Session 1

Opening Address and GRDC Vision

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Introduction

Ladies and gentleman, thank you for the invitation to address the 13th Biennial Sunflower Conference. I am delighted that the GRDC is a sponsor of this important event and I hope that it will help set the future direction for the Australian sunflower industry.

In agreeing to speak at the conference, I was asked to outline the GRDC 'vision' for the future. Unfortunately, this conference is about a year too early, as the GRDC is currently engaged in a strategic planning process that, in part, is about determining our vision for the next five years. Although this planning process has yet to be completed, I can nevertheless provide you with an indication of key themes that will underpin future research investments by the GRDC and how sunflower research is reflecting the importance of these themes. In particular, our sunflower research effort reflects:

- the need to integrate key biotechnologies with traditional technologies;
- the need to meet market needs for food safety and quality;
- the importance of private-public sector partnerships, and
- the need to commercialise research outcomes.

Integrating key biotechnologies with traditional technologies

In accordance with industry priorities, the GRDC's key investments in sunflower research are focused on two areas: disease resistance, in particular rust and Alternaria resistance, and drought tolerance. Both projects illustrate the importance of integrating key biotechnologies into traditional technologies, such as plant breeding.

The drought tolerance project, for example, is focused on developing molecular markers for transpiration efficiency (drought resistance), which we believe will contribute to the development of drought tolerance within sunflowers and, potentially, has worldwide application. Most importantly, increasing drought tolerance in varieties will assist in stabilising Australia's sunflower production. As other examples, our rust research investment with QDPI is on the verge of delivering molecular markers for rust resistance, while work is set to commence on developing markers for Alternaria resistance. (This latter project is a challenging one, as Alternaria resistance is qualitative and it is difficult to develop markers for this kind of resistance.)

The nature of the GRDC's investments in sunflower research illustrates that the use of different biotechnologies – in particular molecular markers and functional genomics – is now a commonplace, and increasingly important, aspect of our investment portfolio. We have made such investments because we firmly believe that biotechnology, including genetic engineering, holds great promise for the future. Indeed, with the help of GRDC investments, Australia is a world leader in developing and applying key biotechnologies in agricultural research.

While recognising the promise of biotechnology, we also recognise that several areas of concern need to be addressed before the potential of biotechnology can be fully realised. For example, with scares in Europe regarding dioxin in feed and the ongoing concerns about BSE, it is unsurprising that consumers are cautious about the history behind the food they eat, including where genetic modification has taken place. Recently, however, there have been encouraging signs that countries sensitive to genetically modified food, such as Europe and Japan, are becoming more confident about this technology and may begin to relax their stringent stance with respect to food produced using this technology. Ensuring that consumers have confidence in this new technology, and the food produced as a result of utilising this technology, is a high priority for the grains industry. To this end, we are supporting the work of Agrifood Awareness Australia in providing balanced information to the public on the risks and benefits of genetic technology.

Food Safety and Quality

The issue of consumer concerns regarding the safety of genetically modified food highlights another theme underpinning GRDC research: food safety and quality. The GRDC is conscious that research is only effective if it supports growers in producing products that consumers want to buy. To this end, the GRDC continues to foster relationships with all sectors along the value chain in order to enhance understanding of market requirements. In addition, we continue to support the development and implementation of on-farm quality assurance programs and we invest in food safety research in order to enhance our understanding of food safety issues in the grains industry, and to assist the industry in implementing improved food safety management mechanisms.

In order to foster food safety and quality consciousness throughout the grains industry, the GRDC works with other industry sectors to enhance grower knowledge of these issues. In the case of the sunflower industry, for example, the GRDC has supported the initiative of the Australian Oilseeds Federation (AOF) in publishing the *Australian Oilseeds Grower Quality Guide*. The AOF should be commended on producing this document, as it is an excellent source of information for growers – and researchers, for that matter – on market requirements and the agronomic and farm management practices that growers can implement to meet these requirements.

It is becoming repetitive, and probably boring, to hear conference speakers emphasising the need to be consumer focused throughout the value chain. However, this issue is stressed so often because it really is a key determinant of profitability in the Australian agrifood industry. In saying this, I stress the word *profitability*, rather than productivity, because merely increasing productivity will not lead to sustainable agriculture unless it also leads to an increase in farmers' margins. Where Australia cannot compete on price, by producing grain more cheaply, it can compete on quality by producing grain that better meets customer requirements. As such, improving the quality and safety of Australian grain will continue to be a key area for future GRDC research investments.

Public-Private Sector Partnerships

A third theme that will increasingly characterise GRDC research, which is also evident in our sunflower program, is the need for both formal and informal partnerships between public and private sector agencies. In the past the GRDC worked, primarily, with public sector agencies. However, increasingly, the private sector is becoming involved and the range of the GRDC's operations is expanding via strategic alliances. These are essential if we are to protect the intellectual property arising from our investments; have access to the best of overseas technologies and ensure that, having invested in R&D, Australian researchers have freedom to operate and Australian growers can use the best available technologies. Strategic alliances also provide us with the opportunity to make larger and, potentially, more powerful, investments.

In the case of the sunflower industry, a significant amount of research in Australia is done through private companies and it is not the role of the GRDC to either displace or duplicate this investment. Instead, we hope to complement this investment so that, collectively, the research efforts of the public and private sector work harmoniously together in reaching industry goals. In Australia's sunflower industry, private companies consider that there are major benefits to be found in GRDC-supported pathology research such as identifying rust races, the development of molecular markers to screen for rust resistance and the identification of new sources of rust resistance. Building links with industry so that we understand industry research needs and, where appropriate, co-invest in research projects together, will be an important determinant of the future success of the GRDC. As such, we look forward to enhancing our relationships with private sector research investors, research providers, growers, marketers, end-users and other stakeholders in the sunflower industry in order to ensure that our investments are being placed appropriately to meet the needs of the industry.

