DEPARTMENT OF AGRICULTURE AND FISHERIES, SOUTH AUSTRALIA

Agronomy Branch Report

REPORT OF VISIT TO CHINA FOR THE
PEKING AGRICULTURAL MACHINERY EXHIBITION
OCTOBER - NOVEMBER, 1978

G.D. Webber,
Principal Agronomist

Report No. 105
1. INTRODUCTION

1.1 Background to visit

1.2 China
   1.2.1 General comment
   1.2.2 Population
   1.2.3 Climate
   1.2.4 The economy and development plan
   1.2.5 The 10 year (1976-1985) economic plan

2. PROGRAM FOR THE VISIT

3. THE AGRICULTURAL MACHINERY EXHIBITION
   3.1 Background
   3.2 Australian Exhibitors
   3.3 Australian Personnel at the Peking Exhibition

4. SEMINARS
   4.1 General
   4.2 Dryland Farming Seminar
      4.2.1 Presentation and Aids
      4.2.2 The participants
      4.2.3 Seminar papers
      4.2.4 Slides details - used in conjunction with Seminar Papers

5. VISITS AND OBSERVATIONS
   5.1 Chinese Agricultural Communes
      5.1.1 The Abaian-Chinese Friendship Commune
      5.1.2 The Logochi Peoples Commune
   5.2 General Visits
      5.2.1 The Great Wall of China
      5.2.2 The Ming Tombs
      5.2.3 The Palace Museum
      5.2.4 Other visits
   5.3 Observations of Agriculture in the Peking Region
   5.4 Train Journey from Peking to Kwangchow

6. COMMENTS

APPENDIX 1: China and its Provinces
2: Peking
3: Display Plan of Australian Exhibit
4: Media report of exhibition

ATTACHMENT 1: Seminar Papers
2: Slide details used in conjunction with Seminar Papers
INTRODUCTION

1. Background To Visit

The Department of Trade and Resources accepted on behalf of the Australian Government an invitation from the People's Republic of China to participate in the first Agricultural Machinery Exhibition to be staged by the Chinese for Foreign Countries.

Behind the decision to hold the Exhibition is the recently proclaimed policy of the Government of the People's Republic of China to implement a comprehensive agricultural modernisation programme embracing all aspects of agriculture, animal husbandry, forestry and fisheries.

As a first step in this direction the Chinese wished to provide their buyers and end-users with an opportunity to examine a wide range of specialised agricultural machinery and to engage in technical discussions with countries which have already built up a high degree of technical expertise in these fields.

With this in mind they decided to organise an Agricultural Machinery Exhibition of nations that they considered to have equipment and/or expertise of particular interest to them.

Participation in the Exhibition was therefore strictly by invitation and nations invited to participate were:

- Australia
- Canada
- Japan
- Britain
- F.R. Germany
- Switzerland
- Denmark
- Italy
- France
- Sweden
- Netherlands
- Romania

The Australian Government accepted the invitation and invited interested companies to display a wide range of agricultural equipment.

It is an accepted practice in most centrally-planned economies and particularly in China to hold seminars/technical discussions/lectures in conjunction with trade exhibitions. For this particular exhibition the Chinese said they expected all participating nations to present seminars on subjects in which their expertise is widely recognised.

In this case the Chinese authorities invited Australia to present seminars in subject areas where our expertise is internationally acknowledged. These areas were sugar cane production, dryland farming, broad-acre farming and animal husbandry. South Australia was invited to participate in this seminar programme, and because of its experience and expertise in areas of dryland farming technology was nominated to deal with this topic.
1.2 China

1.2.1 General comment

China is the third largest country in the world after the
Soviet Union and Canada. It has a land area of 9.6 million square
kilometres (compared with Australia 7.7 million square kilometres).
(See Appendix 1.)

Two thirds of the country consists of mountains and deserts.
It has three major topographical areas:

1.2.1.1 The northern region - includes: Sinkiang, Inner
Mongolia, Heilungkiang. The area consists of mountain
ranges, plateaus, low-lying basins, deserts.

1.2.1.2 The western region - includes: Tibet, Tsinghai,
Western Szechuan - mainly high plateaus (4 000 m in
Tibet) and contains some of the highest mountains in the world.

1.2.1.3 The east, south-east and north-east regions - consist
of fertile river valleys, low mountain ranges, a loess
plateau in the north, limestone area in the south.

China has five main river systems all flowing from west to east.
They are:

- Amur River (North-West) - 4000 km long - forms part of border
  with USSR.
- Yellow River (North) - nearly 5000 km long.
- Huai River (Central) - susceptible to flooding.
- Yangtse River (Central) - over 6000 km long.
- Pearl River (South) - is really a network of three rivers.

1.2.2 Population

Approximately one quarter of the world's population lives in
China. While there are no reliable statistics available, foreign
observers estimate the population at 900-950 million. (The Chinese
official quote is less than this.)

The population is concentrated in the eastern half of the
country particularly on the fertile plains of the Yellow and Yangtse
River valleys and delta areas (the great Northern Plain).

The west and north-west regions of China are sparsely populated.

The main cities are Peking (7-8 million), Shanghai (10 million)
and Tientsin (4 million), and there are 14 other cities with populations
exceeding 1 million.
1.2.3 Climate

Because of its size, the climate varies considerably from north to south, and there are big variations in temperature and rainfall.

The northern half of China lies in the temperate zone with low annual rainfall (concentrated in the summer) and long, dry extremely cold winters.

The southern half is mostly sub-tropical with high average rainfall.

Temperature and Rainfall at some Selected Centres

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean Temperature °C</th>
<th>Mean Annual Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>January</td>
<td>July</td>
</tr>
<tr>
<td>Harbin</td>
<td>-20°C</td>
<td>20°C</td>
</tr>
<tr>
<td>Peking</td>
<td>-5°C</td>
<td>25°C-30°C</td>
</tr>
<tr>
<td>Shanghai</td>
<td>5°C</td>
<td>25°C-30°C</td>
</tr>
<tr>
<td>Canton</td>
<td>15°C</td>
<td>30°C</td>
</tr>
</tbody>
</table>

1.2.4 The Economy and Development Plans

China's economy is basically agricultural with 75-80% of the workforce engaged in this sector. Agriculture is regarded by the leadership as the foundation of the economy. However, China also has extensive mineral resources and the industrial sector has expanded rapidly. The major industries include coal, iron and steel, petrochemicals, machine building, textiles and defence equipment. But much of China's industrial potential has yet to be realized.

There has been much stress on self reliance in their economic development and the model production brigade "Tachai" and the model oilfield "Taching" have been held up as examples for the rest of the country to emulate.

A major change in policy however, has been noted since 1978 and it is clear that China is now prepared to import modern technology from abroad to speed up its industrial development.

1.2.5 The 10 Year (1976-1985) Economic Plan

The 10 year economic plan announced in March this year, sets out specific targets to be achieved by 1985 in China's big modernisation
programme. These targets are:

**Agriculture**
- 4-5% annual increase in agricultural output over next 8 years.
- 400 million tonnes of grain per annum by 1985, (present production estimated at 278-285 million tonnes).
- 35% mechanisation in all major processes of farming.

**Industry**
- 10% annual increase in industrial output over next eight years, and for annual steel production to reach 60 million tonnes by 1985 (present production estimates at 25 million tonnes).
- 120 large-scale projects, including 10 iron and steel complexes, 9 non-ferrous metal complexes, 8 coal mines, 10 oil and gas fields, 30 power stations, 6 trunk railways and 5 major harbours.

**Infrastructure**
- Transportation to be improved to facilitate movement of goods and raw materials (by improved railways, roads, inland water transport and ports).
- Increase level of power to supply requirements of industry and agriculture (with particular emphasis on forms other than thermal e.g. hydro-electricity, wind, solar and nuclear power).

* A large percentage of the land is suitable for cultivation, maximum yields must be obtained through improved technology as well as traditional intensive cultivation techniques, if China is to reach its target of 600 million tonnes of grain a year by 1985.
- China aims to achieve self-reliance in food production and only import commodities such as wheat and sugar to meet shortfalls when they occur.
- Because almost all arable land is used for crops, animal production is restricted predominantly to marginal land in areas such as Inner Mongolia, Sinkiang and Tibet.
The principal crops are:

**Rice:** which is the most important crop, and is grown mainly in the southern part of China under a multiple cropping system. But there is also some rice production in the north where cropping systems and irrigation permit.

The 1977 rice production is estimated at 126.5 million tonnes (source U.S.D.A.).

**Wheat:** is the second most important grain crop, and it is grown predominantly in the northern areas although there is some wheat production in the south as part of multiple cropping programmes (often with rice).

The 1977 production is estimated at 40.3 million tonnes (U.S.D.A.).

**Sugar:** is grown in the southern provinces of China.

Production in 1976 was estimated at 4.4 million tonnes (P.A.O.), but in 1977 production is thought to have decline.

**Other Crops:**

Other important food crops are vegetables (very large areas are intensively cropped to vegetables near the main cities), millet, barley, cove, kaoliang (sorghum), soybeans.

Industrial crops include cotton, tobacco, ramie, hemp, jute.

**Technological Inputs**

**Water Control**

Water conservation, irrigation and flood control have always been very important in Chinese agriculture.

The total irrigated area is now estimated to be 48 million hectares, i.e., nearly half the cultivated area.

However, in many irrigation projects lack of proper drainage and some waterlogging problems have occurred.

**Fertilisers**

While organic fertilisers have always been used in Chinese agriculture, the use of chemical fertilisers is a more recent development.
In addition to many small plants producing mainly nitrogenous fertilizers built in the 1960s, China has recently purchased 13 synthetic ammonia-urea plants, 6 of which had come on stream by mid-1977.

Domestic production of phosphate and potassium fertilizers has been limited, and nitrogenous fertilizers have received the major emphasis in production and imports, thus making it difficult to achieve a satisfactory balance between these three inputs.

Mechanisation of Agriculture

This is a high priority for the Chinese Government, but although significant progress has been made in the production of tractors and implements, agricultural mechanisation is still at an early stage of development.

Under the 10 year Economic Plan, China is aiming at 55% mechanisation in all the major processes of farm work by 1985.

Domestic production is concentrating on tractors, walking tractors, diesel engines and irrigation equipment.

China is interested in importing foreign technology to upgrade its farm machinery industry and has this year sent several farm machinery delegations to Europe, U.S.A., Canada and Australia, and the main effort has been the organisation of this Peking Multinational Agricultural Exhibition.

Land Reclamation

In order to increase grain production to 400 million tonnes a year by 1985, China needs to increase the area of land under cultivation, and plans to reclaim some 13 million hectares of waste land by 1985 (border regions, mountainous areas, along sea coasts and around lakes).

Hellungklang province has already reclaimed over 4 million hectares of marginal land and plans to reclaim another four million hectares by 1985.
The Industrial Sector

Manufacturing and Mining

While industrial production has increased substantially since 1949 with the establishment of major new plants producing both industrial and consumer goods. China remains comparatively undeveloped in relation to the country's resources, population and ambitions.

Oil and gas

The oil industry is a key growth industry for China and it has received heavy investment from the State and in return has shown a growth rate of over 20% in most years.

The domestic demand (for transport and industry) is rising, and exports of oil are also increasing to help finance imports of plant and technology for China's modernisation programme.

China now sees the rapid development of offshore resources as essential for further growth.
PROGRAMME FOR THE VISIT:

     (Monday)  Depart Sydney for Tokyo.

October 17, 1978  Arrive Tokyo International Airport, Narita.
     (Tuesday)  Overnight Tokyo.

October 18, 1978  Depart Tokyo for Peking.
     (Wednesday)  Arrive Peking Airport - Transfer to Friendship Hotel.

October 19, 1978  Peking - Visit Machinery Exhibition.
     (Thursday)  - Introduction to Seminar Interpreter.

October 20, 1978  Peking - a.m. Exhibition
     (Friday)  - p.m. Preparation of Seminar.

October 21, 1978  Peking - a.m. Inspect Seminar Rooms, Attend
     (Saturday)  session of 1st Seminars presented
                 by Dr. P. McInnes & Mr. C. Sturgess.
                 - p.m. Exhibition - Pickup slides, films
                       etc. for Seminars.
                 - p.m. Prepare materials for Seminar.

October 22, 1978  Peking - a.m. Set up slides, charts, films in Seminar
     (Sunday)  Room.
                 - p.m. 1st Seminar on dryland farming.

October 23, 1978  Peking - a.m. 2nd Session of Seminar on Dryland Farming.
     (Monday)  - p.m. 3rd Session of Seminar on Dryland Farming.

October 24, 1978  Peking - a.m. Exhibition
     (Tuesday)  - p.m. Inspect local agriculture in Peking region

October 25, 1978  Peking - a.m. Special meeting with officers of
     (Wednesday)  Ministry of Agriculture.
                 - p.m. Visit city of Peking.

October 26, 1978  Peking - a.m. Local inspections.
     (Thursday)  - p.m. Commune visit - cancelled due to wet weather.
October 27, 1978
(Friday)
Peking - Attend Seminar of Mr. S.T. Smith (W.A.)
- Technical Visit to Automobile Factory.

Evening - Opera/Ballet - by Chinese Operat & Ballet Co.

October 28, 1978
(Saturday)
Peking - Visit the Albanian-Chinese Friendship Commune.
- Australian Embassy Social Evening.

October 29, 1978
(Sunday)
a.m. - Visit Great Wall of China and Ming Tombs.
p.m. - Exhibition - Official visit by Chairman Hua vice premiers and other officials.

October 30, 1978
(Monday)
Visit the Legoshi Peoples Commune, East of Peking.

