DEPARTMENT OF AGRICULTURE AND FISHERIES, SOUTH AUSTRALIA

Agronomy Branch Report

REPORT OF VISIT TO CHINA FOR THE

PEKING AGRICULTURAL MACHINERY EXHIBITION

OCTOBER - NOVEMBER, 1978

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1. INTRODUCTION

1.1 Background To Visit

The Department of Trade and Resources accepted on behalf of the Australian Government an invitation from the Peoples 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 Peoples 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	Rumania

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 conjunctionwith 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, broadacre 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) - 400 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

Location	Mean Temperature °C		Mean Annual Rainfall
	January	July	
Harbin	-20°	20°	450 mm
Peking	- 5°	25°-30°	600 mm
Shanghai	5°	25°-30°	750 mm
Canton	15°	30°	1500 mm

1.2.4 The Economy and Development Plans

China's economy is bascially 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, petro-chemicals, 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).
- 85% mechanisation in all major processes of farmwork.

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 estimated 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).

* Agriculture

- Since only about 12% 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 400 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 40.5 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 (F.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, corn, 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 fertilisers built in the 1960s, China has recently purchased 13 synthetic ammonia-urea plants, 6 of which had come onstream by mid-1977.

Domestic production of phosphate and potassium fertilisers has been limited, and nitrogenous fertilisers 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 85% 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).

Heilungkiang 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:

October 16, 1978 (Monday)	Depart Adelaide for Sydney. Depart Sydney for Tokyo.	
October 17, 1978 (Tuesday)	Arrive Tokyo International Airport, Narita. Overnight Tokyo.	
October 18, 1978 (Wednesday)	Depart Tokyo for Peking. Arrive Peking Airport - Transfer to Friendship Hotel.	
October 19, 1978 (Thursday)	Peking	- Visit Machinery Exhibition. - Introduction to Seminar Interpreter.
October 20, 1978 (Friday)	Peking	- a.m. Exhibition - p.m. Preparation of Seminar.
October 21, 1978 (Saturday)	Peking	- a.m. Inspect Seminar Rooms. Attend session of 1st Seminars presented by Dr. P. McInnes & Mr. O. Sturgess. - p.m. . Exhibition - Pickup slides, films etc. for Seminars. . Prepare materials for Seminar.
October 22, 1978 (Sunday)	Peking	- a.m. Set up aids, charts, films in Seminar Room. - p.m. 1st Seminar on dryland farming.
October 23, 1978 (Monday)	Peking	- a.m. 2nd Session of Seminar on Dryland Farming. - p.m. 3rd Session of Seminar on Dryland Farming.
October 24, 1978 (Tuesday)	Peking	- a.m. Exhibition - p.m. Inspect local agriculture in Peking region
October 25, 1978	Peking	- a.m. Special meeting with officers of Ministry of Agriculture. - p.m. Visit city of Peking.
October 26, 1978 (Thursday)	Peking	- a.m. Local inspections. - 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 Lagochio 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 Lowu (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 29. 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	PRODUCTS ON DISPLAY
Alfarm Industries, ALBURY, N.S.W.	Agricultural machinery.
Chamberlain John Deere Pty. Ltd., WELSHPOOL, W.A.	Agricultural tractors and tillage equipment.
Connor Shea & Co. Pty. Ltd. SUNSHINE, Vic.	Agricultural machinery.
The Dunlite Electrical Company, OAKLEIGH, Vic.	Wind powered electricity generators, alternators and portable electricity generators.
The Farmers & Graziers' Co-op. Co. Ltd., SYDNEY, N.S.W.	Sheep and cattle handling equipment, electric fencing, drenching equipment.
Layne and Bowler Pump Company, FAIRFIELD, N.S.W.	High and low lift turbine pumps for industrial, agricultural and civil applications.
Napier Grasslands Pty. Ltd., TAREE, N.S.W.	Agricultural machinery.
Toft Bros. Industries Ltd., BUNDABERG, Qsld.	Sugarcane harvesting, transport and agricultural equipment.
Toowoomba Foundry Pty. Ltd., TOOWOOMBA, Qsld.	Windmills, water storage tanks, pumps and pumpheads, self-propelled irrigators and irrigation equipment, water troughs.
Transavia Corporation Pty. Ltd., SEVEN HILLS, N.S.W.	Agricultural aircraft used for fertilising crops and for spraying to control insects and crop disease.
Simpson Pope Ltd., DUDLEY PARK, S.A.	Travelling irrigators.
Sunbeam Corporation Ltd., CAMPSIE, N.S.W.	Sheep shearing and wool handling equipment.

3.3 Australian Personnel At The Peking Exhibition

AUSTRALIAN GOVERNMENT

Mr. E. Waldron (Ted), Director,	Department Trade and Resources.
Mr. R. Dulfer-Hyams (Rob), Deputy Director-Marketing,	Department Trade and Resources.
Mr. C. Spendlove (Cyril), Deputy Director-Exhibitions,	Department Trade and Resources.

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

EXHIBITING COMPANIES

Mr. L. Mulkearns, Managing Director,	Alfarm Industries
Mr. N. Cahill, Export Manager,	Alfarm Industries
Mr. E. Smith, Area Manager,	Alfarm Industries
Mr. P. Griffiths, General Manager,	Chamberlain John Deere Pty. Ltd.
Mr. H. Grove, Export Controller,	Chamberlain John Deere Pty. Ltd.
Mr. R. Patterson, Works Manager,	Chamberlain John Deere Pty. Ltd.
Mr. H. Tams (Harry), Sales Manager,	Chamberlain John Deere Pty. Ltd.
Mr. J. Kent, Sales Manager,	Connor-Shea & Co. Pty. Ltd.
Mr. A. Boyd (John),	Connor-Shea & Co. Pty. Ltd.
Mr. J. Tralau (John), Marketing Manager,	Dunlite Electrical Co.
Mr. J. Jaeger,	Dunlite Electrical Co.
Mr. B. Nolte, General Manager,	Dunlite Electrical Co.
Mr. Bray (Col), Chairman),	Farmers & Graziers' Co-op. Co. Ltd.
Mr. C. Bottrell, Merchandise Manager,	Farmers & Graziers' Co-op. Co. Ltd.
Mr. P. Ryrie, Manager,	Layne & Bowler Pump Co.
Mr. J. Broinowski (Gillis), Director,	Napier Grasslands Sales Pty. Ltd.
Mr. D. Daniell (David), Agricultural Consultant,	Napier Grasslands Sales Pty. Ltd.
Mr. P. West, Manager,	Simpson Pope Ltd.
Mr. R. Bastian, Executive,	Simpson Pope Ltd.
Mr. J. Allen (John), General Manager,	Sunbeam Corporation Ltd.
Mr. L.J. Court (Len), Marketing Manager,	Toft Brothers Industries Ltd.
Mr. G. Powell (Gordon), Regional Manager,	Toft Brothers Industries Ltd.
Mr. J. Kong (James), Executive,	Toft Brothers Industries Ltd.
Mr. C. Golledge, Overseas Marketing Manager,	Toowoomba Foundry Pty. Ltd.
Mr. G. Forrester (Gil), Engineer, and Mrs. S. Forrester	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. O. Sturgess, Director,	Sugar Experimental Stations, Queensland.
Mr. W. Devrell, Export Manager,	Commonwealth Sugar Refineries, Queensland.

4. SEMINARS:

4.1 General

The technical seminar programme was an intergral 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, Heifungkian, Honan, Ningsia, 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.
- Sowing methods and seeding machinery.
- Soil conservation practices.
- Small seed harvesting.
- Nitrogen - fertiliser 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 "Ley 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., Heilungkrans, Kirin, Ningsia Hin Autonomous Region, Liaoning Kansu and Hopei provinces. The major participants were:-

- Mr. Hsu Hsieh-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 Ta-chen, Engineer of Research Institute of Ag. Mech. of Kirin Province.
- Mr. Wu Chieh-hsian, Engineer of Research Institute of Mechanised Farming of Kirin Academy of Agriculture.

