Managing Buckwheat Production in Australia

A report for the Rural Industries Research and Development Corporation

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Foreword

Buckwheat appears to have potential in the cooler, elevated and coastal regions of Australia. The crop is in demand for noodle making and other purposes in Japan and has attracted interest in Australia too.

This project has sought to improve an understanding of this quick-growing annual and to address a range of agronomic and harvest related problems.

This project was funded from RIRDC Core Funds which are provided by the Federal Government.

This report, a new addition to RIRDC's diverse range of over 600 research publications, forms part of our New Plant Products R&D program, which aims to facilitate the development of new industries based on plants or plant products that have commercial potential for Australia.

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Peter Core
Managing Director
Rural Industries Research and Development Corporation

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The assistance of overseas researchers and institutes is extremely valuable towards obtaining cultivars and receiving knowledge on the latest technology advancements.

There are also many farmer co-operators who have donated land, labour and resources to assist in the research of buckwheat in Australia. Many other people have helped contribute time and effort into developing the buckwheat industry in Australia and their efforts have been welcomed. This work is greatly appreciated and without the contributions of all of these people, the industry would not be where it is today.

Contents

Executive Summary

This summarises the two RIRDC projects:

- DAV-86A '*Production and export of buckwheat grain and value added products*' and
- DAV-136A *'Total quality management for the production and marketing of buckwheat and honeybee pollination of buckwheat'*.

Background

- Buckwheat, *Fagopyrum esculentum*, is an annual, summer growing, broad leaf crop not related to cereal wheat.
- Buckwheat is widely grown across many Northern Hemisphere countries.
- Grows best in cool climate, highland or coastal areas that have reliable summer rainfall or irrigation.
- Produces black triangular starch-rich seeds used for products such as noodles (Soba) and pancakes for human consumption.

Research

- Research on buckwheat in Australia under RIRDC project DAV-86A (1994–1997) and project DAV-136A (1997–2000) investigated agronomy and physiology of buckwheat in the main growing areas of New South Wales and Victoria.
- Before the commencement of DAV-86A in 1994, only a very limited amount of research and published material was available on buckwheat in Australia.
- Various aspects of research have been completed overseas on genetics, breeding, physiology, ecology, biochemistry, food science and human health on buckwheat.

Outcomes

- Research on buckwheat has shown that high quality buckwheat can be produced in many growing areas of New South Wales and Victoria through good management.
- The best buckwheat varieties in Australia appear to be the shorter maturing ones, for optimum yields and quality.
- Good management from seed bed preparation to harvest timing and method is critical for high quality yields.
- A Quality Assurance manual has been drafted to assist farmers grow high quality buckwheat.

Implications

- An established buckwheat industry in Australia now exports over 2000 tonnes annually to Japan as well as other markets overseas and domestically.
- Buckwheat currently contributes over $2 million dollars directly to farmers and producers.
- Established links with breeders and researchers in Europe, Asia and America have allowed for good transfer of knowledge and collaboration.

Future

- More refined research into agronomy and niche markets such as organic production with emphasis on producing quality grain, including moisture content, specific gravity and groat colour.
- Better understanding of harvest methods and timing for optimal results.
- An established framework for quality assurance to be adopted by the buckwheat industry.
- Develop links and networks across the industry by establishing a communications strategy.

Background

Many areas of Southern Victoria, Central Highlands of New South Wales and the New England Tablelands of Northern New South Wales receive reliable summer rainfall combined with cool daytime temperatures. Many agronomists and farmers alike felt that these areas could be suited to additional summer crops to turnips, rape and potatoes. Research into alternate summer crops resulted in the finding that these climatic conditions are ideal for the growth of buckwheat, an annual broadleaf summer growing crop.

Buckwheat *Fagopyrum esculentum,* is grown widely across the northern hemisphere in Eastern Europe, Northern India, Nepal, China, Mongolia, Japan and North America. It is suited to a range of soil types, is affected by few pests or diseases and doesn't require high inputs. However buckwheat is not frost resistant and does require a soil temperature of 20^{o}C at 9.00am in the morning to germinate. Buckwheat is sown and harvested with conventional crop equipment. Cool temperatures enhance both the seed yield and quality of buckwheat, and climatic comparisons with buckwheat producing zones in Japan and North America show that it is well adapted to the highland, cool climate cropping zones of Australia. Buckwheat produces black triangular starch-rich seeds that are used to produce products such as noodles and pancakes for human consumption. Although used for products such as noodles, it is not a true cereal but a broad leaved crop related to docks and bindweeds.

In 1994, funding was obtained by the Department of Natural Resources and Environment (formerly Agriculture Victoria), from Rural Industries Research and Development Corporation (RIRDC), to investigate the agronomy of buckwheat and develop a buckwheat industry in the cool climate, highland cropping zones of Victoria and New South Wales. This funding was also to be used to integrate buckwheat growers, processors and exporters and to develop both the domestic and export markets.