October 31, 1978
(Tuesday)
- Attend Exhibition.
- Visit Commune for Agricultural Machinery Demonstration.

Depart Peking by Train.

November 1, 1978
(Wednesday)
Travel via Chengchow.

November 2, 1978
(Thursday)
Arrive Kwang Chow (Canton)
Travel to Louu (Border)
p.m. - Arrive Hong Kong.

November 3, 1978
(Friday)
Hong Kong - Confirm airline tickets etc.
Depart Hong Kong for Sydney.

November 4, 1978
(Saturday)
Arrive Sydney.
Travel to Adelaide.
3. THE AGRICULTURAL MACHINERY EXHIBITION

3.1 Background

The Peking Foreign Agricultural Machinery Exhibition was the first trade exhibition organised by the People’s Republic of China for foreign countries. It was also the first multinational trade exhibition held in China. The only previous occasion on which Australian goods have been exhibited in China was at the Australian Exhibition in 1974.

The announcement of the Exhibition coincided with a proclamation by the People’s Republic of China of a comprehensive agricultural modernisation programme and the Exhibition was seen as a first step in this direction.

Participation in the Exhibition was by invitation only and 11 other countries took part besides Australia.

Generally the stands of all exhibitors were most impressive and a very wide range of machinery for almost every agricultural enterprise was represented. It was indeed a first class exhibition by world standards. The Australian stand was well presented and had a good range of agricultural equipment and machinery which was well presented.

A total of 60 pieces of machinery weighing about 400 tonnes, was on display in the Australian stand - the largest consignment of exhibits ever shipped by the Department of Overseas Trade to a display. Australia’s display area covered an area of 2100 square metres.

The machinery displayed included tractors, disc ploughs, scarifiers, combine seeders, airflow seeder, fodder conservation equipment, pumping and irrigation equipment, windmills, wind driven generators, a range of sheep and cattle handling equipment, sheep shearing machines, wool handling equipment, sugar cane harvester and other sugar cane handling equipment.

Australia was fortunate to have one of the best locations at the exhibition, immediately inside of the main entrance gate. Some of the largest displays at the exhibition were from Japan, Italy and West Germany.

There were two preview days (on October 18 & 19), prior to the official opening of the exhibition.

The exhibition was officially opened on October 20, and was open each day until the closing date of November 3.

One of the highlights of the exhibition was an official inspection by Chairman Hua Kuo-Feng, a number of vice premiers and senior government officials on Sunday, October 19. The Chairman and his party inspected all stands in a 2 hour visit, which was seen as emphasising the importance with which the Chinese Government puts on its agricultural mechanisation and modernisation programme.
3.2 Australian Exhibitors

COMPANY NAME AND ADDRESS

Alfarm Industries, ALBURY, N.S.W.
Chamberlain John Deere Pty. Ltd., WELSPool, V.A.
Conner Shoe & Co. Pty. Ltd., SUNSHINE, Vic.
The Dunnite Electrical Company, OAKLEIGH, Vic.
The Farmers & Graziers' Co-op. Co. Ltd., SYDNEY, N.S.W.
Layne and Bowler Pump Company, FAIRFIELD, N.S.W.
Napier Grasslands Pty. Ltd., TAREE, N.S.W.
Toft Bros. Industries Ltd., BUNDABERG, Qld.
Toowoomba Foundry Pty. Ltd., TOOWOOMBA, Qld.
Transvia Corporation Pty. Ltd., SEVEN HILLS, N.S.W.

PRODUCTS ON DISPLAY

Agricultural machinery.
Agricultural tractors and tillage equipment.
Agricultural machinery.
Wind powered electricity generators, alternators and portable electricity generators.
Sheep and cattle handling equipment, electric fencing, drenching equipment.
High and low lift turbine pumps for industrial, agricultural and civil applications.
Agricultural machinery.
Sugar cane harvesting, transport and agricultural equipment.
Windmills, water storage tanks, pumps and pumpheads, self-propelled irrigators and irrigation equipment, water troughs.
Agricultural aircraft used for fertilising crops and for spraying to control insects and crop disease.
Travelling irrigators.
Sheep shearing and wool handling equipment.

3.3 Australian Personnel At The Peking Exhibition

AUSTRALIAN GOVERNMENT

Mr. R. Waldron (Ted), Director,
Mr. R. Duffer-Hyams (Bob), Deputy Director-Marketing,
Mr. C. Spendlove (Cyril), Deputy Director-Exhibitions.

Department Trade and Resources.
Mr. R. Rutkowski (Richard),
Exhibitions Officer,
Mr. A. Tilly (Ron), Stand Supervisor,

**EXHIBITING COMPANIES**

Mr. L. Mulkearns, Managing Director,
Mr. M. Cahill, Export Manager,
Mr. E. Smith, Area Manager,
Mr. F. Griffiths, General Manager,
Mr. M. Grove, Export Controller,
Mr. E. Patterson, Works Manager,
Mr. H. Tams (Harry), Sales Manager,
Mr. J. Kent, Sales Manager,
Mr. A. Boyd (John),
Mr. J. Trelau (John), Marketing Manager,
Mr. J. Jaeger,
Mr. B. Moote, General Manager,
Mr. B. Boyd (Col), Chairman,
Mr. C. Borrill, Merchandise Manager,
Mr. F. Byrke, Manager,
Mr. J. Brimowski (Gillis), Director,
Mr. D. Daniell (David),
Agricultural Consultant,
Mr. P. West, Manager,
Mr. R. Bartian, Executive,
Mr. J. Allen (John), General Manager,
Mr. L. J. Court (Lan), Marketing Manager,
Mr. C. Powell (Gordon), Regional Manager,
Mr. J. Kong (James), Executive,
Mr. C. Collidge, Overseas Marketing Manager,
Mr. C. Forrester (Gil), Engineer,
and Mrs. B. Forrester

Department Trade and Resources

Department Trade and Resources

Alfarm Industries

Alfarm Industries

Chamberlain John Deere Pty. Ltd.

Chamberlain John Deere Pty. Ltd.

Chamberlain John Deere Pty. Ltd.

Chamberlain John Deere Pty. Ltd.

Connor-Shea & Co., Pty. Ltd.

Connor-Shea & Co., Pty. Ltd.

Dunlite Electrical Co.

Dunlite Electrical Co.

Dunlite Electrical Co.

Farmers & Graziers' Co-op. Co. Ltd.

Farmers & Graziers' Co-op. Co. Ltd.

Layne & Bowler Pump Co.

Napier Grasslands Sales Pty. Ltd.

Napier Grasslands Sales Pty. Ltd.

Simpson Pope Ltd.

Simpson Pope Ltd.

Sunbeam Corporation Ltd.

Toft Brothers Industries Ltd.

Toft Brothers Industries Ltd.

Toft Brothers Industries Ltd.

Tooowoomba Foundry Pty. Ltd.

Transavia Corporation Pty. Ltd.
SEMINAR SPEAKERS

Mr. G.D. Webber, Principal Agronomist, South Australian Department of Agriculture and Fisheries

Mr. S.J. Smith, Deputy Director, Western Australian Department of Agriculture.

Dr. P. McInnes, Research Director, Research Centre, Department of Agriculture, Orange, New South Wales.

Mr. G. Sturgess, Director, Sugar Experimental Stations, Queensland.

Mr. W. Devrell, Export Manager, Commonwealth Sugar Refineries, Queensland.
4.

SEMINARES:

4.1 General

The technical seminar programme was an integral part of the exhibition. As previously mentioned the Chinese asked the participating countries in the trade exhibition to hold technical seminars to discuss the relevant technology with their selected technical people. All countries presented seminars on a very wide range of subjects.

The Chinese Government requested Australia to present seminars on:

- sugar cane cultivation,
- dryland farming,
- broadacre agricultural production,
- sheep husbandry.

4.2 Dryland Farming Seminar

The Chinese technologists attending this seminar came from the northern part of the country - the provinces of Kirin, Helfunghsin, Honan, Ningia, Liaoning, Kansu and Hopei. They were particularly interested in our production technology viz.:-

- Mechanisation of all farming practices,
- tillage methods - particularly the concept of shallow cultivation for semi-arid areas and the practice of short and long fallow,
- seeding methods and seeding machinery,
- soil conservation practices,
- seed and seed harvesting,
- Nitrogen - fertilizer responses in dryland areas and the biological fixation of nitrogen.

4.2.1 Presentation and aids

The seminar presentations were over three half-day sessions with the same group of people in a seminar room at the Friendship Hotel. The seminar paper had been forwarded several weeks prior to our departure. Most of the participants had photocopies of the paper in English and the interpreter had a hand-translated summary in Chinese.

The format of the seminar was for the participants to sit around a line of long low tables, well supplied with Chinese tea. There was a seminar officer as Chairman for each seminar and strict protocol was observed in matter of introductions and in the general conduct of the meeting.
The leader was looked to at times to start proceedings and normally even asked the opening questions at each session.

The seminar paper was presented with the aid of sixty-five coloured slides, some charts and a blackboard. The slides were used during each segment to illustrate all points particularly to show production data, the types of plants and practices in our farming system and the range of machinery and equipment used. (See Attachment 2).

The South Australian dryland farming film "Food from the reluctant earth" had been translated into Mandarin by the Department of Trade and Resources.

This proved extremely popular with the seminar groups and they asked for it to be repeated in the final seminar session.

The group appeared extremely interested in each session and came ready to ask a number of questions from the previous session.

The leader requested a package of the handout material from the Australian display stand at the exhibition for each member. He was most appreciative for the copies of "Farming Systems in South Australia", "Pasture Seeds from South Australia" and "Livestock Farming in South Australia. The Chairman looked after the distribution of all materials to the participants.

4.2.2 The participants

The participants in the seminars were mainly agricultural engineers (graduates) from a number of institutions including the Institute of Agric Mechanisation of the Chinese Academy of Agriculture in Peking. There were representatives present from a number of northern provinces viz., Heilung-Kans, Kirin, Ning-sia Xin Autonomous Region, Liasong Kansu and Hopei provinces. The major participants were:

- Mr. Hsu Hsueh-chuen, Senior Engineer of Research Institute of Ag. Mech. of Chinese Academy of Agriculture (leader).
- Mr. Li Shu-tang, Senior Engineer of Research Institute of Ag. Mech. of Chinese Academy of Agriculture.
- Mr. Piao Tai-chen, Engineer of Research Institute of Ag. Mech. of Kirin Province.
- Mr. We Chieh-hsian, Engineer of Research Institute of Mechanised Farming of Kirin Academy of Agriculture.
Mr. Wu Pao-chu, Head of Agricultural Management Division of Shih San State Farm of Heilungkiang Province.

Miss Su Kuan-fan, Engineer of Research Institute of Ag. Mech. of Heilungkiang Province.

Miss Yu Hsiu-chen, Engineer of the Bureau of Ag. Mech. of Honan Province.

Mr. Kao Chin-yuan, Engineer of Research Institute of Ag. Mech. of Honan Province.

Mr. Shih Tsin, Engineer of Research Institute of Ag. Mech. of Liaoning Province.

Mr. Chen Chao-fang, Engineer of Research Institute of Ag. Mech. of Kansu Province.

Mr. Chao Chin-tai, Engineer of Nanking Institute of Soils of Chinese Academy of Science.

Mr. Tao Li-hou, Interpreter of North China Institute of Agricultural Mechanization.

Five additional technical officers attended the last two seminar sessions.

4.2.3 Seminar papers

See Attachment 1.

4.2.4 Slide Details - Used in conjunction with Seminar Papers. See Attachment 2.
5. VISITS AND OBSERVATIONS:

5.1 Chinese Agricultural Communes

China is basically a rural society and it is suggested 75-80% of the population live or work in the rural areas.

The great majority of agricultural production comes from the communes, and the commune is the basic unit of organisation in rural China. There are some 50 000 of these in China.

In addition to the communes, there are also some State Farms (around 2 000) which are mainly in the more remote areas which were only sparsely utilized prior to 1949. The State Farms normally are set up for specific purposes e.g. land reclamation (particularly in the north-east in Heilungkiang), introduction of new technology, utilisation of land in strategic areas (e.g. Sinkiang).

Because of their role as a pace-setter in agriculture, they usually receive heavy investment from the State in the form of agricultural machinery, fertilisers etc.

The communes vary considerably in size and have populations of up to 50 000 people in the Canton area down to less than 20 000 in the northern regions.

The commune is the basic political and economic unit of rural society in China. Each commune is further subdivided into 12 or more production brigades each of which is responsible for several smaller production teams. A production team is made up of several households which may in fact be a small village.

The production team is the basic accounting unit. It organises production, owns simple tools, seed, etc., receives profits and bears losses, and pays its members.

The production brigade co-ordinates the work of production teams, and organises enterprises owned jointly by the production teams, e.g., walking tractors, trucks, brick kilns, livestock and poultry farms.

The commune co-ordinates the work of the production brigades and organises major projects like acei and water conservation irrigation systems, machinery repair shops, tractor stations, seed farms and veterinary centres.

While the Communist Party Cadres have their influence within the commune management, and certain directives and quotas come from the State, the day to day, and to a considerable extent the overall running of the farming operations of the production teams and production brigades is a matter for local decisions.
Among other things the communes are businesses which have expenses and sell goods for money. Their aim is to have larger incomes than expenditures. The payment of money to commune members for the work they do is dependent ultimately on the division of the surplus of income over expenditure, within the commune as a whole, or even within particular production brigades or particular production teams making up the commune. Capital expenditure competes with personal living expenses in a manner very similar to farming enterprises in Australia. Although there is some centralised supply of credit available for major works on communes, the overall proportion of capital applied to agricultural production is small compared with secondary industry.