- Mr. Wu Pao-chu, Head of Agricultural Management Division of Chiu 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. Han Chin-yuan, Engineer of Research Institute of Ag. Mech. of Ningisa Province.
- Mr. Shih Tsuin, Engineer of Research Institute of Ag. Mech. of Liaoning Province.
- Mr. Chen Chan-fiang, Engineer of Research Institute of Ag. Mech. of Kansu Province.
- Mr. Chao Chin-tsai, Engineer of Nanking Institute of Soils of Chinese Academy of Science.
- Mr. Tao Lih-san, Interpreter of North China Institute of Agricultural Mechanisation.

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 special 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 58 000 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 soil 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 Abanian-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 32 000 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 Logochio 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 20 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 Hopei Province and runs westward to the Chiayu Pass in Konsu 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.

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

Ting Ling 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 1 195 square metres.

5.2.3 The Palace Museum

The Palace Museum is the imperial palace of the Ming and Ching 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 Yung 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 52 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 Peking. 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 Chou Dynasty and a glazed nin-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 Peking.
- The Peking Jeep Factory.
- The underground Civil Defence system.
- Tien 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.

5.4 Train Journey From Peking To Kwangchow

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 2000 km and took almost 36 hours. It provided the opportunity to observe in day light a section of China from Chengchow to Changsha, and then a section of the southern country north of Canton through to Luwon 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 cured 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 Yangtse Kiang River. Many river steamers and junks were using the river to transport a wide variety of good. 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 apearance 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 was 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 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:

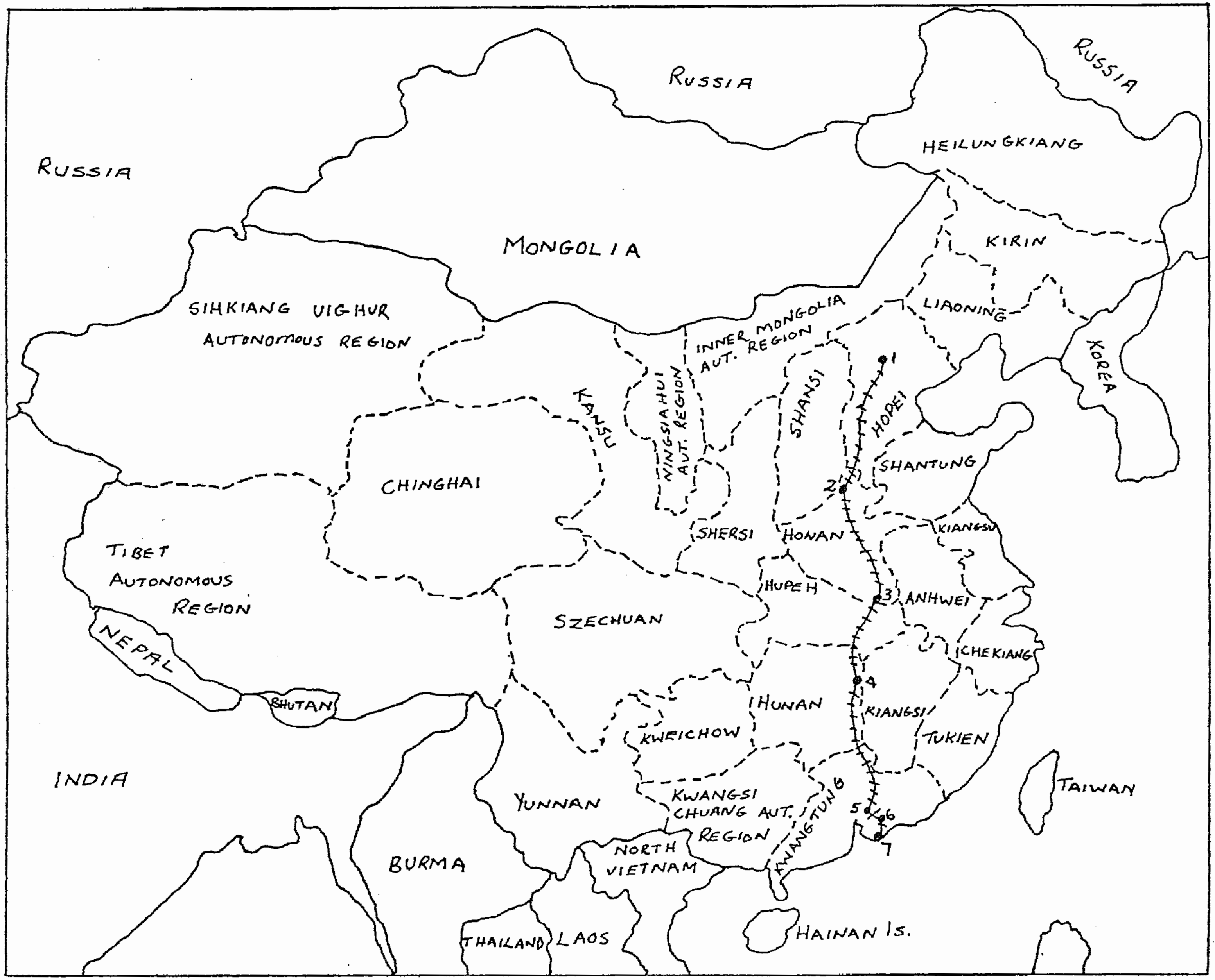
The exhibition has been classified as very successful. The Hong Kong press noted Chinese officials as describing the whole event as "a complete success". (See Appendix 4)

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 reopned 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.