Commercialisation of Research Outcomes

A final theme that I wish to highlight is the importance of commercialising research outcomes. The commercialisation of research can take many forms. However, in general it involves the transfer of research outcomes and know-how to commercial entities on agreed terms and conditions, including that the commercialising company invests in the development of the new technology and makes the technology available to growers. In general, the commercialising entity will pay a royalty, fee or dividend to the consortium that developed the technology and will then market, distribute and service this technology to growers on terms that provide it with an adequate commercial return. This process can sometimes seem obscure to growers because there can be many steps in the commercialisation process, not all of which are obvious.

Research into molecular markers for rust resistance in sunflowers provides a practical example of what I mean. While the development of molecular markers for rust resistance is interesting, it only becomes valuable to growers if, in some way, it is used to produce a product that growers can use – in this case a sunflower variety with improved rust resistance. In order to achieve this outcome, with the agreement of our research partner, QDPI, the rust marker will eventually be made available to the private sector on a fee-for-service basis. Significantly, the provision of rust markers to the private sector will enable the pyramiding of different rust resistance genes within commercial hybrids. The use of markers by the private sector will also potentially create efficiencies within their breeding programs through rationalisation of field testing. These efficiencies will, eventually, be passed on to growers through access to more durable rust resistant sunflower hybrids in a more efficient and effective manner than would otherwise be the case if the rust marker hadn't been developed.

This entire process – from making available the markers to the private sector breeding programs to the eventual production of new rust resistant sunflower varieties – is the commercialisation of research. In thinking about the commercialisation of research, I wish to stress that the GRDC is not concerned about making money for the GRDC. Instead, our focus is always on delivering new technology to growers as fast and as inexpensively as we can. Realistically, however, it is important to acknowledge that the successful commercialisation of many technologies requires cooperation between private and public organisations – that is, it is something that the GRDC simply cannot deliver on our own. Consequently, in the future the GRDC, and our research providers, will need to think even more creatively and assertively about how to commercialise the outcomes of our research so that new technology is made available to growers as effectively and efficiently as possible.

Conclusion

On 1 October 2000, we celebrated the tenth anniversary of the establishment of most of Australia's rural research and development corporations – the RDCs. The RDC model has many attractions to stakeholders. At its heart, it facilitates a research partnership between our two stakeholders – grain growers and government – that ensures grains industry ownership and direction over research, as well as an appropriate emphasis on research that provides benefits to the community. In the grains industry, the establishment of the GRDC has also enabled us to take a national approach to research issues, thereby minimising duplication between research agencies. Building our business around the RDC model has enabled the GRDC to change attitudes and to exert, responsibly, influence over the direction of Australia's grains research effort.

While the important role that the GRDC has had over the past 10 years in shaping Australia's grains research effort has not changed, the environment in which we are operating has changed considerably. Next year, when the GRDC releases our new Five Year Plan, we will be outlining our vision for the future and our strategy for delivering to growers the new technology that they need. Today, however, I have provided you with an indication of some of the themes that will be in this plan and which have already become an integral part of the GRDC's work. These include:

- the need to manage more complex relationships across the full spectrum of the value chain to meet our stakeholders' needs;
- the need to contribute to industry efforts in meeting consumer quality requirements for grain and grain-based products;

- the need to integrate different technologies and research disciplines to achieve holistic research outcomes, and
- the need to manage intellectual property issues and the commercialisation of research outcomes so that we can deliver even better technology to growers at a faster rate.

Today you will be examining more closely the future direction of the sunflower industry. On behalf of the GRDC, our best wishes for your deliberations and I have great pleasure in declaring the Conference open.

Australian Oilseeds Federation Strategic Plan and the Sunflower Industry

Allan McCallum, President Australian Oilseeds Federation

Australian Oilseeds Federation …

The Australian Oilseeds Federation is the industry's peak body that:

- Represents all sectors of the oilseeds industry
- Charter is to promote the growth of the industry
- Facilitates and invests in activities to improve the industry's performance and profitability
- Supports equal participation for all members
- Promotes benefits for all industry sectors

The AOF is currently undertaking a review of its five year plan – Strategy 2002. Whilst Strategy 2002 is still in progress, AOF believes it is timely to review the plan due to a number of key industry changes that are occurring. These include:

i) Changes in S&D scenarios for all crops

- *Canola* – this sector has been the star of the Australian oilseed industry over recent years. Whilst the industry has developed to a position where there is a consistent export surplus, the industry's challenge is on ways in which to extend its life such as the development of high oleic/low linolenic varieties. There remains continued opportunities to expand seed export markets, if the industry's international competitiveness can be maintained and enhanced - a major issue surrounding growth of canola oil exports is trade barriers.
- *Soybeans* – this sector is facing a difficult period as demand for soy meal remains high, but soybean oil products are generally in maturity or decline. The most exciting opportunity for soybeans lies in the edible foods market.

