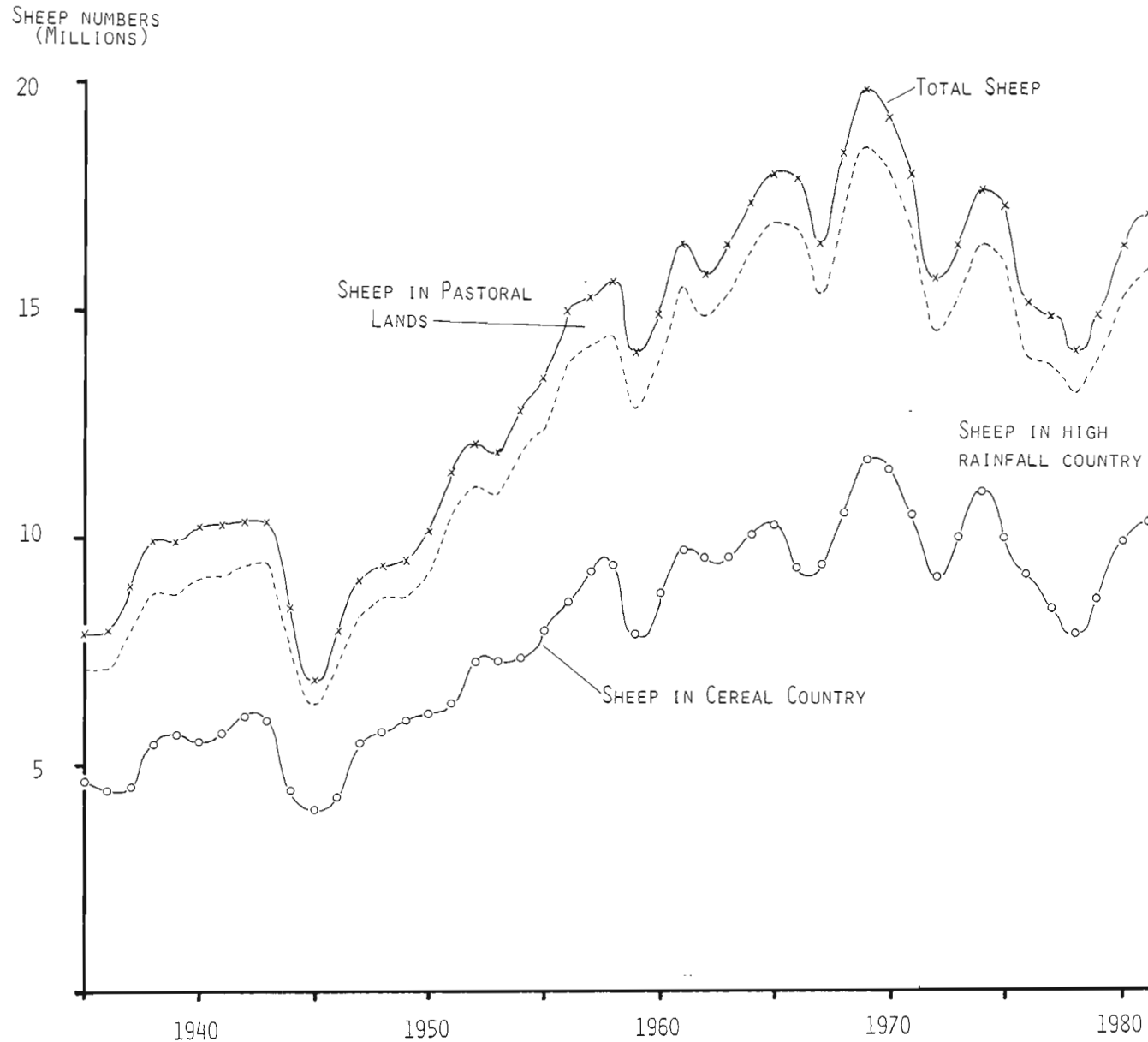
Statistics on S.A. sheep and lamb meat production for the past 4 years are given in Table 1. In this period the State's sheep and lamb numbers have recovered to 17.1 million, representing some 13% of the Australian total of 132 million.

Total sheep and lamb slaughterings in S.A. are of the order of 3 to 3.5 million head per year, about equally divided between sheep and lambs. Lambs slaughtered in recent years in South Australia have represented about 30% of the total number of lambs marked.

While about 75% of the mutton produced is exported, only about 30% of lamb meat finds its way onto the export market. Principal markets for mutton are in the U.S.S.R., Japan and the Middle East. Middle East countries also receive the bulk of Australian lamb exports (68% of 1980-81 total lamb exports). In addition, in recent years a further 2 million or so sheep have been exported live from S.A. to the Middle East annually. This live sheep trade is considered in a separate industry resource paper.

Adult sheep for slaughter are generally a by-product of the wool-growing enterprise on most sheep properties, being mainly cast-for-age ewes and wethers. Numbers slaughtered therefore tend to fluctuate widely depending on seasonal conditions and prevailing prices.

Figure 1: Sheep Numbers in South Australia by Zones, 1935-1981
(from French, 1981)



Lamb slaughterings on the other hand are more constant, being mainly animals specifically crossbred for meat production. While statistics on origin and breeding of lambs at slaughter are not available, some extrapolation of survey data collected in the Australian Sheep Industry Survey 1970-71 to 1972-73 (see Table 2), indicates that about 70% of the State's prime lambs came from the high rainfall zone, about 15% from the cereal/livestock zone, with a small contribution from the pastoral zone. Note that some 13% of the lambs slaughtered in S.A. in 1972-73 were not accounted for by these calculations however (see footnote to Table 2).

Merinos are by far the most numerous of the State's sheep, comprising 85% of the State's flock at March 31, 1980. Merino crossbreds account for a further 7%, followed by Corriedales (3.8%) and Polwarths (0.8%). The bulk of the remainder of the State's sheep are of British breeds, principally Dorsets, Border Leicesters and Suffolks, used for corssing with the above-listed breeds to produce prime lambs or prime lamb mothers.

The distribution of the breeds between the agricultural zones of the State is quite marked (Table 3), with 98% of the sheep in the cereal and pastoral zones being Merino, and virtually all the State's crossbred, Corriedale and Polwarth sheep located in the high rainfall zone.

The pattern of matings is also most pronounced (Table 4), with 95% and 87% of the matings in the pastoral and cereal zones respectively of the State being Merino x Merino, but only 30% in the high rainfall zone. Specific crosses for prime lamb production (British breed rams x Merino, crossbred, Corriedale or Polwarth ewes) accounted for only about 12% of the cereal zone matings, compared with 56% in the high rainfall zone. Prime lambs from the cereal zone are predominantly first-cross lambs (from British breed rams mated to Merino ewes), while the high rainfall zone lamb production comprises both first- and second-cross lambs.

Sheep and lamb slaughterings (including live sheep exports) represent a most important contribution to the State's economy, as shown in Table 1, having risen steeply to a level of \$105 m (gross value) in 1980-81.

3. Interactions with Other Industries

Sheepmeat production and the wool industry are obviously intricately interwoven, with the profitability of one directly affecting the profitability of the other. Short-term decisions by producers as to whether to mate Merino ewes (or Corriedale or Polwarth) to Merino rams (or Corriedale or Polwarth respectively) for wool production, or to British breed rams (for prime lambs or prime lamb dams) can be influenced by the relative profitabilities of the two industries.

Other agricultural industries with which sheep production competes for resources, notably land, in S.A. are beef production and to a lesser extent dairy production, and the cropping industries. Long-term decisions as to running sheep or cattle on the property, or reducing grazing area and increasing cropping operations where this is viable, also tend to be made in the light of relative profitabilities. The difficulty of such long-term decision-making is well-demonstrated by the events in the market place in the last fifteen years, in which:

- Wool has moved from the ruinous prices of 1970-71 to the current buoyant, stabilised levels;
- Wheat has moved from the era of depressed prices and quotas in the early 70's to the current strong export demand and high, stable prices;
- Other grain crops have generally followed the fortunes of wheat;
- Beef reached all-time high prices in 1973-74, spurred on by strong export demand, only to be followed by the disastrous slump in demand and saleyard prices in 1974-75, from which recovery has been slow;
- mutton prices followed a similar trend to beef, with peak prices in 1973-74 when Australian sheep numbers were at their lowest for nearly 20 years, followed by a dramatic slump in saleyard prices the following year. As with beef, recovery of sheep prices has been slow, although aided by the growth in live sheep exports.
- lamb prices and production have been relatively much more stable, reflecting a lesser dependence on the export market.

The most significant event in agriculture in S.A. in recent years has been the dramatic increase in the area cropped for grain each year (from 1.9 m ha in 1975-76 to 2.6 m ha in 1980-81) with a consequent decrease in the area of sown pasture (3.6 m ha to 3.2 m ha). At the same time sheep numbers have remained at about 17 million (with a drop to about 14 million in between) while beef cattle numbers fell from 1.7 to 0.9 million.

About half of this drop in beef cattle numbers over this period occurred in the cropping areas (Nash, 1981), as a consequence of lower returns from cattle and higher grain prices. Interestingly however, sheep numbers in the cereal zone have shown little evidence of declining as the cropping area has increased, although numbers have fluctuated dramatically in recent years (see Figure 1). The cereal zone still supports about 50% of the State's sheep flocks. This would suggest that the stocking intensity (primarily sheep) on pastures in the cereal zone has increased as more intensive cropping has been adopted in the past decade.

Sheepmeat production obviously also interacts with other agricultural industries in the market place, as well as on the farm. Relative prices for alternative meats such as beef and veal, pork and chicken, as well as fish and a range of other human foodstuffs, all affect the demand and subsequent price for lamb and mutton.

Other industries reliant on sheepmeat production include sheep and lambskin processing and fellmongering, the meat slaughtering and processing industries, livestock transport, and the meat wholesaling, retailing and exporting industries.

4. Future Prospects of the Industry

In the marketplace, the prospects for sheepmeat in the next decade appear encouraging. In the short to middle-term, sheepmeat supply is likely to be low due to the recent droughts in the Eastern States which have resulted in reduced flock numbers in these States. These are expected to be rebuilt only slowly over the next 3 to 5 years. At the same time, demand for sheepmeats is expected to be high due to stable domestic consumption (especially lamb) and strong export demand from the Middle East for lamb, and the U.S.S.R., Japan and the Middle East for mutton (Dingwall, 1981). South Australian producers, with sheep numbers back to more than 17 million, appear in a good position to take advantage of this strong sheepmeat demand and anticipated higher prices.

In the longer term, world demand for all animal proteins is predicted to increase. In conjunction with a slower rate of growth in world agricultural production, this should see real prices for all foodstuffs, and animal food products in particular, rising markedly over the next decade (Kelly White 1981).

A point to note in assessing the future prospects of the sheepmeat industry is Australia's current reliance on the Middle East for a very large proportion of our sheepmeat exports - 95% of live sheep, 80% of lamb exports and 40% of mutton exports (Dingwall, 1981). Therefore, as Dingwall says: "The stability of this region is essential if the sheep industry of Australia is to progress". In addition, the likely increased competition from New Zealand for export orders for lamb and mutton to the Middle East region will also have a strong bearing on the continued value of this trade to the Australian sheepmeats industry.

At the farm level, sheepmeat production will continue to be affected by the fortunes of related (e.g. wool) or competing (e.g. beef, grain cropping) agricultural enterprises. If the trend to increased intensity of cropping continues, then ultimately there will need to be a reduction in sheep numbers in the cereal zone of the State, since beef cattle numbers here have already been drastically reduced (Nash, 1981). Fawcett (1981) considered that the State's cropping area could stabilise at about 3.0 m ha per year, with sheep numbers in this area at about 9 million. The need to retain productive pastures in the cropping rotation to maintain soil fertility and control crop diseases is likely to limit the trend to more intensive cropping and less livestock.

There is a possibility that sheepmeat production, and lamb in particular, may become more intensive as meat prices increase relative to grain and forage prices. However, the extensive grazing of sheep at pasture will remain the basis of Australian sheepmeat production in the foreseeable future, with hand-feeding only likely to be profitable in the final stages of preparing animals for market at times when pasture availability or quality may be inadequate. Premium prices for finished stock at these times will be necessary to encourage any major trend to such practices.

5. Major Industry Problems

The following problems relating to the sheepmeat industry are not listed in any order of priority, but are in some approximate order of their occurrence in the production-marketing-processing-distribution chain.

- (1) The deterioration of pastures in many areas of the State, brought about by the arrival and spread in recent years of insect pests, especially the aphids, reduced super phosphate application to pastures, reduced legume content and higher grass and weed content in mixed swards, less attention to pasture management, and higher stocking rates.
- (2) Lack of soundly-based information to producers on the integration of sheep and cropping production, particularly in the light of the recent trends of more intensive cropping and reduced pasture areas.
- (3) Animal health and disease problems, including internal and external parasites, footrot, enterotoxaemia, trace element deficiencies, reproductive failure, plant toxicities such as lupinosis, ryegrass staggers, clover infertility and annual ryegrass toxicity, and "management diseases" such as weaner ill-thrift and pregnancy toxaemia.
- (4) Drought and its consequences, including reduced feed and water supplies, high on-farm mortality rates, excessive demand for slaughtering and processing facilities, shortage of prime condition sheep and lambs (with high prices) but surplus of poor quality livestock at low prices, and reduced sheep numbers and hence lowered slaughter stock turnoff post-drought.
- (5) Seasonal variation in supply of sheep and lambs in slaughterable condition. The problem of peak lamb supply in spring results in reduced prices to producers and taxes slaughtering and processing facilities to the limit. At the other end of the scale, low supply of finished stock in late summer-autumn-early winter creates problems with maintaining abattoir operations and the supply of sheepmeats to local and export markets.

- (6) Production and supply of sheep and lambs to meet market specifications. As markets for mutton and lamb change with time, so too do the types of animals sought. Producers need to be aware of the requirements of various markets, and how their breeding and management programmes may be adjusted to meet these requirements.

In this respect, there may well be a growing consumer aversion to high levels of fat in lamb carcasses in the future, necessitating a trend to production of leaner lambs without a reduction in carcass weights.