There has been some encouragement also for rural communes to invest their capital in manufacturing facilities, and near Peking the communes visited had significant secondary industries as well as their agricultural enterprises. There is still great scope for investment of capital in labour-saving farm machinery.

5.1.1 The Albanian-Chinese Friendship Commune

Two visits were made to this Commune, the first to inspect the operations of the property and the second to attend a large farm machinery demonstration associated with the exhibition.

The Commune covered an area of some 50 square kilometres, had a population of 12,000 people from 6,800 families mainly housed in 27 villages spread across the commune.

It was like most properties on the Great Northern Plain, the land was flat and all under irrigation. The main agricultural production enterprises were:

5.1.1.1 a very large dairy unit consisting of 3,700 cattle, mainly Friesians. These were large animals with good frames, and were classed by the European Agricultural people present as excellent stock with very good production levels.

5.1.1.2 rice, wheat and corn were the main grain crops. At the time of visiting the corn and rice was harvested, and winter wheat was being sown.
5.1.1.3 ducks - there was a very large population of what were claimed to be the authentic Peking Ducks. These were run around a huge man made pond. These ducks were force fed and this process was demonstrated to the visitors.

As well as agriculture, the commune had at least two large enterprises:

- A Foundry, and
- A Machinery shop

5.1.2 The Longch’o Peoples Commune

As is usual this visit started with a tea ceremony and the leader of the commune welcomed the visitors, and proudly talked about the commune which Chairman Mao had personally visited in 1958.

The total area of the commune was 53.9 square kilometres, of which 33sq km was cultivated.

The commune had a population of 48 000 people, 11 000 families, living in 11 villages. They were divided into 21 production brigades, and 50 work teams.

As well as the agricultural pursuits, there were 23 small factories on the commune which mainly produced components or carried out work for larger industrial factories in the Peking area. Because of its proximity to Peking, the commune's main production was vegetables.

The areas of vegetables Chinese lettuce, beans, potatoes, and sugar beet were irrigated in smallish bays which seemed very productive.

In 1977 the commune produced 104 million kilogram of vegetables, and 30 700 pigs and 280 000 ducks were marketed.

The other main crops were rice and wheat. Rice has just been harvested and fields sown with winter wheat which will be harvested in June.

This commune was relatively well mechanised and had large number of lorries for transporting goods to market in Peking, and a number of 4-wheel and hand tractors.

An inspection was made of one village including the local shops, factories and a visit to a typical commune home.
5.2 General Visits

A number of visits were arranged by the Chinese authorities for the visitors. (See Appendix 2). These included visits to-

5.2.1 The Great Wall of China

The Great Wall is one of China's (and the world's) ancient architectural wonders. It winds its way along steep ridges and deep valleys for 12,000 Li (6,000 kilometres) hence its name the Wan Li Chang Cheng (Ten Thousand Li Long Wall).

The building of the wall was an amazing project to say the least, it consists of large stone slabs at the base and the upper part is paved with large bricks.

Surmounting the wall are ramparts and battlements, each one metre high. Two-storeyed block houses are built at regular intervals of a few hundred metres. The average height of the wall is 7.8 metres; the average width at the top is 5.8 metres.

In the east the Great Wall begins at the Shanhai Pass in Hebei Province and runs westward to the Chilayu Pass in Shanxi Province, crossing seven provinces and autonomous regions.

The People's Government restored a section of the Great Wall to its original grandeur at Pa Ta Ling, the area inspected.

5.2.2 The Ming Tombs

After the Ming Dynasty moved its capital to Peking (1403-1644) 13 Ming emperors had their tombs built in the north-west suburb, about 50 kilometres from the city centre of Peking. The sites of these tombs, Shih Son Ling (13 Imperial Tombs), covers some 40 square kilometres.

Cheng Ling is the tomb of the third emperor Chu Li, of the Ming Dynasty.

Ting Liang is the tomb where Emperor Chu I-chun (who reigned from 1573-1620) and his two empresses were buried. This is the first underground palace at the Ming Tombs that has been excavated.

The 27 metre deep underground Palace comprises five halls, the front, central, rear, right and left halls. Their total floor space is 1,152 square metres.
5.2.3 The Palace Museum

The Palace Museum is the imperial palace of the Ming and Qing dynasties, popularly known as the "Purple Forbidden City". It is the most complete architectural grouping of buildings with a history of over 500 years in China today.

In 1406 (the 4th year of the reign of the Ming Emperor Yong Lo) 200,000 labourers were employed to work on its construction which took 15 years. Rebuilding and expansion were undertaken many times. It covers a total area of 720,000 square metres of which the built-up portion is 150,000 square metres. Altogether it contains over 9,000 rooms. It is surrounded by a 10 metre high wall which is in turn enclosed by a 22 metre wide moat. The layout of the palace is geometric and well balanced, all its main halls being located on the axis of the old city of Beijing. The palace is in the unique style of ancient Chinese architecture.

The Palace Museum houses a rich collection of historical and cultural relics and priceless objects of art. It also houses stone drums of the Zhou Dynasty and a glazed nine-dragon screen which is vividly executed.

Before liberation, the palace was badly neglected, over-grown with weeds and with the red walls peeling. After thorough restoration, the Palace Museum was restored to its ancient splendour. It is now a most popular tourist attraction for both Chinese and overseas visitors.

5.2.4 Other visits

- The underground railway - an efficient subway system which runs the full length of the main thoroughway through Beijing.
- The Peking Jeep Factory.
- The underground Civil Defence system.
- Tian An Men Square and the Tomb of Chairman Mao Tse-tung.
5.3 Observations of Agriculture in the Peking Region

The city of Peking is somewhat like a big village, and it is somewhat difficult to really determine where the city begins and ends.

Agriculture, particularly vegetable and fruit growing, but also to some extent rice, maize and wheat growing extends well in towards the centre of Peking.

The Friendship Hotel, where the participants of the exhibition stayed is in a region of the outer area of the city which seems to be divided about half and half between buildings and agriculture.

The National Agricultural Exhibition grounds were several miles away also on the outskirts of the city.

This meant that each visit to the exhibition involved travelling through the very intensive semi-rural areas.

It was therefore possible to observe in transit on a day to day basis, and by inspection on foot around the hotel area a wide range of agricultural practices.

The use of organic fertilizers (animal and human excreta) together with crop residues, tree leaves and soil for making compost is a key feature in farming operations in this particular area.

The rapidity with which one crop was harvested and the land returned to production is quite spectacular.

Another particular feature was the transformation of much of the vegetable area in the vicinity of the hotel, during the course of our stay. Peking winters are extremely cold, much colder than anything experienced anywhere in Australia. However, many of the vegetables used in Peking in winter are produced under plastic and some under glass. Many plastic greenhouses were erected during the course of our stay. Another practice for reducing the severity of winter weather is the erection of windbreaks at quite frequent intervals, sometimes as little as 10 metres apart. These are erected using a lattice of thin bamboos which in turn support maize or sorghum stalks, or rice straw. Another practice seen was the building of rammed earth walls, to which a lean-to plastic shelter is erected over the growing crop. The plastic in some instances was also covered with straw matting.

Also of considerable interest is the method of transport of agricultural products. The roads in the near city rural areas are packed with trucks, converted hand tractors fitted with carts, horse and donkey drawn carts, converted pushbikes and hand carts.
The return journey by train to Hong Kong was undertaken by several of the Australian delegation at different times of departure, because it provided an opportunity to see a significant cross section of the main agricultural areas of China.

The journey from Peking to Kwangchow is over 1000 km and took almost 36 hours. It provided the opportunity to observe in daylight a section of China from Chenghou to Changsha, and then a section of the southern country north of Canton through to Lavor on the Hong Kong border. The countryside scenes were generally much different to the agriculture immediately in the Peking region. Rice was the predominant crop grown, followed by wheat and cotton.

The first 400-500 km of the journey was travelled at night and it was evident that after an initial period of travelling through the flat irrigated plain, there was a significant area of hilly country. Most of the land observed next day had been in rice which had been harvested and some was still in fields on the edges of the irrigation bays being cut or waiting to be carted in, but the winter wheat had already been sown and had germinated.

Almost all areas were flood irrigated, and there was little natural landscape as most areas were terraced, and the rises contour furrowed to collect water for irrigation of lower lying areas.

There was certainly less mechanisation in these central areas, and much ploughing was being carried by oxen pulling single furrow ploughs. The train journey crossed several large river systems, and considerable construction of levy banks and drains were evident to overcome flooding problems.

Near midday the train entered the large city of Wuhan, after passing across the large Yangtze River. Many river steamers and junks were using the river to transport a wide variety of goods. Wuhan appeared to be an important industrial city. The rail-line passed close to several steel furnaces and other industrial manufacturing buildings. Like Peking it had a village-like appearance with vegetable gardens situated well within the city limits. After Wuhan the country mainly consisted of large flat areas which had been levelled. The rocky steeper hills being left as catchment areas and for housing of the workers. The soil appeared heavier than soils previously seen.

Near Kwangchow the countryside changed very dramatically and took on a more tropical appearance.
Tropical fruit crops, extensive areas of sugar cane, and intensive vegetable production were seen. However, rice was still the most significant crop.

Some other observations included:

The railway system seemed very efficient. While the carriages are a little outdated by our more modern railway standards, the train ran very smoothly. This was probably due to closely spaced concrete rail sleepers. The train was fully packed with people. The train after travelling over 2000 km arrived exactly on time in Canton at 7.45 a.m.

The rural workers seem to work very long hours. People could be seen going out into the fields at daybreak and later most workers seemed to be returning home when it was almost dusk.

6. COMMENTS:

The exhibition has been classified as very successful. The Hong Kong press noted Chinese officials as describing the whole event as "a complete success". (See Appendix 4)

Some 300 000 - 350 000 people from all over China attended the exhibition and a considerable amount of the machinery and equipment displayed was in fact purchased by the Chinese.

It is reported that the Chinese officials reopened the exhibition to display the equipment purchased to a further large group of technical people.

It is difficult to judge the impact of the seminar programme, but there was considerable interest at all times in the technology being presented and the participants had obviously studied the seminar papers prior to attending. It was very clear that the technologists in the Chinese society are very excited about the new policies of modernization of China and were most anxious to discuss and learn about technical agricultural developments in other parts of the world.
Machinery exhibition
a complete success

PEKING, Fri. — Peking's first international agricultural machinery exhibition, attended by senior fair officials as "a complete success", closed today after more than 300,000 people from all over China had passed through its gates.

The five-day show exhibition was so successful that the demand to see it is great, the officials told visitors, that they planned to reopen it for a period to display equipment China had purchased from the nations of the 13 countries represented.

Premier Chou En-lai and other leaders underscored the importance the government places on introducing China's farming community to advanced technology by spending nearly two hours going through the fair in the Peking outdoor area Sunday.

Efficient agriculture, producing enough to feed the country's 900 million people is one of the keys to China's modernization programme.

The fair officials said the exhibition provided a very good opportunity for Chinese scientific and industrial workers to learn about advanced technology from foreign nations. They added that the enthusiasm and enthusiasm of the exhibition visitors had "left a profound impression on the Chinese visitors".

The exhibition as a whole was prepared by the interest, starting questions and technical knowledge of the Chinese, ranging from professors of agriculture to commune members — a cross-section of people involved in farming brought in from all over the country.

The emphasis at the exhibition was on farm and construction equipment such as tractors and large trucks, and machinery ranging through tractors, ploughs, reaping machines and harvesters. There was a wide variety of small farm equipment also on show.

The fair officials said China has specifically asked for some of the machinery to be displayed, while companies had also exhibited equipment they thought would be of interest at their own bidding.

Both the officials and individual exhibitors were generally optimistic that the show would lead to further contacts and possible contracts in the future, although the full report would be of immediate interest.

Exhibitors said it was also clear that the Chinese were interested in leasing arrangements for the future production of equipment and machinery in China itself.

The officials said it would be wise to compare the makes of the various items before final decisions were made.

Exhibiting countries were: Australia, Canada, France, Germany, Italy, Japan, the Netherlands, Canada, Sweden, Switzerland and Britain.

The United States was a notable absentee, but major American companies like International Harvester, John Deere, Caterpillar and Allis-Chalmers had produced or displayed at various stands although subsidiaries are joint ventures.

United States Agriculture Secretary Bob Dole was due in Peking tomorrow to strengthen further the growing agricultural ties with China.

An important feature of the machinery exhibition was the 2000 commercial distributors and government companies for the Chinese.

One exhibitor said the four-day trade mission by his company had cost him about $125,000. "We were very satisfied with the level of interest in technical exchanges, and the interest and real business-like approach they showed," he said.
ATTACHMENT 1

SEMINAR PAPER

PEKING AGRICULTURAL MACHINERY EXHIBITION

DRYLAND FARMING

AN INTEGRATED SYSTEM OF FIELD CROP AND LIVESTOCK PRODUCTION

FOR DRYLAND FARMING AREAS

G.D. Webber,
Principal Agronomist,
South Australian Department of Agriculture and Fisheries.

October/November, 1978.
SYNOPSIS

Agricultural production in the dry rainfed areas of South Australia (annual rainfall 250-500 mm) is based on growing field crops, mainly cereals (wheat, barley and oats), in rotation with annual legume pastures, mainly Medicago spp. This farming system is called ley farming, and integrates cereal and livestock production. The legume pastures with their nitrogen fixing properties increase soil fertility, for cereal crops and supply high quality feed for large numbers of livestock.

South Australia has a Mediterranean type climate characterised by a dry summer and short winter rainfall season of 5-6 months which allows the growth of short season crops and legume pastures.

Seasonal rainfall has a low predictability, the soils are mainly alkaline, and vary from shallow rubble limestone to deep sandy soils.