<u>APPENDIX 1:</u> <u>CHINA AND ITS PROVINCES</u>



1. PEKING
2. CHENGCHOW
3. WUHAN
4. CHANGSHA
5. KWANGCHOW
6. LOWU
7. HONG KONG

--- PROVINCE BOUNDARIES

+++ RAILWAY

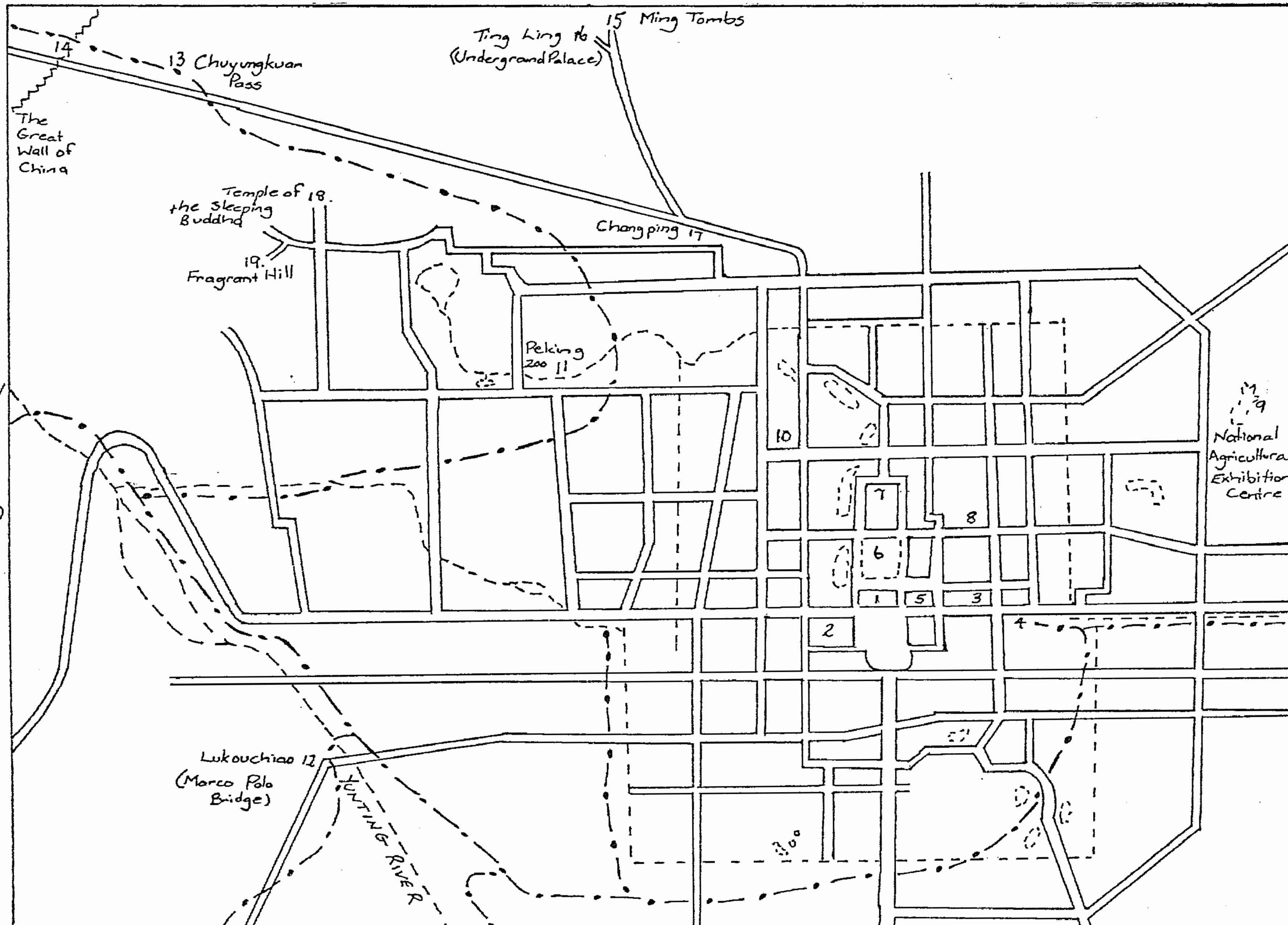
1:25,000,000

0 200 400 600 800 miles

0 300 600 900 1200 kilometres

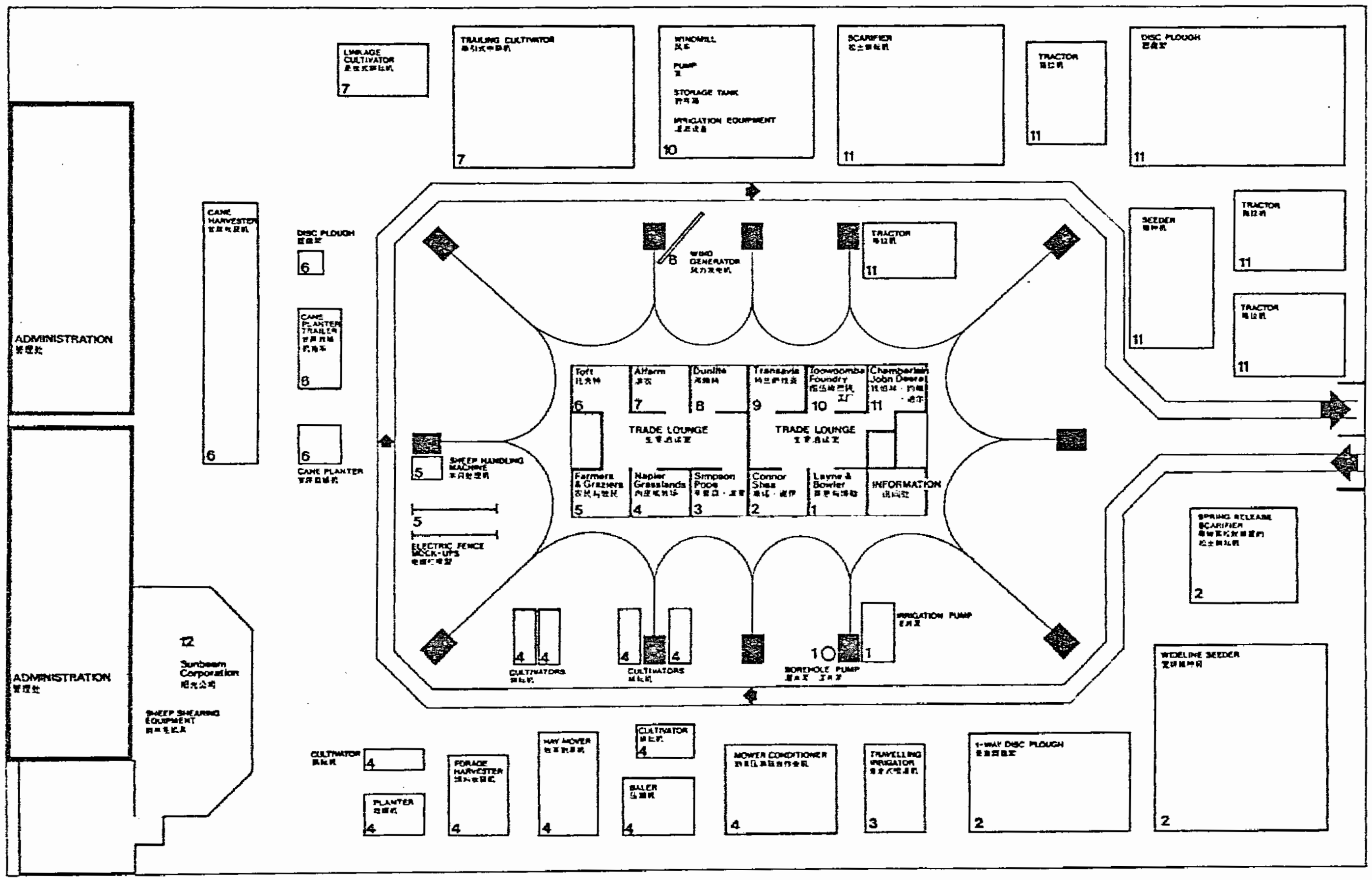
APPENDIX 2: PEKING

1. Tien An Men
2. Great Hall of People
3. Peking Hotel
4. Peking Railway Station
5. Peking Department Store
6. Palace Museum
7. Coal Hill
8. Capital Theatre
9. National Agricultural Exhibition Centre
10. People's Theatre
11. Peking Zoo
12. Lukouchiao (Marco Polo Bridge)
13. Chuyungkuan Pass
14. The Great Wall at Pata ling.
15. Ming Tombs
16. Ting Ling (Underground Palace)
17. Changping
18. Temple of the Sleeping Buddha. (Wofoszu)
19. Fragrant Hill (Hsiangshan)



- - - Water courses
-·-·- RAILWAY LINE

APPENDIX 3: DISPLAY PLAN OF AUSTRALIAN EXHIBIT



Exhibitor Legend

1. Layne and Bowler Pump Company
2. Connor Shea & Co Pty Limited
3. Simpson Pope Ltd
4. Napier Grasslands Pty Limited
5. Farmers and Graziers' Co-operative Co Ltd
6. Toft Bros Industries Ltd
7. Alfarm Industries Pty Ltd
8. The Dunlite Electrical Company
9. Transavia Corporation Pty Ltd
10. Toowoomba Foundry Pty Ltd
11. Chamberlain John Deere Pty Ltd
12. Sunbeam Corporation Ltd

参展商名单

1. 莱恩与博勒泵具公司
2. 康诺·谢伊有限公司
3. 辛普森·波普有限公司
4. 内皮尔牧场有限公司
5. 农民与牧民合作有限公司
6. 托夫特兄弟工业有限公司
7. 澳农工业有限公司
8. 邓禄特电机公司
9. 特兰萨维亚有限公司
10. 图伍姆巴铸工厂有限公司
11. 钱伯林·约翰·迪尔有限公司
12. 阳光有限公司

AUSTRALIAN DISPLAY FLOOR PLAN
of companies and products

澳大利亚展览场地图
公司和产品

PEKING FOREIGN AGRICULTURAL MACHINERY EXHIBITION
october 20 – november 3, 1978

北京外国农业
机械展览会
一九七八年十月二十日至十一月三日

APPENDIX 4

"Media Report of Exhibition"

Standard

HK tennis classic on today

HONGKONG STANDARD Saturday, November 4, 1978 Page 3

NEWSPAPER

Machinery exhibition a complete success

PEKING, Fri. – Peking's first international agricultural machinery exhibition, described 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 three-week exhibition was so successful and the demand to see it so great, the officials told Reuter, that they planned to reopen it for a period to display equipment China had purchased from the stands of the 12 countries represented.

Premier Hua Kuo-feng and other leaders underlined 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 outskirts last Sunday.