- (7) Losses and wastage through carcass rejection and down-grading at slaughter, due to grass seed damage, bruising, CLA ("cheesy gland") and other causes.
- (8) Inefficiencies of current live marketing and sheepmeat trading systems. The development of an objective, universally adopted carcass classification scheme for mutton and lamb will permit marketing schemes allowing more accurate payment for quality to producers, enable them to more accurately produce animals meeting market specifications, and facilitate the direct financial penalty to producers for inferior or blemished carcasses. A standard carcass classification scheme will also facilitate the trading of sheepmeats between processors, wholesalers, exporters and retailers.
- (9) Rising costs of production, processing and marketing. The agricultural sector in particular has been hard-hit by the "cost-price squeeze". The Bureau of Agricultural Economics estimates that the ratio of prices received to prices paid by farmers in 1981-82 will be 62% of the level in the period 1960-61 to 1962-63 (Anon., 1981). That is, in the last 20 or so years, the costs of rural production have risen by about 60% more than the prices received for rural products. Thus, to remain in the industry, farmers have had to increase their productivity and efficiency - a trend likely to continue into the next decade. I see no reason to believe that sheepmeat producers will be spared from the pressures of this continuing "cost-price squeeze".

The development and application of existing and new technology in all facets of sheepmeat production, processing and marketing is therefore needed if the necessary productivity advances are to be achieved.

(6) Future Research Priorities for the Sheepmeat Industry

Listed below are the research areas that need to be pursued in order to solve each of the industry problems identified in the previous section. However, it should be emphasised that research alone will not resolve these problems, but it needs to be linked to the extension and application of existing technology, and in some cases, to social or political measures, e.g. in the adoption of carcass classification and marketing reforms.

A second point is that the research component needed for any particular problem will often involve several factors or approaches - sometimes independent, as alternative solutions, or sometimes interwoven, as part of a "whole farm" or "whole system" approach.

Problem (i) - Pasture deterioration:

Research priorities -

- Introduction and breeding of improved pasture species, with emphasis on insect and disease resistance, adaptation to particular environments and conditions, dry matter production and feed quality, including palatability,
- Insect pest, weed and disease control,
- Pasture/grazing management.

Problem (ii) - Integration of cropping/livestock operations:

- Physical data on various alternative cropping and livestock management strategies, and combinations of enterprises,
- Economic evaluation of enterprises and enterprise mixes, to determine optimum combinations,
- Improving utilisation of crop by-products for sheep production.

Problem (iii) - Animal health and diseases:

- Helminth control through management and drug treatment,
- Blowfly strike control through sheep breeding, management, treatment and biological control measures,
- Development of control programmes and vaccines where appropriate for bacterial diseases,
- Identification of trace element deficient regions, techniques for assessing deficiencies in livestock, and methods of correcting deficiencies,
- Recognition of low reproductive rates, isolation of causes and formulation of corrective measures,
- Etiology of plant toxicity problems, selection and breeding for reduced toxin levels in problem plant species and cultivars, and management programmes to avoid or minimise effects of plant toxins on livestock,
- Early recognition of predisposing factors to management diseases and formulation of preventive or corrective measures.

Problem (iv) - Drought

- Alternative management strategies,
- Information on feed values, especially of novel feeds and agro-industrial by-products,
- Drought feed requirements and feeding strategies,
- Methods of hand-feeding sheep and lambs to reach slaughter weight and condition,
- Fodder conservation methods and strategies,
- Methods of boosting reproduction rate in flocks to allow rapid flock recovery.

Problem (v) - Seasonal variation in sheep and lamb supply

- "Out-of-season" versus "in-season" lamb production systems,
- Improving paddock feed available in late summer-autumn,
- Methods of hand-feeding sheep and lambs to reach slaughter weight and condition,
- Summer irrigated feed for sheep and lambs.

Problem (vi) - Meeting market specifications:

- Carcass characteristics of various sheep breeds and crosses,
- Breeding for increased growth rate and reduced fat content of carcasses,
- Effect of management and nutrition on carcass characteristics,
- Methods of assessing carcass characteristics, especially carcass weight and fatness, in live sheep and lambs.

Problem (vii) - Carcass wastage and rejection:

- Assessment of causes and value of wastage (e.g. trimming) and rejection of sheep and lamb carcasses at slaughter in S.A. abattoirs,
- Formulation of appropriate control measures.

Problem (viii) - Carcass classification and sheep and lamb marketing:

- Method of objective measurement of fatness on hot carcasses at slaughter chain speeds in abattoirs,
- Collection of carcass data for sheep and lambs relating carcass classification categories to yield of saleable meat, wholesale and retail values, and suitability of carcasses for various markets,
- Development and evaluation of sheep and lamb marketing schemes based on objective carcass classification.

Problem (ix) - Rising costs of production, processing and marketing:

Solutions to any of the previously identified problems will obviously improve the potential profitability and viability of the sheepmeats industry. However, there are some areas of research which do not necessarily fall into the problem-solving category, but do offer potential for improving the efficiency of sheepmeat production or processing.

These areas include:

- Increasing the net reproduction rate of sheep flocks;
- Improving growth rate and feed conversion efficiency of meatsheep, e.g. through genetic or nutritional means, or by newly developed implant or feed additive drugs;
- Increasing slaughter weights of sheep and lambs.

Note that although about 30 research areas are listed above as requiring attention, many of these are in common with the other major ruminant industries of wool, beef and dairy production. In fact, only about 13 of these research areas could be considered as being relevant to the sheepmeat industry only. Note also the considerable overlap between a number of these research areas.

7. Research Resources Required

In assessing the present situation and future requirements for research resources for the sheepmeats industry, several points should be made. Firstly, pasture research will not be considered here, mainly because it would appear to fall outside the terms of reference of this Review, and because I feel in no way qualified to comment upon it. A separate background paper on pasture research could be invited if the Working Party feels it should be considered within this Review.

Secondly, the resources for all sheep research, that is wool and sheepmeat production, will be considered jointly since the facilities are common to both industries and, with a few exceptions, sheep research staff either work in areas common to both industries or move freely between the two in their research programmes. As indicated earlier, the two industries are closely interwoven at the farm level and share a number of production problems in common.

The present SAGRIC commitment to sheep research (wool and sheepmeats) amounts to the equivalent of about 13-14 full-time research officers. This figure is difficult to assess, and obviously open to debate, since a number of research officers combine sheep research with either research activities in other fields, e.g. cattle or goats, or with other major extension or managerial responsibilities. The actual number of research officers conducting what may be termed sheep research projects (but excluding general pasture research) is about 20.

Numbers of technical support staff for sheep research are even more difficult to assess, due to shared responsibilities, but a rough estimate is about 12 officers in total.

Within the group of 20 or so research officers currently conducting research projects relevant to the sheep industries, there exists a wide range of specialist disciplines and skills, including:

- Pasture utilisation,
- Ruminant nutrition and physiology,
- Reproductive physiology,
- Animal breeding and genetics,
- Bacteriology, nematology and parasitology,
- Analytical chemistry,
- Wool metrology,
- Carcass dissection and evaluation,
- Statistical analysis.

Finding research solutions to industry problems, both existing and in the future, requires the application of the knowledge and skills of the appropriate officers from within this pool of expertise within the Department. In some cases, it may be necessary to enlist support from other sections of the Department, e.g. economic or statistical inputs, or from other organisations, such as the Institute of Medical and Veterinary Science.

Therefore, if the Department is to retain the ability to respond quickly to the research needs of the sheep industries, then it is important that this core of specialist knowledge and research skills is maintained and continually upgraded. This can be achieved through staff training, attendance at specialist conferences and seminars, opportunities to undertake post-graduate studies, and visits and discussions with research workers in similar areas of activity. It is also important that the Department maintain active, on-going research programmes in these disciplines in order to retain skilled and experienced research staff capable of identifying, defining and conducting research programmes on industry problems as they arise.

The current level of commitment of SAGRIC staff to sheep research appears adequate relative to the research problems of the sheep industries. In addition, the previously-listed range of specialist disciplines and skills possessed by the Department's current sheep research staff, or immediately available to them from elsewhere within the Department or closely related

organisations, is generally adequate for servicing the needs for sheep research in the foreseeable future. One weakness however, is the lack of veterinary involvement in many sheep research programmes, particularly husbandry/nutritional investigations. Many such programmes could be improved if veterinary research officers were available to be involved in the problem definition, research planning and experimental stages.

A second staffing deficiency is the lack (to my knowledge) of a Sheepmeats Industry Specialist within the Department, although there is a Wool Industry Specialist (M. Fleet). Such an officer could act as a liaison officer between all sections of the sheepmeats industry and the Department's research and extension activities in sheepmeats. He/she should also monitor developments and trends within the industry to assist the formulation of Departmental policy on research and extension for the industry, as well as providing information for Government policy decisions.

Specialist facilities for sheep research are good, being mainly located at Turretfield and Kybybolite Research Centres. These two centres are able to service the research needs of sheep industries in the cereal/animal zone and high rainfall zone respectively. Sheep research is also being conducted on Departmental research centres at Minnipa, Parndana, Northfield and Struan, while other more site-specific experiments are being conducted on private properties throughout the State and on a leased property (Cape Borda).

Off-centre research work relating to sheep (and other ruminants) production, although desirable in many cases, often poses problems in management and the degree of experimental manipulation and observation that can be applied. A particular problem arises where treatments may result in financial loss to the co-operating producer. The development of simple but adequate compensation procedures or leasing arrangements could improve the willingness of research staff to conduct off-centre sheep research.

8. Significance and Effectiveness of Current SAGRIC Sheepmeats Research

In assessing the significance of the current SAGRIC research programme for the sheepmeats industry, it is worth noting that all projects do fit in to the priority areas of research previously listed. To this extent then, SAGRIC research programmes are of relevance to the industry.

One area in which this State's contribution is recognised as being at the forefront in Australia is in the development of livestock marketing systems based on carcass classification. I acknowledge that this position has been gained not through the efforts of SAGRIC alone, but through co-operation between many sectors of the industry, including producer groups, SAMCOR, A.M.L.C., Department of Further Education, processors and SAGRIC itself.

In other areas of SAGRIC sheep research the level of expertise and scientific competence is generally on a par with research conducted in other agricultural research organisations in Australia and overseas. Evidence of this is the number of contributions on sheep research published in scientific journals by SAGRIC staff (13 scientific papers published in 1979, 9 in 1980), as well as contributions to technical conferences and workshops. Further evidence of the significance and scientific merit of the SAGRIC sheepmeat research programme is the funding received from the Australian Meat Research Committee. Four SAGRIC sheep and lamb projects are being financially supported in the current year (1981/82), and a further two projects have been submitted for A.M.R.C. funding from 1982/83.

In terms of the effectiveness of the current SAGRIC sheepmeats research programme, two shortcomings are obvious. Firstly, there remains a large volume of research which has been completed in recent years but has not yet been published. Secondly, much of the published research findings have not yet reached the end-user, generally the producers. It is to be hoped that recent moves within the Department to encourage research officers to communicate their research findings to extension staff and to producers will result in an improvement in the flow of this information out to the industry in the future. The adoption of procedures for registering all levels of communication of research results by research staff (i.e. Research Communications Register), and not just scientific papers, is seen as an important step in this direction. Associated with this, however, there needs to be a recognition of the value of such contributions when research staff are assessed for promotion or reclassification.

Regionalisation should also steadily improve the significance and effectiveness of research programmes, as closer links between research and extension staff at the regional and district level are established. I believe this is currently occurring in the Central Region, with Turretfield Research Centre (and its research staff) being recognised more and more as a regional resource. This should provide opportunities for closer extension officer involvement in research programmes and conversely, greater research officer involvement in extension programmes. A difficulty with this however is the fact that about half of the sheep research staff are located within Industry Divisions and not in the Regions.

The appointment of a Sheepmeats Industry Specialist within Animal Industry Division, as proposed earlier in this paper, would also improve the significance and effectiveness of sheepmeats research.

A final factor limiting the effectiveness of research is the lack of opportunities for research projects to be promoted to producers. Research Centre Field Days can provide this opportunity to a localised extent, but it would be advantageous to have some wider medium of informing producers, and other sectors of the industry, what is being done. Both the W.A. and N.S.W. Departments of Agriculture use their regular journals of agriculture to carry short stories on various research projects in progress, with interim results where available. A regular section entitled "Research News" in the N.S.W. Agricultural Gazette also carries quite short stories (100-200 words) on each of 3 or 4 projects in each edition.

9. Areas of Research where SAGRIC Involvement is Not Warranted

Of the major research priority areas defined earlier, several are well-served by other organisations with highly specialised facilities and staff, and are of a generalised, non-site-specific nature, which obviates the need for any SAGRIC research, apart from some involvement perhaps in final field testing. These areas are:

(a) Veterinary/animal health programmes:-

- Etiology of bacterial or viral diseases, plant toxins, etc. (except where the problem appears peculiar or unique to S.A., e.g. annual ryegrass toxicity),
- Development of vaccines and control programmes,
- Development of veterinary drugs, supplements and methods of administration.

(b) Processing and handling of sheepmeats:

- Abattoir procedures for preslaughter handling, and slaughtering and processing techniques and their effect on meat quality,
- Methods of packaging and transporting sheepmeats,
- Abattoir by-product processing techniques.

There are obviously many other smaller research projects being conducted in other organisations where it would be wasteful for SAGRIC resources to be used to duplicate this effort without good reasons. The identification of such areas however is best left to individual research officers and research managers.

10. Areas of Research Inadequately Serviced by SAGRIC or Other Organisations

Research in the following areas of sheepmeat production, processing and marketing could profitably be increased by the S.A. Department of Agriculture, in some instances in co-operation with other local organisations:

(a) Integrating cropping and livestock production:

- Information to determine optimum cropping strategies and hence levels of livestock production.

(b) Internal parasites of sheep and lambs in the cereal/animal zone:

- Most research has been conducted in the high rainfall zone on permanent pastures, and then applied directly to the very different management programmes sheep experience in cropping areas.

