FINAL REPORT

Agronomic packages for improved yield and quality in the Australian peanut industry

UQ00050

Project Details

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- **Project Title:** Agronomic packages for improved yield and quality in the Australian peanut industry
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Summary

Aflatoxin positive loads in dryland peanuts have been reduced by 86% in the past five years through the aflatoxin risk monitoring and extension program in conjunction with the seasonal temperature and rainfall. A peanut drying model and a pod moisture meter have been developed to minimise post-harvest quality losses. The irrigation scheduling program 'AQUAMAN' has helped growers and advisers to improve water use efficiency. Cadmium research in the Bundaberg region was refocused to optimise liming and gypsum management practices. Yield benefits of up to 17% were demonstrated with ultra-early varieties planted in narrow row spacing. A coordinated extension program ensured dissemination of the outputs to 80% of industry stakeholders.

Conclusions

Extension of in-season aflatoxin risk information through the web-based decision support program, 'AFLOMAN' has helped dryland growers to implement appropriate harvest management practices and minimise aflatoxin risk.

A model to simulate the peanut drying process and the effects of drying on the product quality and energy use has been developed in collaboration with the University of New South Wales (UNSW) and validated for six commercial varieties.

A low cost, capacitance-based pod moisture meter tool, which rapidly and non-destructively assesses pod and kernel moistures, has been developed in collaboration with the United States Department of Agriculture (USDA). The technology has been validated for six commercial varieties in Australia. These tools will play a key role in improving the drying efficiency of peanuts and minimising post harvest quality losses at a grower and industry level.

Significant savings in irrigation water (up to 30% in dry years) without compromising yield have been demonstrated through implementation of the web-based irrigation scheduling tool AQUAMAN by growers and consulting agronomists in all high input production regions.

Cadmium research trials have revealed that a chloride concentration in irrigation water is linearly related to cadmium uptake by peanut plants for all soil types, highlighting the importance of irrigation water quality and management as a factor governing cadmium accumulation by peanut plants.

Research trials have revealed interesting information on the variations among commercially relevant peanut varieties in calcium uptake efficiency, suggesting scope for developing variety specific management practices for liming and calcium practices in acid sandy soils.

There is scope to further improve the potential yield and grade of ultra-early peanut varieties by changing row spacing and planting densities, but this practice change may have financial implications to growers who are using conventional machinery.

Recommendations

1. Minimising aflatoxin contamination in dryland peanuts:

Now that AFLOMAN and the UNSW peanut drying model tools are fully developed and available for use, it is recommended that these tools are made available for growers through industry coordinated grower solutions projects.

2. Improving water use efficiency of irrigated peanuts:

High input growers and advisers should be encouraged to use the AQUAMAN program to optimise irrigation practices, as peanut crops are sensitive to both over and under irrigation and realise more crops per drop of water. It may be necessary to organise training courses for growers and advisers as part of Agricultural Production Systems Research Unit (APSRU) activities.

3. Varietal-specific management practices for ultra-early peanut varieties:

The yield and quality benefits from increased seed rate and narrow row configuration have been established in on-farm research trials. However, adoption of this practice change has been slow due to the financial implications for growers. The peanut industry should encourage peanut growers, especially dryland growers, to adopt ultra-early varieties and narrow row planting as a package for late plantings (December) to maximise yield and minimise aflatoxin risk.

4. Industry-driven extension program:

Although the peanut industry has been organising extension activities for growers, technical backstopping by researchers would still be needed when extending complex issues, such as the AQUAMAN and AFLOMAN programs and the drying model. It is recommended that this backstopping support be included as part of the grower solutions projects.

Outcomes

Extension of in-season aflatoxin risk information to dryland growers and advisers using the web-based AFLOMAN program has helped reduce aflatoxin positive loads from more than 50% five years ago to less than 7% in the past five years, which in turn has resulted in lower clean-up costs for the industry and has enhanced Australia's clean and green image.

To minimise postharvest quality losses in drying bins and to improve the energy-use efficiency of dryers, a peanut drying model has been developed in collaboration with the UNSW. The model demonstrated the significant potential to minimise quality losses of peanuts during drying and to improve the energy-use efficiency of dryers.