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

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

The exhibitors in turn said they had been impressed by the interest, searching 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 farmland construction equipment such as bulldozers and huge trucks, and machinery ranging through tractors, ploughs, seeding equipment and harvesters. There was a wide variety of specialised equipment also on show.

The fair officials said China had 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 initiative.

Both the officials and individual exhibitors were generally optimistic that the show would lead to further contacts and possibly contracts in the future, although the full impact would not be immediately apparent.

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

The officials said it would take time to compare and assess the various items before final decisions were made.

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

The United States was a notable absentee, but major American companies like International Harvester, John Deere, Caterpiller and Allis Chalmers had products on display at various stands through subsidiaries or joint ventures.

United States Agriculture Secretary Bob Bergland is also due in Peking tomorrow to strengthen further the growing agricultural ties with China.

An important feature of the machinery exhibition was the more than 200 technical discussions and seminars put on by various companies for the Chinese.

One exhibitor said the four three-hour seminars his company had put on had each extended to between nine and 12 hours. "We were very gratified with the level of people in technical exchanges, and the interest and real business-like approach they showed," he said. – Reuter

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 predicability, the soils are mainly alkaline, and vary from shallow rubbly 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

PEKING AGRICULTURAL MACHINERY EXHIBITION

SEMINAR IN DRYLAND FARMING

by

G.D. Webber

- SLIDE DETAILS -

1. LOCATION AND RAINFALL

Slide No.	Description
1.	Map of Australia - showing location of South Australia.
2.	Rainfall Map of South Australia.

2. LAND USE ZONES

3.	Map showing land use zones of South Australia.
4.	Pastoral zone - native grass and bush steppe.
5.	Pastoral zone - Blue Bush Country.
6.	Pastoral zone - Salt Bush and Blue Bush.
7.	Cereal zone - showing cropping land and pastures.
8.	Cereal zone - lower rainfall areas.
9.	Higher rainfall zone - showing fat lamb production.
10.	Higher rainfall zone - showing legume-grass pastures.
11.	Higher rainfall zone - showing dairy cattle production.
12.	Higher rainfall zone - range grazing of beef cattle.

3. CLIMATE

13.	Chart of temperature and rainfall distribution at three centres.
14.	Chart of wheat production by rainfall zones.

4. SOIL EROSION AND SOIL CONSERVATION

15.	Wind erosion.
16.	Wind erosion.
17.	Water erosion.
18.	Water erosion - rilling.
19.	Poor crop growth.
20.	Building contour banks.

Slide No.	Description
21.	Building contour banks.
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.
26.	Chart of soil nitrogen increase under legume pasture in Southern Australia.
27.	Chart of soil nitrogen increase under longer term pasture at Kybybolite.
28.	Chart showing effect of land use systems on soil structure in Northern Agricultural areas of South Australia.

6. IMPACT OF LEY 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, Stanley and Gawler.
30.	Chart showing ncrease 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 Turretfield Research Centre.

7. THE ANNUAL LEGUMES

34.	Medic pasture.
35.	Subterranean clover pasture.
36.	Chart showing the growing season annual medics.
37.	Harbinger medic.
38.	Close up of Harbinger medic.
39.	Jemalong 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.

Slide No.		Description
9.	MACHINERY	
	45.	Disc plough
	46.	Disc plough (Tandem).
	47.	Cultivator (expanda-wing).
	48.	Wide-line cultivator.
	49.	Combine drill.
	50.	Combine drill.
	51.	Wide-line combine drill.
	52.	Sowing cereal crop.
	53.	Applying pre-emergent herbicide.
10.	LIVESTOCK GRAZING	
	54.	Sheep grazing medic pasture.
	55.	Cattle grazing medic pasture.
11.	CONSERVED FODDER	
	56.	Baled medic hay in shed.
12.	HARVESTING METHODS	
	57.	Harvesting clover seed.
	58.	Harvesting clover seed (replace).
	59.	Harvesting medic seed.
	60.	Harvesting rolled barley.
	61.	Harvesting wheat with pull-type header.
13.	MISCELLANEOUS	
	62.	Stone picker.
	63.	Terminal silo complex - Wallaroo.
	64.	Clover seed for export.
	65.	Other agricultural exports.

C O N T E N T S

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S E M I N A R   P A P E R

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

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 plateau 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 wheats. 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 2a & 2b) 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.

1.3 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 here a low intensity grazing system is based on a 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 spelled 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.

<u>The higher rainfall zone</u> (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 pome 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.

<u>The three zones</u> 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 ARABLE 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 States wheat is harvested in 250-400 mm annual rainfall area. (See Table 1)

TABLE 1

WHEAT PRODUCTION IN SOUTH AUSTRALIA BY RAINFALL ZONES

Annual Rainfall Zones	Percentage of South Australian wheat production (Mean production over 10 year period 1966-1975)
Less than 300 mm	8%
300 mm to 400 mm	57%
Over 400 mm	35%
Over 500 mm	less than 1%

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 rubbly 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 stoney mallee 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 Exploitive 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 subterraneum*. 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 Gawler (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, GAWLER

Period	Wheat			Barley			Total cereal production	Sheep and wool		Cattle
	Area sown '000 ha	Production '000s tonnes	Yield t/ha	Area sown '000 ha	Production '000s tonnes	Yield t/ha	Wheat, barley, oats '000s tonnes	Numbers '000s	Wool production '000s kg	Total nos.
1931-40	263	274	1.04	42	36	0.86	315	543	2 792	30 392
1941-50	192	224	1.17	55	56	1.02	310	667	4 386	29 810
1951-60	157	251	1.60	96	137	1.43	412	938	7 521	30 101
1961-70	213	314	1.47	91	114	1.25	451	1 050	8 744	34 580

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 1961-70 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

Period	Wheat			Barley			Total cereal production	Sheep and wool		Cattle
	Area sown '000s ha	Production '000s tonnes	Yield t/ha	Area sown '000s ha	Production '000s tonnes	Yield t/ha	Wheat, oats and barley '000s tonnes	Numbers '000s	Wool production '000s kg	Total nos.
1931 40	1 326	939	0.71	151	142.3	0.95	1 125.5	8 504	33 731	331 156
1941-50	824	712	0.87	205	222.5	1.09	990.6	9 226	42 842	422 034
1951-60	633	779	1.25	468	579.4	1.24	1 477.0	13 658	70 703	522 797
1961-70	1 128	1 272	1.14	503	537.5	1.07	1 943.5	17 120	100 574	725 323

The alkaline soil areas which grew Medicago spp. successfuly 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 medic areas of Hundred Wokurna 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

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

* 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)

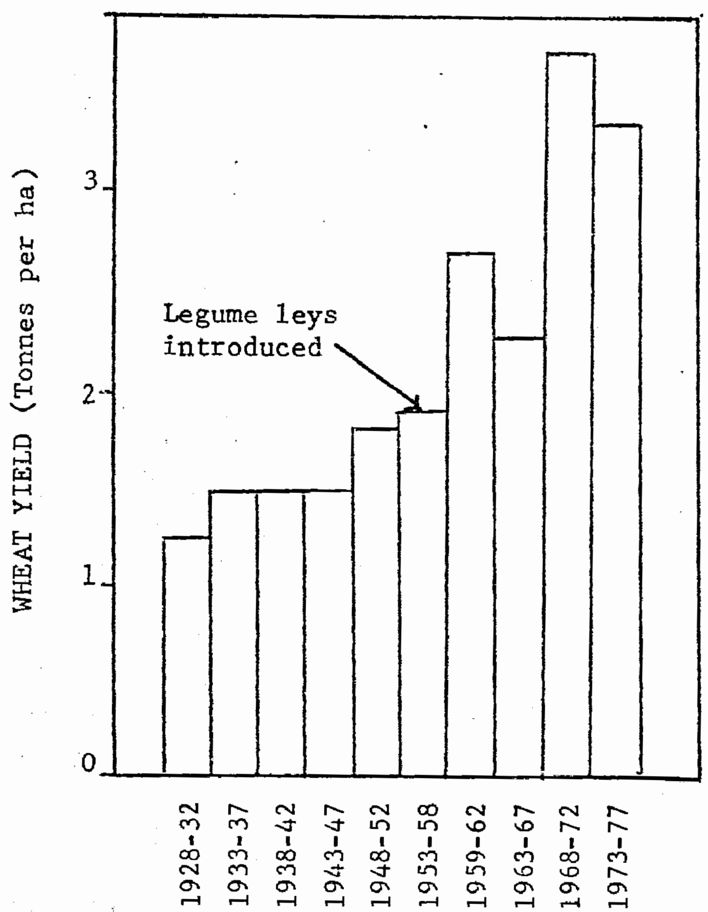
However, in areas where the subterranean clovers were successfully sown, increases in soil fertility resulted in production gains at least equal to gains made in medic areas.