- *Sunflowers* – whilst polyunsaturated cooking oils and spreads have been the driver for the sunflower industry, this market sector is now in late maturity and recent growth has been in monounsaturated oils. High oleic varieties have provided the opportunity for repositioning of sunflower products at the premium end of the growing monounsaturated market. The Australian sunflower industry has tended to mark time over the past decade and is currently under pressure in terms of its future prospects.
- *Processing* – the processing sector has been under pressure in recent years with poor crush margins and competition from export markets for products such as cottonseed. The sector continues suffer from lack of scale and is constrained by trade barriers.

ii) New investment opportunities

The recent End Use Project undertaken by AOF has highlighted some new areas for investment by AOF and issues that the industry needs to address. These include:

- improved economics of oilseed production and processing
- improved oil quality and consistency in oil quality to meet export requirements
- development of high oleic/low linolenic canola (HOLL) – requires determination of the role and opportunity
- consumer promotion to position HOLL canola/high oleic sunflower has healthy and technically superior products to palm and tallow in the food service and food manufacturing markets
- management of GMOs and development of identity preservation systems
- farmer understanding of quality issues and end user needs

iii) Changed needs of the commodity groups

The commodity associations play a vital role in the industry in terms of identifying and managing sector specific issues and in maintaining the relationship with the grassroots industry (farmers and others). However, all the associations are struggling with the challenge of the level of activity required when dependent on voluntary service by people in the industry. This has led all the associations to strategically review their positions and priorities for the future.

iv) Changes to AOF structure, funding and secretariat arrangements

The AOF has been undertaking an internal review of its structure to deal with issues of funding and potential retirement of its long serving secretary.

AOF achievements …

AOF has invested in a number of programs over the past 8 years that have directed benefited the oilseed industry. These investment have been made in higher-level strategies and support the work of the commodity associations, GRDC, departments of agriculture and others. These strategies have included grower information, quality management, consumer education, market development/access and linkages between the market and industry/R&D.

The key achievements of AOF, with the support of the ODF, have been

- A more sustainable industry through increased grower confidence and investment in oilseed production
- Improved quality of the Australian oilseed crop and products through facilitating a better understanding of quality requirements, developing strategies to minimise contamination risks, improving quality practices throughout the supply chain
- Improved market (domestic and export) opportunity through promotion and extension activities, market access negotiation, facilitation of industry to industry relationships across countries
- A greater international profile for the Australian industry, which underpins the industry's increasing position as an exporter
- Improved communication between sectors within the industry

Future Directions

Achievements that members would like to see the AOF target over the next five years include:

- A larger industry with expanded markets
- A more viable industry
- A continued focus on quality
- Increased consumer awareness and acceptance of oilseed products
- A single adequately resourced secretariat
- Improved industry communication

Issues to Address

There are a number of challenges for the industry and AOF to address in delivering the desired achievements of its members and to ensure that the industry is positioned to capitalise on and influence market and industry conditions to its advantage. These include:

- Encouraging greater participation by members from all industry sectors in AOF activities and setting industry priorities
- Balancing diversified and competing interests
- Broadening the funding base
- Increasing consumer awareness and understanding of the health benefits of oilseed products
- Improving the profitability of oilseeds as a crop choice
- Improving international competitiveness
- Improving the flow of information

Industry priorities

<table>
<tr><th>AOF Priorities</th><th>Industry Priorities</th></tr>
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Recognition as the industry's representative body
Active membership participation
Adequate funding base which is equitable across all members
Facilitation of linkages between industry sectors and across commodity groups
Growth of the Association through increased breadth of membership and incorporation of emerging industries e.g. edible beans, olives etc
Improved communication and interaction between secretariat and members
Delivery of value to members

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Import replacement – palm oil, sunflower oil, olive oil and soy meal
Development of alternative uses of oilseeds and products:

Increased use of oils in industrial applications
Development of specialty oils
Expansion of edible soybean industry
Development of higher value protein products

Increase consumer demand for Australian oilseeds

Development of a brand for Australian oilseeds and products
Promotion of Australian oilseeds and products
Consumer education
Acceptance of GM products

Quality

Improved quality of oilseeds and products and alignment with buyer requirements
Implementation of systems to provide quality and safety assurances (non GM and GM products)

Increased scale and profitability of the industry.
Improved information flows and monitoring of key industry issues
Improved communication

Improved trade access and competitiveness of Australian oilseed
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AOF secretariat functions

The AOF is the peak oilseed industry body representing all segments of the industry/one secretariat.

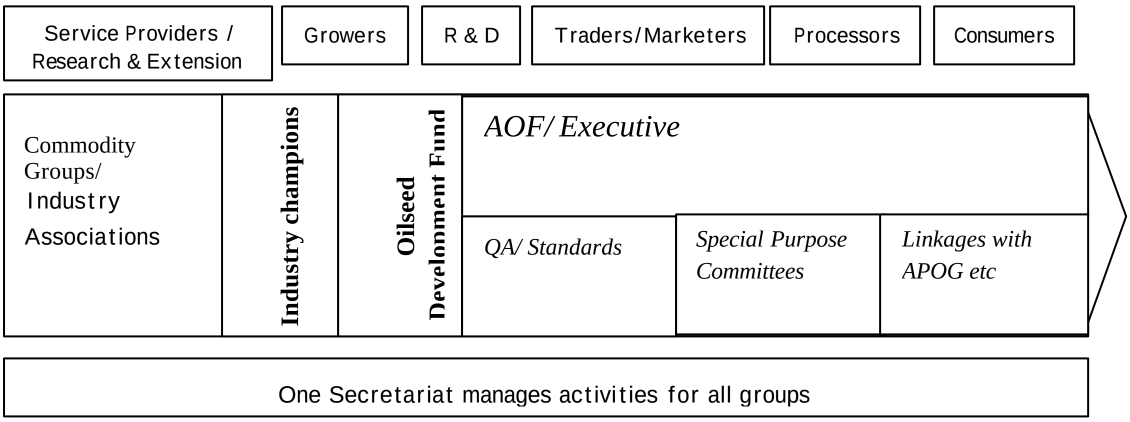
Functions/roles of AOF:

- Central administration on behalf of AOF, the ODF and commodity groups
- Industry issue lobbying/government representation – market access/export development
- Fully inclusive of all sectors
- Industry training/education
- Standards and protocols for trading and handling of oilseeds and oilseed products
- Consumer education
- Set the strategic plan and industry goals
- Facilitate industry access to innovation and opportunities
- Information and communication to/amongst the key interest groups
- Promote Australian grown and Australian made oilseeds and oilseed products
- Oilseed related R&D with government, industry and R&D bodies
- Promote environmentally responsible practices within the oilseed industry

AOF secretariat structure

The draft AOF plan proposes a new structure for the industry that combines the secretariat for the AOF and the commodity associations. Under this proposal, there would be a single national secretariat to service all industry groups. The AOF would take responsibility for the postproduction supply chain, R&D (production and product), communication and lobbying. Commodity groups would be linked into these areas through executive representation. The commodity groups would focus on production issues such as farm QA, farmer extension and production R&D (with AOF). The AOF, ODF and each commodity group would utilise a single secretariat that would undertake all the administration, communication, project management and run the membership databases for each entity.