A second phase of funding was obtained in 1997 from RIRDC. This was used to focus on the production of high quality buckwheat. The aim was to grow 5,000 tonnes of buckwheat with 75% at export quality by the year 2,000. This was to be achieved partly by implementing a Quality Assurance package for the production and marketing of Australian grown buckwheat. Another component of the funding was to investigate the effect of honeybee pollination on buckwheat seed yield and quality. This would contribute to refining the agronomy required to consistently produce high quality buckwheat yields.

The markets for buckwheat at the beginning of this project were mainly to Japan, and there was only small interest domestically. Over the past six years, an increased emphasis has been on promoting domestic markets for Australian grown buckwheat and also in other international markets such as the United States of America, Germany, Russia, Iran and Italy. This has complemented an increasing amount of Australian grown buckwheat being supplied to the Japanese markets.

1. Project Objectives

* To export 5,000 tonnes per year of buckwheat and buckwheat products and increase the use of buckwheat in new and existing food products in Australia to 3,000 tonnes per year, by the year 2000.

* To determine the effect of honeybee pollination on buckwheat seed yield and quality, refine the agronomy required for consistent yield and quality and publish grower guides.

* To develop a total quality management package for the production and marketing of buckwheat.

* To achieve export quality grain from 75% of total harvest by the year 2000 by supporting grower's efforts to optimise production technology.

2. Summary of Activities

Experimental work

Five trial sites were established in Victoria to conduct experimental research into buckwheat production in the past three years. These were situated in the cool climate, high rainfall districts of South-west Victoria at Bullarto, Smeaton, Yambuk, Grassmere and Teesdale. Experiments on these sites investigated the effect on yield and more particularly quality of the following critical agronomic factors.

- Time of sowing
- Types and cultivars (and interaction with T.O.S)
- Nutrition, pH effects
- Irrigation technique and scheduling
- Weed control and herbicide screening
- Harvesting method
- Rates of sowing
- Pollination
- Dryland versus irrigated raised beds

Other trial sites were established across potential new growing areas in Victoria. These sites were in East Gippsland, West Gippsland, Mornington Peninsula, North-east Victoria, Central Victoria, South-east South Australia and Southern NSW.

NSW Agriculture undertook variety testing, time of sowing trials and herbicide screenings at Orange and Blayney as well as agronomy and time of sowing research at Mudgee.

The University of New England, located at Armidale, conducted agronomy trials and also worked on the flowering responses of a wide range of varieties and correlated these with climatic factors such as temperature and daylength. Another large ongoing research project based at Armidale is investigating buckwheat ideotypes across a wide range of soil types and environments.

Groups of interested growers were formed around each site so that they could learn about the crop first hand during the growing season. These regions were well served with LandCare, TopCrop and other similar groups, which were used where possible. All farmers in these regions received technical assistance from the buckwheat agronomists.

The Mobile Agronomy units based in cities close to the buckwheat areas conducted experimental work in Victoria and Central New South Wales. This equipment was available to the summer crop project with the advantage that the sowing and harvesting equipment was used at different times to the peaks of the winter cropping program. Biometrics support was available from specialists in both State Departments and the University of New England. Grain quality testing was conducted at Bunge/Defiance Australia, at Ballarat, for moisture content, protein and specific gravity. Buckwheat Enterprises Pty Ltd and Food Link Asia Pty Ltd both assisted by importing seed and cultivars and dispatching samples.

An important part of this project in the first year was to investigate the pollination of buckwheat. A large site at Smeaton was used to investigate the effect of honeybees on the yield of buckwheat.

Quality analysis and evaluation

Many agronomic treatments can affect quality as much as yield and, particularly for export, quality is vital. Selected samples from treatments from Victorian and New South Wales trials were analysed at Bunge/Defiance Australia for noodle quality parameters such as protein, strength, starch pasting properties and gelatinisation time.

Industry development

Maintaining close contact with local marketing groups was a key part of creating and extending marketing opportunities for buckwheat. This was undertaken through forming the Buckwheat Industry Group which involved key buckwheat farmers, scientists and marketing bodies. Regular meetings were conducted to update stakeholders on issues associated with the growing and marketing of buckwheat and to plan for future industry developments. The meetings provided an excellent opportunity to involve everybody from the growers right through to the end users. Links were also made with marketing groups by working closely with them throughout the growing season, and visiting growers together.

3. Achievements Against Milestones

Milestone 1: TQM for Buckwheat

A draft Total Quality Management (TQM) buckwheat document was circulated to buckwheat growers for the 1997/1998 season. This document identified the key hazards associated with different stages of buckwheat growing. This buckwheat crop monitoring manual is a very useful grower tool and information package to assist in producing optimal buckwheat crops. Monitoring methods and forms of corrective action were also documented.

Quality Assurance has benefits for growers by ensuring they address critical control points, and produce a high quality product. It can also be an important marketing tool. Adoption of QA by the Australian Buckwheat Industry will be essential in the future, to secure our markets. Failure to follow the QA steps and avoid the hazards may result in less money being paid to the grower as well as losses in yield and quality.