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).

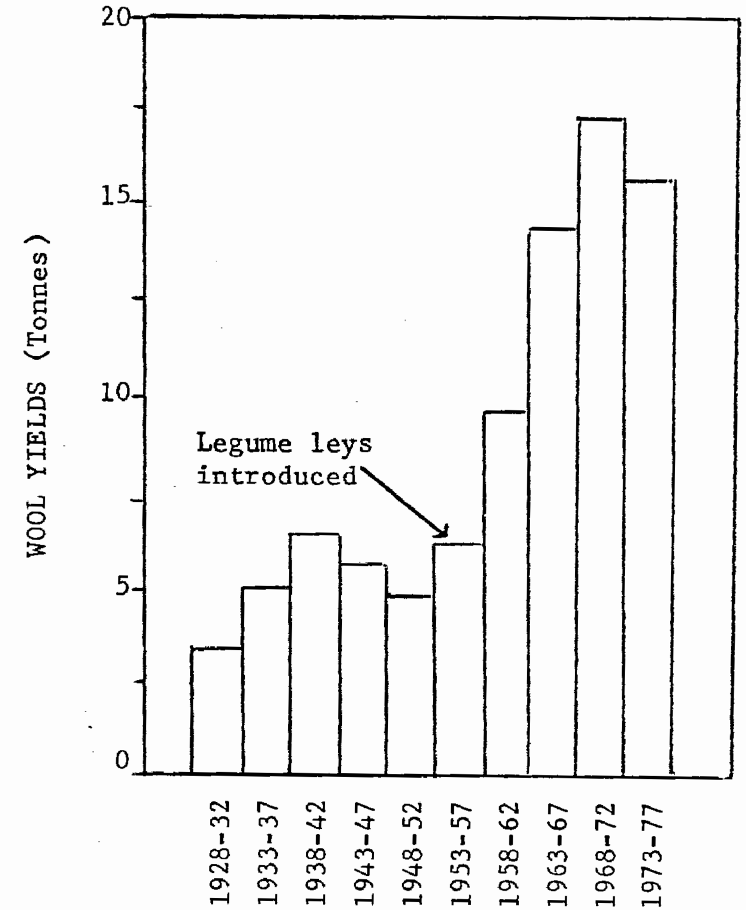
FIGURE 1: EFFECT OF LEGUME LEYS ON WHEAT AND WOOL PRODUCTION - TURRETFIELD RESEARCH CENTRE*

(* Turretfield 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 YIELDS (Tonnes/ha)



(B) WOOL YIELDS (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 rises 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-forming 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

300 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 5

SOIL MEASUREMENTS OF THE NET INCREMENTS OF SOIL NITROGEN UNDER LEGUME PASTURES IN SOUTHERN AUSTRALIA

LOCATION	SOIL	PERIOD OF MEASUREMENTS (YEARS)	PASTURE	DEPTH OF SOIL SAMPLED (cm)	INCREMENT PER YEAR (kg/ha/year)
Kojonup, Western Australia	sandy	2	subterranean clover	0-10	81
Turretfield South Australia	red brown earth	2	subterranean clover	0-10	182
Merridin, Western Australia	calcareous solonized soil	2	medic	0-25	39
Longerenong, Victoria, Australia	grey soil of heavy texture	4	medic	0-15	117
Longerenong, Victoria, Australia	grey soil of heavy texture	8	medic	0-15	93

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 oversupply 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 6

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

SOIL TYPE	LAND USE	PERCENTAGE AGGREGATION	
		> 0.2 m	>0.7 mm
Belalie Loam	Uncultivated natural pasture (in natural state)	50.2	79.9
	Three (3) year rotation Fallow, Wheat, Pasture	42.1	74.9
	Fallow-Crop rotation	16.5	60.8
Yangya Silt Loam	Uncultivated natural pasture (in natural state)	73.5	78.2
	Three (3) year rotation Fallow, Wheat, Pasture	48.5	69.0
	Fallow-Crop rotation many years	32.0	63.8

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 exploitive systems. The green feed period in a normal season is short, (5 - 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 leys. The pastures have annual legumes as their main component. These are either cultivars of *Medicago* spp. or *Trifolium subterraneum*.

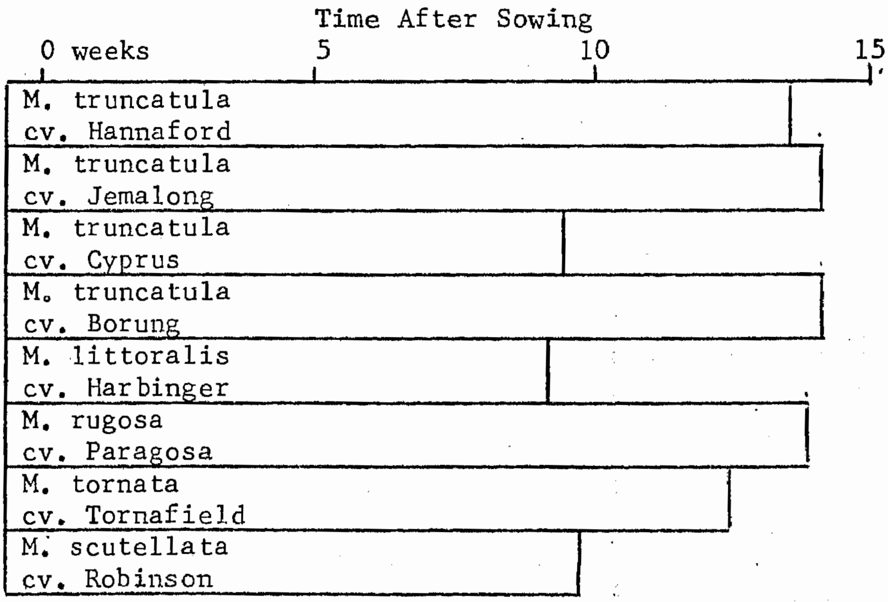
5.1 Medic (*Medicago* spp.)

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 medics are Burr (*M. polymorpha*), Wooly Burr (*M. minima*), Barrel (*M. truncatula*) and Strand (*M. littoralis*).

Five annual medic species are sown in South Australia and there are eight cultivars within these species that are registered. Barrel medic, (*M. truncatula*), Stand medic, (*M. littoralis*) and Snail 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 medics) to suit the various climatic areas of the cereal zone.

FIGURE 2: FLOWERING AND MATURITY TIMES FOR ANNUAL MEDICS



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, sandier, 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-medic areas of the State.

The main cultivars now sown in the cereal zone are *Clare*, *Geraldton*, *Woogenellup*, *Daliak* 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 peat carrier, 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* spp. 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-pasture-crop-pasture rotation has been used in some areas for over 30 years. Better germination of *Medicago* spp. 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.

Whatever the cropping system used, it is important that seed reserves be maintained at a high level to promote vigorous medic 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 medic 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 medic 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 medic pastures are:-

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

* Wheat-pasture-wheat-pasture where medic 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 fallow-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 seasons of pasture depending on the growth of Medicago.

* On heavier soils, particularly in the more favoured rainfall areas, where fallowing 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 Peas (*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, resowing 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 presowing cultivations to prepare a suitable seed bed and control early weed germinations is critical, so that seeding 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 bridle 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:-

* <u>The initial breaking up of land</u> is carried out in early spring (by mid September) if the field is to be fallowed 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 tyned 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.

* <u>Follow up cultivations and subsequent workings</u> 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 tyne 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 60 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 8% of the cereal crop is sown 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 ½-1 cm of soil).