Because Medicago spp. are hard-seeded, cereal crops and pastures are basically grown on an alternate year (crop-pasture) rotational system. Due to the seasonal variability hay is cut from the Medicago pastures in the more favourable seasons to carry livestock through the summer-autumn period of the less productive years. Specially adapted tillage and seed harvesting methods, techniques of livestock grazing management, and soil conservation practices have been built into the system.

The introduction of the ley farming system into South Australian agriculture has resulted in:

- Increased soil fertility and improved soil structure.
- Increased herbage growth and better dry feed in summer resulting in higher, better quality livestock production and a more stable farm income.
- Increased cereal crop yields and greater cropping flexibility.
- Better control of soil erosion, particularly when combined with contour banking in areas susceptible to water erosion.
ATTACHMENT 2

PEXING AGRICULTURAL MACHINERY EXHIBITION

SEMINAR IN DRYLAND FARMING

by

G.D. Webber

SLIDE DETAILS

1. LOCATION AND RAINFALL

<table>
<thead>
<tr>
<th>Slide No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Map of Australia - showing location of South Australia.</td>
</tr>
<tr>
<td>2.</td>
<td>Rainfall Map of South Australia.</td>
</tr>
</tbody>
</table>

2. LAND USE ZONES

<table>
<thead>
<tr>
<th>Slide No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Map showing land use zones of South Australia.</td>
</tr>
<tr>
<td>4.</td>
<td>Pastoral zone - native grass and bush steppe.</td>
</tr>
<tr>
<td>7.</td>
<td>Cereal zone - showing cropping land and pastures.</td>
</tr>
<tr>
<td>8.</td>
<td>Cereal zone - lower rainfall areas.</td>
</tr>
<tr>
<td>9.</td>
<td>Higher rainfall zone - showing fat lamb production.</td>
</tr>
<tr>
<td>11.</td>
<td>Higher rainfall zone - showing dairy cattle production.</td>
</tr>
</tbody>
</table>

3. CLIMATE

<table>
<thead>
<tr>
<th>Slide No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.</td>
<td>Chart of temperature and rainfall distribution at three centres.</td>
</tr>
</tbody>
</table>

4. SOIL EROSION AND SOIL CONSERVATION

<table>
<thead>
<tr>
<th>Slide No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.</td>
<td>Wind erosion.</td>
</tr>
<tr>
<td>16.</td>
<td>Wind erosion.</td>
</tr>
<tr>
<td>17.</td>
<td>Water erosion.</td>
</tr>
<tr>
<td>19.</td>
<td>Poor crop growth.</td>
</tr>
</tbody>
</table>
Slide No. Description
22. Arable country - contour banked,
23. Contour banks and waterways.

5. THE USE OF ANNUAL LEGUMES
24. Legume pastures - Barrel and Burr medic.
25. Subterranean clover pasture.
27. Chart of soil nitrogen increase under longer term pasture at Wyrublalts.
28. Chart showing effect of land use systems on soil structure in Northern Agricultural areas of South Australia.

6. IMPACT OF LEG FARMING ON CEREAL, LIVESTOCK AND WOOL PRODUCTION
29. Chart showing increase in cereal and livestock production from 1931-40 to 1961-70 in counties Daly, Stanely and Gawler.
30. Chart showing increase in cereal and livestock production from 1931-40 to 1961-70 for South Australia.
31. Histogram as for (29).
32. Histogram as for (30).
33. Chart showing effect of legume leys on wheat and wool production at Narrabfield Research Centre.

7. THE ANNUAL LEGUMES
34. Medic pasture.
35. Subterranean clover pasture.
36. Chart showing the growing season annual medic.
37. Harbinger medic.
38. Close up of Harbinger medic.
40. Subterranean clover pasture.
41. Clare Subterranean clover.

8. WHEAT CROPS
42. Wheat crop in head.
43. Mature wheat crop (Halberd).
44. Mature wheat crop.
<table>
<thead>
<tr>
<th>Slide No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>MACHINERY</td>
</tr>
<tr>
<td>45.</td>
<td>Disc plough</td>
</tr>
<tr>
<td>46.</td>
<td>Disc plough (Tandem)</td>
</tr>
<tr>
<td>47.</td>
<td>Cultivator (expanda-wing)</td>
</tr>
<tr>
<td>48.</td>
<td>Wide-line cultivator</td>
</tr>
<tr>
<td>49.</td>
<td>Combine drill</td>
</tr>
<tr>
<td>50.</td>
<td>Combine drill</td>
</tr>
<tr>
<td>51.</td>
<td>Wide-line combine drill</td>
</tr>
<tr>
<td>52.</td>
<td>Sowing cereal crop</td>
</tr>
<tr>
<td>53.</td>
<td>Applying pre-emergent herbicide</td>
</tr>
<tr>
<td>10.</td>
<td>LIVESTOCK GRAZING</td>
</tr>
<tr>
<td>54.</td>
<td>Sheep grazing medic pasture</td>
</tr>
<tr>
<td>55.</td>
<td>Cattle grazing medic pasture</td>
</tr>
<tr>
<td>11.</td>
<td>CONSERVED FODDER</td>
</tr>
<tr>
<td>56.</td>
<td>Baled medic hay in shed</td>
</tr>
<tr>
<td>12.</td>
<td>HARVESTING METHODS</td>
</tr>
<tr>
<td>57.</td>
<td>Harvesting clover seed</td>
</tr>
<tr>
<td>58.</td>
<td>Harvesting clover seed (replaces)</td>
</tr>
<tr>
<td>59.</td>
<td>Harvesting medic seed</td>
</tr>
<tr>
<td>60.</td>
<td>Harvesting rolled barley</td>
</tr>
<tr>
<td>61.</td>
<td>Harvesting wheat with pul-type header</td>
</tr>
<tr>
<td>13.</td>
<td>MISCELLANEOUS</td>
</tr>
<tr>
<td>62.</td>
<td>Stone picker</td>
</tr>
<tr>
<td>63.</td>
<td>Terminal silo complex - Wallaroo</td>
</tr>
<tr>
<td>64.</td>
<td>Clover seed for export</td>
</tr>
<tr>
<td>65.</td>
<td>Other agricultural exports</td>
</tr>
</tbody>
</table>
1. INTRODUCTION
   1.1 General
   1.2 Climate
   1.3 Land Use

2. THE ARABLE DRYLAND FARMING AREAS OF SOUTH AUSTRALIA
   2.1 Rainfall Is Limited
   2.2 Soils Are Variable
   2.3 Land Use Possibilities Are Limited

3. THE DEVELOPMENT OF THE DRYLAND FARMING AREAS OF SOUTH AUSTRALIA
   3.1 The Exploitative Stage
   3.2 The Impact Of The Ley Farming System

4. THE KEY FEATURES OF THE LEY FARMING SYSTEM
   4.1 Legumes Build Soil Nitrogen Levels
   4.2 Legume Leys Improve Soil Structure And Organic Matter Status
   4.3 Stability Of Production

5. THE ANNUAL LEGUMES
   5.1 Medics (Medicago spp.)
   5.2 Subterranean Clovers (Trifolium spp.)
   5.3 Legume Seed Inoculation

6. CROP ROTATIONS
   6.1 Rotations With Annual Medicago Pastures
   6.2 Rotations With Subterranean Clovers

7. SOIL PREPARATION FOR CEREAL CROPS
   7.1 Tillage Methods
   7.2 Fallowing
   7.3 Minimum Tillage
8. CEREAL CROP MANAGEMENT
   8.1 Fertilisers
   8.2 Weed Control

9. MANAGEMENT OF LEGUME PASTURE STANDS
   9.1 Sowing Legume Pastures
   9.2 Grazing Management
   9.3 Other Management Points That May Need Attention
   9.4 Legume Seed Production

10. THE INFRASTRUCTURE IN WHICH THE LELY FARMING SYSTEM OPERATES
    10.1 Rural Water Supplies
    10.2 Agricultural Machinery
    10.3 Cereal and Pasture Seed Supplies
    10.4 Fencing and Yards
    10.5 Transport, Storage and Marketing

11. SUMMARY

12. REFERENCES AND FURTHER READING

FIGURE 1: EFFECT OF LEGUME LEYS ON WHEAT AND WOOL PRODUCTION - TURRETFIELD RESEARCH CENTRE

FIGURE 2: FLOWERING AND MATURITY TIMES FOR ANNUAL MEDICS

FIGURE 3: MONTHLY RAINFALL AND TEMPERATURE DATA FROM KEY CENTRES IN THE SOUTH AUSTRALIAN CEREAL ZONE

APPENDIX 1: MAJOR CLIMATIC ZONES OF AUSTRALIA

APPENDIX 2a: AVERAGE ANNUAL RAINFALL (mm) IN SOUTH AUSTRALIA
   2b: DISTRIBUTION OF RAINFALL, SOUTH AUSTRALIA AND AUSTRALIA
   2c: RAINFALL RECORDING AT KEY CENTRES IN THE CEREAL ZONE OF SOUTH AUSTRALIA
| APPENDIX 3: | LAND USE OF SOUTH AUSTRALIA | 35 |
| APPENDIX 4: | LOCATION MAP - SOUTHERN PORTION OF SOUTH AUSTRALIA SHOWING COUNTIES DALY, STANLEY AND GWLIER IN CEREAL ZONE | 36 |
| APPENDIX 5a: | STATISTICS FOR SOUTH AUSTRALIA (1975/76) SEASON | 37 |
| APPENDIX 5b: | SOUTH AUSTRALIAN WHEAT PRODUCTION 1897-1975 | 38 |
| APPENDIX 6: | TYPICAL FARM IN THE CEREAL ZONE | 39 |
| APPENDIX 7: | A TYPICAL FEED YEAR ON A FARM IN THE CEREAL ZONE OF SOUTH AUSTRALIA CROPPING ABOUT 50 PER CENT OF ITS AREA | 40 |

* * * * *
1. **INTRODUCTION:**

1.1 **General**

A large part of the world grain production is grown on what is generally referred to as rainfed areas, i.e. irrigation is not used to grow the crops. These rainfed cropping areas vary considerably from the continental climatic regions of North America and Eastern Europe, through the tropical climatic regions, including the high plateaus of East Africa, parts of South America, India and Northern Australia to the semi-arid Mediterranean climatic regions of the world, which include Southern Australia.

The dryland farming technology adapted for these regions varies, but to a significant extent depends on the relationship between the rainfall season and the crop growth period.

The degree to which these regions could be classified as dryland farming areas also varies.

In Australia dryland farming is generally the term applied to arable agriculture which is totally dependent on rainfall as the source of moisture and where moisture is the major limiting factor in crop growth and production.

Almost all of the Australian cereal production zone is rainfed (less than 1% of the total cereal area sown is irrigated) and classified as dryland areas, and this is particularly the case in southern Australia where rainfall is of winter incidence and is variable from year to year and in its distribution in any one year.
The most suitable crops for these dryland semi-arid regions are early maturing varieties of cereal crops i.e. wheat, barley (mainly 2 row), oats and cereal rye, which flower and mature before the onset of the long summer drought period.

These cereal varieties can be classified as "spring types" as most Australian varieties have no cold tolerance and little or no vernalization requirement. They are however, normally planted in late autumn and grow through the winter and mature in late spring. They are grown over a season period typical of winter wheat. This is possible because of the mild winter conditions in southern Australia and necessary because this is the only period of sufficient rainfall for crop growth.

1.2 Climate

Australia is the world's driest continent, and of the six Australian States, South Australia has the lowest rainfall. (See Appendix A & B) More than 80% of the State receives less than 250 mm of rain per year, (the pastoral zone), 15% receives between 250 and 500mm, (the cereal zone), and the remaining 4% receives more than 500 mm (the high rainfall zone - rainfall above 500 mm is 'high' in the context of dryland farming in South Australia, but this is only moderate rainfall by world standards).

South Australia has a Mediterranean type climate, with the somewhat erratic rainfall concentrated in the cooler growing season, and this is followed by a hot dry summer. (See Figure 3) There is a big variation in annual rainfall, and droughts are common.

The State has a climate similar to that of the Mediterranean basin, North Africa and parts of Western Asia, Southern Chile, California and a portion of Southern Africa. The pattern of a dry summer and winter rainfall allows short season crops and pastures to grow.

1.7 Land Use

Rainfall mainly determines what kind of farming can be practised and South Australia can be divided into three major zones of agricultural utilisation, mainly based on rainfall divisions. (See Appendix 3)

The dry inland area (less than 250 mm annual rainfall) is the steppe or pastoral zone and have a low intensity grazing system is based on
delicate balance of utilisation and conservation of the native vegetation. The main production enterprise is sheep grazing, supplemented with some cattle.

There was a deliberate policy in the early part of this century of reducing livestock numbers in the arid and semi-arid steppe zones.

Sheep are grazed on the native vegetation at stocking rates varying from 4 to 20 sheep per square kilometre. Apart from fluctuations due to droughts, sheep numbers have remained at about two million in this area over the last 30 to 40 years.

It is important in the pastoral zone to maintain the edible shrubs in good healthy condition. This is done through light grazing and the provision of sufficient watering points. Paddocks may be spelted during good seasons so that the native shrubs can recover and the grasses reseed.

The cereal zone is the intermediate rainfall area (250 - 500 mm annual rainfall) where production is based on growing cereal crops in rotation with annual legumes. This system integrates cereal and livestock production. The legume pastures have nitrogen fixing properties and thereby increase the nitrogen content of the soil for cereal crops and provide quality feed for large numbers of livestock. Specially adapted tillage methods, techniques of livestock management and soil conservation practices have been built into this farming system. There has been a gradual retraction of cropping from the edge of the steppe zone into areas receiving more assured rainfall.