The feedback from growers about this manual has been positive, with most recording information in the manual and sending it back to DNRE for compiling. They have also been helpful by making suggestions on improvements to the manual. Being a new industry in Australia, most see this as a very important management tool to understand best management practices for producing high quality buckwheat.

The Australian Buckwheat Industry Quality Assurance and Crop Monitoring Manual was modified again for the 1998/1999 buckwheat growing season and circulated to most growers in Victoria and New South Wales. Most growers completed the appropriate sections as part of the crop checking process. This information was collected and is extremely important towards making future management recommendations.

The manual and grower guide was further modified from grower suggestions and circulated to growers for use in the 1999/2000 growing season. The framework is now in place to establish a fully developed and integrated Quality Assurance system within the Australian buckwheat industry, although this will need to be primarily driven by commercial companies.

Milestone 2: Field experiments on cultivars, agronomy and herbicides

1997/1998

Over the summer of 1997/1998, field experiments on buckwheat were conducted in Victoria and New South Wales on varieties, sowing times, sowing rates, herbicides, nutrition, pollination and flowering patterns. All of the results from the trials were compiled into a report.

Seven sites were used for buckwheat trials in Victoria during the 1997/1998 season. Yields were generally low (average 1t/ha) due to conditions being hotter and drier than average. The *El Nino* weather pattern reduced yields and quality of buckwheat at some sites but the Smeaton and Bullarto trial sites achieved exceptional yields of over 3t/ha.

In Victoria, as in previous years, shorter maturing varieties generally yielded more than longer maturity ones. One trial at Ballarat tested 43 different varieties that were obtained through collaboration with Japanese and Canadian plant breeders, and highlighted the yield increases of the shorter maturing varieties.

Additional funding was obtained from the Hermon Slade Foundation for a three-year PhD project. Mr Kerrin Henderson at UNE Armidale was offered this scholarship with the aim of describing a buckwheat ideotype for the three main buckwheat growing areas of mainland Australia. As wide a range of genetic material as possible would be tested for quality and yield with this research to complement the current experimental trial program.

The pollination trial at Smeaton produced significant yield increases as the result of the addition of beehives. Yields were doubled when plots were open to insect pollination and gross margins were considerably improved. This trial, principally conducted by Russell Goodman of Agriculture Victoria Knoxfield, will be published as a scientific paper.

Other significant findings last season were that sowing rates between 40 to 60kg/ha gave the highest yields. Time of sowing trials showed that sowing dates between late November and early January gave significantly higher yields than other times. Early to mid December appeared best in the Ballarat area. Little variation between treatments and poor yields meant other trials on nutrition, harvest methods and herbicides produced no significant findings.

Three variety trials were conducted in Armidale, on the northern tablelands of NSW. These were located at Lauradale Research Station (5km N of the University of New England), Puddledock (20km N of Armidale) and Coventry (20km E of Armidale). Due to above average rainfall, bird attacks and weed problems, only the site at Coventry gave useable results.

The Coventry site involved sowing buckwheat varieties at a high rate and thinning some rows down to a low plant density. There were no differences between the thinned and unthinned rows in terms of seed set. Maturity of seed was unaffected by plant density regardless of cultivar, but shorter maturing varieties yielded consistently higher than longer maturing ones.

Three variety trials were conducted at Mudgee, Orange and Blayney and all were sown in mid December. Two later sowings at Orange were not harvested because of poor and variable grain fill under adverse seasonal conditions. Again, the best performing varieties were the quick maturing ones. Kitawase, a short season Japanese variety, continues to perform well across a range of environments and altitudes.

Herbicide trials were conducted at Orange and Blayney. The crop safety of some soil applied herbicides, such as Treflan® and Yield®, appeared to vary with soil types. Dual® and Linuron® showed promise for controlling problem broadleaf weeds.

1998/1999

In the 1998/99 season, trials were conducted at two Victorian sites; Bullarto, near Daylesford and Yambuk which is near Port Fairy. Both sites were used to investigate varieties, crop nutrition, herbicides, harvest methods and sowing rates. Another site at Teesdale was also used to investigate the growth of buckwheat on raised beds. Buckwheat was also trialed in N.S.W at Mudgee, Blayney and Armidale. The main trials investigated a range of varieties, sowing times and also herbicides. There was also a large experiment at Armidale which used glasshouses to investigate the flowering patterns of a large number of cultivars whilst the nutritional requirements were also investigated by a post graduate research student.

There were 68 varieties tested in total from sources all over the world, on a number of sites in NSW and Victoria. The variety trial at Bullarto tested 34 different varieties and yields varied from 1t/ha to over 3t/ha. The variety trial at Yambuk tested 66 varieties with the earlier maturing varieties generally yielding higher than the longer maturing varieties. Many of these varieties were sourced from the leading buckwheat breeder in Canada. These new cultivars are being bred with larger seed, blacker seed and more seeds per plant. Many of these cultivars yielded particularly well and further trials will reveal their potential.