Stakeholders drawn from across the supply chain



Benefits of a single secretariat

- Dedicated support
- Cost
- Level of service
- Better integration
- Reduced duplication
- Retain autonomy

Australian Sunflower Association – Vision of the Sunflower Industry and Opportunities for the Future

Annie Pfeffer B.Bus, GAICD.

My presentation will outline the Australian Sunflower Association's vision of the sunflower industry and opportunities for the future. At the end I will add a few personal comments of my own.

The Australian Sunflower Association is made up of growers, seed companies, researchers, crushers and manufacturers, so from that point of view it has an industry wide focus or as some may say, a supply chain focus.

Vision

Certainly it is the ASA's vision to grow the industry. That doesn't mean we want to take over the oil industry but we do want to remain an established oilseed sector. To do that we must move forward and look at what opportunities exist.

One major advantage over other oilseeds when it comes to quality and identity preservation is that we don't have a GMO issue at this point. Although I'm sure a few farmers might wish we had one if it could increase yield by 20%. We must continue on the path of ensuring we retain a quality product to the consumer and have the ability to preserve the identity of this product all through the value chain.

One of the best avenues for quality improvement is that of the meal. A report commissioned by the ASA and conducted by Rosemary Richards, indicated that significant increased income could be generated from meal if seed was dehulled prior to crushing. New dehulling technologies would permit recovery of meal with protein levels as high as 42%, putting sunflower into direct competition with other Hi-Pro meal. Unfortunately, Cargill have been unable to justify the purchase of such equipment to date.

Growing the industry

Over the last 4 years there has been significant growth in the mono-unsaturated sunflower oil markets. This has been particularly encouraging for the industry and confirms the strategic direction that we focused on some years ago. To grow this on a continuing basis requires mono-unsaturated sunflower oil to be noticed by consumers. Most consumers are unaware of what they eat and therefore are unaware of the amount of imported saturated fat they are consuming, when they could be consuming a high quality, low in saturated fat, local grown product.

We also have a challenge in passing on the market signals early enough to be able to target resources as markets change and expand.

The poly-unsaturated sunflower market has decreased over this time period but has now levelled out.

Birdseed demand also looks to be relatively stable.

One exciting area on the horizon at this point in traditional areas is that of the confectionery sunflower seed. Increased demand has been identified and the Australian Sunflower Association has been asked to set up some standards that can assist the industry. At this point, the retailers are having to contend with cheap imports which contain glass and other undesirable substances as a food item. The demand for confectionery sunflower seed is complementary to the production of sunflower for oil purposes.

Sunflower is becoming a more diversified crop and targeting more niche markets rather than traditional polyunsaturated oil markets.

Non – traditional markets – Oil

It is easy to link sunflower seed with vegetable oil and at this point and most likely well into the future, it will remain the prime use for sunflowers. However that should not exclude us from investigating new avenues of use for the oil or the meal.

America has led the way in the development of Conjugated Linoleic Acid. It has been identified that sunflower oil can be used in the development of this product. What is conjugated linoleic acid you might say? CLA acts as a growth factor, has anti cancer properties and reduces body fat levels. Perceived benefits include:

- cancer reduction
- back fat reduction in pigs of 25% with no reduction in live weight gain
- body fat reduction of up to 20% in humans
- increased bone strength
- cost not prohibitive in animal feeds
- skeletal abnormality reduction in poultry [1]

Studies are currently under way with the University of Wisconsin and approval by the USDA is expected. It is believed that such a feed supplement could assist the farmer significantly in Australia.

Industrial Oils

This is by far the area which is the most topical at the moment and in particular as a result of environmental and greenhouse concerns. Although it is topical and huge amounts of research have been conducted in the US, Australia has been particularly slow to pick up these developments.

[1] Uses of Sunflower Meal (Rosemary Richards) – Study commissioned by ASA in 2000.

It is reported that heavy machinery manufacturers, Caterpillar (Canada) have placed mono-unsaturated sunflower oil as the preferred ingredient in the manufacture of their lubricants.

Following on from this, bio-diesel has an opportunity to reduce greenhouse gases significantly and research provided by Penn State University in the US indicates that mono-unsaturated sunflower oil provides advantages in the production of bio-diesel as a result of its single double bonding. Certainly everything from Tallow, to palm to sunflower has been investigated as ingredients for biodiesel and some of these are being used in different countries around the world. In fact, France has legislated that 5% of all diesel must be Bio-diesel. They have replaced the sulphur with the bio-diesel to produce a more environmentally friendly product. I'm sure it smells better too. We believe that Brazil is moving heavily into the manufacture of bio-diesel using sunflower oil.

The majority of soap now produced in Australia comes from palm oil. Sunflower oil has moisturising properties that make it particularly suitable for the production of soap. It is also a long lasting soap and is very soft to the skin. Competition against palm on a pure cost basis is impossible. Only through the promotion of the use of Australian Products could we move from palm to sunflower.