The lower margin for cereal production lies between the 250 - 300 mm rainfall isohyets. However, the lower rainfall limits of dryland farming cannot be determined by considering only average annual rainfall. Many factors determine whether annual rainfall is adequate for crop growth. These are climatic conditions during the growing season, evapo-transpiration rate, incidence of wind, variability of rainfall and soil type.

Where rainfall is below the lower limit, it is so unreliable and ineffective that cropping has little or no chance of continued economic production. In the past when these areas were cropped, the natural vegetation was destroyed and when crops failed, the land was left exposed and subject to erosion. It is difficult to restore such arid areas to a stable productive system based on natural vegetation again.
4.

The higher rainfall zone (over 500 mm annual rainfall) in the southern portion of the State has a more reliable growing season. Farming is based on high intensity grazing of sheep and cattle. In some areas high value crops such as stone fruits, vegetables and oilseeds are grown. The graziers in this region have developed a higher rate of stocking (at least 8 to 10 sheep per hectare) through the use of annual and perennial legume pastures.

The three zones are interdependent and integrated, which benefits the stability of each system. The pastoral (steppe) zone is mainly a stock-breeding area. Stock in store condition are transported to the better rainfall areas for fattening. There is also a similar interchange of livestock and feed supplies between the cereal and high rainfall zones to cope with seasonal fluctuations.

2. THE ARIDLY DRYLAND FARMING AREAS OF SOUTH AUSTRALIA:

The arable dryland farming areas or cereal zone of South Australia is a semi-arid region where:

2.1 Rainfall is Limited

The main part of the cereal zone in South Australia receives less than 400 mm of rainfall, and 65% of the State's wheat is harvested in 250-400 mm annual rainfall areas. (See Table 1)

<table>
<thead>
<tr>
<th>Annual Rainfall Zones</th>
<th>Percentage of South Australian wheat production (Mean production over 10 year period 1966-1975)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 300 mm</td>
<td>8%</td>
</tr>
<tr>
<td>300 mm to 400 mm</td>
<td>57%</td>
</tr>
<tr>
<td>Over 400 mm</td>
<td>35%</td>
</tr>
<tr>
<td>Over 500 mm</td>
<td>less than 1%</td>
</tr>
</tbody>
</table>

Most of the annual rainfall (over 75%) falls in the 7 months growing period of the crop (i.e. April to October period).
2.2 Soils Are Variable

The soils of the South Australian wheat belt vary from shallow, rubble limestone soils to deeper sandy soils, they are mainly alkaline, low in organic matter and were deficient in both phosphorus and nitrogen.

These soils do not store a great deal of soil moisture except in the deeper clay soils which occur only in limited areas.

Because of the shallow depth of the stony malloa soils, many problems have been encountered in the use of cultivation equipment. Often, limestone rubble or sheet limestone occurs less than 10 cm below the surface.

No doubt these soil problems are the reason for the development of special, and in some cases, unique tillage equipment. Even on soil that is capable of being deeply worked, the depth of cultivation is usually no more than 7 to 10 cm.

2.3 Land Use Possibilities Are Limited

In the dryland arable areas of South Australia it has been necessary to harness these limited natural resources to produce a stable and productive agricultural system.

Developing suitable systems of land use and management for any dryland farming areas of the world has required considerable technology and skills. It has been found that systems must include the basic necessities for stability. These include the maintenance of soil fertility, the retention of vegetative cover for as great a portion of the rotation as possible, tillage systems which preserve soil structure and ensure the best use of available moisture, including practices which prevent damage from wind and water erosion.

The evolution of the ley farming system using annual legumes in the crop rotation over the past 35 years has met these criteria and revolutionized agricultural production in the cereal belt of South Australia. The principle of ley farming is now widely practised over much of the cereal growing areas of Australia.
3. THE DEVELOPMENT OF THE DRYLAND FARMING AREAS OF SOUTH AUSTRALIA

3.1 The Exploitative Stage

Like many of the more arid dryland farming areas of the world much of the South Australian cereal zones has been through the "dust bowl" stage.

The early settlers realizing cereals, especially wheat would grow in the South Australian cereal zone, grew crop after crop - soil fertility soon fell and so did yields from crops. (See Appendix 5b)

They developed a fallow-crop system to help conserve moisture, but this continual cultivation and cropping damaged soil structure, land was left bare by fallowing, and soon wind erosion led to severe dust storms in the summer, and winter rains gouged gutters into the unproductive soils on the hillsides.

We know now of course, that the early farmers up to the late 1930's in South Australia's cereal zone exploited the limited resources by extensive cropping on fallow. As a result of this fallow-wheat system, much of the soil's natural fertility was exhausted, soil erosion was acute in many areas, soils were difficult to work because their structure had been broken down (see Table 6 which shows the severe effects of fallow-wheat rotations on soil aggregation), and there was insufficient forage to feed increasing numbers of livestock.

3.2 The Impact Of The Ley Farming System

The introduction of the ley farming system was to change the whole farming outlook in the dry farming lands of South Australia. Under this system the bare fallow phase of the rotation in alternate years was largely replaced with a legume pasture ley. This practice where legume leys alternate with cereal crops is called the ley farming system.

This farming system now universally practiced in South Australia developed mainly in the period between 1940 and 1960.

The annual legume pastures grown between cereal crops are based on cultivars of Medicago species or Trifolium subteraneum. It is an integrated system of cereal and livestock production, which has resulted in increased soil nitrogen levels, a marked reduction in fallow and a large increase in forage production.
The net result was that within the cereal production zone, crop production and yields per hectare increased and considerably higher stock numbers with increased wool and meat production has been achieved.

The development of the ley farming system was quite rapid. There was a gradual start in the late 1930's and early 1940's, but by 1950 annual legumes (mainly *Medicago* spp.) were sown or had volunteered over a wide area under adapted management techniques.

These grew prolifically in many areas and were stimulated by higher phosphate applications. As well as supporting more sheep, the legume-based pastures rebuilt depleted organic matter reserves and lifted soil nitrogen levels. The increase in soil fertility was reflected in increased cereal crop yields and higher stocking capacities.

In the main cereal growing counties of the State, cereal yields and production rose by 50%, sheep numbers doubled and wool yields more than tripled between the 1930's when medics were first sown and the 1960's when their use was widespread. For example, in Counties Daly, Stanley and Gavler (see Appendix 4), average wheat yields lifted from 1.04 tonnes per hectare in the 1931/40 period, to 1.60 tonnes per hectare in the 1951/60 period, while average sheep numbers lifted from 543,000 in the 1931/40 period to over one million in the 1961/70 period. (See Table 2) These increases in overall production were eventually reflected right across the agricultural areas of the State. (See Table 3)

### TABLE 2

**CEREAL AND LIVESTOCK PRODUCTION, SOUTH AUSTRALIAN CEREAL ZONE - COUNTIES DALY, STANLEY, GAVLER**

<table>
<thead>
<tr>
<th>Period</th>
<th>Wheat</th>
<th>Barley</th>
<th>Total cereal production</th>
<th>Sheep and wool</th>
<th>Cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area sown '000 ha</td>
<td>Production '000 tonnes</td>
<td>Yield t/ha</td>
<td>Area sown '000 ha</td>
<td>Production '000 tonnes</td>
</tr>
<tr>
<td>1931-40</td>
<td>263</td>
<td>274</td>
<td>1.04</td>
<td>42</td>
<td>36</td>
</tr>
<tr>
<td>1941-50</td>
<td>192</td>
<td>224</td>
<td>1.17</td>
<td>55</td>
<td>54</td>
</tr>
<tr>
<td>1951-60</td>
<td>157</td>
<td>251</td>
<td>1.60</td>
<td>96</td>
<td>127</td>
</tr>
<tr>
<td>1961-70</td>
<td>213</td>
<td>314</td>
<td>1.47</td>
<td>91</td>
<td>114</td>
</tr>
</tbody>
</table>
Table 2 (cont'd.)

The apparent decline in crop yields in 1961-70 decade is generally accepted as being due to a higher than average number of dry seasons and droughts during this period. The average of the 10 year mean rainfall recordings in the 1961-76 decade across the main cereal growing centres was almost 10% less than in the 1951-60 decade. See Appendix 2c.

TABLE 3

CEREAL AND LIVESTOCK PRODUCTION, SOUTH AUSTRALIA - AVERAGE OF TEN YEAR PERIODS

<table>
<thead>
<tr>
<th>Period</th>
<th>Wheat</th>
<th>Barley</th>
<th>Total cereal production</th>
<th>Sheep and wool</th>
<th>Cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area sown '000s ha</td>
<td>Production '000s tons</td>
<td>Yield t/ha</td>
<td>Area sown '000s ha</td>
<td>Production '000s tons</td>
</tr>
<tr>
<td>1951-40</td>
<td>1,326</td>
<td>939</td>
<td>0.71</td>
<td>151</td>
<td>142.3</td>
</tr>
<tr>
<td>1954-50</td>
<td>824</td>
<td>712</td>
<td>0.87</td>
<td>205</td>
<td>222.5</td>
</tr>
<tr>
<td>1951-60</td>
<td>633</td>
<td>779</td>
<td>1.25</td>
<td>468</td>
<td>579.4</td>
</tr>
<tr>
<td>1961-70</td>
<td>1,128</td>
<td>722</td>
<td>1.14</td>
<td>503</td>
<td>577.5</td>
</tr>
</tbody>
</table>

The alkaline soil areas which grew Medicago spp. successfully showed the most rapid responses to increased soil fertility.

A slower rate of development occurred on the neutral to slightly acid soils, where volunteer pastures contained little legume. (See table 4 which shows cereal yield and wool production per hectare more than doubled over 25 years in the lower rainfall medics of Hundred Walters to levels equal to or higher than the better rainfall areas of Hundred Stanley, where production remained comparatively static during the same period). These acid soil areas were found to be more suited to early strains of subterranean clover. These were less readily established and needed resowing after each period of cropping.
### TABLE 4

**COMPARISON OF PRODUCTION BETWEEN TWO HUNDREDS** in the Northern Cereal Zone with and without Legume-Based Pastures

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>ANNUAL RAINFALL (mm)</th>
<th>WHEAT YIELD (kg/ha)</th>
<th>BARLEY YIELD (kg/ha)</th>
<th>WOOL PRODUCTION (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hundred of Wokurna (with medic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1931-40</td>
<td>307</td>
<td>745</td>
<td>594</td>
<td>2.0</td>
</tr>
<tr>
<td>1951-60</td>
<td>355</td>
<td>1 680</td>
<td>1 442</td>
<td>5.6</td>
</tr>
<tr>
<td>1961-65</td>
<td>331</td>
<td>1 707</td>
<td>1 506</td>
<td>6.8</td>
</tr>
<tr>
<td>Hundred of Stanley (without legume)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1931-40</td>
<td>442</td>
<td>1 533</td>
<td>1 292</td>
<td>5.2</td>
</tr>
<tr>
<td>1951-60</td>
<td>501</td>
<td>1 600</td>
<td>1 194</td>
<td>8.9</td>
</tr>
<tr>
<td>1961-65</td>
<td>480</td>
<td>1 627</td>
<td>1 275</td>
<td>8.6</td>
</tr>
</tbody>
</table>

* A Hundred is a statistical unit, that is part of a county and represents an area of approximately 25 000 hectares. (See Appendix 4)

**Source:** French, Matheson and Clarke (1968)

However, in areas where the subterranean clovers were successfully sown, increases in soil fertility resulted in production gains at least equal to gains made in medic areas.

These increases are illustrated by data from Turretfield Research Centre (Figure 1) that shows (over five year average periods) that both wool and cereal yields doubled following the sowing of the first legume pastures (mainly subterranean clover).
FIGURE 2: EFFECT OF LEGUMES ON WHEAT AND WOOL PRODUCTION - TURRETFIELD RESEARCH CENTRE

(* Turretfiel Research Centre is a 650 hectare property 55 kilometres north east of Adelaide, on red brown earth clay loam soils with a mean annual rainfall of 450 mm.)

(A) WHEAT YIELD (Tonnes/ha)

(B) WOOL YIELD (Total Production)
An important part of the change to ley farming system and its subsequent impact on agricultural production was the widespread adoption of practices to control soil erosion from wind and water. These included a reduction in fallowing, modified tillage methods to prevent working soils to a very fine state, and the contour banking of large areas of undulating arable land that was susceptible to water erosion (160 000 hectares of land in South Australia has been contour banked since 1946).

It was also necessary to stabilise the lighter sandy soil areas, by reducing cultivation, leaving the soil surface ridged, maintaining soil cover and sowing the less stable ricks with wind tolerant crops like cereal rye.

4. THE KEY FEATURES OF THE LEY FARMING SYSTEM:

4.1 Legumes Build Soil Nitrogen Levels

Nitrogen and phosphorus are the most serious major element deficiencies of South Australian soils in the cereal belt. Nitrogen fertilisers are expensive, and yield responses measured under our semi-arid and erratic climate are variable and often not profitable.

Legume-dominant pastures, on the other hand, rapidly build-up soil nitrogen levels, and the level of organic matter which improves soil structure, water intake, and supplies adequate nitrogen in a form available to crops when required.

Healthy legume plants can fix atmospheric nitrogen through the nodules on their roots which contain bacteria (*Rhizobium* spp.). Consequently, most legumes are rich in nitrogenous compounds. As these compounds are returned to the soil, either through the grazing animal or by decaying plant residues, the level of soil nitrogen increases.

The amount of nitrogen fixed by a legume pasture varies with the soil type, vigour of the legume stand, and also the existing level of soil nitrogen as well as the efficiency of nodule-fixing bacteria.