The nutrition trials investigated the effects of phosphorus (P) and nitrogen (N) on buckwheat. Results indicated that there were no significant yield increases from any treatment at either site. It is still recommended however to sow P with the seed, based on previous research and understanding of buckwheat nutrition requirements. It may be that grain quality tests, still being conducted, on grain weights, protein content and green groat colour will demonstrate responses to P and N.

Buckwheat appears to be very sensitive to herbicides and does not tolerant many of them. Our research has found that most of the chemicals trialed on buckwheat are not suitable, with at least some damage reported. It is hoped that in the future, there will be herbicides registered that can be used effectively on a buckwheat crop. It must be remembered however, that buckwheat will not require herbicides if sown correctly into a moist, weed-free seed bed. Buckwheat will outcompete weeds if it is able to germinate and establish evenly and quickly. As a result of this, organic buckwheat production appears to be a viable option.

Buckwheat is a crop that requires great care at harvest; timing and method being crucial to both quality and yield. Moisture content is one such critical factor that must be timed accordingly and monitored. Foreign matter in the grain sample also affects the moisture content and can decrease quality substantially. Direct heading, desiccation and windrowing have been compared to determine the best method of harvest. Trials have shown direct heading of buckwheat to be the best in terms of yield. Windrowing appears to have a lot of potential and is almost exclusively used in North America. It is recommended desiccation be generally avoided due to it being an extra cost, it appears to decrease yield and it is an avoidable chemical application.

The rate of sowing trials showed significant differences between treatments. Sowing rates in 10kg/ha increments were trialed between 20kg/ha and 80kg/ha. The trials produced a linear trend of yield increasing with sowing rate. These results differ from previous years, with soil type and climate appearing to be the determining factors.

1999/2000

Two sites were selected to conduct the main buckwheat research trials in Victoria, over the summer of 1999/2000. These sites were located on a property at Grassmere (20km North of Warrnambool) and on a property at Bullarto (15km Southeast of Daylesford). The trials at Grassmere were conducted using conventional cropping practices whilst those at Bullarto were grown organically. Trials were conducted to investigate varieties, rates of sowing, nutrition, harvest methods and herbicides.

A third trial site was located on Andrew Morrison's property at Teesdale. The purpose of this trial was to investigate buckwheat being grown on raised beds, both with and without irrigation, testing different trace element treatments.

Specific information was collected for the different sites, particularly the soil nutrient status and the climatic growing conditions. Of particular interest this season was the extremely hot and relatively dry months of February and March when most of the buckwheat plots were grain filling. This caused

devastating losses to yield and also decreases in quality. As a result, some trials were either abandoned due to insufficient yield data or were at the very least severely affected. The trial site at Grassmere, where the altitude is low, was particularly affected by the harsh conditions.

An unreplicated trial was sown at the Bullarto site, investigating 30 different buckwheat cultivars. Although only an observational trial, some useful comparisons were made between cultivars. Of particular interest were the cultivars K3 and K5, which were obtained from our collaboration with Clayton Campbell, director of Kade Research in Canada. These cultivars have been bred with extremely large, black seeds and appear to yield very well. However, their specific gravity was quite low which is not desirable. Future research on varieties needs to further focus on evaluating some of these cultivars to investigate their viability under a range of Australian conditions.

The rate of sowing trials investigated sowing rates between 30kg/ha and 70kg/ha for both 'Hitachi' and 'Kitawase'. The poor yields at Grassmere meant that no comparable yield data was obtained. At the Bullarto site, the highest yields of Kitawase were obtained using sowing rates of 50kg/ha, although the difference between 40kg/ha through to 70kg/ha was minimal and not statistically significant. This would mean that under these conditions, 40kg/ha would be recommended. Specific gravity was highest at the heavier seeding rates, although again not statistically significant. No significant yield differences were found between the different rates of Hitachi at the Bullarto site. Consequently, the lowest rate of 30kg/ha would be recommended under these growing conditions. Specific gravity was again higher with the higher sowing rates, although not statistically significant.

The nutrition trials investigated sowing Kitawase with different rates of conventional fertilisers at Grassmere, organic fertilisers at Bullarto and both these at Teesdale. The extremely poor yields at Grassmere meant no yield comparisons of the different treatments could be made. Under these conditions, buckwheat sown with no fertiliser would be the most economical. The organic nutrition trial had to be abandoned due to blockages in the sowing equipment due primarily to the large pellets of the 'Grow-well' and the moist powdery substance of the 'Blood & Bone' organic fertilisers. The site at Teesdale was sown down to Kitawase under different nutrition treatments on two raised beds, one with irrigation and one without. Although both raised beds allowed for good growth of the buckwheat plants, buckwheat on the non-irrigated beds had no grain fill at all. This may mean that the well-drained sandy soils may not be conducive for buckwheat grain filling to occur during the usual summer heat of February and March. Some buckwheat yields were recorded from the irrigated beds, meaning that water is essential for this crop growing in these conditions. Trace elements also seemed to be important as buckwheat with the complete foliar mix yielded the highest, although it appears the biggest limiting factor in this area is lack of moisture and high temperatures. Future research on the Teesdale site needs to consider varying the sowing time, either earlier (possibly around November) or later (up to the start of February). Irrigation should also be available, particularly if sowing late, to apply as required. More research also needs to be conducted on the trace element deficiencies of these soils in order to optimise yields.

