

South Australia's Potato Industry

Role of the SA Department of Agriculture/PIRSA in its development

Background

Potatoes were introduced as a key vegetable crop by First Fleet settlers, being planted initially in the Parramatta district west of Sydney. They were a staple crop of most home gardens from settlement through until the 1960's. South Australia's early commercial potato production developed mainly in the South East and Mt Lofty Ranges districts where higher rainfall favoured natural growth.



Harvested potatoes packed in hessian bags at Woodside, 1930. Hessian bags were used for transporting potatoes until the introduction of bulk handling and smaller consumer size plastic bags in the 1960's.

Source: State Library of SA Image 57990

Early 1900's development of irrigation in vegetable growing districts east and west of Adelaide resulted in expansion of potato production in those areas. Later, urbanisation of these vegetable growing areas during the 1950's and 1960's, forced many potato growers to move to the expanding vegetable growing district on the Northern Adelaide Plains (near Virginia and Gawler River). Larger properties, increased mechanisation and development of washed pre-packed consumer packs resulted in significant expansion of South Australia's potato production.

Today, potato production is predominantly along South Australia's eastern border in the South East, Mallee and Riverland districts. This range of climatic zones in conjunction with light sandy soils allows year round production of fresh potatoes. Combined with consolidation of marketing by a number of large packing sheds has resulted in South Australia becoming the major supplier of fresh potatoes to Australia.

The SA Department of Agriculture, PIRSA and SARDI have played an important role in introducing new technologies to the South Australian potato industry. This article provides an overview of the role of various personnel and the impact the technologies they introduced have had on South Australia's potato industry.



Potato harvester field day, Adelaide Hills 1959. Post WW2, the Department of Agriculture had a program to foster mechanisation and bulk handling to overcome farm labour shortages.

Development of the SA Potato Industry

Up until the mid 1800's, South Australia's potato production was focussed on supplying local markets. Development of the railway network enabled easier transport from country regions to cities and interstate trading commenced. Because potato cropping was reliant on natural rainfall, most production was in the cool, higher rainfall areas of the South East and Mt Lofty Ranges.

During the late 1890's there was significant expansion of commercial potato production. In 1905, the SA potato industry planted 9,540 acres of potatoes. More than 75% (7,242 acres) of these plantings were in the South East, with the remaining production being in the Mt Lofty Ranges and Adelaide Plains. At the time, growers were receiving £5/10/0 per ton, and the industry had a total value of £155,716.

By 1913-14, the South East district was exporting significant quantities of potatoes by rail to Victoria, New South Wales and Western Australia. SA's area of potato plantings gradually expanded until the 1930's when there was some decline during the Great Depression. A surge in plantings occurred during WW2 to meet the demands of the armed services (see SA Potato Marketing Act section).

Until the 1950's, the South East along with the Mt Lofty Ranges and Adelaide Plains (in areas that are now suburbs of Adelaide) continued as the main production districts. Growing under natural rainfall gave yields of 4 to 5 t/acre (10-12.5 t/ha). With widespread adoption of irrigation and fertilizers, yields more than doubled, and production expanded into emerging irrigation districts.



Bags of potatoes stacked ready for loading onto railway trucks at Mt Gambier railway yards, 1888. Through until the 1950's, the higher rainfall South East was South Australia's main potato production district.
Source: State Library of SA Image B14730



Hauling potatoes from a paddock near Rendelsham, 1914. Horses were used to transport bagged potatoes to railway sidings until more widespread adoption of motor vehicles in the 1930's and 1940's.
Source: State Library of SA Image B38556

Shortages of farm labour post WW2 encouraged mechanisation in the SA potato industry, especially the use of planters and harvesters. Port Implements at Gepps Cross (subsequently taken over by H.V. McKay) was a local manufacturer of a wide range of potato machinery between the 1950's and

1970's. Kaesler Brothers at Hahndorf also built potato harvesters, tractor mounted fork lifts and other bulk handling equipment during this period.

Development of underground water for irrigation on the Northern Adelaide Plains (Virginia and Gawler River areas) from the late 1950's triggered rapid expansion of potato production in this district. Low incidence of frost in this district enabled extension of the harvest season by mid-winter planting for early spring production, and delaying of harvest of autumn grown crops into winter (in sandy soils). Development of major potato washing and packing businesses on the Northern Adelaide Plains created the nucleus for long term fresh potato marketing across Australia.

By the mid 1980's potato growers were seeking larger areas of land where they could use long term crop rotations (to minimise the incidence of soil borne diseases like common scab) to improve the quality and attractiveness of washed potatoes.

South Australian Potato Statistics 1985-86*

District	Area (ha)	% of State Plantings	Yield (t)	Number of Growers
Adelaide Plains	1,077	28.3%	31,800	63
Mt Lofty Ranges (Adelaide Hills)	752	20.1%	24,200	90
Barossa	19	0.5%	600	5
Upper Murray	436	11.6%	10,200	22
Lower Murray	451	12.0%	11,700	15
South East	1,013	27.0%	34,600	42
Total	3,747		113,000	237

*Source: Australian Bureau of Statistics

The introduction of centre pivot irrigators enabled large scale production of potatoes on sandy soils in the Mallee and Riverland districts, reducing reliance on the Northern Adelaide Plains. This change to larger scale production operations in Riverland and Mallee districts, along with consolidation of marketing by several major washing/packing sheds resulted in significant expansion of South Australia's fresh potato production through the 1990's.

From 1985-86 to 1992-93, potato and vegetable production in the Mallee and Riverland expanded from 7,450 ha to 10,650 ha, an increase of 42%, driven in part by adoption of centre pivot irrigators in the Parilla, Pinnaroo, Lameroo and Waikerie, Loxton, Bowhill, and Nildottie districts. Expansion of these new production districts resulted in smaller scale higher cost potato production in the Mt Lofty Ranges declining rapidly in the 1990's.

Today (2014), South Australia is the nation's largest producer of potatoes, worth \$206m at the farm gate, and contributing \$440m to the state's gross food revenue. SA produces approximately 385,000 t of fresh potatoes and 100,000 t of potatoes for French fry and crisping potatoes from 11,900 ha. South Australia now produces approximately 80% of the nation's fresh washed potatoes.

Early market innovation – the fresh box trade

Up until the 1960's, consumers had difficulty obtaining fresh potatoes year round. Fresh potatoes were available from November to May, with other potatoes being supplied from storage during the winter months.

This meant that growers could obtain premium prices for immature “new season” spring harvested potatoes. Immature tubers skin easily if machine harvested and packed in the traditional hessian bags. To avoid this, new season potatoes were hand dug with a fork and packed into wooden boxes.