Rapid assessment of pod moisture is critical to monitor peanut quality, including the efficacy of the post-harvest drying process. In collaboration with the USDA, a low cost moisture meter which uses radio frequency-based technology has been successfully calibrated for six commercially relevant peanut varieties. This technology has worked perfectly well for assessing the moisture content of single or multiple pod and kernel samples. There is good scope for commercialising the tool for rapid assessment of pod and kernel moistures in the drying bins, at intake points, as well as within peanut processing plants. There is also scope to use the tool to monitor the moisture of other grains and biomaterials.

Over the project period, 84 growers and advisers representing a total area of about 1,000 ha in the irrigated regions have been able to implement AQUAMAN - a web based irrigation scheduling decision support program. Results to date showed up to 20% improvement in water use efficiency and 30% savings in irrigation water in dry years, with up to 34%yield gains compared to conventional irrigation practices.

Following relaxation of cadmium regulatory standards in peanuts in the year 2009, the cadmium research and development (R&D) was refocused on rationalising an expensive cadmium minimisation package, including liming and gypsum practices in the coastal cane system. Results revealed scope to optimise liming and calcium practices in acid sandy soils without compromising yield and quality.

Results from 20 field experiments have shown that a yield benefit of up to 18% could be achieved with ultra-early varieties by adopting narrow row spacing (30cm) compared to the conventional row spacing of 90cm. The optimised row configuration for ultra-early varieties presented dryland and irrigated growers with a choice of varieties that would best suit their farming systems and achieve high yield and better quality.

Over the project period, a total of 33 major information exchange activities including grower updates (12) and field walks (11) were implemented jointly with the Peanut Company of Australia (PCA) and industry consulting agronomists to extend project outputs. In addition, the extension activities included 15 media releases and the delivery of the web based AFLOMAN and AQUAMAN decision support tools to over 80% of growers and advisers.

Achievement/Benefit

In dryland regions of the Burnett, pre- and post-harvest aflatoxin contamination continues to be the key major food safety issue and costs the Australian peanut industry (shellers and growers) between $5-10 million each year through analytical costs and associated sorting losses. In irrigated regions, increasing water shortages and rising input costs have a major impact on the profitability of irrigated growers. The tight water budgeting and rising energy costs mean that there is a need for growers to improve their skills in using limited water supplies more efficiently than has previously been the case.

Following the relaxation in cadmium food standards in 2009, the cadmium management R&D in the project was refocused to investigate opportunities for rationalising expensive cadmium minimisation practices, and optimising liming and gypsum management practices without compromising yield and quality and risking cadmium contamination of peanuts in the coastal cane systems.

The on-going climate variability in both dryland and irrigated regions requires peanut growers to explore the potential of choosing new varieties, including ultra-early types, to suit their farming systems and resources. The GRDC-Department of Agriculture Fisheries and Forestry (DAFF)-PCA breeding program has recently released ultra-early maturing varieties (e.g. Walter[A] and Tingoora[A]) which can mature in 100-110 days. However, yields of ultra-early varieties are lower compared to full season varieties due to their shorter growing period. There is a need to develop agronomic practices for these varieties to match their yield to full season varieties, and to ensure the production of high quality peanuts for Australian and overseas markets.

In addition, there is a need for a coordinated information extension program to ensure dissemination of outputs from this and related GRDC peanut projects, and to ensure they are adopted by growers and advisers.

The peanut agronomy project has been designed to address the above constraints by implementing the following activities:

1. Monitor the in-season aflatoxin risk using the web-based decision support system AFLOMAN and extend the risk information to dryland growers and industry agronomists through the AFLOMAN website, local newspapers and SMS media, each year.
2. Develop and validate a peanut drying model, in collaboration with the UNSW to monitor and minimise post-harvest quality losses in the dryers, and validate a low-cost monitoring system for kernel and pod moisture for its suitability to the Australian peanut industry, in collaboration with the National Peanut Research Laboratory, USDA. Rapid assessments of pod moisture and airflow rates in drying bins are the key factors in assessing the efficacy of the drying process.
3. Develop 'integrated' cadmium reduction strategies (in the high input Bundaberg region) including liming and calcium management practices for the production of high quality peanuts, and further develop and promote the web-based decision support program AQUAMAN for high input growers and advisers to achieve increased water use efficiency in irrigated regions.
4. Develop specific variety x agronomic management packages for commercially relevant ultra-early varieties for the dryland and high input irrigated systems, and implement a coordinated information extension program to ensure the dissemination of project outputs to peanut industry stakeholders.