The harvest method trial at Bullarto investigated using both windrowing and direct heading for both Kitawase and Hitachi varieties. Direct heading again yielded higher than windrowing for both varieties. Although the yields were closer between harvest methods for Hitachi, direct heading would still be recommended over windrowing. Specific gravity was basically the same for either treatment within varieties. It would be recommended that all potentially low yielding crops be direct headed as a result of these results and previous years data. Windrowing should be considered on potentially high yielding crops, although with much care and attention to timing and application.

The buckwheat variety Hitachi was sown at the Grassmere site using a number of experimental post and pre emergent herbicides for broad leaf and grass weed control. Unfortunately, poor yields meant the trial was not justified for harvest but a number of observations were made. These included that both rates of Linuron® affected buckwheat to some degree and should not be considered for further

trials. Dual® as a broadleaf herbicide did not appear to visually affect buckwheat at any of the rates tested, similar to previous year's trials. Sertin Plus® likewise did not appear to affect buckwheat at either rate tested. Buckwheat plant samples were taken during grain fill to allow for Maximum Residue Levels (MRL's) to be conducted on both Dual and Sertin Plus for possible registration in the future. It is important to recognise that these herbicide trials are experimental only. There are no herbicides currently registered for buckwheat and none of these treatments can be applied to buckwheat crops.

Milestone 3: Extension activities

1997/1998

A field day was organised on the Ballarat Demonstration Farm during the growing season. More than 50 farmers and other members of the community attended this information day. This highly successful day involved touring the trials and also commercial buckwheat crops around the district. NSW Agriculture and UNE Armidale held similar grower information sessions during the season.

The buckwheat industry is still at an early stage of development, with only a small number of growers. Consequently, individual grower assistance was given by the buckwheat agronomist throughout the growing season. It has remained an important extension activity for the duration of the project.

1998/1999

A number of highly successful buckwheat field days were conducted in Victoria and New South Wales during the 1998/1999 buckwheat season. Four field days were conducted across the State of Victoria. More than a hundred people attended the Victorian field days that were held at Yambuk, Bullarto, Dromana and Paynesville. These involved walking tours of trials and commercial crops. Buckwheat agronomists, marketing companies and experienced growers were involved in educating the participants in various aspects of buckwheat production. Feedback from these field days was very positive with a high level of interest and enthusiasm.

New South Wales field days were more grower focussed and involved farm walks and crop inspections. They were organised at the two main buckwheat growing areas in the Central Highlands and the New England Tablelands. They were a very valuable extension tool for growers and other interested people.

The 'Buckwheat Bulletin' continued its role as a timely information package for growers. The newsletters are published and dispatched quarterly to inform growers and other interested people on industry developments, marketing opportunities and requirements, growing specifics, research results and other important buckwheat information. This is still seen by everybody as a key resource and efforts are being made to improve the framework and structure of this publication to make it even more successful.

1999/2000

Two successful field days were held at Grassmere and Bullarto during the buckwheat season to discuss questions relating to the research, agronomy and marketing extension issues of the Australian buckwheat industry. More than fifty people attended the two field days that included keynote speakers from different areas within the buckwheat industry. As well as walking through the experimental plots and discussing key issues related to the treatments being investigated, the field days also included walks of neighbouring commercial buckwheat crops. Visitors were able to ask questions about various aspects of the buckwheat industry in Australia from a growing, marketing, processing or consumer perspective. The field days also included informal discussions over light refreshments with different supply chain members within the Australian buckwheat industry.

4. Commercial Buckwheat Production

Victoria

In the 1997/1998 season, some major production achievements were made in Victoria, although the hot, dry conditions reduced the yield and quality of buckwheat to below expectations. Food Link Asia, the largest buckwheat marketing company in Victoria, sent a trial shipment of about 160 tonnes of buckwheat to Japan.

Although slightly low in moisture content, this sample was well received by the Japanese. They have stated that within five years we could be supplying them with 10% of their total imports, which equates to 10,000 tonnes. This demonstrates the importance and confidence that countries such as Japan have in Australia to be able to supply them with a significant component of their buckwheat.

During the 1998/1999 season, around 1000 tonnes of buckwheat was produced in Victoria, a significant increase on the previous year. Most was contracted to Food Link Asia. Despite the successful season in terms of buckwheat growing, many new challenges and issues emerged in regard to marketing. Unlike 1997 and 1998, where a lack of moisture downgraded the quality of the harvested seed, a sizeable amount of seed was rejected by the Japanese due to high levels of moisture. This was caused by cool and wet conditions occurring during the harvesting period.