This market innovation progressed to washing and prepacking potatoes into smaller, consumer size plastic bags. Gradual expansion of potato production into districts with a low frost incidence (such as the Northern Adelaide Plains) resulted in year round supplies of fresh harvested potatoes.

Mechanisation of potato washing and packing systems during the 1960’s and 1970’s resulted in control of South Australia’s fresh potato marketing and distribution moving from individual growers into the hands of a series of major packing sheds.



Hand digging “new” potatoes, 1959. Early season “new” potatoes packed in wooden boxes received a premium price.

Emergence of the Processing Potato Industry

South Australian potato growers supply product to three processing sectors:

- Crisps or snack food products.
- French fry and other frozen potato products.
- Fresh processed potato food products (potato salad, diced product, fresh French fries)

Crisps: SA's potato crisp industry developed in the 1950's and 1960's through establishment of a number of smaller crisp manufacturers. Over the years, numerous amalgamations and changes of ownerships of crisp manufacturing businesses occurred, consolidating this industry sector.

Smith's Potato Crisps Ltd was formed in the UK after WW1. They established a subsidiary in Australia in 1931. In August 1998, The Smith Snackfood Company Ltd was purchased by Pepsico, and is now the main potato crisp manufacturer operating in South Australia. They use about 23% of the SA's processing potatoes through their plant at South Rd, Regency Park, and also source potatoes from other production districts across Australia.

Smith's originally had their potato storage and processing plant at Kilkenny (near the Arndale shopping centre). In 1986, they built a new processing plant at the current South Road, Regency Park location. This plant supports other Australian Smith's Snackfoods processing plants in Perth and Brisbane.

Through the 1960's and 1970's, potato variety trials conducted by the SA Department of Agriculture/PIRSA incorporated cooking tests and assessments for crisp manufacture. Support was provided to the crisping industry in the 1970's with trials for the commercial adoption of CIPC (chlorpropham) as a sprout inhibitor for stored potatoes. CIPC mixed in a special oil formulation was fogged into potato storages using a Pulsfog model K1 machine imported from Germany by the Department of Agriculture.

The adoption of Atlantic as a specialised crisping variety by the industry resulted in the move to year round production and elimination of storage from the production system. Crisping potatoes are now supplied year round from different production districts across Australia.



Taste testing and assessing new crisping potato varieties 1973. Potential new varieties were run through a commercial crisp cooking process with the finished product being assessed by a tasting panel.

A specialised extension and technology transfer program (with focus on improved agronomy) was delivered to crisping potato growers by Sandra Lanz for 3 years from 1989. This program was supported by PIRSA, Potato Growers of SA and the Horticultural Research & Development Corporation.

French fries: Frozen French fry production emerged as a new potato industry sector when local company Safries Pty Ltd established a processing facility near Penola in the 1980's. The SA Housing Trust provided assistance through the construction of the initial

factory buildings which were leased to and subsequently purchased by Safries Pty Ltd.

Safries was purchased by the Canadian company McCain Foods in 1992 and the Penola plant was upgraded. McCain's announced closure of this Penola facility from December 2013 to rationalise and improve the efficiency of Australian processing facilities, and give better competitiveness against

imported frozen potato products. French fry potatoes continue to be grown in the South East, but are trucked to McCain's larger manufacturing facility at Ballarat (Mc Cain also have a French fry plant at Smithton, Tasmania).

PIRSA supported the South East processing potato industry with a comprehensive potato crop monitoring service between 1993 and 1998 (see separate section – Mark Heap – Potato Crop Management Service) to improve the efficiency and competitiveness of its supplying growers.

Fresh processed potato products: During the 1970's and 1980's, several growers developed manufacture of fresh French fries, supplying fresh potato chips to fast food outlets, fish and chip shops and caterers. The fresh processed potato food sector continues with the manufacture of potato salads and other fresh meal ready potato products. These are sold through supermarkets and to restaurants, hotels, hospitals and other institutions.

Seed Potato Industry

The isolated position of the South East potato production district (near Mt Gambier, Kalangadoo, Penola and Coonawarra), its cooler climate (with low aphid populations), and reduced virus incidence made it a popular seed potato production area from the late 1800's to the 1970's. The location of a Horticultural Inspector at Mt Gambier (from January 1908) played a critical role in development of the seed potato industry. Inspection of paddocks, growing crops and tubers ensured seed crops met certain standards. There were also some minor areas of seed potato production in the Mt Lofty Ranges.

A formal South Australian seed potato certification scheme was first introduced in the 1940-41 season, with 8 crops being assessed, 4 crops passing certification and producing 32 t of seed. The number of seed crops being certified gradually expanded. A special category of certified seed was introduced in 1943 to encourage seed production during WW2 (assessed 34 crops producing 1,243 t in 1944).

From the mid 1950's onward, the number of South Australian seed potato growers declined as Victorian seed potato production districts gained a marketing advantage.

The SA seed potato industry seed certification scheme was administered by the Department of Agriculture/PIRSA. The small number of seed potato growers made providing this service uneconomic. From 2004, arrangements were made for the Victorian Certified Seed Potato Authority (VicSPA) to provide seed potato certification services to SA seed potato growers.

Between the 1970's to the 1990's, tissue culture and mini tuber seed production techniques were developed, reducing the number of years potato seed crops need to be multiplied in the field. This dramatically reduced contamination with viruses and seed/soil borne pathogens, improving seed quality and commercial crop yields.

Developing isolated seed production areas to further reduce the incidence of virus and soil borne disease on seed potatoes offered further yield and quality benefits, and was recognised as a high priority by the SA potato industry. Kangaroo Island with its natural isolation was identified as an opportunity to provide this elite potato seed, and several specialist seed potato growers commenced production.

Surveys involving soil and plant sampling of production areas showed that Kangaroo Island was free of soil borne diseases such as black dot, powdery scab, root knot nematode and pink rot.

Kangaroo Island was gazetted as a quarantine area, the “Kangaroo Island Protected Production Area” (for Bacterial Wilt and Potato Cyst Nematode) under the Fruit and Plant Protection Act 1992 in August 2000. The following regulations were introduced to:

- Ensure seed potatoes were only introduced onto Kangaroo Island as mini tubers or plantlets from accredited tissue culture laboratories.
- Apply protocols to minimise the risk of disease being introduced to Kangaroo Island on potato machinery or used containers.
- Require ware potatoes for consumption on Kangaroo Island to be washed and prepacked.

Today, there are a small number of certified seed potato growers on Kangaroo Island and the South East producing high quality seed.

Seed potato growers across South Australia (both certified and non-certified) produced approximately 30,000 t of seed potatoes in 2012.