Measurements taken in the wheat belt of Southern Australia while they vary considerably, (see Table 5) indicate that an average *Medicago* stand (4 000 to 5 000 kg/ha dry matter production), increased soil nitrogen by at least 60 to 70 kg/ha in one season, i.e. the equivalent of about...
306 kg/ha of sulphate of ammonia. Occasional measurements of up to 200 kg/ha of soil nitrogen fixed on sandy soils have been recorded with vigorous stands of Harbinger strand medic on low fertility sandy soils.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SOIL</th>
<th>PERIOD OF MEASUREMENTS (YEARS)</th>
<th>PASTURE</th>
<th>DEPTH OF SOIL SAMPLED (cm)</th>
<th>INCREMENT PER YEAR (kg/ha/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kejonup, Western Australia</td>
<td>sandy</td>
<td>2</td>
<td>subterranean clover</td>
<td>0-10</td>
<td>81</td>
</tr>
<tr>
<td>Turrettfield, South Australia</td>
<td>red brown earth</td>
<td>2</td>
<td>subterranean clover</td>
<td>0-10</td>
<td>182</td>
</tr>
<tr>
<td>Merredin, Western Australia</td>
<td>calcareous soldonised soil</td>
<td>2</td>
<td>medic</td>
<td>0-25</td>
<td>39</td>
</tr>
<tr>
<td>Longerenong, Victoria, Australia</td>
<td>grey soil of heavy texture</td>
<td>4</td>
<td>medic</td>
<td>0-15</td>
<td>117</td>
</tr>
<tr>
<td>Longerenong, Victoria, Australia</td>
<td>grey soil of heavy texture</td>
<td>8</td>
<td>medic</td>
<td>0-15</td>
<td>93</td>
</tr>
</tbody>
</table>

Source: Clarke, A.L. and Russell, J.S. (1977)

4.2 Legume Leys Improve Soil Structure and Organic Matter Status

Organic nitrogen added to the soil by legumes is released continuously by mineralization during the growth of a subsequent crop; that is, it acts as a natural "slow release" fertilizer. This avoids problems involved in either the over-supply of nitrogen to plants or the rapid loss of nitrogen due to leaching in wet seasons.

The inclusion of legume based pastures in the rotation also improves the soil's physical properties, particularly soil structure (see Table 6 which shows the effect of pasture leys on soil aggregation on two soil types in the northern agricultural areas of South Australia). Better
soil structure increases productivity and renders the soil less vulnerable to erosion. This amelioration is essential to balance the destructive effects of fallowing and cropping.

**TABLE 1**

EFFECT OF LAND USE SYSTEM ON SOIL STRUCTURE - NORTHERN AGRICULTURAL AREAS

<table>
<thead>
<tr>
<th>SOIL TYPE</th>
<th>LAND USE</th>
<th>PERCENTAGE AGGREGATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.2 m</td>
</tr>
<tr>
<td>Belalie Loam</td>
<td>Uncultivated natural pasture (in natural state)</td>
<td>50.2</td>
</tr>
<tr>
<td></td>
<td>Three (3) year rotation Fallow, Wheat, Pasture</td>
<td>42.1</td>
</tr>
<tr>
<td></td>
<td>Fallow-Crop rotation</td>
<td>16.5</td>
</tr>
<tr>
<td>Yangya Silt Loam</td>
<td>Uncultivated natural pasture (in natural state)</td>
<td>75.5</td>
</tr>
<tr>
<td></td>
<td>Three (3) year rotation Fallow, Wheat, Pasture</td>
<td>48.5</td>
</tr>
<tr>
<td></td>
<td>Fallow-Crop rotation many years</td>
<td>32.0</td>
</tr>
</tbody>
</table>

Source: Stephens et al (1945)

4.3 Stability Of Production

Individual farms in most parts of the cereal belt can now crop a stable crop area and carry a regular number of livestock. (See Appendix 6)

This was a major breakthrough under marginal semi-arid farming conditions compared with previous unstable exploitative systems. The green feed period in a normal season is short, (2 - 7 months) through most of the cereal areas and volunteer grass species rapidly lose their feed value after maturity leaving a considerable gap in the feed year.
Annual legume pastures retain feed quality in the dry residues which extends the quality feed season significantly.

The variation in yearly production can be buffered by cutting good quality pasture hay in the better season.

5. THE ANNUAL LEGUMES:

This farming system is basically a system where grain crops alternate with pasture legumes. The pastures have annual legumes as their main component. These are either cultivars of *Medicago* spp. or *Trifolium subterraneum*.

5.1 Medic (Medicago spp.)

In general the *Medicago* spp. are suited to the neutral to alkaline soils. Considerable selection and testing work has been carried out to develop species and cultivars suited to the variety of climatic and soil conditions in the cereal belt. The most commonly occurring medic is Burr (*M. polymorpha*), Wooly Burr (*M. minima*), barrel (*M. truncatula*) and Strand (*M. littoralis*).

Five annual medic species are grown in South Australiz and there are eight cultivars within these species that are registered. Barrel medic (*M. truncatula*), Strand medic (*M. littoralis*) and small medic (*M. scutellata*), grow on a range of neutral to alkaline soils. Disc medic (*M. tornata*), is showing potential on some sandier soils and Gama medic (*M. rugosa*), on heavier soils.

These species have a range of flowering and maturity times, (see Figure 2 which shows the time between sowing and flowering for cultivars of medic) to suit the various climatic areas of the cereal zone.

**FIGURE 2:** FLOWERING AND MATURITY TIMES FOR ANNUAL MEDIC

<table>
<thead>
<tr>
<th>Time After Sowing</th>
<th>0 weeks</th>
<th>5 weeks</th>
<th>10 weeks</th>
<th>15 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>M. truncatula</em></td>
<td>cv. Mannford</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M. truncatula</em></td>
<td>cv. Janalong</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M. truncatula</em></td>
<td>cv. Cyprus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M. truncatula</em></td>
<td>cv. Borang</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M. littoralis</em></td>
<td>cv. Herbinger</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M. rugosa</em></td>
<td>cv. Pafiosa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M. tornata</em></td>
<td>cv. Trosfield</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M. scutellata</em></td>
<td>cv. Robinson</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.2 Subterranean Clovers (Trifolium spp.)

The Medicago spp. do not flourish on the red-brown, neutral to slightly acid soil and the light-coloured, sandy, transitional solonetz soils. The subterranean clovers have proved more suitable on these soils.

While the newer, earlier maturing strains have extended the lower rainfall zone limits for subterranean clovers, under South Australian conditions, 350 - 400 mm average annual rainfall seems to be the lower limit for successful stands. This situation is influenced to some degree by soil factors in that most of the lower rainfall areas of the cereal zone in South Australia have alkaline soils.

A number of cultivars have been tried over the past 20 years with variable degrees of success. However, the range of cultivars now available have suitable characteristics to cover most of the non-medicago areas of the State.

The main cultivars now sown in the cereal zone are Clare, Geraldton, Moonganup, Balaik and Seaton Park.

5.3 Legume Seed Inoculation

The correct strain of Rhizobium is vital for effective nodulation and nitrogen fixation by the sown legume. While in many of our soils the appropriate Rhizobium are present in sufficient numbers, they are lacking in some soils. For successful establishment of particular legumes on these latter soils, the appropriate strain of Rhizobium cultivated artificially and mixed into a finely ground pasteuriser, is coated on the seed prior to sowing. A variety of coating techniques, developed for different soils and legume species or cultivars are used to attach the Rhizobium inoculation to the seed.

Different species of Rhizobium nodulate Medicago and Trifolium spp. R. meliloti is used for medics and R. trifolii is used for subterranean clovers. R. Meliloti will not nodulate clovers and vice versa.
6. CROP ROTATIONS:

The type of crop rotations used in the ley farming system has been influenced by the type of legume pastures grown as part of the integrated system.

6.1 Rotations With Annual Medicago Pastures

Because Medicago sp. produce hard-seeds (i.e., seeds with a coat that resists entry of water) optimum regeneration of pastures is achieved where a basic alternate year cropping programme is practised. The basic crop-crop pasture rotation has been used in some areas for over 30 years. Better germination of Medicago sp. occurs after the crop year because there is a greater degree of breakdown of hard-seeds after they have been through two summer periods of exposure to temperature extremes at or near the soil surface.

This tends to cause the seed coat to crack and allow entry of water and with the seed incorporated in the top few centimeters of soil, it is in a better environment for germination and establishment than on the soil surface.

Whenever the cropping system used, it is important that seed reserves be maintained at a high level to promote vigorous medics stands in subsequent years.

The concept of fixed rotations has tended to change in recent years. The build-up in soil fertility under legume-dominant pastures has allowed greater flexibility in the management of crops and pastures to maximise profits. Rotations in medics areas, while based on alternate year cropping, can vary with soil type, seasonal factors, density and vigour of pastures, and the relative prices of crop and livestock products.

As a general principle however, the objective is to grow one or two cereal crops for every moderate to good medics pasture year. Less intensive cropping than this can be wasteful as it allows poor types of annual grasses to become dominant on the increased fertility. Some of the rotations used in conjunction with medics pastures are:

* Barley-pasture-barley-pasture is used in the good medics areas suited to barley production.

* Wheat-pasture-wheat-pasture where medics growth is regular on deeper loamy soils of 350-475 mm average annual rainfall. A modification of this would be wheat-pasture-barley-pasture, or follow-wheat-pasture-barley-pasture.
* On lighter soils in the marginal cropping areas where rainfall is lower and not as reliable, the crop year can be followed by two or more years of pasture depending on the growth of Medicago.

* On heavier soils, particularly in the more favoured rainfall areas, where following is likely to be necessary for maximum returns, a rotation of fallow-wheat-pasture-barley-pasture or fallow-wheat-pasture is practised.

When soil fertility has been increased, crop rotations are more flexible and can be adjusted to take advantage of prevailing market price opportunities for various crops. It is possible in the better rainfall areas to replace a pasture year with a grain legume crop such as Field Pea (Pisum arvense) or Lupins (Lupinus angustifolius).

Whatever rotation is used, it is necessary to assess soil fertility and seed reserves carefully. Seed reserves can reach low levels after poor pasture years, or when paddocks are cropped for two years or more in succession. Operations such as hay cutting can also reduce the quantity of seed set. If legume seed reserves are in doubt, resewing is necessary.

6.2 Rotations With Subterranean Clovers

Unlike medics, subterranean clovers have fewer hard seeds and regenerate best in the year following seed set. They are therefore not generally as well suited to close rotations, and have tended to fit best into a system where there is a pasture phase followed by a cropping phase. However, when seed reserves have built up over several years, closer rotations and alternate year cropping has been successfully practised in some areas.

After a multiple cropping phase, subterranean clovers will normally need to be resown and it is very important that the pastures establish well in the first year.

7. SOIL PREPARATION FOR CEREAL CROPS

In dryland farming districts with a limited growing season for grain crops and an unreliable start to the season due to moisture shortages, the timing of preparing cultivations to prepare a suitable seed bed and control early weed germinations is critical, so that sowing of the crops can be carried out at the optimum time for that season.
7.1 Tillage Methods

The tillage system that has evolved in conjunction with the ley farming system is by overseas standards a shallow tillage system. In general there are no advantages in deep ploughing in our semi-arid areas, and, in fact, there are considerable disadvantages in terms of cost, timing, deep placement of some weed seeds which remain dormant for long periods, and in the resultant rough and uneven conditions of the seed bed. In addition on many soils deep working would expose the sub-soil.

Shallower cultivation with maximum depth of 7-10 cm is therefore an essential part of the ley farming system.

Tillage implements used in South Australia are of a strong construction and almost universally equipped with a stump-jump mechanism to enable them to ride over stones, stumps and uneven areas.

The original bridie mechanism on ploughs and scarifiers has been superseded. In most cases these implements have been fitted with hydraulics for depth control.

A typical programme of cultivation of pasture land in preparation for seeding of the cereal crop consists of 3-6 workings depending on soil type and seasonal condition for fallow, and 2-4 workings on non-fallow.

These workings consist of:

* The initial breaking up of land is carried out in early spring (by mid September) if the field is to be followed or following any early rains during late summer - early autumn (February-March) for non-fallow sowings.

These first workings are usually carried out with a disc plough or tynes scarifier. Disc ploughs are useful when significant amounts of herbage or trash are to be handled, but scarifier type implements are also now widely used for initial workings.

* Follow-up cultivations and subsequent workings are usually carried out with a scarifier and even a combine drill to achieve weed control and good seed-bed tilth. In recent years a range of wide line cultivators or scarifiers have been produced; these enable farmers to cultivate large areas in a short time, and this is important for timely weed control.
Harrowing with heavy trailing harrows, is carried out to control young germinating weeds and to break down clods to a finer tilth before seeding.

Seeding operations on well prepared land are almost exclusively carried out with a "combined" drill and cultivator.

The Australian type combined drill and cultivator is a multi-purpose machine for cultivating, for sowing cereal and pasture seeds, as well as for sowing or spreading fertiliser. These machines sow seed and fertiliser in close proximity, at an even depth, control weeds at sowing with their cultivating tynes, and leave the soil in an even friable condition for seed germination. They are also capable of sowing large areas in a short time, which is important in many seasons. Where there is a large amount of straw and trash in the seed bed, a disc drill can be used. Some combine drills can be converted to disc drills by removing the type floats and replacing them with disc attachments.

7.2 Fallowing

While the amount of land fallowed for wheat has been considerably reduced there is still some fallowing carried out in parts of the cereal zone.