Good rains occurred throughout the growing season at critical times and this allowed for record buckwheat yields to be produced. However, as quality is the critical factor in this industry, more attention was required at harvesting. As well as having high moisture contents, some grain also had a lower than expected specific gravity (or test weight). Another problem that occurred last season was the delays in importing seed by the main Victorian marketing company, Food Link Asia, compounded by A.Q.I.S holding the seed for six weeks. This caused extended delays in sowing and although the grain should be ideally sown in November in many areas, some farmers were not able to sow until the start of January.

As a result of the problems that occurred during the 1998/1999 season, a number of issues were identified;

- If the industry was to grow and develop, further infrastructure needed to be put in place regarding drying facilities and some mechanical supports. This was addressed in Victoria with the establishment of drying facilities.
- Growers needed to take more care in the timing of harvesting to address moisture content. Growers were also required to look at issues involving adequate harvesting infrastructure and transport to the appointed seed cleaner prior to the crop being planted.

The 1999/2000 season saw the introduction of significant commercial developments and alternatives for growers in Victoria. New opportunities arose for growers to grow buckwheat under contract for alternative marketing companies, with the option of growing 'premium' organic buckwheat. These important developments in the Australian buckwheat industry will help shape and establish buckwheat as a viable summer crop alternative for farmers to grow. These changes in marketing opportunities and consumer needs are also helping to create new products as well as marketing opportunities.

Most of the commercial buckwheat crops produced in Victoria recorded below average quality and yields. The season was again highlighted with well below average rainfall, whilst temperatures soared at critical growth and grain filling stages. Whilst most buckwheat crops were filling during February, temperatures in many areas of Victoria were the hottest on average ever recorded. This appears to be the major reason why buckwheat yields and quality was low.

Despite the generally poor reports across the State, high quality commercial buckwheat crops were again produced in the Bullarto area, where the high altitudes make buckwheat conditions ideal. Some general findings from this past season have highlighted the importance of addressing sowing times as well as identify heat tolerant varieties that suit our conditions.

New South Wales

In 1997/1998, a lack of subsoil moisture prior to sowing combined with low rainfall during flowering and grain fill, early frosts and hail contributed to a reduced amount of buckwheat harvested in the Central Tablelands of New South Wales. Plantings of about 1,200 hectares were expected to produce 2,500 tonnes of seed in this area, but only about 1,000 tonnes of seed was produced. The quality of this seed was affected by moisture stress during grain filling.

Northern New South Wales has experienced problems in recent years, including extremely wet conditions over summer time causing waterlogged buckwheat crops, and infestations of fast growing summer grass weeds. This has reduced the amount of commercial buckwheat production in the area. Until farmers can control these grass weeds, they will remain wary of growing this crop. Herbicide trials were performed around Armidale to combat this problem. Another concern for growers in this area is market stability and hopefully, as these problems are overcome, New England growers will have their confidence in buckwheat restored.

In 1998/1999, deliveries to Buckwheat Enterprises in Parkes came to about 1300 tonnes from nearly 2000 hectares. Crops failed if they were not sown on fallow or were direct drilled. From the 1300 tonnes, about 950 tonnes (73%) was export quality. The later maturing varieties produced higher yields than the early maturing varieties due to rain falling when the later crops were in full flower. Sowing rates over 30kg/ha caused plants to run out of moisture at the critical time and resulted in poorer quality grain.

In future years, all buckwheat delivered to Buckwheat Enterprises will be tested for noodle quality before it is lotted together. Much stricter delivery standards will also be introduced. The changes will be made to increase grower returns and cut marketing costs. Buckwheat Enterprises have also recently installed a dehulling machine to start supplying the domestic market with high quality Australian buckwheat and replace the cheap and poorer quality Chinese kernels.

Only a small amount of commercial buckwheat crops were grown in the New England Tablelands of Northern New South Wales in 1999/2000. Adequate moisture was available at sowing and during early growth that resulted in good establishment. Unfortunately though, poor conditions during grain filling resulted in yields and quality to be well below average. It was recognised that one of the most important issues in this area is knowing what is the best variety to grow. A range of varieties have been grown in this area with varying yield and quality. Many of the crops in the district had the potential to yield 2.5t/ha, but hot and dry conditions during the grain filling stage resulted in grain abortion or only half filling.

The buckwheat season on the Central Tablelands during 1999/2000 began with a tremendous start following 75 mm of rain between late December and early January, with most crops being sown around mid January. February was a relatively dry month with only two rainfall events of around 10mm, whilst the warm temperatures in early February stressed many crops. March was dominated by an early autumn break, something not experienced in the last 40 years according to some of the locals. The district received 150 mm (or 6 inches) of rain that damaged some crops. While later sown crops were in full flower and should have benefited from the rain, flowers aborted to some degree because of the prolonged wet overcast weather. Some grain from the early sown crops also shot and sprung.