SA Potato Marketing Act and the SA Potato Board

During WW2, there was significant expansion of South Australia’s potato production to meet the needs of the armed services. This expansion was fostered nationally by the Australian Potato Committee under national security Regulations. It sought to increase plantings of potatoes by 50% in 1941-42 through the issue of production contracts with growers. SA potato plantings increased from 6,335 ac in 1942-43 to 9,105 ac (1,686 growers) in 1943-44, and 12,259 ac (1,815 growers) in 1944-45.

Inspection and acceptance of potatoes from contracted growers on behalf of the Commonwealth Potato Controller (for the Australian Potato Committee) was done by SA Department of Agriculture horticultural inspectors based at Mile End and Mt Gambier. Contract purchase of potatoes by the Australian Potato Committee continued until the 1947-48 season. The tuber inspection equipment used at Mile End and Mt Gambier for potato inspection and subsequently quarantine services was upgraded in 1963.

The cessation of contracted marketing of potatoes in 1948 resulted in oversupply. The industry contained many small growers, and the difficult marketing environment with poor returns to growers led to development of new SA potato marketing legislation. All major potato growing states established potato marketing boards after 1948. In December 1948, South Australia’s *Potato Marketing Act 1948* was enacted following a poll of potato growers. By late 1956, only potato boards in South Australia, Western Australia and Tasmania were operating.

The *Potato Marketing Act 1948* provided for establishment of the South Australian Potato Board. The Board was made up of nine members, including five grower and two merchant representatives elected from registered growers and merchants. The Chairman and a retailer/consumer representative were recommended by the Minister.

The Act gave the SA Potato Board powers to:

- Register growers
- License merchants
- Market all potatoes grown and marketed in South Australia. Potatoes grown in South Australia but sold outside of the state were not subject to control of the Board.
- Fix the quantities of potatoes or proportion of a grower's crop that could be marketed at any time.
- Fix maximum and minimum prices for potatoes (taking account of grade, quality, quantity and other circumstances), and terms and conditions under which they may be sold, including a maximum retail margin.
- Administer the fining of people (summarily) who fail to comply with the Act.
- Arrange polls of growers and merchants to decide whether the Act should continue.

These powers gave South Australia more stable retail potato prices, encouraged more stable production levels, and created more income stability. However these regulations did not encourage growers to grow the best product technically possible or produce crops more efficiently.

The SA Potato Board purchased premises at Kent Town where its offices and inspection facility were based. Its staff collected considerable information about the quantity of potatoes planted along with expected production and demand on a month by month basis, and ran regular consumer promotion programs. Crop and marketing information was provided to growers, packers and merchants via regular regional meetings and newsletters, and was valuable for planning production and marketing.

The emergence of potato washing and packing required the Potato Marketing Act 1948 to be amended to incorporate the definition and licensing of "potato washers". This occurred in March 1964. Functions of the Board were also updated with this amendment. A further amendment was passed in October 1973 strengthening fines and documentation required under the Act.

Following complaints about irregularities in operation of the SA Potato Board, the Ombudsman undertook an investigation and tabled a report in January 1984. South East potato growers had long complained that the Potato Marketing Act was an impediment to their competitive operation.

The Ombudsman's report was followed by a more comprehensive investigation into the role of the SA Potato Board and its supporting legislation. This was undertaken by a Working Party to Review the Potato Marketing Act, which was chaired by Mr G.D. Webber (Chief Regional Officer, Central Region) with membership comprising grower representatives, the Potato Board's Manager, and Mr Ian Lewis a SA Department of Agriculture Horticultural Marketing Officer. Formed in June 1984, the Working Party received 44 public submissions and tabled its final report in March 1985. This final report recorded a 5:3 vote in favour of retaining the Potato Marketing Act.

Following tabling of this report, preliminary legislation was introduced in June 1985 for repeal of the *Potato Marketing Act 1948*. In March 1986, the Act was repealed and provisions made for redeployment or retrenchment of staff, and settling of assets and liabilities.



Potato promotion at a Mt Gambier supermarket – June 1975. The SA Potato Board ran regular promotion programs (using the Sammy Spud character) with consumers to increase consumption and sales.

Source: State Library of SA Image BRG 347/1715

South Australian Potato Industry Trust

Following wind up of the SA Potato Board, residual assets after settling all liabilities were transferred to a trust fund. The Potato Industry Trust Fund Committee was established in 1987 to administer the investment of these residual funds and utilise income from these assets for various industry development activities and projects.

The initial Potato Industry Trust Fund Committee had a chairman appointed by the Minister of Agriculture, potato industry trustees, and was administered by the SA Department of Agriculture/PIRSA with funds being invested in secure Government interest bearing deposits (mainly SA Financing Authority).

In 1996-97, a new Trust Deed Agreement between the Minister of Agriculture and the potato industry was developed to manage the then \$1.52m of assets. This new agreement updated operation of the trust, enabled use of a wider range of investment opportunities, and moved management of the trust to industry via appointing 3 grower trustees and a fourth trustee representing the Minister of Agriculture. The Trust Deed Agreement required development of a 3 yearly Strategic Plan to guide investment of trust income in industry projects.

A further update of the SA Potato Industry Trust Fund agreement occurred in 2008-09 with appointment of new trustees and linking it with the newly formed industry organisation, Potatoes South Australia. A new longer term industry funding model is being developed, incorporating levy mechanisms from the Primary Industries Funding Schemes Act.

Early Research Activities

Earliest records of potato research date back to 1909. Mt Gambier branch of the SA Agricultural Bureau requested a series of experiments on “efficacy of phosphatic, potassic, and nitrogenous manures singly and in combination” and seed sources on productivity. Potato fertiliser experiments at Mt Barker were also reported in the July and August 1909 Journal of Agriculture.

New varieties of potato were also recorded to have been imported in 1909. The 12 varieties included Early Regent, Duke of York, May Queen, Ruby Queen, Klondyke, Royal Kidney, British Queen, Ninetyfold, Up to Date, Challenge, Discovery, and Queen of the Veldt.

Seed potato trials were conducted at Bridgewater and Blackwood in 1910-11. These compared open stored vs covered seed potatoes using 8 varieties. It showed that open stored seed potatoes produced stouter shoots and achieved higher marketable yields.

Early Management of Pests and Diseases

Late (Irish) Blight (*Phytophthora infestans*) was first discovered in a number of South East potato crops in the 1910-11 season. In an attempt to curb spread of this debilitating disease, restrictions were placed on movement of potatoes from infected crops to other districts. Amendments to the *Vine, Fruit and Plant Protection Act 1885* were proclaimed on 23 November 1911 preventing removal of potatoes from the Hundreds of Mac Donnell, Robe and Grey to other parts of the state. Controls were administered by Mr Rodney Fowler, Inspector of Orchards in the South East. Despite these measures, Late Blight was discovered across many potato crops in the Mt Lofty Ranges in 1912.