During the project, there has been a wide range of climates with hot and dry summers initially and heavy rains and prolonged water-logging conditions towards the end of the project. Despite these challenges, the project has been able to make significant progress in achieving all milestones. The contribution of the project team, consulting agronomists and participating growers including the collaborators from UNSW and NPRL (USDA), in this achievement is thankfully acknowledged.

Achievements

Annual review and planning meetings involving the project team, advisers and industry partners, have helped to develop a shared understanding of the project against targeted deliverables and to identify areas of synergy in implementing technical work plans.

Reduction in aflatoxin contamination through increased adoption of pre- and post-harvest management practices, including web-based AFLOMAN decision support tools and new ultra-early peanut varieties, was the expected outcome for dryland regions of southeast Queensland. The AFLOMAN program predicted in-season aflatoxin risk with a high degree of accuracy, which matched with positive load data at the intake points during the project period.

Extension of AFLOMAN decision support tools through the establishment of model farms, and the creation of awareness through grower meetings, updates, newsletter articles and field days has helped growers to monitor not only the on-farm aflatoxin risk but also the accumulation of heat units by the crop as a measure of maturity. The program has been made available to individual growers at www.apsim.info/afloman and 67 weekly updates were posted on the program website and in local newspapers. A combination of awareness about aflatoxin monitoring and favourable rainfall conditions has reduced the aflatoxin positive loads from 50% five years ago to less than 7% in the past five years, suggesting the positive influence of the approach. This has in turn resulted in lower clean up costs for the industry and has enhanced Australia's clean and green image.

Poor post-harvest drying methods including in-field windrow-drying and artificial drying in silos, can result in uneven drying, which can lead to increased loss of product quality in storage. Both under- or over-drying can significantly affect seed quality especially splits, blanchability, flavour (off-flavours) and seed germ inability in the case of seed programs. A peanut drying model developed in collaboration with UNSW has been validated for six commercially relevant varieties. The model has been fully developed and ready for use in the peanut industry to (a) predict drying times (for given environmental conditions), (b) predict effects of product mixing during drying, (c) predict moisture tempering and uniformity, (d) predict energy use and end product quality estimates, (e) design drying equipment, (f) train in dryer operations, and (g) conduct desktop proactive simulations or 'what if' scenarios to determine the most appropriate strategy for drying.

The model has been used for the first time to monitor PCA's commercial storages at Tolga. The simulations showed that the pod moistures in the Tolga storage bins can rise from 10% at intake to more than 16% within three months due to high ambient humidity. These results alerted PCA to implement appropriate management practices to keep the in-store pod moisture at desirable limits and prevent product quality deterioration in storage.

Costs of irrigation in high input peanut systems account for up to 20% of the total variable costs in dry seasons. Significant savings in irrigation water (up to 30% in dry years) without compromising yield are expected in irrigated regions through the adoption of the web-based irrigation scheduling tool (AQUAMAN) by growers and consulting agronomists in all high input production regions. AQUAMAN has been used to various extents by 84 growers over the past five seasons in several peanut growing regions, including outside of Queensland. Results to date show up to 20% improvement in water use efficiency (1.1kg grain/m^3 water compared to 0.9 kg grain/m^3 water in the grower practice) with up to 30% savings in irrigation water noted for growers who used the AQUAMAN program until the end of crop maturity. The extension of this tool was achieved through collaboration with crop advisers, although individual growers have also continued to profit from the tool. AQUAMAN, in addition to projecting irrigation requirements, gives users an idea of crop maturity which is crucial to plan harvest operations.

Results from the 200709 trials revealed that plant cadmium concentrations increased linearly for all soil types as the concentration of chloride in irrigation water increased. Results from a glasshouse experiment provided an insight into some of the complex environmental interactions that govern cadmium uptake by peanut plants in the field and highlight the importance of irrigation water quality and management as a factor governing cadmium accumulation by peanut plants.

Following the relaxation of cadmium maximum residue limits (MRLs) in peanuts by the PCA in 2009, cadmium R&D was refocused on rationalising an expensive cadmium minimisation package, including liming and gypsum practices, without compromising the yield and quality of peanuts in the coastal cane system. A strategic survey of samples drawn from paddocks with historically high cadmium risk has shown that rationalisation of cadmium minimisation practices in coastal cane systems had little impact on kernel cadmium levels. Results from a glasshouse and field trial showed significant variation in calcium uptake efficiency amongst varieties, suggesting scope for developing variety-specific liming and gypsum practices without compromising yield and quality.