* Seeding rates and fertiliser

  Rates of 8-12 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 on rough 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 P205/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 medics 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 thrashers 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 medics.

* In most cereal districts the newer suction-type harvesters reap about 0.5 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 farmerowned 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 realized.

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.

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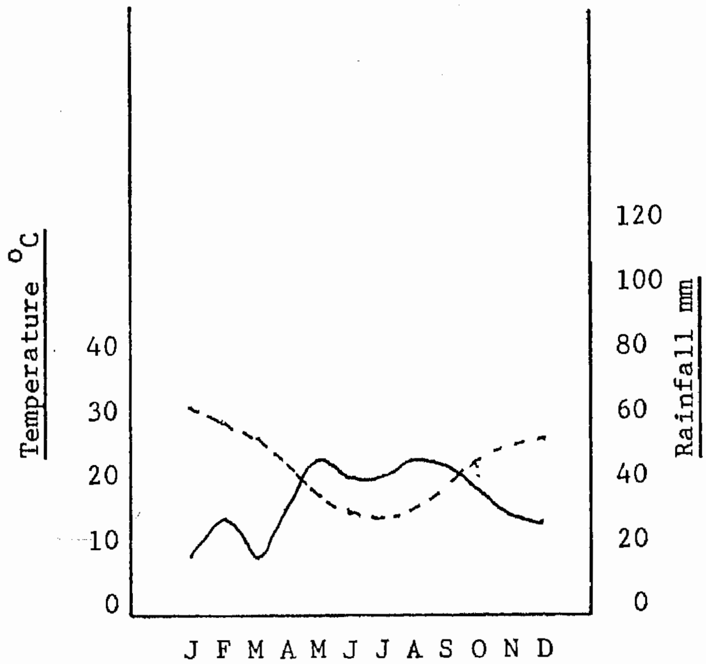
FIGURE 3: AVERAGE MONTHLY RAINFALL AND TEMPERATURE DATA FROM KEY CENTRES IN THE SOUTH AUSTRALIAN CEREAL ZONE