(c) Mapping of trace element deficiencies in sheep and lambs in S.A., with particular attention to copper, cobalt, selenium, zinc and manganese:

- This could make use of Departmental and I.M.V.S. records.

(d) Nutritional management of sheep flocks for optimum production, especially at the critical times of late pregnancy - lambing and in drought:

- Sheep feed requirements are well-documented. These now need to be adapted into flock management and feeding programmes, under conditions of varying levels of available paddock feed and feed quality.

(e) Other aspects of drought management.

(f) Carcass classification information on sheep and lambs:

- Classification data on sheep and lambs passing through SAMCOR's Gepps Cross abattoirs would assist the development of the classification scheme and alternative marketing systems.

(g) The causes and extent of sheep and lamb carcass rejection in S.A. abattoirs.

11. References

- Anon. (1981). Statistics, in *Quarterly Review of the Rural Economy* 3(4): 378.
- Bureau of Agricultural Economics (1976). "The Australian Sheep Industry Survey, 1970-71 to 1972-73." (Australian Government Publishing Service, Canberra, 1976).
- Dingwall, K. (1981). Sheep meat. Commodity Outlook Statement to National Agricultural Outlook Conference, Canberra, January 1981. (In Supplement to *Quarterly Review of the Rural Economy* 3(1): 38-39).
- Fawcett, R.G. (1981). Foreseeable trends in tillage practices for the cereal zone in South Australia. Paper to Workshop on "Future Farming Trends in the Cereal Zone of South Australia", Adelaide, November 1981. (Research Policy Advisory Committee, S.A. Department of Agriculture).
- French, R.J. (1981). The cereal-medic livestock farming system in South Australia, in "The Medic Crisis in Cereal-Livestock Farming Systems of South Australia", Symposium at Roseworthy Agricultural College, September 17, 1981. (Ed. N.L. Richardson).
- Kelly White, T. (1981). World food, feed and fibre prospects. Keynote Address to National Agricultural Outlook Conference, Canberra, January 1981. (In Supplement to *Quarterly Review of the Rural Economy* 3(1): 8-14).
- Nash, H.M. (1981). Livestock trends in the cereal zone. Paper to Workshop on "Future Farming Trends in the Cereal Zone of South Australia", Adelaide, November 1981. (Research Policy Advisory Committee, S.A. Department of Agriculture).

TABLE 1: SOUTH AUSTRALIAN SHEEP AND LAMB MEAT PRODUCTION AND LIVE SHEEP EXPORTS, IN PAST 4 YEARS

Statistic	Year			
	1978	1979	1980	1981
Sheep and lamb numbers (at March 31 - '000 head)	14 073	14 940	16 046	17 056
Slaughteringings (year to June 30 - '000 head)				
- sheep	1 735	1 022	1 666	1 864
- lambs	1 505	1 501	1 785	1 685
Meat production (year to June 30 - '000 tonnes carcass weight)				
- mutton	32.9	22.0	34.9	39.3
- lamb	23.9	25.8	29.3	28.6
Meat exports (year to June 30 - '000 tonnes shipped weight)				
- mutton	18.7	12.5	20.8	27.5
- lamb	5.6	10.1	7.8	4.7
Exports as % of production (%)				
- mutton	67	79	72	n.a.
- lamb	27	43	29	n.a.
Live sheep exports (year to June 30 - '000 head)	2 451	2 104	1 861	1 866
Gross value of sheep and lamb slaughteringings (year to June 30 - \$ '000) ¹	64 261	56 365	98 827	105 217p

p Provisional

1 Includes value of live sheep exports

Source: Australian Bureau of Statistics, except "Meat Exports" (Australian Meat and Livestock Corporation), and "Live Sheep Exports" (S.A. Department of Agriculture).

TABLE 2: SOUTH AUSTRALIAN PRIME LAMB PRODUCTION BY AGRICULTURAL ZONES,
1972-73¹

Statistic	Agricultural Zone			Total S.A.
	Pastoral	Cereal	High Rainfall	
Estimated number of properties	693	7 940	3 840	12 473
Average number of prime lambs sold per property	111	41	382	150
Estimated total number of prime lambs sold from zone	76 923	325 540	1 466 880	1 869 343
Percentage of S.A. lamb slaughterings ²	3.6%	15.2%	68.5%	87.3%

1. Source: "Australian Sheep Industry Survey, 1970-71 to 1972-73."
2. Total lamb slaughterings in S.A. in 1972-73 were 2 141 000 (A.B.S. figures). Discrepancy in figures may be due to:
 - (a) Animals classified as "lambs" at slaughter but not as "prime lambs" in survey data (e.g. Merino lambs).
 - (b) Lambs from other states slaughtered in S.A.
 - (c) Sampling errors in survey data.

TABLE 3: SOUTH AUSTRALIAN SHEEP NUMBERS AND BREEDS BY AGRICULTURAL ZONES

Statistic	Agricultural Zone ¹			Total S.A.
	Pastoral	Cereal	High Rainfall	
<hr/>				
Total number of sheep and lambs, at March 31 ('000 head): ²				
- 1981	2 434	7 811	6 810	17 056
- 1973	2 439	7 365	5 848	15 651
Percentage of S.A. flock in zone, at March 31 (%) ²				
- 1981	14.3	45.8	39.9	100.0
- 1973	15.6	47.1	37.4	100.0
Percentage of zone flock of each breed (1972-73) (%): ³				
				(1974) ²
- Merino	97.9	98.2	64.3	86.5
- Crossbred	2.0	1.1	19.8	7.0
- Corriedale/Polwarth	-	0.4	15.0	4.8
- Other	0.1	0.3	0.9	1.7

1. Agricultural zones as defined in "Australian Sheep Industry Survey, 1970-71 to 1972-73".

2. Source: Australian Bureau of Statistics.

3. Source: "Australian Sheep Industry Survey, 1970-71 to 1972-73". Figures shown for 1972-73.

TABLE 4: SOUTH AUSTRALIAN SHEEP MATING TYPES BY AGRICULTURAL ZONE, 1972-73¹

Mating Type Ram x Ewe	Percentage of total matings in agricultural zone		
	Pastoral	Cereal	High Rainfall
Merino x Merino	95.1	87.0	29.8
British breed x Merino	2.4	12.3	30.5
British breed x Crossbreed	-	-	18.2
British breed x Other pure	-	-	7.3
Other pure x Other pure	-	-	13.7
Other x Other	2.5	0.7	0.5

1. Source: "Australian Sheep Industry Survey, 1970-71 to 1972-73."

APPENDIX I.6

LIVE SHEEP EXPORTS:

INVITED RESOURCE PAPER FOR RUMINANT INDUSTRY RESEARCH REVIEW

A.S. Pell,
Principal Research Officer,
Animal Industry Division

1. Historical Perspective

The export of live sheep from Australia has built up over the last 10-15 years, the market being predominantly the Middle East countries. Initially numbers were small, utilising unsophisticated transportation, feeding and management techniques. Recently, over the last 5-10 years particularly, considerable capital investment has occurred in specially converted vessels, some capable of carrying in excess of 100 000 animals, with sophisticated husbandry practices being developed.

2. Current Situation

Numbers of live sheep exported from Australia have increased from 1.3 million in 1974/75 to 5.7 million in 1979/80 and 5.4 million in 1980/81. The animals exported are typically 50-55 kg wethers. There is a trend however to increased numbers of younger sheep. Merino wethers predominate, with a proportion of first cross animals used if available.

Geographically, the states mainly involved in approximate order of numerical importance, are Western Australia, South Australia, Victoria and Tasmania.

In 1980/81, approximately 1.9 million sheep were exported from South Australia, although of these only approximately 1 million were from South Australia (the remainder being from Victoria 650 000 and N.S.W. 200 000).

Gross value of live sheep exports was an estimated \$157 million in 1980/81 (Australian total). This represents approximately one-third of the total export value of lamb, mutton and live sheep.

3. Interactions with Other Industries

(1) Other Ruminant Industries

There is little direct effect on ruminant industries other than sheep, although it is clear that continuing high prices for export wethers have markedly improved the profitability of the sheep enterprise. While there is considerable debate, it can be argued that the live sheep trade has changed the size and structure of the Australian sheep population, resulting in more sheep and lambs being marketed from a larger national flock. Producers have responded to the profitable export market by increasing ewe proportions in their flocks and by increasing sheep numbers, seasons permitting.

(2) Other Agricultural Industries

The animal feed industry benefits substantially. Between 100 000 and 150 000 tonnes of pellets for export sheep are produced annually, at an approximate value of \$15 million.

Export sheep are normally shorn prior to shipping, representing significant employment in the shearing/wool industries.

(3) Other Industries

There is a direct benefit to the transport industries in transporting and loading live sheep.

4. Future Prospects of the Industry

Prospects are largely dependent on continuing strong demand by the Middle East countries, particularly Iran. Political instability in that area gives some unpredictability to any assessment, but short term prospects appear reasonable with some expansion in demand from Middle East markets.

In the longer term, prospects for export of Australian live sheep to the Middle East appear good. Meat consumption per person in the Middle East is low compared with that in other high-income countries; this potentially large consumption growth is likely to be met through increased imports.

It appears likely that the cost of live sheep for export will increase sharply in coming years, as these sheep will have to be bought from producers wishing to build up flocks.

Subject to political events in the Middle East, live sheep exports could experience moderate expansion, perhaps to around seven million head annually, provided a premium price continues to be paid and the trade remains unrestricted (B.A.E. Situation and Outlook 1981, Meat).

5. Major Industry Problems

Major industry problems, from a commercial viewpoint, relate to pressures exerted by Trade Unions and by animal welfare groups. Such problems are not seen as requiring research resources.

From a technical viewpoint, major problems fall into three areas:

- (a) Adequate long-term supply of suitable sheep for the trade.
- (b) Environmental and behavioural problems peculiar to the live sheep export trade (e.g. transport stresses, "shy feeder" behaviour, inappropriate pen densities, heat and humidity stresses).
- (c) Performance problems associated with nutrition and disease (e.g. weight loss during voyage, abnormal mortality rates).

6. Future Research Priorities for the Industry

In the main, these relate directly to the technical problem areas identified in the previous section 5 (a), (b) and (c).

Priorities in each area are as follows:

(a) Sheep supply long-term

(i) Genetic improvement of sheep fertility.

(ii) Increased growth rate of the Merino in order to turn off export animals earlier, at 1-2 years of age (e.g. identify high growth rate lines, develop feeding and management strategies to improve production rates).

(b) Environment and behaviour

(i) Definition of appropriate shipboard environments, pen densities, ventilation requirements.

(ii) Investigate effects of time off-feed before and during transport on subsequent performance, feeding behaviour and mortality.

(c) Performance, nutrition and disease

(i) Examine potential for use of grain legumes and for use of alkali treated, low quality roughage in feeds for export sheep.

(ii) Examine effects of ration nutrient density and pellet quality on performance.

7. Resources Required

The majority of the research priorities identified could be covered within existing physical and manpower resources devoted to sheep research. Existing pen-feeding facilities at Northfield and Turretfield are adequate for production and nutrition research, while existing research officers are well-qualified to conduct such research.

Of relevance is the fact that the Western Australian Department of Agriculture is currently constructing a 500 sheep feeding/behavioural complex. This facility will incorporate the ability to manipulate temperature, air movement and to simulate shipboard conditions as far as possible.

8. Current Research Programme in the S.A. Department of Agriculture

Currently there is no research work being conducted by the Department specifically geared to the live export of sheep industry. A proposal is currently being considered relating directly to the priorities outlined at 6(c), viz: nutritional aspects of the trade and the potential for use of grain legumes in export sheep rations.

9. Research Areas Already Covered

Of the research priorities identified at 6 (a), (b) and (c), the Western Australian Department complex is designed to carry out investigations in the area of 6 (b), "Environment and Behaviour", and partly in the area of 6 (c), relating to performance and feeding aspects.

Priorities identified at 6 (a) are receiving considerable research attention, particularly in the area of genetic improvement of sheep fertility (e.g. in S.A., W.A., N.S.W., C.S.I.R.O.). The area of identifying high growth

rate lines is receiving less attention but is of lower priority than that of fertility improvement.

10. Research Areas Requiring Attention

There is a need for investigations directly relevant to performance deficiencies on board ship, and relating to the feeding and management systems peculiar to the live-sheep trade.

Such investigations are relatively short-term and are not likely to justify large Departmental resource inputs. The importance of the live sheep export sector to the sheep industry generally and to other ancillary industries however, is well recognised and can justify the utilisation of certain existing Departmental resources.

APPENDIX I.7

GOAT RESEARCH:

INVITED RESOURCE PAPER FOR RUMINANT INDUSTRY RESEARCH REVIEW

D. Phillips,
Livestock Research Officer,
Struan Research Centre

1. Historical Perspective

The first recorded goat introductions to Australia occurred in 1788 being principally European dairy breeds such as Saanen and Toggenburg. Angora and Cashmere goats arrived around 1832 with later introductions of goats occurring mainly to clear up rough country.

As a result of a slump in world mohair prices after World War I, large numbers of Angoras were released to the wild where they have interbred with other goats to form the feral goat population which exists in many areas of Australia. Conflicting views of pastoralists and Government bodies over the potential of these goats to Australian agriculture have arisen because of a lack of reliable observations and experimentation. This has resulted in a mixture of State attitudes concerning the feral goat (Mitchell, 1977a). South Australia's Verbrate Pests Control Authority is carrying out research to determine whether feral goats should be declared vertebrate pests (Henzell 1980).

Renewed interest in mohair production in Australia commenced during the 1970's following high world prices and a buoyant demand for mohair. The industry until now has been principally a "backyard industry" with little commercial production of mohair. Animals are registered with either the Angora Breed Society of Australia (A.B.S.) or the Angora Mohair Association of Australia (A.M.A.A.). A rapid growth in Angora numbers since the 1970's has centred around breeding programmes involving backcrossing with feral goats.

High world prices for cashmere, a knowledge that some feral goats possess high yields of cashmere (Smith, Clarke and Turner, 1973) and an input by Dawson International, a Scottish based company which processes and markets cashmere, has led to the development of the Australian Cashmere Goat Society. Currently Australia's cashmere industry is at the entrepreneurial stage with Dawson International encouraging producers to enter the industry.