Demonstrations of copper fungicides (in 1911-12) to control Late Blight using a Fleming type of potato sprayer were done at the garden of Mr George Packer at Athelstone with “gratifying results”. Mr Packer was so impressed, he bought the spraying machine after the trials were completed. A similar demonstration of Bordeaux and Burgundy copper sprays on 4 large potato fields at Mt Gambier improved yields dramatically. The success of these trials was widely reported in newspapers across Australia at the time.

Late Blight outbreaks were an ongoing problem in high rainfall seasons over the next 5 years until use of copper sprays became a regular treatment. At the time, Western Australia was a major market for SA potatoes. With outbreaks of Late Blight, they introduced stringent controls on potatoes entering the state, greatly reducing this trade.

Verticillium wilt was discovered at O.B. Flat in 1917, being identified by Prof T.G.B. Osborn from the University of Adelaide. An article about this appeared in the Journal of Agriculture in June 1917.

Potato tuber moth was a major pest, especially in hot dry seasons. The introduction of overhead irrigation systems, chemical pest control in the 1940’s and integrated pest management systems in the 1990’s, mean that potato tuber moth is now a minor problem.

In 1970, serological testing for viruses like leaf roll virus was introduced. This technique was used as part of the seed certification scheme.

The soil and seed borne disease Bacterial Wilt emerged as a significant problem during the 1990's with outbreaks occurring in several districts. This again impacted on sales of potatoes to Western Australia, requiring introduction of 20 km quarantine zones around Bacterial Wilt outbreaks, and use of a range of other treatments and procedures.

In 1992, Dr Helen Dillard, an extension pathologist from Cornell University conducted a major review of strategies for reducing pesticide use in the SA potato industry. This survey identified that rhizoctonia and target spot continued to be diseases of main concern to growers. A major outcome from this study was the accelerated adoption of IPM pest management systems across SA's potato industry. Much of this IPM technology had been developed by the Victorian Department of Agriculture.



Potato industry field day, Woodside, February 1973. These district field days provided comprehensive information about new varieties, irrigation, nutrition, pest and disease management and other technology to potato growers.

Recent Potato Disease Research

Since 2000, SARDI's (South Australian Research & Development Institute) horticulture pathology team (comprising Dr Trevor Wicks, Barbara Hall, Robin Harding and a number of other staff) have undertaken a broad array of national potato disease research and management trials. This team has developed management strategies and provided the Australian potato industry with comprehensive management packages for the following key diseases:

- Bacterial breakdown in washed potatoes caused by three species of *Erwinia*, and strategies for managing this significant disease in washing plants.
- Black Dot (*Colletotrichum coccodes*) is a significant soil borne disease, and control strategies have been developed for seed and washed potato crops.
- Potato Early Dying, a soil borne disease complex caused by a combination of root lesion nematodes (*Pratylenchus spp.*) and the fungus *Verticillium dahlia*.

- Pink Rot (*Phytophthora erythroseptica*) is a significant tuber rotting disorder on poorly drained soils.
- Rhizoctonia or black scurf (*Rhizoctonia solani*), a common “cosmetic” tuber disease causing significant downgrading of washed potatoes.
- Incidence of soil borne diseases on seed potatoes.
- SARDI also provides a testing service (using leaf or tuber samples) for the potato viruses PLRV, TSWV, PVX, PVY, and PVS .

A comprehensive list of project reports associated with this recent potato pathology research work is available from the SARDI web site at

www.sardi.sa.gov.au/pestsdiseases/horticulture/horticultural_crops/potatoes .

Information about potato diseases and their control has been supplied to growers and industry via numerous workshops, conference presentations, meetings, leaflets, fact sheets and a comprehensive illustrated book, “Potato Diseases in South Australia” (prepared by C.M.J. Williams, T.J. Wicks and S. Akiew; 1985, SA Department of Agriculture).

Nematologists Graham Stirling and later Greg Walker completed a number of nematode soil surveys across South Australia’s potato growing districts over several decades. These identified the presence of root knot nematodes in some districts, and confirmed that South Australia is free of Potato Cyst Nematode (PCN).

Department of Agriculture/PIRSA horticulture pathologists and entomologists have provided South Australia’s potato industry with comprehensive pest and disease identification and advice services over many decades.

Michael Rettke has also been instrumental in assembling a wide range of potato pathology science to develop the elements of the Predicta Pt soil borne disease diagnostic tool.

Molecular Diagnostics for Potato Soil Borne Diseases

SARDI has developed a national potato soil disease diagnostic and risk assessment service in collaboration with Tasmanian Institute of Agriculture, Department of Environment and Primary Industries Victoria. Launched in August 2013, this service is known as PreDicta Pt.

The PreDicta Pt service utilises SARDI’s Molecular Diagnostic Centre to assess the risk of soil borne diseases that reduce yield and tuber quality, particularly root knot nematode, powdery scab and black dot. Part of the service includes training and manuals to assist agronomists to deliver this service to Australian potato growers.

SARDI was awarded the John Deere Productivity Partner Award at the 2014 AUSVEG Awards for Excellence in June 2014, and Kathy Ophel Keller along with the collaborative team won the Bayer Crop Science Researcher of the year at the 2013 Ausveg Awards for development of the PreDicta Pt service.

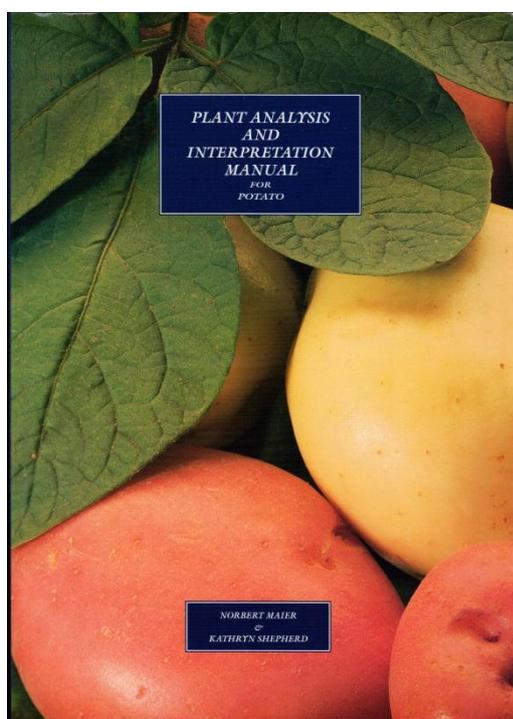
Further information about PreDicta Pt is available from SARDI’s web site at

www.sardi.sa.gov.au/diagnostic_services/predicta_pt .