Non – Traditional markets – Meal

Traditionally, the only market for meal has been stock feed. As meal accounts for 60% of the product, it is a major determinant of demand. In the past, a major limiting factor for the demand for sunflower has been the lack of demand for low protein meal. Alternatively, if the meal could be upgraded to a high protein meal, through dehulling, then demand for meal would drive the demand for the sunflower seed.

As this has not been achieved so far, we are looking at other opportunities that exist for low protein meal in non-traditional areas.

South Africa is using sunflower meal to produce a roofing material that looks like a tile but is in the shape of roofing iron. Other countries are using it to produce a flooring material and bench tops which actually looks quite spectacular. For this to be progressed within Australia, a feasability study would have to be conducted, including strength testing and certification by the building industry.

While at the International Sunflower Association conference in Toulouse in France last year, Murray Todd and Scott Gibson had the opportunity to speak with French scientists who had developed a flower pot to replace the plastic ones that we use today. The major benefits were of course environmental, as the pot and all were planted into the ground and there was no waste. Significant early growth was also achieved due to minerals held in the pots themselves.

The disadvantage of the pots that could be identified was that they had a limited lifespan, after which they decomposed. Hopefully this wasn't before you were able to buy and transplant it.

When they left Toulouse this had not been commercialised and they were looking for partners in this particular project. Certainly, this is an area where in conjuction with the **building material idea, a feasibility study could be conducted under** Australian conditions.

Hulls

If by dehulling, the meal was to become a high protein meal and we then had the disposal of hulls to consider, a number of opportunities come into play. Firstly there are such options as green power, but one which is seen to more commercially achievable is cat litter, or litter for other animals. In the US, sunflower hulls are used in a range of bedding/litter applications. Litter for turkey production operations is the most popular as the hulls are very absorbent and keep the birds dry and clean. Bedding for horses and cat litter are a couple of other options being used. The pet litter and animal bedding market in the USA is valued at around $US3 billion. Studies by the rice, wheat and peanut industries in Australia have developed a number of products within this industry for disposal of their hulls. These trends indicate that there may be significant potential for this market in Australia.

Other current and proposed uses of sunflower and other hull products in this market sector include mulch/compost, worm farming, potting mix, erosion control/soil stability and sewage sludge mix.

Food Products from Hulls

An area with some opportunity but one which would require significant involvement with a nutra-ceuticals partner is the extraction of components for uses in food products. Components such as plant sterols, vitamin E, glycerol betan and pectin have all been identified as being present. Little research has been conducted to determine if extraction of these components is financially viable. Certainly this is an area where some research from CSIRO could benefit the industry.

Challenges

We are not without challenges when it comes to our future. A major challenge is to ensure that the growers gross margin aligns with other crops to ensure that they can continue to supply sunflower seed to meet demand. As there are limits to the price the manufacturers are prepared to pay because of the flood of palm oil on the international markets, there must be an increase in yield or some improvements in the markets for meal to ensure that the grower returns are in line with sorghum. Last year the disparity between the two was quite large and this year although a little improved, certainly it was not where it needs to be. If a profitable market was available for the hulls and high protein meal was a viable option for Cargill, or other uses developed for meal, I see benefits flowing back to the grower. In the mean time we must work with the seed companies and researchers to improve yield.

So what does it matter, if the sunflower industry disappears you might say. They can replace it with Canola or palm or whatever else. That may be the case from the consumers point of view, but from an employment point of view and the many researchers and breeders and others that service the sunflower industry in particular, it is certainly the wrong way to be going.

More importantly from an environmental and farming systems point of view, the sunflower industry is critical. Sunflowers provide a break in disease and insects as well as providing soil conditioning. Without sunflowers, many farms would find their summer cropping options halved.

Oilseeds Working Together

The Australian Sunflower Association is part of the Australian Oilseeds Federation. Here we have an opportunity to work together to enhance the Australian Oilseeds Industry.

The soybean industry has been steered away from oil to the edible market, so as to not compete with Canola or Sunflower. This is paying dividends for this industry.

Around 10 years ago, the ASA moved from polyunsaturates to monounsaturates to ensure they were not competiting with the Canola industry and particularly with guidance from the manufacturers. Demand continues to rise for this product, although it is being tempered by high imports of cheap palm oil.

There is also a perception amongst the ASA, that we are less visible and being overshadowed by the canola industry in terms of research and end-use interest by the processors and manufacturers.

We need to find a way to work together rather than competing for such a market. It is not the manufacturers who will lose out if we don't, but it will be all those who service the industry, including the growers.

Where to From Here

Last year, the ASA commissioned a report entitled :Potential Opportunities for Economic Uses of Sunflower Meal". The following recommendations came from this report.

i) That the ASA develop a program targeted at increasing the profile of sun meal and sun oil. Given its small volume, sun products are not a key focus of the marketers and thus, industry may have to play a role in maintaining and enhancing the profile of sun products.

ii) That the ASA work with the major crusher – Cargill – to investigate the feasibility of implementing equipment to produce high pro meal. This would represent a significant investment by Cargill, who would need to be confident about the market potential (commitment and premium).

iii) The ASA could assist to build this confidence through implementation of a promotion campaign to secure the feed industry's commitment to the product and grower commitment to production would assist to place some of the meal.

iv) That the ASA encourage Cargill to develop markets for disposal of sunflower hulls including animal feed, animal bedding and fertilizers/ mulch

v) That the ASA work with Ridley and Oleo Industries to develop opportunities for ground hulls for use in pelleted feeds. This may involve Cargill or a related business investing in grinding facilities.

vi) That ASA undertake a market research project to establish the potential for use of sunflower hulls in the cat litter market and, subject to the market potential being established as viable, undertake product development and testing. This could be jointly funded by ASA, AOF, Cargill and GRDC

vii) That ASA continue liaison with CSIRO to identify whether there are opportunities in the food processing sector and whether there are processing innovations in relation to improving the feed quality of sunflower products

viii) That ASA further investigate the potential opportunities related to CLA and, if appropriate, seeking GRDC/industry funding to look at the potential for sunflower products as a source of CLA in the livestock industry and the nutra-ceuticals industry[2]

A Personal Point of View

It is easy to become discouraged when you continually see the challenges ahead and feel that we can't control the future. If we bury our head in the sand and say it is someone else's problem, then, we will never have an opportunity to control the future.