Australia's dairy goat population is small although there are some signs of it rising (Round, 1980). Modern dairy goat breeds in Australia are registered with the Goat Breeders Society (G.B.S.) which commenced in 1953. It is unlikely a dairy goat industry within Australia would reach the same level of importance at which the mohair industry now stands or to a level an Australian Cashmere or goat meat industry could obtain.

It suffices to say that at the present time great inroads have been made towards development of a significant mohair industry within Australia while there is a keen interest, particularly interstate, towards commencement of cashmere and goat meat industries.

2. Current Situation

(1) Angora Goats

The South Australian population is estimated to be between 16 000 and 20 000 Angora, grade and foundation goats (Cann, 1980). These goats are distributed throughout most agricultural areas of the State.

Phillips (1980) from a survey conducted within the South East Region of South Australia classified present mohair producers into four groups:

- (a) Small scale or hobby farmers possessing herd sizes of less than 50 goats. Very little potential for increasing herd numbers and their future significance to the industry is doubtful.
- (b) Producers upgrading to pure Angora animals but maintaining a constant herd size.
- (c) Producers upgrading to pure Angora animals but in addition increasing total herd size.
- (d) Producers entering commercial production of mohair.

It was apparent from this survey that goat numbers were on the increase in the South East region and that increasing numbers of producers were entering commercial production of mohair.

It is difficult to assess production level and value since, depending on grade, animals produce variable quantity and quality of mohair with foundation animals producing no mohair at all. In addition a premium is paid for kid over adult mohair. The annual production of mohair for South Australia is around 20 000 kg with prices varying from 300c/kg to 1 000c/kg (June, 1980 prices) depending on type and quality.

(2) Feral Goats

A population of 160 000 feral goats is estimated for South Australia (Henzell, 1980) but the number varies greatly year to year dependent mainly on the season. They occur mainly in the pastoral areas south of the dingo proof fence and in small populations in the Adelaide Hills, near Clare, on Kangaroo Island and a few other coastal islands.

Depending on the ease of capture these animals form the bulk of a small scale goat meat exporting industry amounting to 1 406 tonnes for South Australia in 1980 (A.M.L.C. statistics). Feral does are also used for upgrading programmes with Angora bucks in the mohair industry.

Work is proceeding both in New South Wales (Mitchell, 1977b) and South Australia (Hancock, Phillips and Sabine, 1979) on selection for a "meat" goat from Australia's feral goat population.

(3) Cashmere Goats

As mentioned earlier the Australian Cashmere Goat Society has recently been formed; however, to my knowledge there are no cashmere producers operating within South Australia.

(4) Dairy Goats

Although it is estimated there are about 12 000 registered dairy goats in Australia (Round, 1980), compared with the other states South Australia's contribution is small with a total commercial dairy population estimated at 800 goats (M. Round, personal communication). One larger machine-milked herd (250 goats) and a number of smaller hand-milked herds currently supply milk to Adelaide.

There are no reported data on volumes of goat's milk produced in Australia and there is no control over its price. Producers currently receive 70c/litre in Adelaide (Round, 1980) where demand currently exceeds supply.

3. Interactions with Other Ruminant Industries, Agricultural and Other Industries

With renewed interest particularly in mohair production a number of producers have commenced running goats together with their other agricultural industries. Numerous reports in the literature both overseas and within Australia have encouraged the incorporation of goats into grazing enterprises for improved grazing management.

With continued interest in mohair production and more producers entering commercial production a change from the current situation of high prices for animals will result enabling more producers to enter the industry. Mohair and cashmere prices are determined by world demand for these fibres, in turn influenced by fashion and total world production. Therefore, the buoyancy of the Australian mohair industry and future cashmere industry will be dependent on the ruling world prices for these fibres.

Phillips (1981) suggested development of a goat meat industry would undoubtedly aid the future development of the Angora industry. Such development would interact with other meat industries particularly the sheep meat industry. It is not expected this would be significant due to the relative low number of goats which would be involved. In any case it would be expected that producers running goats would do so by reducing their existing sheep and/or cattle numbers, thus maintaining a constant stocking rate.

4. Future Prospects of the Industry

(1) Angora Industry

Gifford (1979) listed a number of requirements of the Angora industry which would pass it through its current transition phase to a viable grazing industry. The requirements centred around increased goat numbers and a movement into commercial production of mohair.

A survey conducted by Phillips (1981) of goat producers in the South East of South Australia indicated total goat numbers would double from 1979 to 1984. It is most likely this trend would be statewide. It was also apparent from this survey that an increasing number of producers were entering commercial production of mohair.

The future prospects of the mohair industry may be summed up by Cann (1980) who stated: "The industry is now approaching a transitional period from an entrepreneurial and early development stage to being accepted as large scale commercial enterprises on farms. This change will necessarily be accompanied by

some fall in stock prices to levels which relate to the value of mohair production. The next few years will be a critical period in which the continuance of sound leadership of the industry is even more vital now that it has been in its early development".

There will need to be further development of markets for mohair, goat meat and skins. Currently good opportunities exist both overseas and within Australia for these products providing they can be fully exploited.

(2) Meat Industry

Potential exists for development of a goat meat and/or cashmere industry from South Australia's feral goat population. Such industries are currently being examined interstate, notably by the New South Wales Department of Agriculture, but to date in South Australia only preliminary investigations have been performed.

A resource does exist in our pastoral areas which should be utilised.

(3) Dairy Industry

Round (1979) has stated: "Any safe future expansion of the industry would seem to need to be based on meeting the demand by those people who have a genuine medical need for an alternative to cow's milk". While future expansion of this industry could occur it is not likely to be extensive and would certainly be accompanied by increasing Government control, affecting the activities of the part-time producer.

5. Identified Major Industry Problems

The major industry problem of any of the fibre, meat or milk goat industries resides in insufficient goat numbers. Particularly in the fibre and meat industries, potential exists for increasing local and export markets and there is also some scope to increase goat milk production on the local scene.

As mentioned previously the mohair industry is entering an era of commercial production entailing reduced prices for animals (enabling more producers to enter the industry), an approach to a stable price for mohair and increased mohair production. A need exists to improve the goat meat marketing situation likening the Angora situation to that existing for Merinos in the sheep industry, where good market outlets exist for both fibre and meat.

While a small scale cashmere industry is developing on an entrepreneurial scale in New South Wales, to my knowledge no such advances have been made in South Australia.

Work is well advanced in New South Wales on development of a meat goat via selection from Australia's feral goat population while a small project in this area is also proceeding in South Australia conducted by the Waite Agricultural Research Institute. Phillips (1981) stated: "Goat meat production in Australia presently relies heavily on our feral goat population. Irregular slaughterings of feral goats and associated high killing charges are factors limiting the development of reliable markets for meat and skins.... Until the producer is able to ensure a reliable supply of goats (either from organised meat goat production or as a by-product of the Angora industry), it is unlikely any major developments will proceed in market organisation".

6. Future Research Priorities for the Industry

The following list of perceived research and extension needs of the goat industries was generated during group discussions of research workers, relevant industry personnel and goat producers at a workshop on "Goat Research in South Australia" held at Waite Agricultural Research Institute, December 1979 (Gifford and Dolling, 1980). No attempt has been made to assign priorities to the identified needs although, on goat numbers alone, it is my belief priorities should be (1) Fibre, (2) Meat, and (3) Milk. Because of the relative smallness of the goat industries when compared to Australia's other livestock industries I believe a need exists for Australia wide co-ordination when setting research priorities for goats.

There is a need to point out some particular areas where research is required: Marketing the product appears to be a problem affecting all three goat industries. There is also a general lack of knowledge in the areas of nutrition and health of goats and while there may be some differences between breeds it is likely work in this area would aid all goat industries.

Perceived Research and Extension Needs of the Goat Industries

(1) FIBRE

(a) Marketing the product

Assessment of known and potential markets
Standardization within Australia on nomenclature of mohair lines
Definition of market requirements in terms of fleece quality
Degree to which mohair types need to be segregated for marketing
Effect of medullation on manufactured product.

(b) Reproduction

Need to maximize rate of increase of animal numbers (Angoras)
Reducing reproductive losses and improving management practices
 a) Evaluating benefits of multiple births
 b) Effect of predation on kid mortality rate
Collection and storage of semen from superior bucks
Increasing proportion of female kids in up-grading programmes.

(c) Genetics

Increasing greasy fleece weight
Increasing Angora live-weight and body size
Development of an "easy-care" goat
Knowledge on genetic and phenotypic parameters of Angoras
Need to monitor incidence of abortion - relationship with selection for fleece weight
Investigation of influence of age on fleece quality
Face cover and fertility in bucks
Inheritance of coat colour
Incidence of pigmented fibres in a grading-up programme
Gene-environment interaction of selecting animals in one environment for use in another
Knowledge of best type (hair) of feral doe for up-grading - hair type and colour
Increasing gene pool through imports.

(d) Nutrition

Impact of nutritional stress on fleece production and quality
Roughage component of goat nutrition.

(e) Health

Prevalence of diseases in goats
Bibliography of disease in goats - worldwide
Parasite control programs - availability of commercial drugs for goats
Plant poisoning in goats.

(f) Organisational

Funding for research and development
Flexible, computer-based data recording system
Lack of information to producers
Supplying veterinarians with current information on treatment of goats.

(2) MEAT

(a) Establish eco-types

Breeding resistance

(b) Information pool

Research Liaison Group - Breeders/Researchers
Breed Standards
Extension

(c) Market research

Domestic
Overseas

(d) Processing technology

Specific research
Post-slaughter processing
Storage

(e) Carcass quality

Weights - birth, growth rate, sex
Food conversion
Classification system

(f) Disease/parasite research

Specific research
Feeding-disease relationship
Direction of research levy funds
Producer education

(g) Place in agriculture

Compatability

(h) Promotion

Image - producer and consumer.

(3) MILK

(a) Definition of market (need for market survey)

(b) Need for regularity of supply and quality control

(c) Industry promotion

(d) Adequate system of milk production recording

(e) Need to increase production by selection and nutrition

(f) Studies on disease

(g) Possible advantage of milk goat in the meat industry

(h) Near total lack of biological data!

7. Resources Required

Existing resources within SAGRIC (research centre facilities) should be adequate to conduct any research programmes planned for goats. However, SAGRIC does not own any goat herds, which would need to be obtained if work was carried out on research centres. It was apparent from the survey conducted by Phillips (1981) that many goat producers would be in support of research work (depending on its nature) on their own herds and properties.

8. Significance and Effectiveness of Current SAGRIC Research Programme and its Extension

The current research programme conducted by SAGRIC in the goat industry revolves around one research project conducted by Gifford and Ponzone on a private property in the South East of South Australia: "The estimation of phenotypic and genetic parameters for Angora goats" (Experiment Preschedule F5/L1). The information resulting from this project is at a preliminary stage, thus extension of research findings has been limited.

9. Areas of Research Adequately Covered by Other Organisations

In March 1980, P.J. Holst of the New South Wales Department of Agriculture prepared a directory of workers and projects relevant to non-milch goat production in Australia, for use by the Animal Production Committee of the Standing Committee on Agriculture (Holst, 1980).

Areas of specialization or special interest indicated by relevant research workers included administration and policy formulation, behaviour and husbandry, biochemistry and physiology, biometrics and statistics, fibre, meat, skins, disease prevention and control, economics and farm management, reproductive physiology, extension method and communication, genetics and applied breeding, marketing and product development, mechanisation and automation, nutrition, product quality and processing, environmental impact, population dynamics, livestock exports and weed control.

This long list does not imply by any means that all areas of goat research are adequately covered by other organisations. The document could, I believe, be well used by SAGRIC in determining what research, if any, should receive attention.

10. Areas of Research Not Adequately Serviced by SAGRIC or Other Organisations

(1) Fibre

It would appear from the document prepared by Holst (1980) there is still need for further research into the improvement of production and quality of mohair through breeding and nutrition. In addition the production and economic aspects of an Angora goat up-grading programme have not been fully detailed although Gifford and Lampe (Experiment Preschedule F5/C1) have proposed the same.

(2) Dairy

While there are a number of areas of research outlined by Round (1979) which require investigation, because of the relative size of this industry compared to the other goat industries there seems little justification for research involvement by SAGRIC.

(3) Meat

Goat meat production as a by-product of the Angora industry should receive immediate attention by either SAGRIC or some other body, as it is important for the future development of the Angora industry in Australia.

11. References

- Cann, B. (1980). The economics of Angora goats in South Australia. In *Angora Goat Seminar*, 1980, ed. H.M. Nash, S.A. Dept. of Agriculture.
- Gifford, D.R. (1979). On Angora goats and the mohair industry in South Australia. *Livestock Branch T.I.C.* 47.
- Gifford, D.R. and Dolling, C.H.S. (1980). Goat research in South Australia. Proceedings of a goat research workshop held at Waite Agricultural Research Institute on 14th December, 1979. *Animal Industry Division T.I.C.* 53.
- Hancock, T.W., Phillips, D. and Sabine, J.R. (1979). Development of a meat goat for southern Australia. Preliminary investigations. *Proc. Inaugural Conf. Aust. Assoc. Anim. Breeding and Genetics*, 1979, pp. 387-388.
- Henzell, R.P. (1980). Feral goats in Australia, In *Animal Industry Division T.I.C. No. 53*.
- Holst, P.J. (1980). Directory of workers and projects relevant to non-milk goat production in Australia. Prepared by P.J. Holst, Department of Agriculture, Cowra, N.S.W. For use by A.P.C. of S.C.A.