Potato Crop Nutrition

Since its inception, the Department of Agriculture/PISA/PIRSA/SARDI has supported the South Australian potato industry with various potato fertilizer research trials and information. These commenced in 1909 with phosphorus and potassium fertilizer trials in the South East. Further demonstration trials applying nitrogen fertilizers via sprinkler systems were undertaken in the 1950's.

However the most significant series of fertilizer experiments were undertaken by SARDI Horticultural Research Officers Mr Norbert Maier and Dr Chris Williams over a 20 year period commencing in 1982. These were initiated following ongoing problems being experienced by the fresh and processing potato industries with after cooking flesh darkening, other tuber quality problems, and variable yields.



The SARDI handbook "Plant Analysis and Interpretation Manual for Potato" prepared by Norbert Maier and Kathryn Shepherd in 1998 assembled the best national and international plant analysis data for use by Australian potato agronomists. It was supported by a decision support software CD to assist potato agronomists with interpreting potato tissue analysis data.

These potato nutrition experiments evaluated:

- The effects of nitrogen, phosphorus, and potassium rates on tuber yield, specific gravity, crisp colour, and tuber chemical composition. These experiments this included comprehensive cooking tests to verify tuber quality improvement.
- Effects of nitrogen, phosphorus and potassium application rates on petiole sap nutrient concentrations across the main potato cultivars being grown.
- Development of new rapid "in field" petiole sap testing techniques.
- Assessed the impact of potassium and phosphorus fertilizers on the uptake of cadmium by potato tubers.

This nutrition research was significant nationally in that it developed potato yield and quality response curves for application of nitrogen, phosphorus and potassium. These response curves allow soil and sap nutrient tests to be used to optimise yield, tuber quality, and minimise environmental pollution from excessive use of fertilizers.

The huge array of potato nutrition data sourced from research in Australia, the USA, Canada and several other countries was summarised and assembled by Norbert Maier and Kathryn Shepherd in 1998. It was published as a handbook entitled "Plant Analysis and Interpretation Manual for Potato".

This significant national document contains comprehensive information about:

- Key steps in using plant analysis with potato crops including sampling techniques, laboratory analysis techniques, and interpretation of plant test data.
- Tissue analysis values (for various parts of potato plants by potato variety) for essential plant nutrients: nitrogen/nitrate, phosphorus, potassium, calcium, magnesium, sodium, chloride, sulphur, boron, copper, zinc, manganese and iron.
- Deficiency symptoms for various essential nutrients for growth in potatoes.
- A comprehensive bibliography of papers and references applicable to each section of the handbook.

This handbook was also supported by a decision support software CD titled “Crop Test – Potato Crop Nutrient Evaluation System”. This software tool was designed to be used by agronomists and other potato crop managers. It contained:

- Keys for identifying symptoms of plant nutrient stress.
- Provides information about deficiency and toxicity symptoms, including a large array of photographs of plant nutrient deficiency symptoms.
- Interprets petiole and leaf test results for a wide range of potato cultivars (from deficient to excess nutrient levels).
- Charts plant nutrient data during the growing season and enables presentation of multiple charts for crop performance comparison.
- Provides a comprehensive information database and bibliography for each nutrient.

Development of an on farm sap nitrate test

Correct management of nitrogen (N) is essential since excess or deficiency may reduce potato yield and/or quality, or may lead to pollution of water supplies. Dr Chris Williams in collaboration with Norbert Maier calibrated a rapid sap nitrate test for potatoes at different crop growth stages (growth stage based on the length of a plant’s longest tuber). This was developed into a kit form and commercialised as the Nitraqwik test kit for on farm use in 1991. Use of the Nitraqwik nitrate tests allow potato growers to side dress or withhold N applications depending on crop needs and avoid deficiencies or excessive nitrogen applications.

Soil and Land Management

Potato and vegetable growers had been identified as contributors to water pollution in the Mt Lofty Ranges water catchment area, a major supplier of urban water to the city of Adelaide. In 1989-90, the Mt Lofty Ranges Land Management Project (managed by Greg Cock) was established. This project demonstrated and encouraged the adoption of soil conservation techniques (including rapid establishment of cover crops after harvest, modified tillage to reduce organic matter loss, and better nutrient application techniques) across 6,000 ha of potato and vegetable growing land in the Mt Lofty Ranges.

Over the past 20 years, the Mt Lofty Ranges potato and vegetable industries have been greatly reduced and replaced mainly by perennial wine grapes. The significant reduction of tillage has reduced soil and nutrient quantities in runoff, and the risk of water storage contamination.

Heavy Metals in Potatoes

During the mid 1990's, crop residue testing revealed that some Australian potato crops had cadmium (a heavy metal) levels close to the maximum residue level. Adelaide based, CSIRO Soils Division, researcher Dr Mike Mc Laughlin ran a national research program to evaluate the cause (with support from Norbert Maier and Dr Chris Williams). This revealed that irrigation water salinity was a major cause of higher cadmium absorption and residues. The choice of potato cultivar also had moderate effects. An extension program encouraged grower adoption of irrigation strategies (especially where more saline irrigation water was being used) to avoid high cadmium residue levels in tubers.

Herbicides and Weed Control

Traditionally potato growers used mechanical methods of weed control, involving harrowing at emergence, inter row cultivation and banking or hilling to remove weeds in the inter row space and bury young weeds along the plant row. The advent of tractors with 3 point linkage made this mechanical control of weeds easier and more accurate.

Growers obtained an additional weed control tool with the release of the post emergent herbicide metribuzin (commonly marketed as Sencor^R) in the late 1960's. Applied to young potato crops, this herbicide greatly improved grass and broadleaf weed control, and reduced reliance on mechanical weed control techniques.

Further farm trials to identify the different tolerances of newer potato cultivars to metribuzin were also conducted by Dr Chris Williams of SARDI with Dave Riches of Bayer Aust. Ltd from 1996 to 2000. They found that the new red skinned cultivar Bison, was highly sensitive to metribuzin and the major crisp cultivar Atlantic and red skin Pontiac for fresh market were moderately sensitive to label rates. This work led to Bayer modifying label rates for registered usage of metribuzin in Australia. Matching funding for this research was provided by Bayer Aust. Ltd and Horticulture Research & Development Corporation (HRDC).