Analysis of 20 trials conducted over the project phase revealed that narrow row configuration can result in higher yields of up to 17% compared to conventional row spacing, although yield benefits vary depending on the environment. Recent trials have also shown that the pre-release ultra-early line D193-Tan showed a further yield advantage over its sister line Tingoora in the narrow row configuration due to its better tolerance to foliar diseases.

Two separate large on-farm trials in Kingaroy and North Queensland (NQ) demonstrated up to one tonne yield benefit from planting Tingoora under the narrow row configurations, compared to the conventional 90cm rows, although some mechanical limitations of managing narrow rows were apparent and may present a constraint for rapid uptake of technology by growers with conventional machinery. There are some limitations (mainly financial investment-related) for growers to adopt the technology rapidly. It is possible that they will adopt it in future when changes are made to their planting and harvesting gear.

Coordinated information exchange activities were implemented in collaboration with PCA and industry consulting agronomists to extend project outputs, via review and planning meetings, attendance at PCA and Bean Growers Association field days and grower meetings. A total of 11 peanut industry Updates (six in Bundaberg and five in NQ) were held to disseminate project outputs to growers and advisers. A total of 17 field walks and field days were held in dryland and irrigated production regions. The coordinated extension program ensured dissemination of the project outputs to 80% of the industry stakeholders. Regular press articles and web-based delivery of peanut research, development and extension information will continue to promote the research outputs.

Other Research

1. Preliminary research has shown that the AFLOMAN program can also be customised to assess aflatoxin risk in maize. A significant funding grant from AusAid to apply this concept to maize in Africa has been approved and a CSIRO led project is now in progress.
2. The success of the AQUAMAN program has inspired the development of the online 'Watershed' program which has been funded by Queensland Government. The tool has also been made available to growers.
3. Growers have faced difficulty in finding time to use AFLOMAN and AQUAMAN online. There are opportunities to develop Smartphone compatible applications of the web-based programs to overcome this limitation experienced by growers. This will also assist crop advisers.
4. The research with the USDA pod moisture meter in Australia also revealed that the meter can be customised to measure oil content rapidly and non-destructively in single or multiple kernel samples. There is an opportunity to develop a project focussing on developing (and commercialising) an embedded system to measure moisture as well as oil for application in peanut and other oil seed industries.

Intellectual Property Summary

The AFLOMAN and AQUAMAN programs have been developed as modules of the Agricultural Production Systems simulator (APSIM) peanut model which is the intellectual property (IP) of APSRU.

Background IP of the moisture probe (design and circuit board) is owned by NPRL USDA.

Future IP ownership of the sensor and product design for the moisture probe will need to be worked out as the product is further developed into a complete embedded system and tested for commercialisation, and presumably will be based on relative contributions made by collaborating parties (NPRL, QAAFI, DPI&F, and GRDC). If the product has significant application in peanut (and other grain) industries, future commercialisation will be explored in Australia and the US.

Collaboration Organisations

Aflatoxin minimisation.

Rapid and non-destructive assessment of pod and kernel moistures.

1. Dr Chari Kandala, Ag Engineer, and designer of the capacitance-based peanut moisture meter, NPRL, USDA, GA, USA.
2. Peanut drying: Chris Bautts, peanut drying specialist, at the USDA, National Peanut Research Laboratory, Georgia, USA.
3. Collaboration with the PCA to assess the use of the kernel moisture probe for non-destructive pod moisture measure in their plant. The Australian Peanut Industry considers the continuing development and testing of optimum artificial drying systems, including the rapid and non-destructive assessment of nut-in shell moisture, is a major priority to minimise post-harvest quality losses and enhance peanut quality.

Collaboration Details

This collaboration was initiated in the previous peanut improvement project (DAQ00070), but the progress was severely delayed due to issues with IP. Following the visit to NPRL by RCN Rachaputi, a new contract has been signed by USDA and DEEDI (DAFF) in 2008 and renewed in 2010. The prototype probe was imported for testing in Australia. The major aim of the international collaboration was to test the performance of USDA pod moisture meter under Australian conditions and assess its potential application in the Australian peanut industry, in collaboration with the PCA.