- Mitchell, T.D. (1977a). Goats in semi-arid Australia. In Goats for fibre and meat production, ed. P.J. Holst and N.W. Moore. Proc. Symp. held by Aust. Mohair Res. Found. and Aust. Soc. Anim. Prod., Sydney.
- Mitchell, T.D. (1977b). Meat Goats. *Agric. Gazette, N.S.W.* 88(5): 34-35.
- Phillips, D. (1981). Meat production from goats. Report of a survey conducted in the South East Region of South Australia, 1980. *S.E. Regional Report No. 2*, 1981, S.A. Dept. Agric.
- Round, M.H. (1979). Dairy goats - extension activities. In S.A. Dept. Agric. *Livestock Branch Annual Report year ending 30th June, 1979*. Ed. B.C. Jefferies, pp. 46.
- Round, M.H. (1980). Dairy goats in Australia: Perspective and Prospects. In *Animal Industry Division T.I.C. No. 53*, 11-17.
- Smith, I.D., Clarke, W.H. and Turner, H.N. (1973). The potential of feral goats in Australia for cashmere production. *J. Aust. Inst. Agric. Sci.* 39(2): 128.

APPENDIX 1.8

DEER RESEARCH:

INVITED RESOURCE PAPER FOR RUMINANT INDUSTRY RESEARCH REVIEW

D.W. Russell,
Senior Livestock Officer,
Central Region

1. Historical Perspective

In South Australia interest in deer farming began in 1978 following the New Zealand success story publicised by both the media and in a book "Gold on Four Feet" written by Ronald Anderson. However the industry had already been pioneered in Australia by Willow Ware Pty. Ltd. in South Gippsland, Victoria.

The main stimulus for development of the industry was the high price being paid for antler velvet by Korean buyers during the late 1970's. However prices for antler velvet have since declined to a level where venison has again become the major product of deer farming with antler velvet production becoming a complementary form of income.

At the time of the surge of interest in deer farming in 1978, the S.A. Department of Agriculture formed a working party to determine the Government's attitude towards the industry as an agricultural pursuit. It was agreed to accept deer farming as a valid enterprise with deer becoming stock under the Stock Diseases Act. A Proclamation to prevent diseased deer entering the State was declared but no other restrictive legislation has been enacted. Control of the industry came under the Department of Agriculture.

In 1979, the Animal Production Committee appointed an Australian-wide working party to report on deer production in Australia. This report is published as no. 5 in the Standing Committee on Agriculture Technical Report Series (1980). The report contains (on pages 45 to 54) a section entitled "The Need for Research, Extension and Regulation in the Development of the Industry".

2. Current Situation

No accurate estimation of numbers of farmed deer is available, but several sources believe the number to be in the region of 1 000 head. The main species in S.A. is the fallow deer. Small numbers of rusa and red deer have been brought in from interstate.

I understand that there are about 80 members of the S.A. Deer Breeders Association but this number is expanded by some husband and wife members.

There is a scattered distribution of deer farms over the farming and high rainfall regions of the State.

The current market anticipation for venison in South Australia is estimated at 4 tonnes/annum. There is concern that New Zealand imported venison at about \$5/kg will spoil the prospects for S.A. breeders who have decided to settle on a selling price of carcass venison of \$7-00/kg.

The aim of the Association in conjunction with the restaurant trade is to promote venison as a high priced luxury meat with emphasis on quality. Value of a two year old stag carcass of 35 kg should be \$245.

Antler velvet fluctuates widely in price. It is expected that prices for A grade velvet will be between \$75 and \$100 per kg in 1982. Stags may yield an average of around 2 kg of velvet per annum. Costs of harvesting, storing and marketing are not available but are high.

Skins, sinews, pizzles and eye teeth are other marketable by-products.

3. Interaction with Other Industries

Deer farming and production from deer is unlikely in any way to compete with other agricultural industries, as the products from the industry are either in the luxury (venison) class or unique in their own right.

The high cost of facilities needed for deer farming (fences and yards) imply that deer will be confined to small areas of farming or high rainfall country in which they may present an option to generate secondary incomes to farmers dependent on traditional enterprises. Part-time farmers or small land-holders could also be interested.

The world market for antler velvet is limited to possibly less than 40 tonnes per year (the supply from Australia may be only 10% of this) and the venison market, while expected to reach 150 tonnes in a few years cannot be seen as a serious competitor against traditional meats for the housewife's table.

4. Future Prospects for the Industry and Major Industry Problems

A strong factor favouring the future prospects for deer is that they are better converters of feed to meat than either sheep or cattle.

On current costs and returns the gross margins for deer are higher than those for sheep and cattle. However, the industry is going through a long breeding-up phase making it difficult to predict the situation when deer numbers and prices stabilise in balance with long term market trends.

It appears that expansion of the industry will be more dependent on the market for venison than the limited market for antler velvet. New Zealand places great importance on the West German market as its major outlet for venison but also threatens to undercut Australian prices for the local trade here. This competition is of real concern to local deer farmers in the young industry in Australia.

The industry may be seen as one compatible with the Australian agricultural environment, but constraints include the lack of parent stock and low herd numbers, the high establishment costs of facilities and stock, poor cash flow during the build-up phase, competition from New Zealand and the unknown capacity of the local market. However the Deer Breeders Association have members with faith in the industry and with leadership qualities which give deer farming every chance to become a viable agricultural industry.

Recommendations for Government agencies to assist the industry are included in "Deer Production in Australia - the 1979/80 situation and the outlook for the future. S.C.A. Technical Report Series - No. 5".

5. Future Research Priorities for the Industry

See pp. 45 to 47 S.C.A. Tech. Report Series, No. 5.

6. Resources Required

It is suggested that research into deer production in South Australia cannot be justified in the foreseeable future because of the scale of the industry, the lack of existing resources, and the research work progressing in New Zealand and to some extent in Victoria.

The real need is the training of at least one resource/extension person to gain some degree of expertise in deer farming and knowledge of its problems. The identification of problems and research needs would then become a sequence of the first step.

A case for funding for work on deer in South Australia would be difficult to justify at present.

7. Current Research

None being conducted in SAGRIC.

8. Other Organisations

Victoria could be regarded as the leading State in Australia regarding deer farming. Support to the extent of \$11 600 from the Commonwealth Special Research Grant was received by the Victorian Department of Agriculture in 1980 to enable multidiscipline studies of deer to be undertaken.

9. Areas of Research in Deer Not Being Serviced

No SAGRIC research currently.

APPENDIX I.9

VETERINARY RESEARCH FOR THE RUMINANT INDUSTRIES:

INVITED RESOURCE PAPER FOR RUMINANT INDUSTRY RESEARCH REVIEW

D.N. Mackie,
Regional Veterinary Officer,
Central and Murraylands Regions

1. Introduction

"Australia's economy is heavily dependent on sustaining its home and export market of livestock products. Animal health considerations are of the utmost importance in this regard. The economic effects of animal disease on the export trade or by lowering the efficiency of animal production must constitute a priority in animal health research." (Report by A.H.C. to S.C.A. 118; 1980.) Efficient production is related to the maintenance of cost effective, applied research.

It is proposed to identify areas of applied research in the ruminant industries which, because of the needs of producers and environmental conditions in South Australia, require expertise best provided by local research.

2. Future Prospects of the Ruminant Industries

The survival of the ruminant industries is as much dependent on efficiency of production as is any other industry.

(1) Rising costs are eroding the economic advantages which Australia once held and to combat these costs the trend is towards larger production units. This in itself is posing problems of management, disease control and prevention. Failure to recognise, identify and rectify disease problems will place the ruminant industries at risk.

(2) To enable the industry to sustain the export and home markets in meat, milk and fibre, research must be directed into diseases which can affect access to those markets. Diseases which encourage the imposition of non-tariff barriers include infective agents, parasites, chemical residues and zoonoses.

(3) Live ruminant export and home market trade depend on efficient disease reporting based on accurate diagnostic techniques coupled with computerized recording and retrieval systems.

The ruminant industries depend upon research aimed at increasing efficiency of production and reducing costs.

3. Identified Major Ruminant Industry Problems

Research into animal health and disease cannot be considered separately from management, nutrition and economic production.

Problems affecting the industry in South Australia include:

- (a) Diseases brought about by changes in management, such as the stress-induced diseases of E. coli and salmonella infections which are as much related to the infective agents as to management practices.
- (b) Diseases affecting marketability of the products of the industry such as chemical residues and diseases communicable to man or animals.
- (c) Diseases affecting the efficiency of production such as post-natal losses, internal and external parasites, trace element deficiencies and plant toxins.
- (d) Diseases associated with housing, transport and lot feeding.
- (e) The emerging viral diseases associated with scouring in young stock and reproductive failure in mature animals.
- (f) The cost effectiveness of vaccines and chemotherapy.
- (g) The difficulty in identifying subclinical diseases which depress productivity.
- (h) Diseases related to interactions between chemical fertilizers, farming practices and trace elements, such as selenium responsive conditions.

4. Future Research Priorities

The recognition of conditions most likely to provide cost benefits and thus establish priorities is being hampered by the difficulty of researchers and managers in retrieving data.

(1) The collection and correlation of information, in accessible form, from the field, private and Government advisers, laboratory and abattoir are essential priorities.

(2) Since much basic research is available from outside sources, South Australia should be concentrating on applied research which emphasises prevention rather than cure under local conditions.

(3) The assessment of efficiency of production on the basis of production per unit of capital rather than per animal or per hectare emphasises the effect of livestock losses from all causes. Research is required into the economic effects of disease in the whole farming system.

(4) Trade in live ruminant export and intensive farming practices pose problems of disease associated with feed lots, housing and transport by sea and land. These are important fields of research and investigation.

(5) The tail tag system for cattle enables information to be recorded at the point of slaughter and related to the property of origin. No such system is available to the sheep industry. The development of a trace back system for all ruminant species is seen as an essential requirement in identifying the source of hidden problems such as C.L.A., sarcosporidiosis and the damage caused by toxic agents which are not apparent prior to slaughter.

(6) International trade demands certification of the absence of specified diseases. Monitoring for exotic diseases, although not a research entity, has become a priority in monitoring and recording techniques.

(7) Control or eradication of disease in ruminants requires regulatory restrictions. Investigations into voluntary and regulatory disease control methods is needed. An example is lice control.

5. Resources Required to Conduct Research

(1) Manpower

Existing resources for veterinary investigation and research by veterinary officers specializing in animal species within SAGRIC are depleted to the critical level. Reallocation of manpower from the traditional regulatory functions to an investigation and research role is an essential move within the service.

Government veterinary services to country areas have been achieved mainly through Commonwealth funds supplied for the eradication of Brucellosis and Tuberculosis. As this programme approaches completion, allocation of these officers to field investigatory roles will need funds from State sources. The reallocation of present manpower resources will provide a nucleus of animal health investigatory support for districts and research stations within SAGRIC. In the future, staffing levels can increase as demand and cost effectiveness are established.

(2) Facilities

The State has access to specialised equipment, research facilities and farms in keeping with the size and value of primary industries. These facilities are under the control of various bodies such as I.M.V.S., Waite Agricultural Research Institute and SAGRIC.

Individual investigators often obtain access to specialised facilities by personal approach but because of varying priorities within each organisation delays may occur. Unified control of these facilities is not necessary to achieve maximum effectiveness but having a commitment to a common goal is.

(3) Computer

Computer facilities and skilled operators will be required to collect and collate data. Training will be necessary.

(4) Finance

The constant struggle between independent bodies for research monies and the time lost in establishing priorities creates problems. Special attention must be given to simplifying the systems of assessing research priorities and the allocation of funds.

6. (1) Significance and Effectiveness of Current Research by SAGRIC Animal Health

The value of research into animal health and disease in ruminants has been and is reduced by the diversity of the functions of staff in the Animal Health Division. Nevertheless investigation carried out by field staff over the years has highlighted problems which have subsequently led to research projects by other groups within SAGRIC, the Institute of Medical and Veterinary Science, Waite Institute and Northfield Research Centre with the aid of animal health staff.

Examples of such applied research are mastitis in dairy cattle, eperythrozoonosis in sheep, vitamin B12 in young stock, annual ryegrass toxicity, sarcosporidiosis and brucellosis.

At present investigations are being directed into mycotic dermatitis in sheep and iodine levels in milk of dairy cows.

(2) Extension of Research Projects

The effectiveness of extension of research projects, as judged by the acceptance of results by the producers, has been good. However, the contribution to the industry though high in quality has been low in quantity because of restrictions on funds and restricted research time available to specialist staff.

7. Areas of Research Adequately Covered

Research into diseases which are associated with temperate to high rainfall areas are adequately covered by other states or organisations such as C.S.I.R.O.

Duplication of research effort is undesirable.

8. Areas of Research Not Adequately Serviced

(1) The application of basic research findings obtained from work carried out in environmental conditions unlike those of South Australia, requires a nucleus of applied researchers and investigators to interpret the results to meet local requirements, for example:-

- The importance of internal and external parasites in the hot dry areas of the State.
- The identification and plotting of trace element deficiencies.
- The cost effectiveness of current therapeutic procedures developed for climatic conditions not necessarily experienced in S.A.

(2) Investigatory and applied research is required into:

- The differential diagnosis of the causes of lowered production.
- The measurement of the economic effects of disease, nutrition and management on production.
- Herd/flock health schemes.
- The forecasting of diseases and institution of preventive measures using retrievable historical data.

9. Conclusion

Research workers in a variety of disciplines, in different organisations within the State, work together by mutual arrangement to provide an integrated approach into animal health and disease in ruminants.

To increase the effectiveness of the research resources it is necessary for all divisions within the industry from the grower to the producer of the end-product to recognise a common goal.

Also, administrative effort should be directed towards facilitating the sharing of funds and resources for projects being undertaken jointly by co-operating organisations.

Applied research into the cost effectiveness of management practices and the improvement of State herd and flock health will have a great impact on the ruminant industries over the next decade.

APPENDIX II

SUBMISSIONS TO RUMINANT INDUSTRY RESEARCH REVIEW

APPENDIX II.1

SUBMISSIONS MADE TO RUMINANT INDUSTRY RESEARCH REVIEW

FROM WITHIN SAGRIC

Submissions were received by the Working Party from the following SAGRIC officers/sections:

- Animal Health Division (from J.H. Holmden, Chief Veterinary Officer)
- C. Cargill, Senior Specialist Veterinary Pathologist, Veterinary Sciences Division
- Dairy Section, Animal Industry Division (from G.R. Norman, Principal Dairy Officer)
- K.J. Dobson, Principal Veterinary Officer, Health Programmes, Animal Health Division
- Economics Division (from G.J. Ryland, Chief Economist)
- R.W. Ellis, Principal Research Officer, South East Region
- R. Giesecke, Senior Specialist Veterinary Pathologist, Veterinary Sciences Division
- Northern Region (from R. Vandegraaff, Acting Chief Regional Officer)
- M.H. Round, Research Officer, Animal Industry Division
- M.R. Till, Principal Soils Officer (Irrigation), Land Use and Protection Division
- C. Trengove, Acting Regional Veterinary Officer, Eyre Region.