New Variety Assessment and Introduction

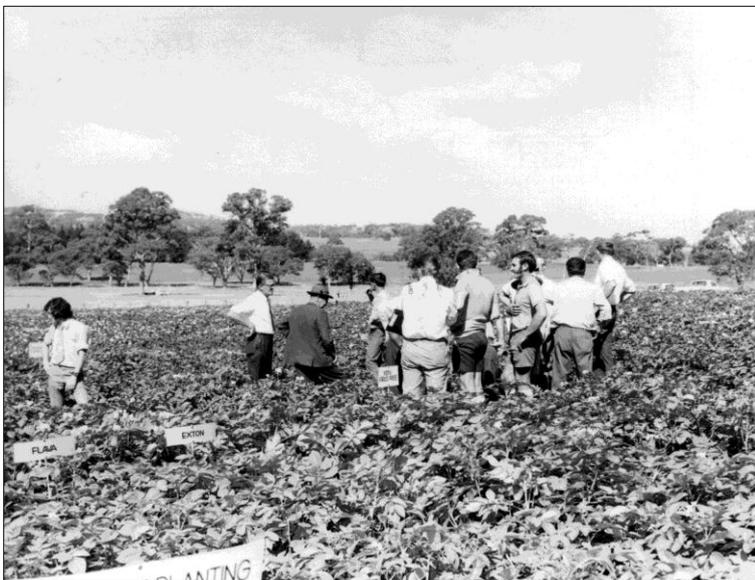
The first new potato variety assessment project is recorded in 1909. The 12 varieties imported from the UK at this time included Early Regent, Duke of York, May Queen, Ruby Queen, Klondyke, Royal Kidney, British Queen, Ninetyfold, Up to Date, Challenge, Discovery, and Queen of the Veldt.

Post WW2, the Victorian Department of Agriculture established a potato breeding program at Toolangi Research Centre. In the 1990's this was upgraded to a coordinated national program, being known as the National Potato Improvement and Evaluation Scheme (NaPIES), funded in part by a potato Industry levy of \$1/t, and matched with Federal funds through HRDC. Promising new breeding selections and imported varieties were distributed to each state for assessment in the main potato growing districts. Dr Chris Williams coordinated the NaPIES work in SA from 1982 to 2002. This project has been successful with the release of a number of important commercial cultivars.

Of special interest to SA potato growers were new varieties highly suited to washing and prepacking and others for the processing industry. Some of the new varieties released in SA from the Victorian breeding program and NaPIES included:

- Evaluation of Onka – a potential replacement for Kennebec in the mid 1970s and release of the major washed cultivar, Coliban in 1972
- Introduction of Atlantic and Denali (major crisp varieties), Russet Burbank (major French fry variety), and Shepody.
- 1988-89 – Crystal and Bison
- 1991-92 – Wilwash and Winlock
- 1993-2002 – Desiree, Snow Gem, Nadine, and Ruby Lou

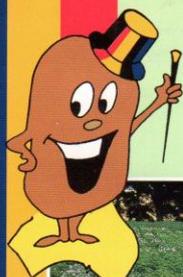
Following Australia’s introduction of the *Plant Breeders Right Act 1994*, a number of the leading potato processors (both crisping and French fries), and many fresh potato packers began to establish relationships with overseas potato breeding schemes. Exclusive company to company relationships were formed, with agreements for access to specific varieties, and development of promotion and marketing opportunities for growers licensed to grow these varieties.



Inspecting a potato variety trial, Adelaide Hills 1973 – part of the regular field day program.

Potato breeders in the USA, NZ, Scotland and various European countries have provided access to proprietary varieties. These are introduced to Australia as tissue culture material through the AQIS quarantine service, and post-quarantine release are considered for protection under the *Plant Breeders Rights Act 1994*. Eligible varieties that can be shown to be distinct from existing varieties can obtain 20 years protection giving their owners the opportunity to establish exclusive production and marketing arrangements.

After many years of investment in the National potato breeding program, the Australian potato industry and DPI Victoria commenced an exit strategy from this program in 2011.



Potato variety introduction and evaluation program in South Australia



1 Select promising new breeders lines and overseas varieties, Agriculture Victoria, Healesville, Victoria.



2 Sow trials in commercial crops in the Mt. Lofty Ranges



3 Inspect trial plots (for diseases, growth habits)



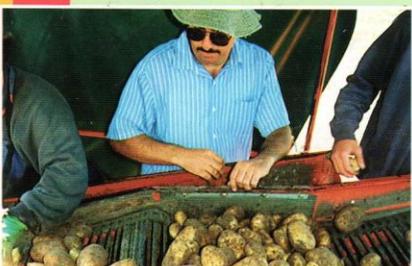
4 Harvest trials on the North Adelaide Plains



5 Grade plots (to assess yields, tuber size grades)



6 Assess tuber quality (fry colour from storage)



7 Chris Williams inspecting a bulk trial of MacRusset in the Lower South East



8 Technology transfer (show best lines to industry at a Mallee field day)

Steps in the SA potato cultivar evaluation program – 1997. Source: Potato Varieties for South Australia – a guide to performance and selection by Chris Williams et al; published by PIRSA 1997.

Demonstrating Record Tuber Yields

In 1991-92, SA on farm variety evaluation trials demonstrated that it was possible to achieve tuber yields in excess of 100t/ha on farm. These world leading yields were achieved at a time when Australia's potato growers were achieving average commercial yields of 19-44 t/ha.

Dr Chris Williams working with experienced Mt Lofty Ranges potato grower Mr Ron Wenzel, grew trial plots in his commercial crop and obtained tuber yields of over 100t/ha (of No 1 grade tubers 80-450 grams) for the cultivars; Winlock, Kennebec, Patrones and Wilstore. These world leading yields were obtained using high quality seed, calibrated soil and plant tests for optimum plant nutrition, well managed irrigation, and maintaining a fully functional, healthy, closed crop canopy for about 95 days after the start of tuber initiation.

Personnel Delivering Research and Extension Services

Since its establishment in 1905, the Department of Agriculture/PIRSA/SARDI has provided a wide range of services to the SA potato industry. Prior to WW2, this was via the network of district inspectors and instructors or advisers.

Post WW2, district advisers continued their important role of delivering information and technology to potato growers. However the introduction of specialist potato research officers from 1949 onwards introduced a new level of specialised support for the potato industry.

With the gradual reduction in Government funded extension services from about 2005 onwards, there has been a transition to sourcing technical information from commercial services.

Below is a summary of the key research staff servicing the SA potato industry, their major activities and achievements.

Pre WW2 Activities

From 1908 through to 1920, SA's horticulture districts were serviced by District Orchard Inspectors who gradually developed an advisory role. In 1920, these inspectors were formally endorsed to become Orchard Instructors. Up until WW2, the South East was SA's main potato growing district. From 1905 to WW2, the South East Orchard Inspector/Instructors were the main Department of Agriculture officer serving the SA's potato industry.