LAMEROO

Altitude: 97.8 metres

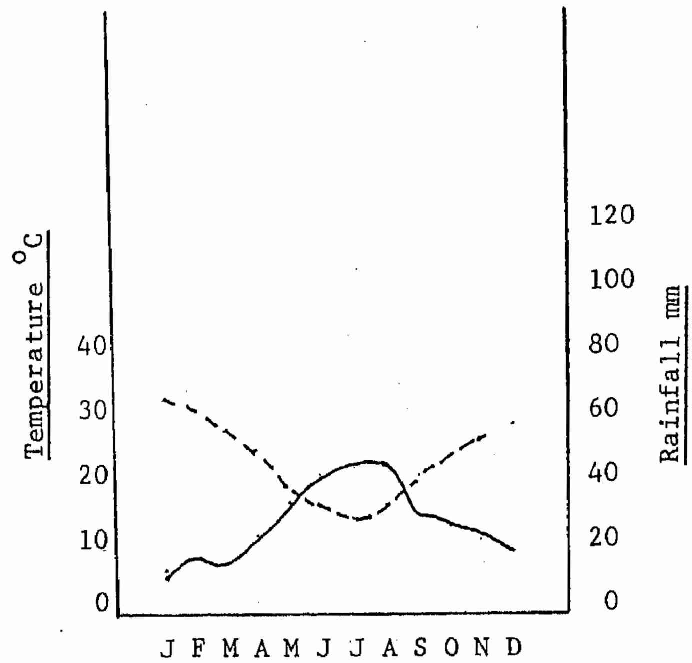
Mean Annual Rainfall: 393 mm



KYANCUTTA

Altidude: 58.2 metres

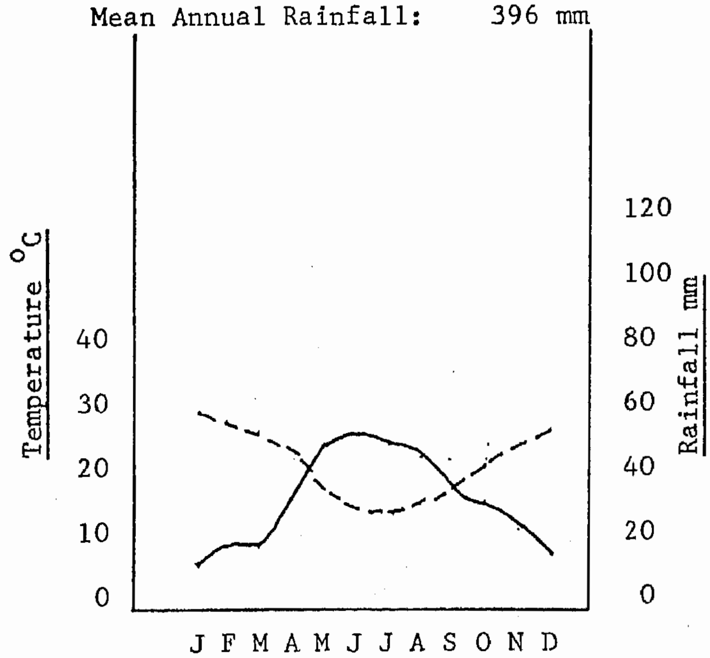
Mean Annual Rainfall: 330 mm



KADINA

Altitude: 44.2 metres

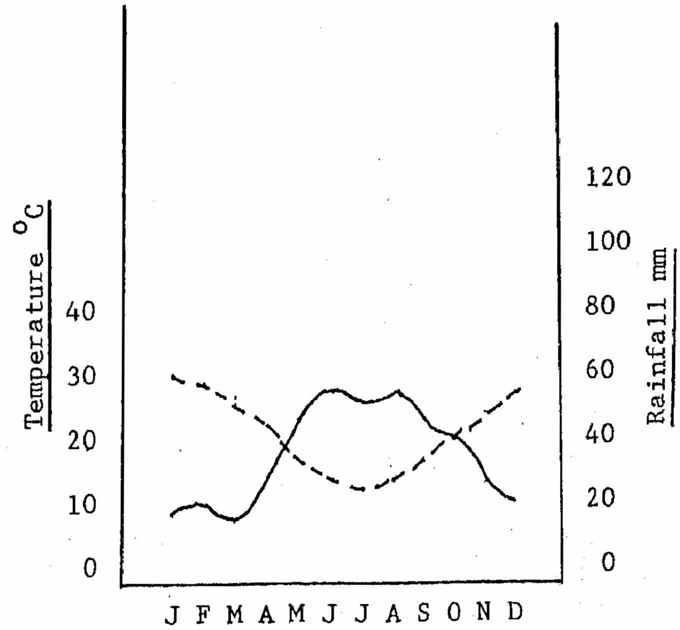
Mean Annual Rainfall: 396 mm



GEORGETOWN

Altitude: 273.1 metres

Mean Annual Rainfall: 468 mm



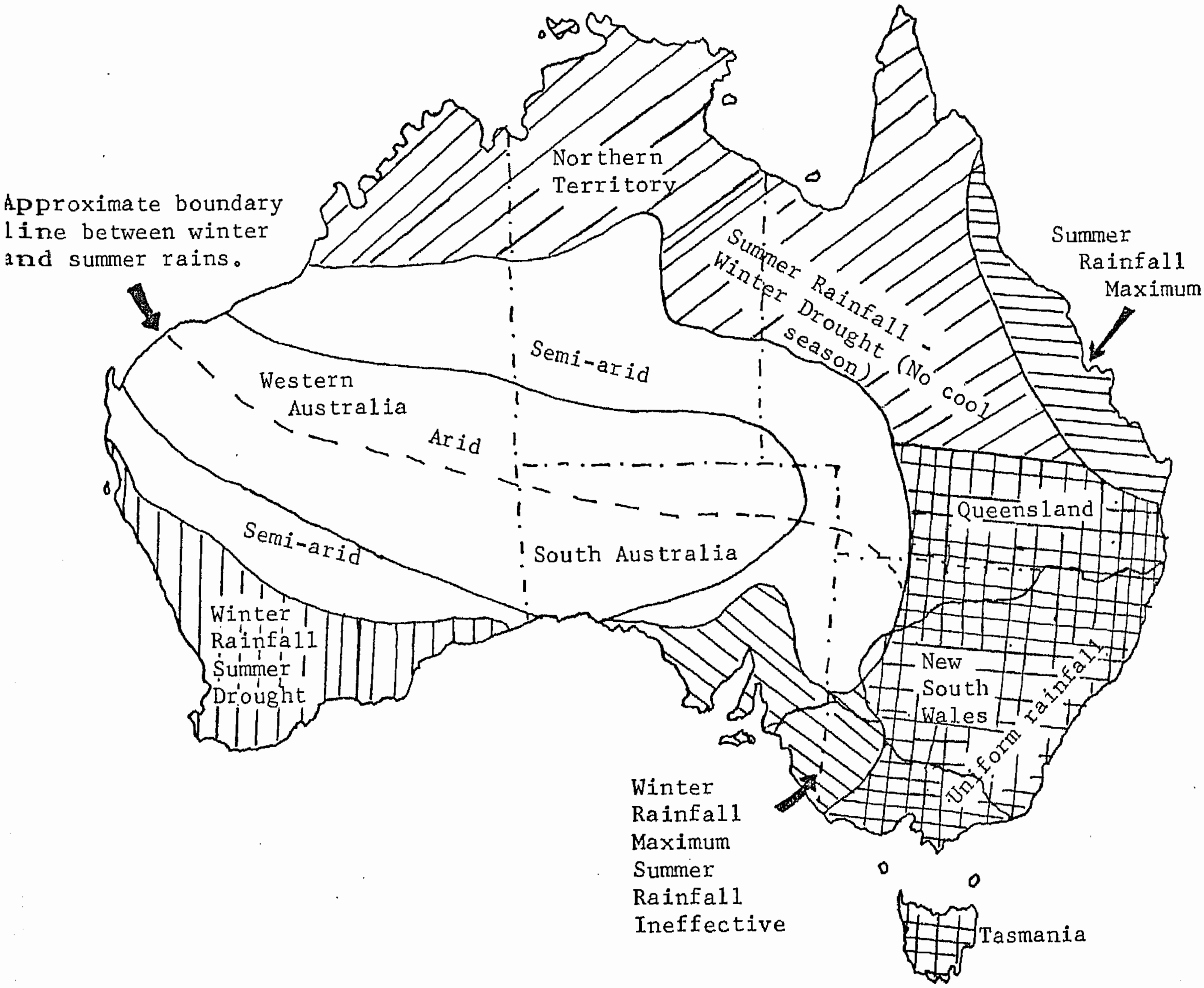
- - - = Temperature

—— = Rainfall

APPENDIX 1

MAJOR CLIMATIC ZONES OF AUSTRALIA

(Based Mainly On Rainfall)

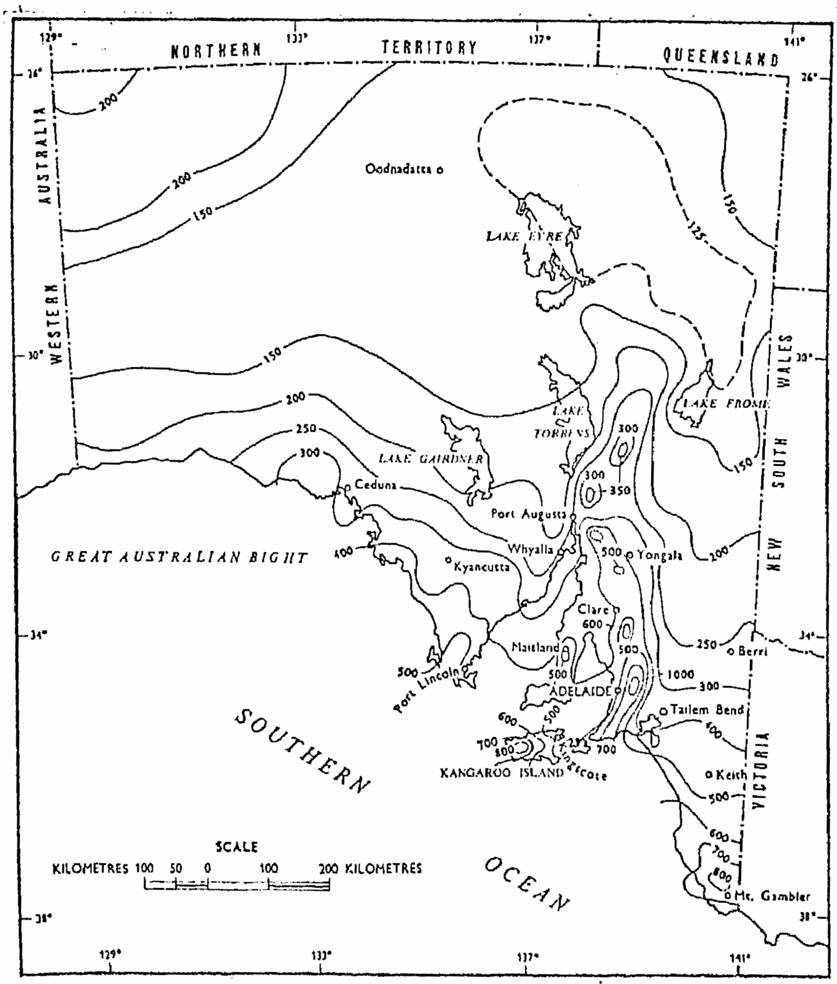


Source: Nuttonson (1958)

APPENDIX 2a

RAINFALL STATISTICS

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



Source: South Australian Year Book, 1976.
Bureau of Statistics.

APPENDIX 2b

RAINFALL STATISTICS

(b) Distribution of Rainfall, South Australia and Australia

AVERAGE ANNUAL RAINFALL	PROPORTION OF TOTAL AREA	
	SOUTH AUSTRALIA %	AUSTRALIA %
Under 250 mm	82.6	38.8
250 mm and under 400 mm	9.1	19.8
400 mm and under 500 mm	4.5	11.2
500 mm and under 600 mm	2.6	9.5
600 mm and under 750 mm	0.8	7.5
750 mm and under 1000 mm	0.4	6.2
1000 mm and over	*	7.0
TOTAL:	100.0	100.0

* 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.

APPENDIX 2c

RAINFALL STATISTICS

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

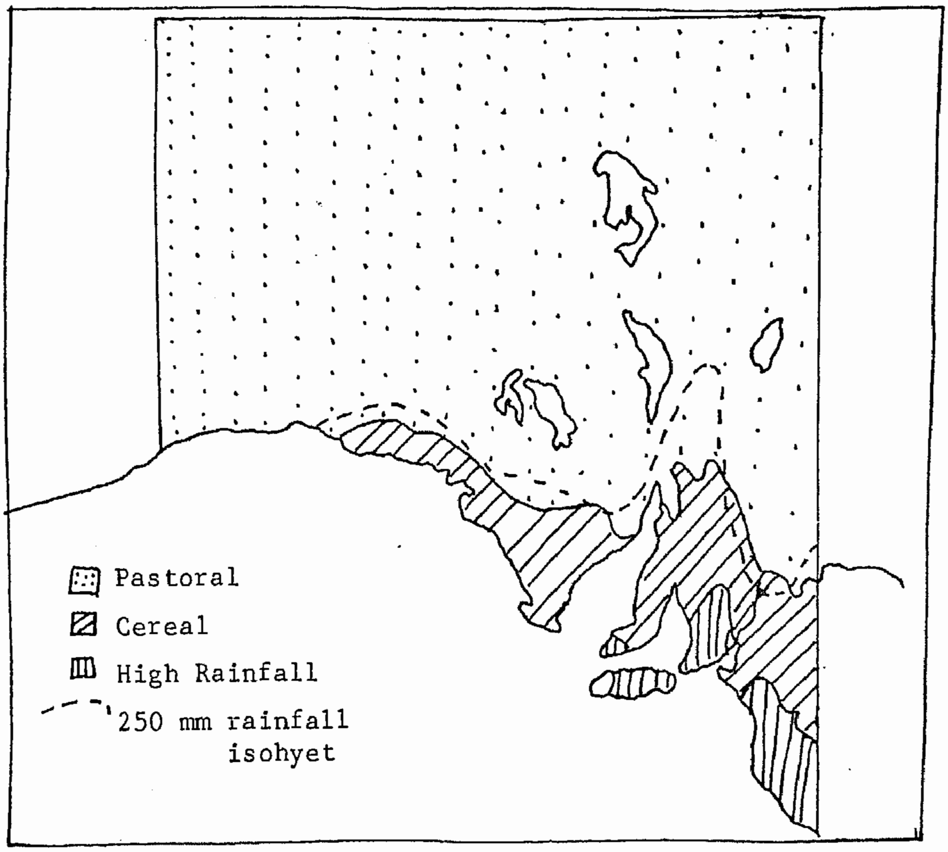
CENTRE	*LTM	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	Mean
		Annual Rainfall (mm) : 1951-60 Period										
Minnipa	351	465	391	422	273	453	593	232	426	207	491	395
Kadina	386	481	463	344	333	500	512	261	369	218	432	391
Roseworthy	435	561	644	455	395	544	519	238	411	274	551	459
Lameroo	384	395	381	437	354	533	515	222	394	207	419	386
Crystal Brook	393	486	535	425	367	509	510	270	294	209	523	413
Mean	390											409