APPENDIX II.2

SUBMISSIONS MADE TO RUMINANT INDUSTRY RESEARCH REVIEW

FROM OUTSIDE SAGRIC

Submissions were received by the Working Party from the following individuals/organisations:

- P. Ashby, E.P. Ashby & Co., Chartered Accountant, Adelaide
- Australian Cashmere Goat Society, Region 51 (from L. & G. Hudson, Cockatoo Valley, S.A.)
- Australian Labour Party (S.A. Branch)
- D. Barratt, Angora Goat Breeder, Toorak Gardens
- K.H. Greenfield, "Billa Kalina", Woomera
- Liberal Party of Australia (S.A. Division)
- L. Mathewson, Research Officer, Institute for Aboriginal Development, Alice Springs
- Metropolitan Milk Board, Adelaide
- E.D. Mills and Sons, Longdown - Longford, Tasmania
- C.H.B. Oldfield and Co., Cowarie Station, via Maree
- Private Treaty Wool Merchants Association of S.A. Incorporated
- S.A. Division, Australian Veterinary Association
- I. Schafer, Managing Director, Davian Pty. Ltd., Dry Creek
- South Australian Dairymen's Association Incorporated
- South Australian Stud Beef Cattle Breeders Association
- South Australian Stud Merino Sheepbreeders Association Incorporated
- South Eastern Dairymen's Association of S.A. Incorporated
- United Farmers and Stockowners of S.A. Incorporated, Wool and Meat Section.

APPENDIX III

SAGRIC RUMINANT RESEARCH AND RESOURCE ALLOCATION

RESEARCH AREA & DISCIPLINE	RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING*
<u>General Resource</u>			
Agricultural Chemicals, Soils, Fertilisers	Nil		
Non-commodity Oriented Disciplines	Nil		
Agricultural Engineering	Nil		
<u>Production</u>			
Genetics and Reproduction	1. Dairy production and genetics 2. Superior milk protein	BE4N-2DAN TD4N-2D18	State D.R.T.F.
Husbandry and Livestock Management	1. Dairy husbandry investigations	BE4N-2DCA	State
Nutrition and Grazing Management	1. Dairy research (Murray Bridge) 2. Dairy cattle nutrition 3. Heifer growth and mammary development 4. Fodder utilisation and conservation 5. Fodder analytical services	BE4N-2DAV BE4N-2DAM BE4N-2D09/TD4N-2D09 BE4N-2DBK BE4N-2DBL	State State State/D.R.T.F. State State
<u>Protection</u>			
Animal Health	1. Mastitis 2. Cell counts on milk 3. Virology research - bovine abortion (shared with beef cattle)	BE4N-2DAU TD4N-2D16 BE4N-2RKD	State D.R.T.F. State
Entomology	Nil		
Plant Pathology	Nil		
Weeds	Nil		
Vertebrate Pests	Nil		
<u>Product Technology</u>			
Harvesting and Processing	1. Milk product quality improvement 2. Cheese moisture control	BE4N-2DAP BE4N-2DAR	State State
Quality and Quality Control	1. Dairy product technology 2. Dairy product standards 3. Assessment of bacteria in milk	BE4N-2DAS BE4N-2DAT TD4N-2D19	State State D.R.T.F.

APPENDIX III.1(a) continued

RESEARCH AREA & DISCIPLINE	RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING*
<u>Extension and Economic Services</u>			
Extension and Social Factors	Nil		
Farm Business Management	Nil		
General Economics and Marketing	Nil		
<u>Miscellaneous</u>	1. Northfield Research Centre - operation	BE4N-2DBP	State
†Chemistry, Biochemistry, Microbiology and Remote Sensing.			
Trust Fund abbreviations:			
A.M.R.C.	= Australian Meat Research Committee		
B.A.H.	= Bureau of Animal Health		
D.D.C.F.	= Deposit - Dingo Control Fund		
D.R.M.I.S.I.P.	= Deposit - River Murray Irrigation and Salinity Investigation Programme		
D.R.T.F.	= Dairy Research Trust Fund		
D.W.R.I.P.	= Deposit - Water Resources Investigation Programme		
L.R.T.F.	= Lucerne Research Trust Fund (United Farmers and Stockowners)		
N.C.C.S.C.	= National Carcass Classification Supervisory Committee		
R.C.D.T.F.	= Rural Credits Development Trust Fund		
S.A.W.I.R.C.	= South Australian Wheat Industry Research Committee		
W.I.R.C.	= Wheat Industry Research Council		
W.R.T.F.	= Wool Research Trust Fund		

RESEARCH AREA & DISCIPLINE	RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING*
<u>General Resource</u>			
Agricultural Chemicals, Soils, Fertilisers	Nil		
Non-commodity Oriented Disciplines	Nil		
Agricultural Engineering	Nil		
<u>Production</u>			
Genetics and Reproduction	1. Life-time productivity of breeding cows	BECT-2BAL	State
	2. Grazing management (part only)	BEMW-2PAU	State
	3. Cattle reproduction	BESS-2BAD	State
	4. Cattle crossbreeding - South East	BESS-2BAP	State
	5. Integration of beef production systems	TMSS-2B08	State/A.M.R.C.
Husbandry and Livestock Management	1. Early weaning effects	TMSS-2B07	State/A.M.R.C.
	2. Zeranol effects on heifers	TMSS-2B10	State/A.M.R.C.
Nutrition and Grazing Management	1. Ruminant nutrition (shared with sheep)	BECT-2BAC	State
	2. Grazing management (part only)	BEMW-2PAU	State
	3. Grain legumes for cattle and sheep (part only)	TMSS-2R14	State/A.M.R.C.
<u>Protection</u>			
Animal Health	1. Beef nematodiasis	BECF-2BAE	State
	2. Nematodiasis in young cattle	BECT-2BAN	State
	3. Virology research - bovine abortion (shared with dairy cattle)	BELF-2KKD	State
Entomology	Nil		
Plant Pathology	1. Ryegrass toxicity (shared with sheep)	TM5B-2M12	A.M.R.C.
Weeds	Nil		
Vertebrate Pests	Nil		
<u>Product Technology</u>			
Harvesting and Processing	Nil		
Quality and Quality Control	Nil		

APPENDIX III.1(b) continued

RESEARCH AREA & DISCIPLINE	RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING ^a
<u>Extension and Economic Services</u>			
Extension and Social Factors	Nil		
Farm Business Management	Nil		
General Economics and Marketing	1. Cattle auction by description (sight unseen)	UA4M-2505	N.C.C.S.C.
<u>Miscellaneous</u>	Nil		

RESEARCH AREA & DISCIPLINE	RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING*
<u>General Resource</u>			
Agricultural Chemicals, Soils, Fertilisers	Nil		
Non-commodity Oriented Disciplines	Nil		
Agricultural Engineering	Nil		
<u>Production</u>			
Genetics and Reproduction	1. Carcase evaluation of high fertility Merinos	BECT-2MAE	State
	2. Strains x flock management interaction	BECT-2WAM	State
	3. Efficiency of wool growth in high fertility Merinos	BECT-2WAP	State
	4. High fertility Merino evaluation	BEEM-2WAB	State
	5. Comparison of crossbreeding	BE4A-2W32/TW4A-2W32	State/W.R.T.F.
	6. High twinning rates	TMSK-2M15	State/A.M.R.C.
	7. Investigation into the use of the hormone melatonin, as a means of modifying seasonal breeding activity of sheep	TMSK-2M17	State/A.M.R.C.
	8. Merino strains for prime lambs	BESS-2MAB	State
	9. High fertility Merino strain	TMSS-2M14	A.M.R.C.
	10. Sheep reproduction	BE4A-2WAF	State
	11. Sheep genetics	BE4A-2WAG	State
	12. Animal breeding and genetics	BE4A-2WAX	State
	13. Research farm - Cape Borda	BE4A-2WAY	State
Husbandry and Livestock Management	Nil		
Nutrition and Grazing Management	1. Ruminant nutrition (shared with beef cattle)	BECT-2BAC	State
	2. Grazing management (part only)	BEMW-2PAU	State
	3. Prime lamb finishing systems	BECT-2MAD	State
	4. Ruminant feeding studies	BE4N-2RGH	State
	5. Management of highly fertile sheep	BESK-2WAK	State
<u>Protection</u>			
Animal Health	1. Epidemiology of sheep nematodes	BECT-2WAT	State
	2. Copper prophylaxis in sheep	BEEQ-2RAA	State
	3. Drenching for worms	BESK-2WAL	State
	4. Mycotic dermatitis	TW3A-2W31	W.R.T.F.
	5. Sheep blowfly control	BE4A-2WAE	State
	6. Merino genetic improvement - blowfly	BE4A-2W26/TW4A-2W26	State/W.R.T.F.
	7. Oestrogenic pastures	BE4A-2W27/TW4A-2W27	State/W.R.T.F.
	8. Biochemistry research - copper oxide	BELF-2KHT/EDLF-2RA1	State/Glaxo
	9. Tissue pathology research - ram wastage	BELF-2KJD	State
	10. Tissue pathology research - pelleted ruminant diets	BELF-2RJE	State/B.A.H.
	11. Microbiology development - footrot	BELF-2RJK	State
	12. Research - sheep bacterial diseases	BELF-2RLW	State

APPENDIX III.1(c) continued

RESEARCH AREA & DISCIPLINE	RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING*
Entomology	Nil		
Plant Pathology	1. Ryegrass toxicity (shared with beef cattle)	TM5B-2M12	A.M.R.C.
Weeds	Nil		
Vertebrate Pests	Nil		
<u>Product Technology</u>			
Harvesting and Processing	Nil		
Quality and Quality Control	1. Meat research (sheep) 2. Melanin pigmented fibres	BE4A-2MAF BE4A-2W37/TW4A-2W37	State State/W.R.T.F.
<u>Extension and Economic Services</u>			
Extension and Social Factors	Nil		
Farm Business Management	Nil		
General Economics and Marketing	1. Wool marketing research	BE4A-2WAQ	State
<u>Miscellaneous</u>	Nil		

RESEARCH AREA & DISCIPLINE		RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING*
<u>General Resource</u>				
Agricultural Chemicals, Soils, Fertilisers	Nil			
Non-commodity Oriented Disciplines	Nil			
Agricultural Engineering	Nil			
<u>Production</u>				
Genetics and Reproduction	1.	Angora goats parameters	TRCT-2J11	R.C.D.T.F.
Husbandry and Livestock Management	1.	Milk goats	BE4N-2RCB	State
Nutrition and Grazing Management	Nil			
<u>Protection</u>				
Animal Health	Nil			
Entomology	Nil			
Plant Pathology	Nil			
Weeds	Nil			
Vertebrate Pests	Nil			
<u>Product Technology</u>				
Harvesting and Processing	Nil			
Quality and Quality Control	Nil			
<u>Extension and Economic Services</u>				
Extension and Social Factors	Nil			
Farm Business Management	Nil			
General Economics and Marketing	Nil			
<u>Miscellaneous</u>	Nil			

RESEARCH AREA & DISCIPLINE	RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING*
<u>General Resource</u>			
Agricultural Chemicals, Soils, Fertilisers	1. Phosphorus and sulphur requirements - soils 2. Trace element responses (part only) 3. Plant test for phosphorus	BESQ-24AY BESQ-24AZ TW6R-2W35	State State State/W.R.T.F.
Non-commodity Oriented Disciplines	1. Nature of aphid resistance in <i>Medicago</i>	BESP-2PBM	State
Agricultural Engineering	Nil		
<u>Production</u>			
Genetics and Reproduction	1. Seed production of clovers 2. Reproductive performance 3. Subclover improvement 4. Subclover evaluation 5. Low phosphorus annual legumes 6. Subclover breeding, selection and development 7. Evaluation of <i>T. subterraneum</i> 8. Scorch resistant subclover 9. Factors affecting pasture production 10. Legume evaluation 11. Aphid resistant cultivars (lucerne) 12. Pasture improvement 13. Pasture genetic resource 14. Pasture accession evaluation 15. Regional evaluation of introduced lines 16. Sainfoin for meat production 17. Lucerne cultivars/fleas, redmite resistance 18. Lucerne breeding 19. Lucerne resistant to weevil 20. Lucerne breeding	BECF-2PAY TWCP-2W25 BECF-2PBC BECQ-2PAJ TWCP-2W38 BECT-2PBB TTCT-2P02 TWCT-2W39 BESK-2PAV BESK-2PBF TWSK-2W34 TWSK-2W41 BESM-2PAP BESM-2PAQ BESM-2PAR TM5P-2B09 TM5P-2M16 BESP-2PAH TW5P-2W40 BESP-2PAG/TM5P-2C01/TT5P-2C01	State W.R.T.F. State State W.R.T.F. State W.I.R.C. W.R.T.F. State State State/W.R.T.F. State/W.R.T.F. State State State A.M.R.C. A.M.R.C. State W.R.T.F. State/ S.A.W.I.R.C./ W.I.R.C. State L.R.T.F.
Husbandry and Livestock Management	21. Insect screening of legumes 22. Breeding lucerne	BESP-2PBG UN5P-2P03	State L.R.T.F.
Nutrition and Grazing Management	1. Pasture utilization 2. Legume grazing management	BE4A-2PAT BESP-2PAK	State State
<u>Protection</u>			
Animal Health	Nil		
Entomology	1. Sitona weevil 2. Pathogens to control Sitona weevil	BESB-2JAJ/TT5B-2C07 BESB-2JCA	State/W.I.R.C. State