The South East Orchard Inspectors/Instructors during this period were:

- 1908 to 1920 – Mr Rodney Fowler – he moved on to become the Manager of the Blackwood Experimental Orchard in 1920
- 1920 to 1922 - Mr J.B. Harris
- 1922 to 1934 - Mr H.H. Orchard
- 1934 to 1939 - Mr A.L. Warren

Some of the major projects and issues dealt with by Orchard Inspectors/Instructors during this period were:

- Outbreaks of Late/Irish Blight and subsequent quarantine and control measures from 1911 to 1917.
- Introduction of *Sale of Fruit Act 1915* introducing grade standards with a further upgrade in 1928 and introduction in 1935 of the *Fruit and Vegetable Grading Act 1934*.

- 5 acres of variety and fertilizer experiments at Moorak on the property of A.A. Klisby from 1915 to 1923. There were also other fertilizer experiments at Rendelsham, Penola and Mt Gambier (Pope Bros 1916).
- Potato crop competitions at Mt Gambier and Rendelsham from 1928 to 1934, which encouraged the use of high quality seed. Potato crop competitions were re-established after WW2 and continued through until the 1970's.



Presenting a cup to Mr Ron Telfer of Glencoe for his superior potatoes, July 1964. L-R: Robert "Bob" Beck, Greg Botting, Gilbert "Gill" Myer and Ronald "Ron" Telfer. Potato crop competitions ran from the 1928 to the 1980's. Crop competitions were important for encouraging growers to adopt new production technology.

Source: State Library of SA Image BRG 347/1759.

Gordon Edwards

In January 1949, Gordon Edwards was appointed as the first Horticultural Research Officer specialising in

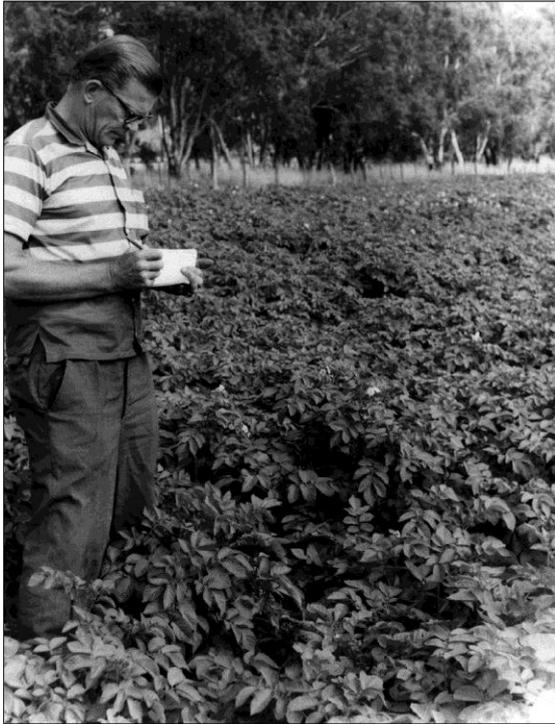
vegetables. Since potatoes were the main vegetable crop, approximately half of his time was spent working with the potato industry.

Some the key potato industry programs initiated by Gordon Edwards through the 1950's included:

- encouraging mechanisation in the potato industry to overcome post WW2 farm labour shortages (introduction of harvesters and bulk handling).
- demonstration of post planting applications of nitrogen by application of urea through sprinkler systems.
- an ongoing series of potato crop competitions in the Adelaide Hills with associated field days.
- rhizoctonia and aphid control trials.
- assessment of systemic insecticides and early top killing to reduce leaf roll virus infections.
- warning services for autumn Late/Irish Blight infections.
- fostering development of potato production on the Northern Adelaide Plains.

Henry Feddersen

With the growing significance of the potato industry, Heinrich (Henry) Distel-Feddersen was appointed as the first specialist Potato Adviser in September 1959. He immigrated to Australia from Germany after WW2, and continued in this role until 1981.



Potato Adviser Henry Feddersen observing potato variety trials – Woodside February 1973. Many of these new varieties were sourced from the national potato breeding program based at Toolangi in Victoria.

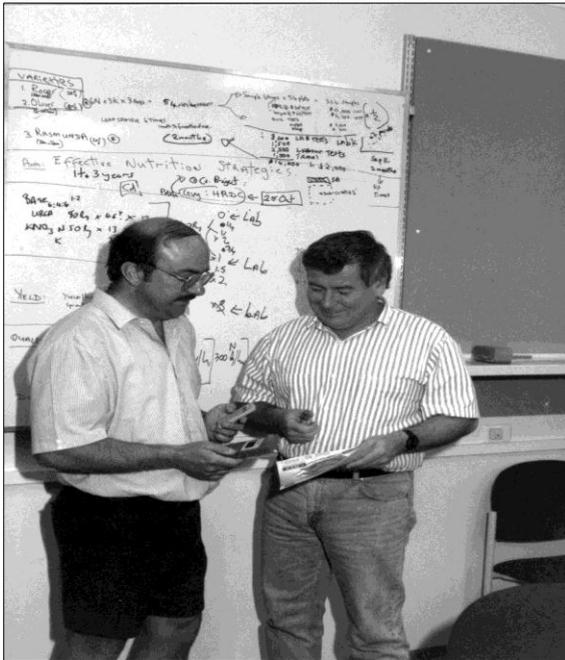
Some of the key technologies and activities fostered by Henry Feddersen included introduction and evaluation of:

- new fresh and crisper potato varieties, including Onka and European yellow fleshed varieties.
- demonstration of seed pre-cutting techniques (1965)
- improving potato plant nutrition through post emergent potato fertilizer trials at Virginia and the Mt Lofty Ranges.
- assessment of maleic hydrazide and CIPC to delay tuber sprouting in storage, including the purchase of a Pulsfog type K1 fogging machine in 1972 for treatment of potato storages.
- developing cool night air potato storages (based in a large shed on the property of R.A. Nitschke at Littlehampton) between 1967 and 1972 to improve the out-turn of stored potatoes. This work was done in conjunction with Post Harvest Researcher Barry Tugwell and with support from USA based potato storage specialist Dr Walter Sparks from the University of Idaho Aberdeen Research and Extension Centre.
- herbicides for weed control in potato crops.
- crop competitions for improving productivity and an emphasis on profitability.
- improving control of target spot and other leaf diseases.
- Trapping, monitoring and providing warnings about aphid flights. This information was used by growers to minimise the spread of leaf roll virus in ware and seed crops on the Adelaide Plains and in the Mt Lofty Ranges.

Henry Feddersen was also active in the German community, being President of the SA German Club. In December 1982, he was awarded an MBE for services to the migrant community and German Australian relationships.

Chris Williams

During his period as Senior Research Officer – Potatoes from 1982 to 2006, Dr Chris Williams was responsible for a range of research projects to support the South Australian and Australian potato industry.