Good rains and mild conditions during April delayed the start of harvest, as crops stayed green and some growers had to wait for paddocks to become trafficable. Yields were generally disappointing with the unseasonal conditions lowering both quality and yields. Some of the significant events of the season included the identification of Downy Mildew on buckwheat in Australia. It seems likely the disease has been present in Australia for years but it has only now been positively identified. Seed from infected crops will be collected at harvest and grown in the glasshouse to obtain an indication as to the incidence of infection. A fungicide seed treatment trial is proposed for next season. Some buckwheat crops matured during the wet weather and ended up germinating, therefore of no market value, only as stock feed if a market. Some crops in the Oberon area were abandoned due to heat stress in February whilst the seed coat colour was brown instead of black in many crops, although the grain was still of good quality containing plump green kernels. Some mice damage was reported in the windrowed crops as well as some rain damage. Overall, what looked to be a promising season for buckwheat on the Central Tablelands in 1999/2000 ended up to be frustrating and disappointing.

5. Strategic Future Directions of the Australian Buckwheat Industry

A workshop was held in Canberra at the beginning of March 2000 to bring together buckwheat growers, processors, researchers and marketing companies to develop "strategic directions" for the Australian buckwheat industry. About 25 people were involved in identifying the strengths, weaknesses, opportunities and threats of the buckwheat industry and ways to use these to springboard the industry into the next phase of development.

A dinner was held on the evening before, which gave everyone an opportunity to informally meet. It was also an opportunity to listen to our guest speaker, Alan Hunter; chairman of Pulse Australia, who spoke about similar issues and problems that have occurred in the development of the Pulse industry. His knowledge and thoughts were extremely valuable on how they overcame issues facing the Pulse Industry. His support and valuable input 'of looking in from the outside' were of great value also during the workshop the following day.

It was evident from the workshop that a number of issues need to be addressed for buckwheat in Australia to develop further. The main concern was the size of the global buckwheat markets and who and at what price we are competing against. This will be addressed in the next six months with a comprehensive market analysis being conducted. This will form the basis of any future research and help identify if and where there are market opportunities.

Other issues of communication were raised, with most seeing the Buckwheat Bulletin as essential in terms of information transfer. Some felt that a web site might also be appropriate in the future. Future research topics were also discussed, as was the difficulty in determining and testing grain quality.

It was decided unanimously that a follow-up workshop should be scheduled in the winter of 2001, after a detailed market analysis has been conducted, and at which point we can formulate and strategically direct the future of the buckwheat industry.

6. Conclusion

Buckwheat production has increased significantly since the beginning of this project, in all growing districts. This was largely due to better, more seasonal growing conditions, improved farmer practices and the introduction of total quality management into the industry. The conditions in Central New South Wales and the Northern Tablelands were drier than average over the past few seasons and consequently, many crops yielded below average and did not reach export quality. Hail damage also caused significant yield losses as well as early frosts on many of the crops grown in higher altitudes during 1997/1998.

Important buckwheat management lessons have been learnt as a result of this project in regard to producing buckwheat in Victoria and abroad. It is essential that we get a better understanding of sowing timing, with many thinking that we are not sowing buckwheat at the optimal time. Sowing times need to be based around the buckwheat grains filling when temperatures do not exceed 30^{o}C on consecutive days.

Many lowland and coastal areas experience these extremely hot conditions from mid January through to mid March on average in most years. This may mean that sowing in early October may prove lucrative in many areas, so that grains fill when moisture should not be limiting and temperatures not exceeding. In coastal areas where frost risk is low, later sowings may also be worth trying so that grain fill occurs after the hottest weather.

Time of sowing must consider though the risk of frosts and soil temperatures, with both of these important for germination. Areas in higher altitudes are more likely to be at risk of frosts. It is these areas though which, at least in Victoria, have consistently produced the highest yields and quality of buckwheat from December sowing's, when even last season, yields of close to 2.5t/ha were achieved. Consequently these sowing times in December may be best.

Variety trials across both States tested a wider range of material than ever before. Cultivars were obtained from Japan, Slovenia, Czech Republic, France and Canada. Some of the latest developed cultivars have performed exceptionally well. These are being developed with larger, blacker seeds and higher yield, and good results have indicated that further collaboration and research is essential. Some of these cultivars are already being further investigated now for possible commercial production in future years.

The pollination research conducted during the 1997/1998 buckwheat season was important in understanding the effects of bees on buckwheat in Victoria. Results proved that yields could be doubled when bees are included in the production system and gross margins were increased. This was an important finding and helped support other work from around the world on the effects of bees on buckwheat. We recommend the addition of bee hives to buckwheat crops at the beginning of flowering.

The research on herbicides on buckwheat has shown that only one of those tested for broadleaf control is worth further testing. Dual® is the only chemical that has not affected buckwheat. Other post and pre-emergent herbicides such as Trifluralin, Stomp and Linuron have all affected buckwheat to some degree and could not be considered for registration. Buckwheat will not require herbicides if sown correctly into a moist, weed-free seedbed, germinating quickly to outcompete weeds. It is therefore a potential organic crop.

The rate of sowing trials showed that 40 to 60kg/ha produced the best yields in Victoria. This is similar to previous research, although last season, some of the higher sowing rates up to 80kg/ha,

yielded higher than others. Rates of 40 to 45kg/ha are recommended for non weedy paddocks and this should be increased by about 10kg/ha in potential weedy paddocks.