APPENDIX III.1(e) continued

RESEARCH AREA & DISCIPLINE	RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING*
Plant Pathology	Nil		
Weeds	Nil		
Vertebrate Pests	Nil		
<u>Product Technology</u>			
Harvesting and Processing	Nil		
Quality and Quality Control	Nil		
<u>Extension and Economic Services</u>			
Extension and Social Factors	Nil		
Farm Business Management	Nil		
General Economics and Marketing	Nil		
<u>Miscellaneous</u>			
	Nil		

RESEARCH AREA & DISCIPLINE	RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING*
<u>General Resource</u>			
Agricultural Chemicals, Soils, Fertilisers	1. Water repellent soils	BEEU-24AC, BE6R-24DA	State
	2. Soil and land survey	BEEU-24AN, BE6C-24BZ, BE6C-24CA	State
	3. Soil conservation	BEMD-24DD	State
	4. Regional soils research	BEMD-24AP, BEMM-24AR	State
	5. Fertilisers: macro- and micro-nutrient	BESQ-24AZ, BE6R-24CF, BE6R-24DE	State
	6. Soil and water salinity	BEEU-2HAN	State
	7. Water conservation and management	BEEU-2HAM, BE6W-2HAE	State
	8. Agro-meteorological studies	DM6W-2HM7	D.R.M.I.S.I.P.
	9. Regional water resources	DW6W-2HW1, DW6W-2HW2, DW6W-2HW3	D.W.R.I.P.
	10. Arid zone ecology	BE6C-24CB	State
Non-commodity Oriented Disciplines	1. Analytical services, methods and maintenance	BESK-2PBL, BE6R-24CG, BE6R-24CH, BE6R-24DK	State
	2. Nitrogen fixation in legumes	BE5P-2C18/BE5P-2PAL	State/W.I.R.C.
	3. Seed physiology	BE5S-2CCF	State
	4. Resource modelling/systems analysis	BE6W-2HAG, BB8E-26BA	State
Agricultural Engineering	Nil		
<u>Production</u>			
Genetics and Reproduction	1. Seed production	BE5S-2PBK	State
Husbandry and Livestock Management	Nil		
Nutrition and Grazing Management	1. Farm systems	BECT-22AK	State
	2. Grain legumes for cattle and sheep	TMSS-2R14	State/A.M.R.C.
<u>Protection</u>			
Animal Health	1. General animal health	BEMD-2RBC, BEMM-2RBF, BE3A-2TAP	State
	2. Biochemistry - trace elements, vitamins, toxicities	BESQ-24AZ, BELF-2RHN/TWLF-2W43, BELF-2RHP, BELN-2RLX	State/W.R.T.F.
	3. Microbiology: bacterial identification, abortion and infertility	BELF-2RJM, BELF-2RJN	State
	4. Tissue pathology - neuropathology	BELF-2RJC	State
	5. Parasitology - nematodes - sporozoa	BELF-2RJW, BELF-2RJX/TWLF-2W42 BELF-2RJY/TMLF-2M18	State/W.R.T.F. State/A.M.R.C.
	6. Animal welfare	BELF-2RHD	State
Entomology	1. Control measures including biological control for wingless grasshopper, legume aphids and army worm pests	BE5B-2JBA, BE5B-2JBC, BE5B-2JBH, BE5B-2JBL, BE5B-2JCC	State
	2. Introduced dung beetle	BE5B-2JCB	State
Plant Pathology	Nil		

RESEARCH AREA & DISCIPLINE	RESEARCH PROJECTS	PROJECT CODE	SOURCE OF FUNDING*
Weeds	1. Biological studies of weeds 2. Herbicidal weed control 3. Weeds research - general	BE5B-28AE BE5B-28AF BE5B-28AG	State State State
Vertebrate Pests	1. Rabbits 2. Feral goats 3. Dingoes	MV6V-2NAQ, MV6V-2NAS MV6V-2NAR DD6V-2ND2	State State D.D.C.F.
<u>Product Technology</u>			
Harvesting and Processing	Nil		
Quality and Quality Control	1. Pesticide residue studies	BE5Q-2CBR	State
<u>Extension and Economic Services</u>			
Extension and Social Factors	1. Extension research	BE7E-21AA	State
Farm Business Management	1. Farm management (research) 2. Cropping systems in wheat/sheep zone 3. Input-output model of dryland farming 4. Farm mechanization (research)	BE8E-22AE TR8E-2201 TT8E-2202 BE8E-23AA	State R.C.D.T.F. W.I.R.C. State
General Economics and Marketing	1. Marketing services 2. Economic services (research)	(BE8E-25AB) (BE8E-26AR)	State State
<u>Miscellaneous</u>	Nil		

APPENDIX III.2

Current resource allocation for SAGRIC ruminant industry research:
Estimate of Professional man-years input† (year ending June 30, 1983).
State-funded positions, with Industry-funded manpower in parentheses.

Research Area & Discipline	Dairy	Beef	Sheep	Industry Goats	Pasture	Multi-Industry
<u>General Resource</u>						
Ag. Chemicals, Soils, Fertilisers	-	-	-	-	1.3 (1.0)	8.5
Non-Commodity Oriented Disciplines*	-	-	-	-	0.05	4.5
Agricultural Engineering	-	-	-	-	-	-
<u>Production</u>						
Genetics & Reproduction	1.0	2.1	5.1	-	2.7 (2.4)	0.8
Husbandry & Livestock Management	0.4	0.5	-	0.1	-	-
Nutrition & Grazing Management	3.1	0.8	2.6	-	-	1.1
<u>Protection</u>						
Animal Health	0.7	0.8	3.3	-	-	5.5 (1.0)
Entomology	-	-	-	-	1.1	2.35
Plant Pathology	-	(0.5)	(0.5)	-	-	-
Weeds	-	-	-	-	-	1.8
Vertebrate Pests	-	-	-	-	-	1.9
<u>Product Technology</u>						
Harvesting & Processing	1.7	-	-	-	-	-
Quality & Quality Control	1.9	-	1.0	-	-	-
<u>Extension and Economic Services</u>						
Extension & Social Factors	-	-	-	-	-	2.0
Farm Business Management	-	-	-	-	-	1.1
General Economics & Marketing	-	-	0.2	-	-	2.9
<u>Miscellaneous</u>	0.1	-	-	-	-	-
INDUSTRY TOTALS	8.9	4.2 (0.5)	12.2 (0.5)	0.1	5.15 (3.4)	32.45 (1.0)

† Officers with classification of AS/AA/VO/SO/SV/VP/EO.

* Chemistry, Biochemistry, Microbiology and Remote Sensing.

APPENDIX III.3

Current resource allocation for SAGRIC ruminant industry research:
Estimate of Technical man-years input† (year ending June 30, 1983).
State-funded positions, with Industry-funded manpower in parentheses.

Research Area & Discipline	Dairy	Beef	Sheep	Industry Goats	Pasture	Multi-Industry
<u>General Resource</u>						
Ag. Chemicals, Soils, Fertilisers	-	-	-	-	-	4.6
Non-Commodity Oriented Disciplines*	-	-	-	-	0.1	5.4
Agricultural Engineering	-	-	-	-	-	-
<u>Production</u>						
Genetics & Reproduction	-	1.4 (1.0)	1.1 (1.0)	0.2	5.3 (7.0)	-
Husbandry & Livestock Management	0.3	-	-	-	-	-
Nutrition & Grazing Management	2.9	0.25	0.15	-	-	0.3
<u>Protection</u>						
Animal Health	2.1	0.3	0.3 (1.0)	-	-	3.1 (3.0)
Entomology	-	-	-	-	0.45 (1.0)	1.1
Plant Pathology	-	(1.0)	(1.0)	-	-	-
Weeds	-	-	-	-	-	1.0
Vertebrate Pests	-	-	-	-	-	-
<u>Product Technology</u>						
Harvesting & Processing	0.7	-	-	-	-	-
Quality & Quality Control	0.5	-	0.3	-	-	0.4
<u>Extension and Economic Services</u>						
Extension & Social Factors	-	-	-	-	-	-
Farm Business Management	-	-	-	-	-	0.5
General Economics & Marketing	-	(1.0)	-	-	-	-
<u>Miscellaneous</u>	0.8	0.2	0.2	-	-	-
INDUSTRY TOTALS	7.3	2.15 (3.0)	2.05 (3.0)	0.2	5.85 (8.0)	16.4 (3.0)

† Officers with classification of AT/TO/TA/TV.

* Chemistry, Biochemistry, Microbiology and Remote Sensing.

APPENDIX III.4

Current resource allocation for SAGRIC ruminant industry research:
Estimate of Ancillary salaried staff man-years input† (year ending June 30, 1983).
State-funded positions, with Industry-funded manpower in parentheses.

Research Area & Discipline	Dairy	Beef	Sheep	Industry Goats	Pasture	Multi-Industry
<u>General Resource</u>						
Ag. Chemicals, Soils, Fertilisers	-	-	-	-	1.75	4.1
Non-Commodity Oriented Disciplines*	-	-	-	-	-	-
Agricultural Engineering	-	-	-	-	-	-
<u>Production</u>						
Genetics & Reproduction	-	0.1	1.7	-	0.5 (4.0)	-
Husbandry & Livestock Management	0.2	-	-	-	-	-
Nutrition & Grazing Management	0.8	-	0.3	-	-	-
<u>Protection</u>						
Animal Health	1.4	0.8	1.0	-	-	0.45
Entomology	-	-	-	-	-	-
Plant Pathology	-	(0.5)	(0.5)	-	-	-
Weeds	-	-	-	-	-	2.0
Vertebrate Pests	-	-	-	-	-	3.0
<u>Product Technology</u>						
Harvesting & Processing	1.1	-	-	-	-	-
Quality & Quality Control	0.5	-	-	-	-	-
<u>Extension and Economic Services</u>						
Extension & Social Factors	-	-	-	-	-	-
Farm Business Management	-	-	-	-	-	-
General Economics & Marketing	-	-	-	-	-	-
<u>Miscellaneous</u>	-	0.1	0.1	-	-	-
INDUSTRY TOTALS	4.0	1.0 (0.5)	3.1 (0.5)	-	2.25 (4.0)	9.55

† Officers with classification of AG.

* Chemistry, Biochemistry, Microbiology and Remote Sensing.

APPENDIX III.5

Current resource allocation for SAGRIC ruminant industry research:
Estimate of Weekly Paid staff man-years input† (year ending June 30, 1983).
State-funded positions, with Industry-funded manpower in parentheses.

Research Area & Discipline	Dairy	Beef	Sheep	Industry Goats	Pasture	Multi-Industry
<u>General Resource</u>						
Ag. Chemicals, Soils, Fertilisers	-	-	-	-	(0.3)	-
Non-Commodity Oriented Disciplines*	-	-	-	-	-	-
Agricultural Engineering	-	-	-	-	-	-
<u>Production</u>						
Genetics & Reproduction	(0.4)	-	(0.3)	-	6.8 (4.2)	-
Husbandry & Livestock Management	-	(1.0)	-	-	-	-
Nutrition & Grazing Management	-	-	-	-	-	-
<u>Protection</u>						
Animal Health	(0.5)	-	(0.25)	-	-	-
Entomology	-	-	-	-	(0.25)	-
Plant Pathology	-	-	-	-	-	-
Weeds	-	-	-	-	-	-
Vertebrate Pests	-	-	-	-	-	-
<u>Product Technology</u>						
Harvesting & Processing	-	-	-	-	-	-
Quality & Quality Control	-	-	(0.5)	-	-	-
<u>Extension and Economic Services</u>						
Extension & Social Factors	-	-	-	-	-	-
Farm Business Management	-	-	-	-	-	-
General Economics & Marketing	-	-	-	-	-	-
<u>Miscellaneous</u>	6.0	5.5	3.5	-	2.0	1.5
INDUSTRY TOTALS	6.0 (0.9)	5.5 (1.0)	3.5 (1.05)	-	8.8 (4.75)	1.5

† Officers with classification of GH and casual labour.

* Chemistry, Biochemistry, Microbiology and Remote Sensing.

APPENDIX IV

RESEARCH IN OTHER ORGANISATIONS RELEVANT TO
SOUTH AUSTRALIAN RUMINANT INDUSTRIES

APPENDIX IV.1

RUMINANT RESEARCH PROJECTS IN OTHER SOUTH AUSTRALIAN ORGANISATIONS

UNIVERSITY OF ADELAIDE:

(i) Waite Agricultural Research Institute:

1. Assessment of grain legumes for beef cattle and sheep.
Aim is to evaluate a range of grain legumes suitable for use in S.A., and their crop by-products, as a source of feed for growing beef cattle and sheep, and for sheep reproduction.
Mortlock Experimental Station, Mintaro.
2. The use of grain legumes for intensive lamb production in a Mediterranean environment.
Aim is to examine the effect of grain legumes on lamb growth rates, lambing frequency and ewe prolificacy, and breed and seasonal sensitivity to nutritional "primers" under conditions of once yearly or more frequent lambing.
Mortlock Experimental Station, Mintaro.
3. Pasture and supplement intake and nutrient yield in grazing cattle.
Aim is to evaluate yields of nutrients in grazing cattle to provide a basis for improvement of efficiency of use of pasture and supplemental energy and protein; to devise new feeding strategies with grain and grain legumes for beef cattle.
Mortlock Experimental Station, Mintaro; and Waite Institute.
4. The influence of grain legumes upon growth and reproductive rates of ruminants.
Aim is to study the effect, and evaluate mechanisms of effect, of short-term feeding of grain legumes upon post-partum (lactational) anoestrus in sheep and beef cattle.
Mortlock Experimental Station, Mintaro.
5. The induction of fertile oestrus in post-partum ewes.
Aim is to develop and refine the LH-RH treatment of post-partum ewes to produce normal ovulation and functional corpora lutea; to investigate the use of progesterone to prime the ewes so that behavioural oestrus will be associated with the induced ovulation; to apply the method in a practical situation and test the fertility of ewes at the induced oestrus; and to study pertinent basic aspects of post-partum anoestrus.
Mortlock Experimental Station, Mintaro.
6. Interrelation of wool growth, weight gain and diet.
Aim is to examine the influence of weight gain on wool growth rate, and the sources of variation between individual sheep in wool growth efficiency.
Waite Institute.