The Australian sunflower industry needs a champion if it is to remain a core part of the Australian oilseed industry and develop the critical mass necessary to develop an efficient and effective market. The strategy for growing the sunflower industry is multi-faceted and it is critical that there is someone who is responsible for coordinating and driving the strategy. The ASA agrees with the proposal that ASA achieve this through appointment of an industry development officer or sunflower industry champion, jointly funded by AOF and GRDC, who can implement the recommendations highlighted in this report and build on the opportunities identified by the ASA.

The ASA may also be able to capture greater resources through greater integration with the AOF. We need to form closer ties to ensure that we work together rather than from competing camps. We must ensure that we keep the lines of communication open and allow opportunities to be considered.

From within our own industry, we must be challenged. I'm sure everyone in this room would say they are continually challenged, from one thing or another, but do you really have a commitment to this industry. That's what this industry needs at this point, a committed community.

How many of you would buy Olive oil over sunflower oil?
How many buy Canola over sunflower Oil?

[2] Alternative uses for meal (Rosemary Richards)

How many don’t care what their chips are cooked in when they eat out?

Your Future – Take Control of It

Unless those who are connected to the industry are committed to it, how can we expect anyone else to be? Stand up and be counted and represent your industry by example.

Session 2

Grower's Prospective from Murray Todd

"Dalkeith" Cambooya

AGRONOMY:

Sunflowers, beging a taprooted crop encourages the soil to crack and enhance the process of self mulching soils.They are the premium crop for soil conditioning and are perfect to double crop after, should we ever get the moisture again, on the Downs anyway. The major disadvantages of growing sunflowers is very little erosion control and no chemicals to control in crop broard leaf weeds, yet chemicals to contrpol grassy weeds. e.g summer grasses and Johnson grasses - are excellent.

MARKETING:

Trying to ascertain whether we as growers are paid import or export parity price is not an easy task. It has been claimed by some that we are paid import parity as we are predominantly net importers of oil. It is not an easy task as there are no futures for sunflower where there is with most other crops, or at least a correlating equation. e.g CBOT corn is used to establish our sorghum price. I will endevour to collect some evidence as to the pricing of sunflower internationally and domestically to see if farmers are recieving fair prices.

WORLD SUBSIDISATION:

Th effect of subsidies from Europe and America in particular do not effect Australian farmers directly, however indirectly it causes massive overproduction which of cause then effects all farmers world-wide as the price drops according to the amount of surplus. In France farmers are receiving approximately 3100 FF per hectare for sunflower, which aquates to $315 which is equal to our gross return plus some, per acre on the Downs anyway. Remember they get the world value for their cropes plus the subsidy.

I thing Australian farmers would cope very nicely if their income was double.

THE LEVEY DEBATE AND THE CLOSING OF CARROL PARK:

There has been some concern in the GRDC and farmer ranks that with the closing of Carrol Park the sunflower industry was finished, this is certainly not the case. As a consequence some funding for research into particularly rust, altenaria and white blister carried out by the DPI was threatened to be severely cut by GRDC. A delegation of ASA members went to Canberra to try to convince GRDC and particularly the Northern Panel that this funding to DPI was of the utmost impotance. The outcome after many more meetings by concerned parties was an extension of funding for three years for the DPI and 18 months for the CSIRO for their drought tolerance project. The overall effect of the closing of Carrol Park has to date been minimal and farmer returns appear uneffected.

GROWERS PERSPECTIVE'S

Ross Ingram , Manager, Arcturus Downs Ltd., Springsure Qld.

Sunflowers are a very important summer cropping option in Central Qld.
Opportunistic cropping, based on unreliable rainfall means you need every crop option available, especially a top rooted summer rain grown crop.

As the biggest individual grower in Qld, we have consistently grown 7,450 acres of Sunflower producing 2,575 tonne = 331kg/ acre per year. Last seasons' prices just covered cost, current prices weren't expected at planting, so we halved this year's crop area. I believe much of the industry's problem comes from; world over production of comparable oils, lack of marketing options, poor forecasting within Australia and the fact that cheaper oil can get into this country too freely.

Like all farming operations we are under constant strain to stay viable. I expect all businesses serving us to equally perform; such as banks, seed companies and local businesses, past loyalties are losing their influence. We have constant demand on our work time from unproductive meetings, seminars and field days, staffing problems, increased government regulation and wasted office time.

For the future we need improved marketing options such as; an oil plant in CQ, improved Mono Sunflowers and better market forecasting. All agricultural producers need to be pro-active and support their representatives, through greater professional industry representation.

We must counter non-farming groups, set on sterilizing farming and imposing unreasonable demands. We have to accept change, adopt improvement through; technology, weather forecasting, risk management, quality control and better influence Government decisions. We want to continue to grow Sunflower but only if they pay their way.

Sunflower in the Central Queensland Farming System

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Abstract

Sunflower has historically been an important crop in Central Queensland. In recent years the sunflower area in Central Queensland has been reduced due to low and variable prices and increased competition from alternate summer crops. Issues of tall persistent stubble that provides little ground cover and a lack of in-crop weed control options have also contributed to declining popularity of sunflower in an area where adoption of zero tillage practices continues to increase. However, recent improvements in farming practices have impacted favourably upon sunflower production and profitability, and while sunflower faces challenges, it is a valuable option Central Queensland farmers should retain.