CENTRE	*LTM	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	Mean
		Annual Rainfall (mm) : 1961-70 Period										
Minnipa	351	218	241	303	394	264	449	214	580	350	264	328
Kadina	386	334	301	411	366	257	411	213	517	441	319	357
Roseworthy	435	397	419	474	463	274	451	221	615	489	423	423
Lameroo	384	413	397	454	439	307	329	199	457	498	351	384
Crystal Brook	393	414	299	397	380	313	405	195	485	442	411	374
Mean	390											373

*LTM = Long Term Mean

APPENDIX 3

LAND USE OF SOUTH AUSTRALIA



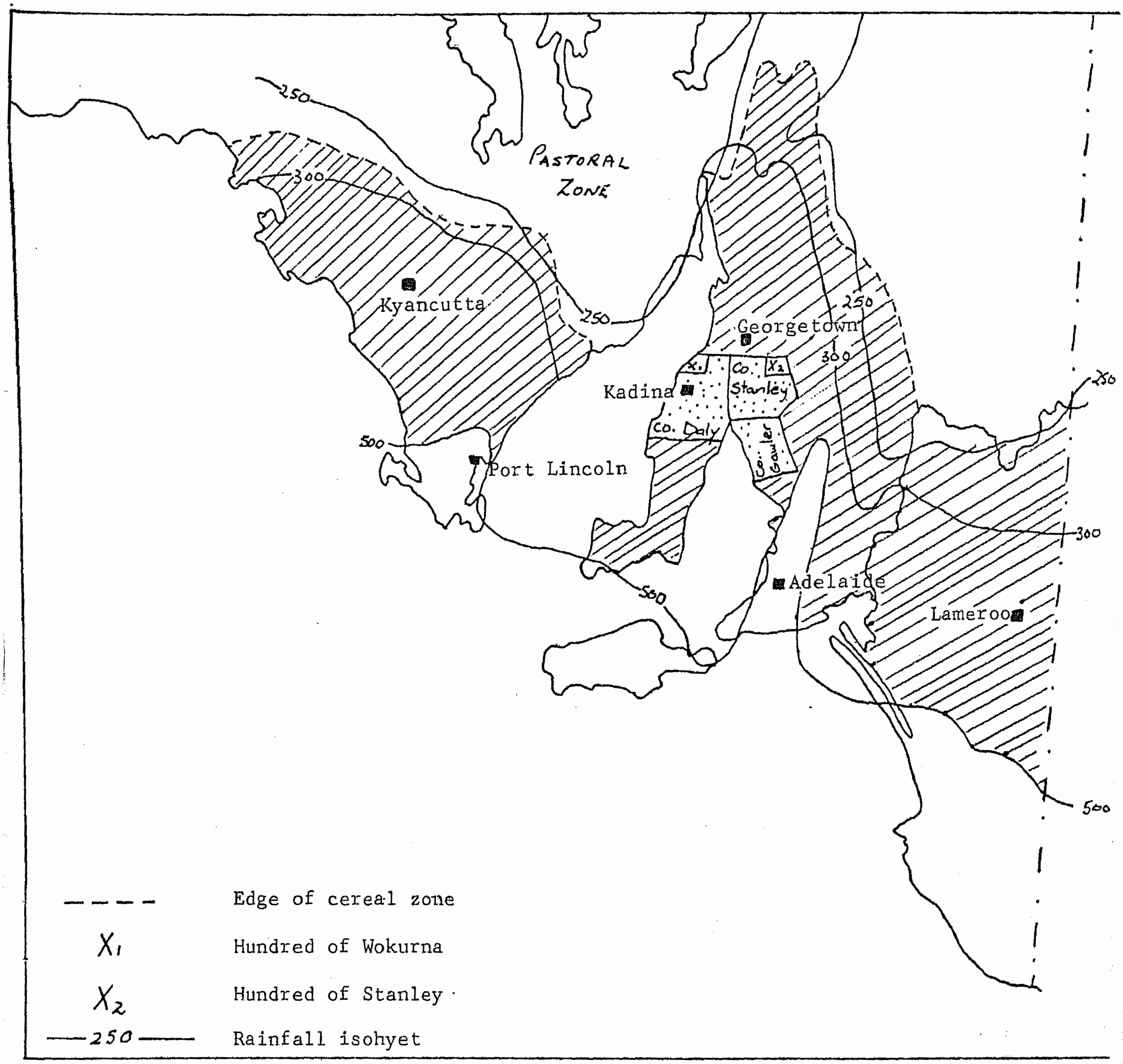
Source: Pasture Seeds from South Australia

APPENDIX 4

LOCATION MAP

SOUTHERN PORTION OF SOUTH AUSTRALIA

SHOWING COUNTIES DALY, STANLEY, AND GAWLER IN CEREAL ZONE



APPENDIX 5a

AGRICULTURAL STATISTICS

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

TOTAL AREA (ha)	98 400 000
DISTRIBUTION OF LAND BY RAINFALL	
600 mm	1 082 000
500-600 mm	2 165 000
400-500 mm	4 428 000
300-400 mm	3 051 000
300 mm	87 674 000
LAND USED FOR AGRICULTURE (ha)	63 577 471
Cereals for grain (ha)	1 917 559
Other annual crops* (ha)	231 021
Fallow (ha)	293 803+
Vineyards (ha)	31 161
Orchards and Vegetables (ha)	25 975
Pasture (ha)	3 588 848
Rangeland (ha)	59 272 000
Unproductive farm lands (ha)	tr
SUPERPHOSPHATE USED (tonnes P_2O_5)	
Crops	241 723
Pastures	141 869
CEREAL PRODUCTION	
Wheat harvested (ha)	958 453
Wheat yield (kg/ha)	1 188
Barley harvested (ha)	832 046
Barley yield (kg/ha)	1 315
LIVESTOCK	
Sheep	17 279 077
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 1897-1975

PERIOD	AREA (ha)	FALLOW (%)	PHOSPHATE USED* (%)	YIELD (kg/ha)
Phosphate use commenced				
1897-05	705 575	n.a.	18.5	383
1906-15	845 587	n.a.	77.4	662
1916-25	956 548	70	85.1	826
1926-35	1 421 276	67	88.2	593
Self-regenerating annual legumes became widespread				
1936-45	981 290	65	90.1	778
1946-55	746 156	52	95.6	999
1956-65	840 152	35	98.5	979
1966-75	1 164 062	30**	98.5	1 140

* 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

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

Source: Farming Systems in South Australia (1976)

APPENDIX 7

A TYPICAL FEED 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.

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.

EARLY AUTUMN: March, April.

During this period the last of the paddock feed is eaten. Increased hand-feeding of hay and/or grain may be necessary in less productive years. Young growing stock and pregnant females need hay and/or grain supplements in most years.

LATE AUTUMN: April, May.

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