Investigations into harvest methods in commercial crops and trial plots have shown that direct heading can produce high quality and yields of buckwheat. Care is needed to set the appropriate harvester settings. Direct heading is now the preferred harvest method for buckwheat growers in Victoria. Windrowing is used in Australia and shows plenty of promise, but desiccation is not recommended due to the additional costs involved and possible effects on markets.

The framework is now in place to establish a fully developed and integrated Quality Assurance system within the Australian buckwheat industry, although this will need to be primarily driven by commercial companies. A Total Quality Management (TQM) buckwheat document has been produced to identify the key hazards associated with different stages of buckwheat growing. This monitoring manual is a very useful grower tool and information package that is used to assist in producing optimal buckwheat crops and crop monitoring.

Increasing buckwheat markets in both Australia and overseas provide a unique opportunity for Australian buckwheat growers. The RIRDC Buckwheat project has developed a nutrition brochure that is being used domestically to increase the demand and awareness of buckwheat. This will be circulated more intensively in the future to further develop the opportunities of Australian grown buckwheat. Increasing the consistency and supply to meet the increasing demand will be the main challenge that needs to be addressed by the industry.

A major task to be completed during 2000/2001 will be to identify existing and potential markets around the world. This market research will be used to identify optimal niche markets for supply and further development.

Continued commitment by different levels of the supply chain will help ensure that the buckwheat industry continues to develop and supply potential markets. This is at a time when there is an increase in commercial buckwheat marketing companies operating in Australia. The continuing commitment of supply chain members is essential towards the establishment of a sustainable, profitable and successful industry in future years.

7. Significant Developments

The project played a major role in the choice of Ballarat as the site of a noodle factory built by a Japanese company, Hakubaku. This factory started operations in 1997 and employs over 30 local people. They are currently producing noodles from Rosella wheat, but the prospect of buying fresh, locally grown organic buckwheat was one of the reasons they came to Ballarat. They are about to start trial production of some noodles from locally grown buckwheat.

The increase in buckwheat grown near Orange was the reason why another Japanese businessman chose that city as the site of his Japanese garden and restaurant, serving buckwheat cuisine from local grain.

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9. Buckwheat Publications

The project has been publicised in buckwheat growing areas through local newspapers, television and radio stations. A general awareness has also been created State and Australia-wide for buckwheat in terms of growing and also through nutritional aspects.

Books and Agnotes

* Production and export of buckwheat grain and value added products, September 1997
* Buckwheat, February 1998
* Buckwheat; in The New Rural Industries, Ed. KW Hyde, RIRDC 1998
* VII International Buckwheat Symposium and Study tour of Canada and North America, October 1998

Newspaper articles

Ballarat Courier, other rural newspapers including quarterly Agricultural Focus, Southern Farmer, Western District Farmer. Also Statewide Rural Newspapers (Weekly Times, Stock and Land, Go Grain and The Land) and general National media (Australian Farm Journal and Agriculture Today)

* December 1997	Buckwheat price bonanza
* January 1998	Bringing big bucks from bush country
* February 1998	Agricultural experts tip Asian buckwheat boom
* March 1998	Buckwheat for Japan could be $m regional industry
* March 1998	Japan keen to buy buckwheat
* April 1998	Japan has a yen for our noodles
* July 1998	Buckwheat best for pancakes
* August 1998	This wheat bucks the trend
* September 1998	Buckwheat is the future
* October 1998	Buckwheat seen as growth export
* October 1998	Japanese interest in regional buckwheat
* October 1998	Japan identified as Buckwheat market
* December 1998	The crop of the future
* December 1998	Farmer may sue AQIS – Buckwheat shipments released at last
* January 1999	Grain bucks the trend
* January 1999	Research points to strong future for Australia's buckwheat industry
* February 1999	Buckwheat trials on show
* March 1999	Buckwheat trials offer new hope
* March 1999	Buckwheat is breaking all records
* April 1999	Rich harvest for Ballarat Buckwheat growers
* April 1999	Buckwheat production in Victoria
* May 1999	Record harvest for buckwheat growers
* May 1999	Buckwheat success
* May 1999	Trial yields $400/t
* June 1999	Healthy future for buckwheat – and those who grow it

Electronic media

Buckwheat experiments and field days have featured on Win TV television news and on radio on several occasions.

Other publications

* Buckwheat Nutrition Brochure 'A Healthy Grain for a Healthy Lifestyle'. Reprinted January 2000
* Buckwheat industry newsletters 'Buckwheat Bulletin' printed seasonally

Buckwheat field days

* February 1998	Yambuk and Bullarto (Vic) & Orange (NSW) Field Days
* February 1999	Yambuk and Bullarto (Vic) & Blayney (NSW) Field Days
* March 1999	Mornington Peninsula and Bairnsdale (Vic) Field Days
* March 1999	Teesdale (Vic) Buckwheat on raised beds information day