Introduction

For many years sunflower was second only to grain sorghum in terms of area under summer crop in Central Queensland (CQ). Sunflower provided an option for late summer planting opportunities, had reliable production and was profitable when compared to other summer crops. However, the continuing refinement of management practices for sorghum (Spackman et al., 2001), maize, and mungbeans has lifted the popularity of these crops to the extent that over the previous 5-10 years the sunflower area has declined from a typical 70-100 000ha to current levels of 40-60 000ha. Although currently at similar potential profit levels to other summer crops, sunflower presents the following significant management problems:

- It has a tall, robust, persistent stubble that is difficult to manage in a minimum tillage system

- The stubble is also sparse and often does not provide adequate levels of soil protection
- A lack of in-crop weed control options
- The above points culminate to the effect that soil moisture profiles are difficult to recharge following sunflower crops due to low cover levels, weed growth and tillage that may be necessary to reduce stubble size

These are significant but not insurmountable problems. Instead, they demand a 'rethink' of how sunflower can best fit into the CQ farming system. This paper aims to focus on what we believe are important considerations for the best management practice of sunflower in CQ.

Considerations for Best Management Practice

Rotational Fit

The problem of cover

The fact that sunflower provides low levels of effective cover means that it should be considered in zero tillage systems, where cover levels are already high.In situations where sunflower is double cropped into wheat stubble, there are usually useful levels of stubble cover present in the fallow following the sunflower crop. Useful cover will also exist in zero-till paddocks that have several seasons of crop residues still intact on the surface. Controlled traffic farming systems facilitate the sowing of sunflower between rows of standing stubble

Planting window

The planting window for sunflower runs from mid-late January through to very early March, similar to the maize window. Recent experience indicates that sunflower is a better choice for planting dates beyond the end of February, as it is more tolerant of frost than maize.

Control opportunity for grass weeds

Grass weeds, (eg.summer grasses and *Sorghum almum*), have become significant problems in CQ farming systems. This system is becoming increasingly dominated by sorghum and maize, and in many situations atrazine has not proven effective on summer grasses. There are effective, competetively priced options for grass weed control in sunflower crops. In an opportunity cropping system, this is a more attractive option for grass weed control than a summer fallow.

Cost of planting

Sunflower is significantly cheaper to plant than maize, due to lower seed cost and lower nitrogen fertiliser requirement. While maize grain is currently well priced and comparitively profitable, the cost of getting into the crop makes sunflower more attractive to farmers on shallow soils of low fertility. On the open downs soils of CQ, these lower up-front costs mean that sunflower may present less financial risk than maize for the February planting window.

Soil Insects

Soil insects have been a massive problem for sunflower growers, and this applies especially in zero-till situations. The advent of truly effective control measures (unfortunately still off-label) has greatly reduced the incidence of crop losses and poor plant stands that tended to be prevalent where cover levels were high. Control of soil insects is imperative when aiming for the low to moderate plant populations which have become the norm.

In situations where high soil insect pressure is anticipated, insectide treated baits are required. There may be scope for baiting in the fallow preceeding sunflowers to reduce pressure before sowing.

Nutrition

Sunflower has a lower nitrogen requirement than that of sorghum or maize when grown under similar conditions of water availability. Many of the cropping soils of CQ are of low to moderate fertility, and are shallow, providing only moderate water holding capacity, and therefore yield potential. Risk of crop failure is relatively high, and reduced spending on fertiliser N can be viewed as an advantage.

Application of phosphate containing fertilisers at sowing is good practice, and is extremely important where preceeding fallows are longer than 10-12 months (potential for low VAM spore numbers).

Weed control

Greatest weed problems in sunflower occur when good rain falls in the first month after planting, particularly where a full disturbance planting operation creates a situation where weed seeds are placed into a position where they can germinate.

The incidence of this problem is reduced where knockdown herbicides are applied pre-plant or post-plant, pre-emergence. This practice is facilitated by controlled traffic. Zero tillage systems further reduce in crop weed problems due to (often) lower weed seed numbers, and minimal soil disturbance.

Farmers operating under a controlled traffic system also have the option of using shielded sprayers for in-crop weed control while the crop is young. Inter-row cultivation is feasible but will significantly reduce any cover present in the form of previous crop residues.

Autumn or winter rain will usually result in infestation of winter weeds. In these situations there is some experience to indicate that aerial herbicide application onto senescing sunflower crops can result in conserved soil moisture for following crops, and a reduction in the potential weed seed bank and the amount of green material present at harvest. There is anecdotal evidence that the practice can also result in an earlier harvest, largely by eradicating late maturing sunflower plants which contribute little to yield. In wet autumn/winter periods the benefits can be similar to those obtained through pre-harvest sprayout of sorghum.

Plant population and row spacing

Extensive trial and commercial experience indicates that plant populations in excess of 25 000 established plants/ha provide no advantages in CQ. Moderate populations frequently provide highest yield levels in seed company varietal evaluation experiments, under a range of seasonal conditions.

Planters with precision seed metering capabilities have proven valuable for sunflower (and maize) where consistent plant spacing becomes important when low populations are targetted. These planters also complement the shift in industry focus from a planting rate based on kg/ha of a certain seed size, to seeds/ha.

One metre is becoming a standard row spacing for all crops except wheat. Experiments with sunflower under wide rows and skip rows have not yet pointed to clear advantages from these practices, although further work is warranted. At 1m centres, growers have more options in terms of shielded and directed sprays, inter-row cultivation, potential for post-sowing or in-crop fertiliser application, and cheaper zero-till planting equipment.