Development of the new Nitraqwik nitrate sap testing meter for potatoes – Dr Chris Williams, Senior Research Officer, Potatoes and Barry Philp, Regional Officer, Central Region. Development of rapid nitrate sap testing was part of a major national program to improve potato crop nutrition management.

Major potato research work conducted included:

- Evaluation of new breeding lines and cultivars (fresh, crisping and French fry cultivars) in South Australia's potato production districts.
- Calibration of simple on farm petiole sap nitrate tests for assessing the nitrogen status of potato crops. Work based on his research published in 2 papers in the journal of plant nutrition 1990.
- Assessment of the tolerance of various potato cultivars to the herbicide metribuzin.
- Marketing and production of yellow fleshed potato cultivars.
- Dr Chris Williams presented a paper at the national potato industry conference in Warragul, Victoria in 1990 co-authored with Norbert Maier on using calibrated soil and plant tissue tests for potatoes (awarded best presentation at the conference based on value to the potato industry).
- Natural products for the control of potato tuber seed piece decay. An 8 page laminated guide folder titled: "Make more money by correct handling of potato seed tubers", by Drs Williams and Wicks was sent to every potato enterprise in Australia in 1993.
- Achieving world leading 100 t/ha yields with improved cultivars and management systems.
- Convenor of 'Potatoes 2000 –linking research to practice', a very successful national potato research and technology transfer to industry conference, held in Adelaide, attended by over 300 delegates from Australia and overseas. Dr Chris Williams and Leigh Walters were the editors of the 283 page proceedings.

Since Dr Williams' retirement in 2009, PIRSA/SARDI has not appointed another dedicated potato research officer.

Norbert Maier

Norbert Maier in his role as a PIRSA/SARDI Senior Horticultural Research Officer completed a wide range of research projects with various vegetable crops. This included a large number of trials with potatoes between 1980 and 2000, focussed primarily on potato nutrition, including:

- Calibration of soil and plants tests for potassium nutrition of potatoes for optimum yield and quality
- Comparison of phosphorus fertilizers and their impact on the soluble phosphorus concentration in petioles.
- Effects of nitrogen, phosphorus and potassium on potato yield and petiole nutrient concentrations.
- Effects of nitrogen, phosphorus and potassium on yield, specific gravity and crisp colour and tuber chemical composition (including reducing sugar concentration) of potatoes.
- Development of interpretation standards for assessing the nutrient status of irrigated potato crops.

See the Potato Nutrition section for more details.

Mark Heap - Potato Crop Management Service

South East Horticulture Adviser, Mark Heap, developed the specialist Potato Crop Management Service (PCMS) for frozen French fry potato growers in the South East. The business plan for this service was developed through the South Australian Enterprise Workshop in 1992 (the service won the F.H. Faulding award for Commercial Development).

PCMS was a joint venture involving PISA, Mc Cain's Foods, South East Potato Growers Association and the Horticultural Research and Development Corporation (HRDC). This commercial crop management service combined the best available technical information into a holistic crop management system delivered by a number of field officers including Derek Cameron. It commenced in July 1993 and incorporated:

- pre plant checking of soil borne pests and diseases.
- soil nutrient testing to recommend pre plant fertilizers.
- regular petiole analysis to recommend nutrient applications during the growing season.
- assessment of irrigation system performance, and scheduling of irrigation to meet crop evapotranspiration and stage of growth water requirements.
- scouting and monitoring of pest and disease outbreaks in the crop to recommend control measures.
- in field crop maturity and quality testing to assist harvest decision making by the processors.
- developed new easy to understand ways of presenting crop monitoring data to growers.

At its height, the service was monitoring 1,100 ha of crops or approximately 50% of the South East potato crops. The PCMS was operated and improved by PISA for approximately 4 years, and significantly improved the competitiveness of South East potato growers. Following pressure from commercial service providers, a package of the systems and technology was provided to a series of

fertiliser and chemical resellers (mainly IAMA resellers) in the South East, and the Potato Crop Management Service was wound up.

Potato Research Technical Officers

Potato Research Officers have been supported by Potato Technical Officers to assist with preparation and operation of field trials, planting, harvesting, recording crop observations, development of machinery, and collation of trial data. These Technical Officers were people with considerable practical experience in commercial potato production.

Ron Nitschke assisted Henry Feddersen between 1970 and 1975. He was followed by Ross Allen provided support to Henry Feddersen, Dr Chris Williams and Norbert Maier between 1975 and 1992. During peak planting and harvest periods between 1973 and 1976, Henry Feddersen was also assisted by the Technical Officer - Vegetables, Barry Philp.

Research Machinery

With a major “on farm” variety and fertilizer testing program operating across the state, specialist planting and harvesting machinery was essential to improve the accuracy of experimental work, replicate techniques used by commercial potato growers, and reduce trial labour needs.

The first potato trial planting machine was built in 1969. Mounted on a trailer, this planter could be hauled to grower properties. This trailed machine incorporated trays to hold predetermined sequences of seed and a fertilizer delivery belt for application of premixed and weighed quantities of fertilizer to standard plots. It used a gearbox from a cereal seed drill to enable variation in planting distances and plot length.

The original trailed planter was replaced by a new 3 point linkage mounted planter in 1991. Built at Lenswood Horticultural Centre, this machine was more compact and much more manoeuvrable. It utilised two cone heads for fertiliser distribution (adapted from units used on cereal trial planters). The greater planting accuracy and flexibility was particularly important for the large number of fertilizer trials conducted in the 1990's.

A specialist potato trial harvester was custom built by Echunga Sales and Service with support from Vegetable Technical Officer, Mr Barry Philp in 1973-74. Using the frame, lift chain and trash rollers from a Port Major potato harvester, this machine had an extended sorting belt and bagging gates to accommodate harvesting of small plots and grading tubers into a range of sizes. This harvester was too heavy for towing and was trucked to grower properties for harvesting trials.



First potato trial planting machine built in 1969. Variable planting distances, row widths and fertilizer belt speeds enabled planting of a wide range plant spacing, row width and plot length configurations.



The second trial potato planter built at Lenswood Research Centre by Ross Allen and Mervin Schubert in 1991. More compact, it featured twin cone fertilizer distribution heads, important for planting trials requiring very accurate application of soil additives.



Machine harvesting a potato trial, Woodside, Adelaide Hills 1973. A customised potato trial harvester was designed and built in 1974.

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Acknowledgements/Authors

This article has been prepared by Barry Philp with contributions and assistance from Dr Chris Williams, Ross Allen, John Fennell, Dr Trevor Wicks and Dr Kathy Ophel Keller.

January 2015.