Fallowing is usually carried out at the end of winter (August-September) when pastures are flowering, in the year before a crop is sown in the following May, i.e. (8 months under fallow). Normally wheat is the only cereal crop sown on fallowed land.

Fallowing is considered most effective for storing water in soils that have moderate to high clay content at 15-30 cm depth.

In general, fallowing is carried out under conditions where:

* Soils are low in fertility because they have had a relatively poor legume pasture history and nitrogen build-up has been limited, and where mineralisation under fallow will help make soil nitrogen available.

* If soils have a good pasture legume history, and nitrogen status, fallowing is recommended to conserve moisture only where:

  - clay sub-soil is present to effectively store moisture.
- July-August rains exceed 100 mm in the year preceding the cropping year.
- Average rainfall is below 450 mm.

In all other situations, fields are prepared with cultivations over a period of 1-3 months prior to seeding.

7.3 Minimum Tillage

The ley farming system in itself has resulted in a significant reduction in the number of cultivation operations for sowing crops, but there is growing interest, and increasing research in many parts of the world including Australia, on minimum tillage and direct drilling techniques.

The main areas of interest are:
* The effects of planting cereals without cultivation or with reduced cultivation.
* The development of new machinery which makes these planting techniques possible.
* New herbicides to give pre-emergence or early post-emergence control of weeds in crops planted too early to obtain weed control by normal cultivation.

8. CEREAL CROP MANAGEMENT

Because of the limited rainfall over most of the South Australian cereal zone, crop production tends to be an extensive form of production with relatively low outputs and low inputs. While wheat is the main crop grown in dryland farming areas, barley production is also important (during the 10 year period up to 1976/77 barley represented 30% of the total cereal area sown). Almost all of the barley grown is of the 2 row variety and of good malting quality. As previously mentioned it is most important to make maximum use of the limited rainfall that falls in the growing season, this means the varieties grown are early maturing, and crops are generally sown as early as possible after the opening rains,
to provide maximum growing season as moisture is often limiting during maturity. Seeding rates by general standards tend to be low; there are seldom yield increases obtained at seeding rates above 50-60 kg/ha of wheat and 40 kg/ha of barley.

8.1 Fertilisers

All South Australian soils need regular additions of superphosphate for maximum production and this is the main fertiliser used. Current recommendations for application with the crop, vary from 50 kg/ha in the drier fringes to 140 kg/ha in better cereal production areas. In many agricultural regions of the world heavy dressings of nitrogen fertilisers are applied to supply crop needs. In the agricultural areas of South Australia responses depend greatly on seasonal rainfall and on the level of mineral nitrogen in the soil. It has been found that there is little benefit from applied nitrogen when rainfall limits crop growth. Because of the unreliable seasonal rainfall and responses to applied nitrogen, the crops mainly depend on organic nitrogen from legumes. Less than 5% of the cereal crop is grown with applied nitrogen. Trace-element deficiencies are seldom a problem on the soils in the South Australian wheat belt. Responses to copper and zinc have been obtained in limited areas, while manganese is sometimes lacking on some highly calcareous soils.

8.2 Weed Control

Weed control is based on a combination of cultivation and use of herbicides. While over the years hormone-type herbicides and early post emergence herbicides for the control of broad leaved and early competing weeds have mainly been used, in recent years there has been widespread use of pre-emergent chemicals to control the grass type weeds, wild oats (Avena spp.) and annual ryegrass (Lolium rigidum).

9. MANAGEMENT OF LEGUME PASTURE STANDS

The whole system of ley farming depends on establishing good productive stands of medics or clovers as quickly as possible and maintaining these stands.
Once legumes have been established, they are normally relatively persistent under a suitable rotation and grazing management system.

9.1 Sowing Legume Pastures

Normally annual legumes are best established by seeding them into a shallow prepared seed-bed. In some circumstances (on lighter soils) establishment can be achieved by seeding directly into unprepared soil before the opening rains.

Some of the important factors about sowing *Medicago* spp. are:

* Time of seeding

Because of the relatively short growing season in most parts of the cereal zone seeding should be carried out early to allow plants to make maximum growth and set seed. *Medicago* seed is usually sown dry in autumn (i.e. April/May in Australia).

* Depth of seeding and seed-bed conditions

Because *Medicago* seeds are relatively small, they should be sown into a fine seed-bed, free of large clods. However, where soils have a tendency to form a hard crust on the surface, soils should not be worked down too fine. *Medicago* seed should not be sown too deep, (1-2 cm maximum into prepared seed-bed), or dropped onto the cultivated surface with superphosphate and covered with light harrows (normally 0-1 cm of soil).

* Seeding rates and fertiliser

Rates of 6-12 kg/ha of annual legume seed have been found to give good productive stands in the first year. Higher rates (15 kg/ha) may be required in tough uneven seed-bed conditions.

* Adequate superphosphate is essential for good legume pasture establishment and growth. Depending on how much phosphate has been applied previously, rates of 75-140 kg/ha of superphosphate (i.e. 30-55 kg P2O5/ha) are usually recommended.
9.2 Grazing Management

Sheep and to a lesser extent beef cattle are an integral part of the production system in the wheat belt and normally over 7 million sheep are run in this zone. Sheep are run in this area both for wool and meat production. There is considerable fluctuation in the quantity of feed available for livestock both within a season and between drought and flush feed years, and it is necessary to adjust stocking rates and conserve fodder in the form of hay and grain to feed livestock during the deficit periods. Stock are grazed for the whole year and a typical feed year is set out in Appendix 7. For 5-6 months of the year sheep graze dry feed, and South Australia has developed hardy large framed strain of Merino sheep which carries a strong wooled bulky fleece of well nourished wool that is able to stand up to the dry and dusty conditions.

The main objectives in grazing management in the ley farming system are to:

* obtain the maximum grazing potential from the legume pastures for livestock throughout the year.

* achieve a high level of seed set so that a continuous high level of regeneration and production from the legume pasture is obtained.

These objectives can be achieved by following a few basic rules of grazing management to control weeds and grasses and to encourage maximum seed set, e.g.

* New stands need careful grazing management early in the season. Medicago plants should be allowed to become well established e.g. to the six to eight leaf stage before grazing, then grazing levels should be aimed to keep weed and volunteer grass growth under control.

* Once the stand is established, it should be kept grazed short, 3-8 cm until flowering commences. Maximum seed set is achieved in this way provided grazing is carefully controlled during flowering and podding.

* After seed pods have fallen to the ground after maturing, the dry medic residues will provide good grazing. The grazing pressure should not be so heavy as to force the stock to eat out all the seed pods. This is particularly important with first year medic stands.
9.3 Other Management Points That May Need Attention

* Medic pastures regenerate poorly in dense cereal stubbles. Stubbles should be grazed heavily or treated with a slasher to reduce or break down the blanketing effect of the stubble.

* Topping the pasture with a slasher or mower is often a useful way of controlling pasture weeds so that they do not overgrow the more prostrate growing medic.

* In the better seasons, medic pastures make bulky growth, and this provides the opportunity to make large quantities of good quality hay, (reasonable medic stands will cut 5 tonnes/ha of hay). This fodder reserve is important in dryland areas to buffer the effects of drought years, and enables farmers to carry livestock through the lean periods. It is important to note that hay cutting may seriously reduce seed set of medic and reseeding may be necessary.

9.4 Legume Seed Production

The development of the ley farming system has depended on having sufficient quantities of good quality annual legume seed available. The early seed harvesting methods were mainly carried out with sheep skin rollers, and rotary brooms and the pods were put through various types of thresher to separate the seed.

More sophisticated harvesting machines have now been developed and today almost all seed is reaped using the Horwood Bagshaw suction-type machine.

Some of the important points involved in seed production are:

* High yields of seed can only be harvested from well prepared level paddocks.

* Paddocks should be well grazed until flowering commences.

* Dry top growth should be removed with a side delivery rake or harrows and medic pods loosened by dragging chain wire or similar equipment over the paddock.
An average well managed medic stand in the cereal areas will yield 300-400 kg/ha of seed in a normal season. Experienced seed producers produce 50-100 per cent above this quantity. Subterranean clovers stands in the wheat belt average about 20% less in seed yield than the medic.

In most cereal districts the newer suction-type harvesters reap about 0.3 hectares per hour.

10. THE INFRASTRUCTURE IN WHICH THE LEY FARMING SYSTEM OPERATES:

A number of complementary facilities of Government and business firms provide services and resources necessary for the operation of the agricultural systems. These are backed by technological developments provided by research and development programmes from research organisations and manufacturers.

Some of the important facilities, services and developments are:

10.1 Rural Water Supplies

South Australia has a harsh dry climate and very limited water resources. Considerable money has been spent in supplying water for the agricultural areas. There are three methods for farmers to obtain water, i.e. from bores, from runoff into earth tanks, or from the extensive reticulation systems provided by the State, (there are 12 000 kilometres of pipelines to supply valuable reticulated water for livestock and farm families in South Australia). One scheme, the Tod River Scheme on Eyre Peninsula, is the longest gravity reticulation system in the world.

10.2 Agricultural Machinery

The agricultural machinery industry has contributed significantly to the success of dryland farming in South Australia. The development of special strong and adaptable seeding and tillage machinery, equipped with accurate depth control, with stump jump mechanisms and for good ground clearance has been an important contribution. Similarly the development of efficient stone picking machinery and a vacuum type clover seed harvester has been vital to agricultural development.
10.3 Cereal And Pasture Seed Supplies

The supply of quality seed of both cereals and pasture plants is an important factor in our agriculture and much work has been directed at producing both cereal and pasture species suited to South Australia. New cereal varieties are bred at two main centres, whose programmes are aimed to increase disease resistance, and increase adaptation to the South Australian environment. New varieties released, are multiplied by approved farmers in a Department of Agriculture Registered Seed-grower's Scheme.

The production of seed of herbage plants is regulated in certification schemes conducted by the Department of Agriculture and Fisheries for the majority of important herbage species grown in South Australia.

10.4 Fencing And Yards

The livestock industries are based mainly on range grazing and fencing is most important component in the system.

Most fences are of post and wire construction. Cattle generally require more expensive fencing than sheep and often incorporate barbed wire in their construction. A variety of new types of post and wire fences have been erected; these have light gauge wire and widely spaced posts.

Much work has gone into the design and material used for handling yards for sheep and cattle management.

These yards allow the routine operations of sorting various classes of stock, branding, drenching, inoculation and sundry other operations to be performed with an economy of labour.

Various prefabricated steel yards are available; these can be erected in a permanent position, or in some instances, are transportable and can be re-erected wherever the necessary operations are carried out.

10.5 Transport Storage And Marketing

Most South Australian agricultural produce is exported and so efficient transport and marketing facilities have been developed.

A cereal storage system operated by Co-operative Bulk Handling Limited has developed over the last 25 years. This is a wholly farmer-
owned organisation. It has a series of storages at local railway sidings, larger storages at country centres and terminal depots with ship-loading facilities.

Large wool stores mainly operated by public companies, receive wool offers for sale and despatch it to Australian and overseas mills. Most of the wool in South Australia is now sold at auction in sale-by-sample, with objective measurement of yield, mean fibre diameter and percentage vegetable matter being the main criteria for prices realised.

The major cereals, wheat and barley, are marketed by two separate statutory corporations. These are the Australian Wheat Board and the Australian Barley Board. These organisations acquire all grain that meets their standards. A first advance of cash is paid to farmers on delivery of grain to storage silos.

The marketing of livestock operates mainly through auction markets. Much of the meat produced is consumed locally, but a considerable amount is exported. Exports are organised largely by meat exporting firms under supervision of the Australian Meat Board.

11. SUMMARY:

South Australia has developed a stable integrated and productive system of agriculture within the limited resources of its dry environment. The ley farming system integrates cereal and livestock production and uses the nitrogen fixing properties of the legume pastures to increase soil fertility for cereal crops and supply high quality feed for large numbers of livestock.

Australian experience has shown that the introduction of the ley farming system has resulted in:

* Increased soil fertility and improved soil structure, and better control of soil erosion particularly when combined with contour banking.
* Increased cereal crop yields and greater cropping flexibility, and often improved grain protein levels.
* Increased herbage growth and better dry feed in summer resulting in higher, better quality livestock production.
* Greater farming stability - individual farms can now crop a
stable crop area and carry a regular number of livestock,
(with a planned fodder conservation programme).

The inputs which have made the system possible are:
* The selection and development of suitable annual legume cultivars.
* The development of an integrated rotational management system for
crops and legume pastures.
* The development of a shallower more effective tillage system.
* The development of management techniques for efficient livestock
production.
* Complementary facilities such as water supply, seeds, special
machinery, handling facilities and technical support.

12. REFERENCES AND FURTHER READING:

Carter, E.D. (1975) - The potential role of integrated cereal-livestock
systems from Southern Australia in increasing food production in

Clarke, A.L. and Elliot, D.E. (1975) - The use of nitrogen fertilisers
on field crops and pastures in South Australia. Soil Conservation
Branch Report, No. 55/75, Department of Agriculture, South Australia.

in a semi-arid environment." Edited by J.S. Russell and E.L. Gracens
(University of Queensland Press).

Cocks, P.S., Webber, G.B., Crawford, E.J. and Mathison, M. (1977) -
"Pasture seeds from South Australia." Department of Agriculture
and Fisheries, South Australia.

Cocks, P.S., Mathison, M. and Crawford, E.J. (1978) - From wild plants
to pasture cultivars - annual medics and subterranean clover in
South Australia. Proceedings International Legume Conference, New
Gardens. (In Press)

Crawford, E.J. (1973) - Annual medics: Establishment, management and
general utilisation. Agronomy Branch Report No. 51, Department of
Agriculture and Fisheries, South Australia.