7. Factors controlling partition of protein use in wool, body tissue and milk synthesis in ewes.
Aim is to provide a physiological basis for nutritional manipulation of the partition of amino acids into wool, body tissue and milk constituents in ewes.
Mortlock Experimental Station, Mintaro; and Waite Institute.
8. Metabolism of amino acids in sheep.
Aim is to provide a sound basis for evaluation of amino acid requirements of sheep and a definition of factors which limit efficiency of use of amino acids; from this to evolve practical approaches to the improvement of protein synthesis in sheep.
Waite Institute.
9. The ecology of annual grasses in the Mediterranean annual type pasture.
Aim is to examine growth responses to nitrogen, forage quality and persistence (seed production, seed dormancy and plant establishment) in a Mediterranean environment; to better understand the factors that contribute to yield and botanical composition in annual-type pastures.
Mortlock Experimental Station, Mintaro; and Waite Institute.
10. Interactions between nitrogen and phosphorus assimilation in the symbiotic association between legumes, *Rhizobium* and mycorrhizal fungi.
Aim is to investigate the role of mycorrhizas in the assimilation of nitrogen and phosphorus, including the way in which mycorrhizas affect nitrogen fixation in improved phosphate uptake, their involvement in the uptake and assimilation of the combined nitrogen sources ammonium and nitrate, and the effects of fertilizers on mycorrhizal establishment.
Waite Institute and Botany Department, University of Adelaide.
11. Control of the pasture cockchafer *Aphodius tasmaniae* Hope.
Aim is to demonstrate the effectiveness of the pathogenic fungus, *Metarhizium anisopliae*, which occurs naturally in cockchafer larvae in South Australia, in suppressing cockchafer populations.
Insect Pathology Laboratory, Waite Institute; field work at Mt. Barker, Mt. Pleasant, Mt. Crawford and Echunga.
12. A feasibility study of the potential of microbial agents for the suppression of the sheep blowfly, *Lucilia cuprina*.
Aim is to determine if insect pathogens may be used to suppress the sheep blowfly, *Lucilia cuprina*.
Insect Pathology Laboratory, Waite Institute; field sampling at 25 sites throughout the wool-producing areas of S.A.
13. Control of annual ryegrass toxicity.
Aim is to control ryegrass toxicity without eliminating ryegrass.
Plant Pathology Unit, SAGRIC, at Waite Institute.
14. The role of choline and betaine in the nutrition, metabolism and production in sheep and cattle.
Aim is to evaluate the role of dietary choline and betaine in the nutrition, metabolism and production in sheep and cattle.
Department of Agricultural Biochemistry, Waite Institute.

15. Endogenous acetate production and ketogenesis in sheep liver.
Aim is to study the control and interrelation of acetate and ketone body production in the liver.
Department of Agricultural Biochemistry, Waite Institute.
16. Development of a meat goat for southern Australia.
Aim is to develop, by selection and breeding from feral goats, one or more strains of goat suitable for commercial meat production in the Mediterranean environment of southern Australia.
Waite Institute; Mortlock Experimental Station, Mintaro; and three commercial properties in S.A. and Victoria.
17. Cashmere goat production.
Aim is to develop and maintain a small breeding and experimental flock of cashmere-producing goats.
Waite Institute.
18. Reproductive capacity of meat goats.
Aim is to determine the feasibility of obtaining two sets of kids each year from meat goats.
Mortlock Experimental Station, Mintaro.
19. Comparative metabolism of sheep and goats.
Aim is to compare the metabolic responses of sheep and goats to nutritional stress, under both hot and cold conditions.
Waite Institute.
20. Surface proteins of ram sperm in maturation, and their use in promoting survival during dilution and cold storage.
Aim is to characterize the protein composition of the surface of ram spermatozoa and identify deleterious changes which result from dilution and cryopreservation procedures; to minimize these deleterious changes by the inclusion of appropriate protein constituents in sperm diluents; to develop more successful procedures for cryopreservation of sheep semen.
Waite Institute.
21. Characterization of changes in the sperm surface in the bull reproductive tract and during semen storage.
Aim is to characterize changes in the protein composition of the sperm surface of bull spermatozoa as sperm pass through the epididymis; to establish whether detrimental effects on sperm viability during cryopreservation result from modification to the protein composition of the sperm surface.
Davies Beef Cattle Unit, Waite Institute.
22. Vitamin A and testicular function in the bull.
Aim is to investigate the role of vitamin A and related polyprenols in the synthesis of glycoproteins and glycolipids; to establish why testicular function is particularly sensitive to vitamin A deficiency.
Davies Beef Cattle Unit, Waite Institute.

23. Epididymitis of rams: a physico-chemical and histopathological study.
Aim is to evaluate variations in strains of bacteria responsible for causing epididymitis in rams; to establish the usual routes of transmission of the disease; to establish the mechanism of lesion formation in the epididymis.
Institute of Medical and Veterinary Science, South East Regional Veterinary Laboratory, Naracoorte.
24. The ecology and productivity of annual medic pastures.
Aim is to identify the main factors influencing the seed/seedling dynamics of medic pastures grazed by sheep in the cereal-livestock zone of South Australia.
Waite Institute; cereal-sheep farms mainly in the Mallala district, County Gawler, S.A.

(ii) Botany Department:

1. Regressions between sheep stocking intensity and effects on saltbush vegetation.
Middleback Field Station, via Whyalla.
2. Flock behaviour in the arid zone.
Middleback Field Station.
3. Computer modelling of arid zone grazing systems (sheep).
Middleback Field Station.
4. Plant biomass reduction in relation to stocking intensity.
Middleback Field Station.
5. Regeneration of saltbush vegetation after overgrazing.
Koonamore (North East pastoral zone).

(iii) Department of Obstetrics and Gynaecology:

1. Embryo transfer and related technologies (sheep and goats).
Aim is to develop techniques for superovulation; artificial insemination; embryo collection, storage and transfer; synchronization of donor and recipient.
2. Seasonal breeding.
Aim is to develop practical ways of adjusting breeding season, principally in sheep, by investigating the factors which determine breeding season in animals.
3. Ovarian studies.
Aim is to understand ovarian function and its control by studying the physiology and biochemistry of the sheep ovary.
4. Other sheep and goat reproductive studies: timing of onset of parturition; foetal physiology; early embryonic loss.

ROSEWORTHY AGRICULTURAL COLLEGE OF ADVANCED EDUCATION:

No ruminant research being currently conducted.

APPENDIX IV.2

INTERSTATE ORGANISATIONS CONDUCTING RESEARCH RELEVANT TO
SOUTH AUSTRALIAN RUMINANT INDUSTRIES

STATE AGRICULTURE/PRIMARY INDUSTRY DEPARTMENTS:

New South Wales Department of Agriculture
Northern Territory Department of Primary Production
Queensland Department of Primary Industry
Tasmanian Department of Agriculture
Victorian Department of Agriculture
Western Australian Department of Agriculture

C.S.I.R.O. DIVISIONS:

Division of Animal Health
Division of Animal Production
Division of Entomology
Division of Food Research
Division of Plant Industry
Division of Protein Chemistry
Division of Textile Industry
Division of Textile Physics
Division of Tropical Crops and Pastures

UNIVERSITIES:

James Cook University of North Queensland, Department of Tropical and
Veterinary Science
La Trobe University, School of Agriculture,
University of Melbourne, School of Agriculture and Forestry
University of Melbourne, School of Veterinary Science
Murdoch University, School of Veterinary Studies
The University of New South Wales, School of Wool and Pastoral Sciences
University of Queensland, Department of Agriculture
University of Queensland, Department of Animal Production
University of Queensland, Faculty of Veterinary Science
University of Sydney, Department of Animal Husbandry
University of Sydney, Faculty of Veterinary Science
University of Tasmania, Department of Agricultural Science
University of Western Australia, Faculty of Agriculture, Department of
Animal Science and Production

AGRICULTURAL COLLEGES:

Queensland Agricultural College, Lawes (Gatton)

FEDERAL GOVERNMENT BODIES AND AUTHORITIES:

Australian Bureau of Animal Health
Australian Meat and Livestock Corporation
Australian Wool Corporation
Bureau of Agricultural Economics
Commonwealth Serum Laboratories

NOTE: This list may be incomplete since several of the organisations contacted
for information did not reply.

TECHNICAL REPORTS INDEX

No.	Subject	Author/s	No.	Subject	Author/s
1	Agriculture in South Australia — A submission to the working group preparing a policy discussion paper on agriculture	Department of Agriculture	30	Proceedings of a fertilizer and salinity workshop for potato growers	C.M.J. Williams
2	The Northfield Pig Research Unit — Annual Report to pig producers 1982	Department of Agriculture	31	Wind erosion on Eyre Peninsula, 1975-1979	K.G. Wetherby W.J. Davies W.E. Matheson
3	Australian Merino Society tour of South America, 1981	B.C. Jefferies	32	Review of research centres Report to the Research Policy Advisory Committee	Department of Agriculture
4	Study Tour Report — Computer use in the Ministry of Agriculture and Fisheries (NZ)	J.H. Richardson Chief, Extension Services Division	33	The water and salt balance of the Lower Murray swamps for the 1980-81 year	R.E. Desmier G. Schrale
5	Control of <i>Heliothis punctiger</i> on field crops — Preliminary trials of fenvalerate as a substitute for DDT on field peas	P.T. Bailey G. Caon P.I. McCloud R. Britton	34	Testing of onion cultivars for dehydration	I.S. Rogers R.D. Henderson
6	Agronomic Evaluation Report — Irrigated sugar beet in the South East of South Australia	T.D. Potter D.C. Lewis	35	Cereal diseases in Victoria — Report on a visit to Victorian Crops Research Institute, Department of Agriculture, Horsham	J.A. Davidson
7	Glasshouse vegetable production in Western Europe — Overseas study tour report	Barry Philp	36	Future directions in extension	J.H. Richardson
8	Report of the Vegetable Research Conference, New Zealand	I.S. Rogers	37	Use of radio and press by farmers on Yorke Peninsula — A survey among members of the Agricultural Bureau	J.E. Both
9	An input-output model of the South Australian Dryland Farming System (1) model development	G.J. Ryland	38	Biological Sciences Report 1982-83	P.E. Madge
10	Selenium in barley and grain legumes from Kangaroo Island	R.L. Davies	39	Dairy Research Report 1982	Northfield Research Centre, Animal Industry Division
11	Research priorities in the Economics Division	Working Party to the Research Policy Advisory Committee	40	Review of bovine brucellosis and tuberculosis traceback methods in South Australia	M.A. Reid B.L. Wilson N.M. Kowalick R.C. Robinson R.C. Butler
12	Study tour of agricultural waste management practices in Southern New South Wales and Victoria	C.M. Klingberg G. Schrale P.D. Harvey P. Deinum	41	Introduction of dung beetles into South Australia 1970-1983	K.R. Henry
13	River Murray Horticultural Crop Survey 1981 — Regional summaries and statistics	G.N. Thomas B.A. Smith	42	A review of the brucellosis and tuberculosis campaign in pastoral areas of South Australia	G.B. Neumann G.C. Curran
14	A report on the Australian Cashmere Industry	S. Ellis	43	Irrigation requirements for almonds on the Northern Adelaide Plains	G. Schrale
15	Gross margins South East	N. Ward	44	Redevelopment of fruit blocks in the Riverland Region: An inter-temporal programming approach	B.R. Hansen G.T. Osborne
16	The role of SAGRIC in marketing — Working Party Report	Department of Agriculture	45	Evaluation of irrigation equipment 1. Small low-level sprinklers	K.A. Watson
17	Agriculture aspects of water management in Western Europe and Israel	M.R. Till	46	Structural changes in agricultural co-operation in Britain	D. Crabb
18	Progress report on the River Murray irrigation and salinity investigation programme	M.R. Till D.J. Plowman	47	The extent and significance of water repellent sands on Eyre Peninsula	K.E. Wetherby
19	Impact of videotex on agricultural extension — Report of a study tour to France, England, Canada and the U.S.A.	J.H. Richardson	48	A look at the Californian Pistachio Industry	I.P. Bond
20	Report on Pig Industry tour in Europe	P. Heap	49	A direction finding and telemetry system for sheep in arid zone paddocks	M.C. Willcocks K.W. Sarkies
21	Seed and pasture developments in New South Wales — Report of a study tour	R.S. Martyn	50	Sheep husbandry in South Australia	B.C. Jefferies
22	Proceedings of the Ovine Footrot In-service Training Course	M.J. Riley	51	The recognition and treatment of dryland salinity	Ed. W.F. Matheson
23	Report on workshop — Research priorities for the cereal/sheep zone — A farmer's point of view	R.B. Wickes for Research Policy Advisory Committee	52	An input-output mode of the Southern Australian dryland farming system (2) Systems design and database	G.J. Ryland M.A. Petty R.I. Inglis
24	Damage to livestock caused by domestic dogs in Adelaide's urban fringe	Vertebrate Pests Control Authority	53	Biennial Report to pig producers 1984	Northfield Pig Research Unit
25	Agriculture in the South Australian economy	Economics Division	54	Report on apricot collecting expedition to Syria and Turkey	F.J. Gathercole
26	A study tour in Europe with emphasis on nutrition of horticultural and ornamental crops	J.B. Robinson	55	The commercialization of seeds of new cultivars of pastures and crops produced by publicly funded breeders in New Zealand	D.C. Ragless
27	Report of a six-month simulation of a prestel-standard videotex data storage and retrieval system	M. Allison I. Graham	56	A report on study tour of pea improvement work in USA and Europe, April-May, 1983	S.M. Ali
28	Report on a visit to the Federal Republic of Germany for the XXIst International Horticultural Congress, Hamburg	R.L. Wishart	57	Gross margins for agricultural enterprises for Yorke Peninsula and the Mid North	R. Edwards
29	Biological Sciences Group — 1981-82 report	Plant Industry Division	58	Merino strains in crossbred prime lamb production — Preliminary findings	D. Phillips A. W. Singh E. A. Dunstan