French, R.J., Matheson, W.E. and Clarke, A.L. (1968) - Soils and agriculture of the Northern and Yorke Peninsula regions of South Australia. Bulletin 1/68, Department of Agriculture, South Australia.

Higgs, E.D. (1974) - Seminar Paper - Department of Agriculture, South Australia. (Unpublished)


Bagless, D.C. (1973) - Seed production - The key to profitable medic pastures. Bulletin No. 26/74, Department of Agriculture, South Australia.


Webber, G.D. (1975) - The ley farming system in South Australia. Special bulletin No. 20/75, Department of Agriculture and Fisheries, South Australia.
FIGURE 3: AVERAGE MONTHLY RAINFALL AND TEMPERATURE DATA FROM KEY CENTRES IN THE SOUTH AUSTRALIAN CEREAL ZONE

LANEROO
Altitude: 97.8 metres
Mean Annual Rainfall: 393 mm

KYANJUTA
Altitude: 58.2 metres
Mean Annual Rainfall: 330 mm

KADINA
Altitude: 44.2 metres
Mean Annual Rainfall: 396 mm

GEORGETOWN
Altitude: 273.1 metres
Mean Annual Rainfall: 468 mm

--- = Temperature
--- = Rainfall
APPENDIX 1

MAJOR CLIMATIC ZONES OF AUSTRALIA
(Based Mainly On Rainfall)

Source: Nutterson (1958)
RAINFALL STATISTICS

(a) Average Annual Rainfall (mm) in South Australia

## APPENDIX Tb

### RAINFALL STATISTICS

**(b) Distribution of Rainfall, South Australia and Australia**

<table>
<thead>
<tr>
<th>Average Annual Rainfall</th>
<th>South Australia</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 250 mm</td>
<td>82.6</td>
<td>38.8</td>
</tr>
<tr>
<td>250 mm and under 400 mm</td>
<td>9.1</td>
<td>10.2</td>
</tr>
<tr>
<td>400 mm and under 500 mm</td>
<td>4.5</td>
<td>11.2</td>
</tr>
<tr>
<td>500 mm and under 600 mm</td>
<td>2.6</td>
<td>9.5</td>
</tr>
<tr>
<td>600 mm and under 750 mm</td>
<td>0.8</td>
<td>7.5</td>
</tr>
<tr>
<td>750 mm and under 1000 mm</td>
<td>0.4</td>
<td>6.2</td>
</tr>
<tr>
<td>1000 mm and over</td>
<td>*</td>
<td>7.0</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

*Less than 0.05% - an area of the order of 750 hectares in the Mount Lofty Ranges.*

**Source:** South Australian Year Book, 1976, Bureau of Statistics.
### RAINFALL STATISTICS

(c) Rainfall Recording at Key Centres in the Cereal Zone of South Australia

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnipa</td>
<td>351</td>
<td>465</td>
<td>391</td>
<td>422</td>
<td>277</td>
<td>453</td>
<td>593</td>
<td>252</td>
<td>426</td>
<td>207</td>
<td>401</td>
</tr>
<tr>
<td>Kadina</td>
<td>386</td>
<td>461</td>
<td>463</td>
<td>344</td>
<td>333</td>
<td>300</td>
<td>512</td>
<td>261</td>
<td>369</td>
<td>218</td>
<td>422</td>
</tr>
<tr>
<td>Roseworthy</td>
<td>435</td>
<td>581</td>
<td>644</td>
<td>455</td>
<td>395</td>
<td>544</td>
<td>519</td>
<td>238</td>
<td>411</td>
<td>274</td>
<td>551</td>
</tr>
<tr>
<td>Loxton</td>
<td>384</td>
<td>395</td>
<td>381</td>
<td>437</td>
<td>334</td>
<td>533</td>
<td>515</td>
<td>222</td>
<td>394</td>
<td>207</td>
<td>419</td>
</tr>
<tr>
<td>Crystal Brook</td>
<td>486</td>
<td>535</td>
<td>625</td>
<td>367</td>
<td>509</td>
<td>510</td>
<td>270</td>
<td>794</td>
<td>209</td>
<td>523</td>
<td>411</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>390</td>
<td>521</td>
<td>520</td>
<td>393</td>
<td>501</td>
<td>513</td>
<td>290</td>
<td>761</td>
<td>217</td>
<td>520</td>
<td>409</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnipa</td>
<td>351</td>
<td>218</td>
<td>241</td>
<td>303</td>
<td>394</td>
<td>264</td>
<td>449</td>
<td>274</td>
<td>580</td>
<td>350</td>
<td>264</td>
</tr>
<tr>
<td>Kadina</td>
<td>386</td>
<td>334</td>
<td>301</td>
<td>411</td>
<td>366</td>
<td>257</td>
<td>411</td>
<td>213</td>
<td>517</td>
<td>441</td>
<td>919</td>
</tr>
<tr>
<td>Roseworthy</td>
<td>435</td>
<td>397</td>
<td>419</td>
<td>474</td>
<td>463</td>
<td>274</td>
<td>451</td>
<td>221</td>
<td>613</td>
<td>489</td>
<td>423</td>
</tr>
<tr>
<td>Loxton</td>
<td>384</td>
<td>413</td>
<td>397</td>
<td>454</td>
<td>430</td>
<td>307</td>
<td>329</td>
<td>199</td>
<td>457</td>
<td>438</td>
<td>351</td>
</tr>
<tr>
<td>Crystal Brook</td>
<td>393</td>
<td>414</td>
<td>399</td>
<td>397</td>
<td>380</td>
<td>312</td>
<td>405</td>
<td>193</td>
<td>485</td>
<td>442</td>
<td>411</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>390</td>
<td>392</td>
<td>402</td>
<td>397</td>
<td>382</td>
<td>312</td>
<td>405</td>
<td>193</td>
<td>485</td>
<td>442</td>
<td>411</td>
</tr>
</tbody>
</table>

*LTM = Long Term Mean*
APPENDIX 3

LAND USE OF SOUTH AUSTRALIA

Source: Pasture Seeds from South Australia
APPENDIX 3.

LOCATION MAP

SOUTHERN PORTION OF SOUTH AUSTRALIA

SHOWING COUNTIES BALK, STANLEY, AND SAUNDER IN CEREAL ZONE

— — — Edge of cereal zone

$X_1$ Hundred of Wokuru

$X_2$ Hundred of Stanley

— 250 — Rainfall isohyet
### AGRICULTURAL STATISTICS

**Statistics For South Australia (1975/76 Season)**

<table>
<thead>
<tr>
<th>TOTAL AREA (ha)</th>
<th>98 400 006</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISTRIBUTION OF LAND BY RAINFALL</td>
<td></td>
</tr>
<tr>
<td>600 mm</td>
<td>1 082 000</td>
</tr>
<tr>
<td>500-600 mm</td>
<td>2 165 000</td>
</tr>
<tr>
<td>400-500 mm</td>
<td>4 428 000</td>
</tr>
<tr>
<td>300-400 mm</td>
<td>3 051 300</td>
</tr>
<tr>
<td>300 mm</td>
<td>47 674 006</td>
</tr>
<tr>
<td>LAND USED FOR AGRICULTURE (ha)</td>
<td></td>
</tr>
<tr>
<td>Cereals for grain (ha)</td>
<td>63 577 471</td>
</tr>
<tr>
<td>Other annual crops (ha)</td>
<td>1 917 519</td>
</tr>
<tr>
<td>Fallow (ha)</td>
<td>231 021</td>
</tr>
<tr>
<td>Vineyards (ha)</td>
<td>253 805+</td>
</tr>
<tr>
<td>Orchards and Vegetables (ha)</td>
<td>31 161</td>
</tr>
<tr>
<td>Pasture (ha)</td>
<td>25 975</td>
</tr>
<tr>
<td>Rangeland (ha)</td>
<td>3 588 848</td>
</tr>
<tr>
<td>Unproductive farm lands (ha)</td>
<td>39 272 000</td>
</tr>
</tbody>
</table>

| SUPERPHOSPHATE USED (tonnes P₂O₅) | |
| Crops | 241 723 |
| Pastures | 141 869 |

| CEREAL PRODUCTION | |
| Wheat harvested (ha) | 958 433 |
| Wheat yield (kg/ha) | 1 188 |
| Barley harvested (ha) | 852 046 |
| Barley yield (kg/ha) | 1 315 |

| LIVESTOCK | |
| Sheep | 17 276 077 |
| Cattle | 1 891 241 |

* Includes cereals for hay and green forage crops.
+ 1972/73 figures.

Source: 1975/76 Statistical Register
### Appendix 5b

**Agricultural Statistics**

(b) South Australian Wheat Production 1847-1975

<table>
<thead>
<tr>
<th>Period</th>
<th>Area (ha)</th>
<th>Fallow (%)</th>
<th>Phosphate Seed (%)</th>
<th>Yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphate use commenced</td>
<td>705 575</td>
<td>n.a.</td>
<td>18.5</td>
<td>363</td>
</tr>
<tr>
<td>1897-05</td>
<td>846 587</td>
<td>n.a.</td>
<td>77.4</td>
<td>662</td>
</tr>
<tr>
<td>1916-25</td>
<td>956 548</td>
<td>70</td>
<td>85.1</td>
<td>826</td>
</tr>
<tr>
<td>1946-35</td>
<td>1 421 274</td>
<td>67</td>
<td>88.2</td>
<td>593</td>
</tr>
</tbody>
</table>

Self-regenerating annual legumes became widespread

<table>
<thead>
<tr>
<th>Period</th>
<th>Area (ha)</th>
<th>Fallow (%)</th>
<th>Phosphate Seed (%)</th>
<th>Yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1936-45</td>
<td>981 290</td>
<td>65</td>
<td>90.1</td>
<td>778</td>
</tr>
<tr>
<td>1946-55</td>
<td>746 156</td>
<td>52</td>
<td>95.6</td>
<td>999</td>
</tr>
<tr>
<td>1956-65</td>
<td>840 152</td>
<td>35</td>
<td>98.5</td>
<td>979</td>
</tr>
<tr>
<td>1966-75</td>
<td>1 164 062</td>
<td>30**</td>
<td>98.5</td>
<td>1 140</td>
</tr>
</tbody>
</table>

* Percentage of wheat crop sown with superphosphate.

** This is very variable from district to district depending on soil type and rainfall pattern also price of livestock products.

Source: E.D. Carter (1975)
**APPENDIX 6**

**TYPICAL FARM IN THE CEREAL ZONE**

<table>
<thead>
<tr>
<th><strong>AREA:</strong></th>
<th>600 hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RAINFALL:</strong></td>
<td>375 mm - 400 mm</td>
</tr>
<tr>
<td><strong>CROPPING:</strong></td>
<td>Total: 280 ha of cereals Consisting of: 160 ha wheat 100 ha barley 20 ha oats</td>
</tr>
<tr>
<td><strong>FALLOW:</strong></td>
<td>40 ha</td>
</tr>
<tr>
<td><strong>PASTURE:</strong></td>
<td>280 ha</td>
</tr>
<tr>
<td><strong>SUBDIVISION:</strong></td>
<td>15 main paddocks, 3 small paddocks, 40 km of fencing.</td>
</tr>
<tr>
<td><strong>WATER:</strong></td>
<td>1 water point per paddock, 5 km of piping</td>
</tr>
<tr>
<td><strong>LIVESTOCK:</strong></td>
<td>1,000 sheep Comprised of: 500 Merino ewes (1½-3 Years) 300 Wethers 200 Young sheep 25 beef cows</td>
</tr>
<tr>
<td><strong>IMPROVEMENTS:</strong></td>
<td>Owner's house, shearing shed, implement shed, grain silos.</td>
</tr>
<tr>
<td><strong>MACHINERY &amp; PLANT:</strong></td>
<td>2 tractors (80 &amp; 50 H.P.), 1 header/harvester, 1 cultivator (29 hoe), 1 disc plough (18 disc), 1 combine seeder (24 row), harrows, wizeline searifier, siasher and hay rake, bulk grain equipment, truck, utility and workshop equipment.</td>
</tr>
<tr>
<td><strong>LABOUR:</strong></td>
<td>1 owner/operator, 3-4months casual labour for hay bailing, grain carting and contract shearing.</td>
</tr>
<tr>
<td><strong>PRODUCTION:</strong></td>
<td>The average production of the 600 ha farm over the last three years has been 6000 kg of wool, 4000 kg of meat and 420 tonnes of cereal grains.</td>
</tr>
</tbody>
</table>

**Source:** Farming Systems in South Australia (1976)
APPENDIX 7

A TYPICAL PAST YEAR ON A FARM IN THE CEREAL ZONE OF SOUTH AUSTRALIA
CROPPING ABOUT 50 PER CENT OF ITS AREA

WINTER: June, July, August.
With a normal seasonal opening
In May, legume pastures support
stock numbers through winter.

SPRING: September, October, November.
The spring flush of growth is normally
well ahead of stock needs and provides
valuable reserves for carryover dry
feed and/or paddocks for hay cutting.

LATE AUTUMN: April, May.
Opening rains normally come in late
April to May. Pastures then germinate. Continued head-feeding during
the first month of pasture growth is
often necessary to keep stock healthy.

EARLY AUTUMN: March, April.
During this period the last of the
paddock feed is eaten. Increased head-
feeding of hay and/or grain may be
necessary in less productive years.
Young growing stock and pregnant
females need hay and/or grain supple-
ments in most years.

EARLY SUMMER: December, January.
Carryover dry pastures are grazed during
this period with stubbles also becoming
available after the cereal harvest.

LATE SUMMER: January, February.
Normally pasture residues and
stubbles support stock in good
condition and last well into
early autumn.