The Future

Weeds

A better fit into zero till farming sytems and improved weed control are crucial for the long term prosperity of the sunflower industry.

In the current phase of the GRDC funded Central Queensland Sustainable Farming Systems Project, sunflower has been identified as a weak link in the achievement of sustainable long term weed management. Lack of effective in-crop weed control options in sunflower adds to the costs of strategic weed management for future summer crops. Not only is yield (sunflower) compromised in the short term, but weed control costs in future summer crops increases due to the increased weed burdens resulting from the weed seed set during the sunflower phase. During the second phase of the CQ Farming Systems Project (2002-), the weed agronomy team (Vikki Osten & Megan McCosker) will be addressing issues such as weed – crop competition, and in-crop weed control in sunflower. While an Integrated Weed Management approach will be taken, it is envisaged that herbicides will be a key component. Herbicide selection will be based on appropriateness for the farming systems of the region (Osten, personal communication, June 2001).

There is also some focus on selection for herbicide tolerance in private breeding programs which should prove positive for sunflower in the long term.

Insects

There are highly effective insecticidal seed dressings which are readily available, cost effective, and in commercial use to combat soil insects. Registration of these products for use in sunflower should be an industry priority.

Similarly, locusts are an ever present problem in CQ. There are cheap, highly effective control measures registered for use in other crops (fipronil) that are not available to the sunflower grower.

Rutherglen bug may be responsible for a lot more sunflower crop damage in CQ than they are given credit for. There is scope for improved grower and agronomist awareness of economic thresholds and control measures.

Conclusion

Central Queensland farming systems are increasingly centred around zero tillage and practices which maximise storage and efficient use of soil water. Traditional methods of growing sunflower struggle to find a place in this system and while market prices for sunflower are below about $300/t on farm, the sunflower area may continue to decline due to increased area under sorghum and maize.

Through embracing recent advances in management practices, sunflower is viewed as a valuable opportunity in situations where ground cover levels are high, anticipated weed pressure is low, or where control of grass weeds is desirable. Sunflower is an option that the CQ farming system can not afford to lose.

References:

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Private Seed Company Sunflower Research

Alan Scott – Research Manager, Pacific Seeds. Senior Breeder – Advanta.

Introduction.

The scope and role of the Private Seed Company Research activities will always be defined by the market's size, stability, seed price, growth potential and the sunflower crops competitive status. The scope of private seed company research in Australia will also depend on these market forces, but with the added seed export opportunities available in mind. This is normally restricted to African and Asian opportunity markets.
The normal range of research spending in the private seed company sector remains between 10 and 15% of market sales value, but this can be influenced by any of the market forces described. Variation from these guidelines will vary enormously depending on each market situation. The rule of risk and reward normally applies.

The long term composition and structure of private seed company research remains unclear at this point in time? Most of the major seed companies active in seed variety research in Australia are or were part of multi-national agrochemical companies. Cultural differences and different financial expectations between the agrochemical and seed businesses continue to dampen some technical developments. Which is generally based on risk and return issues.

A total of 38 breeding programs from around the world feed germplasm into the Australian private seed research programs. This provides the Australian industry with massive genetic stocks that it would never have had available as a stand-alone industry. This breeding effort plus the results of new technologies, such as molecular markers and transformation systems could never be justified otherwise.

A 35% decrease in the past five years in the area planted to sunflower in the major markets available to the major private companies has forced many companies to review their levels of funding to sunflower research. The available global 1999 sunflower seed market was estimated to be around $A384 million with a global R&D spending of approximately $A50 million. The Australian market estimated at 120,000HA in 1999 had a seed market value of $A2.9 million with an estimated R&D expenditure of approximately $A1.3million. This represents a research expenditure of 44% of sales, which is disproportionately high by international standards. The only other country in the world where a similar scale of research expenditure is maintained is in France, where seed prices are three times Australian prices.

Research Strategies.

The private sector defines its participation strategy into three broad outlines:

a) Defined use or target. Can it develop an IP position.

b) Value added chain. Can it share in down stream income.

c) Ability to compete – access to high performance germplasm, access to new technology, the ability to integrate appropriate technology and the ability to protect elite germplasm and technology.

Key Traits

Table 1 outlines the key target traits for the Australian sunflower industry and the developmental techniques employed to address these target.

Table 1: *Trait Strategies for major Australian targets.*

Trait	**Technology.**
Yield	Primarily through traditional plant breeding.
Rust Resistance	Traditional pathology screens are the primary screens but with the increasing use of molecular markers. These molecular markers are being developed and utilised by both the private and public sector and utilised through collaborations with public Institutions and their own global research programs.

Trait	**Technology**
Modified Oils	Oleic acid profile is the main target and GC and refractometer testing are the main techniques used. Molecular markers are also being used by some for the detection of major gene action in breeding populations.
Albugo and alternaria tolerance.	Traditional breeding. This remains a target for molecular marker developments.
Sclerotinia tolerance	This target has been very difficult to breed traditionally and achieve high levels of resistance. Transgenic approaches have recently provided increased levels of resistance.
Other modified oils	Both high palmitic and stearic acid targets have been addressed in collaborations between private and public Institutions using both mutagenesis and transgenic approaches. Neither of these outcomes is commercial as yet but it is expected that molecular markers will be needed to handle these breeding targets effectively.
Downy Mildew resistance	This is one of the main sunflower diseases in the world. It is not in Australia but is one of the main reasons we have a severe quarantine system in place. Working behind a quarantine system can have benefits but can also restrict expedient germplasm exchange and the ability to pro-actively participate in any projects that require fast seed transfer. Molecular markers now exist for this disease and are being used in line conversion and trait fixing in breeding programs. It will also facilitate breeding systems in Australia to breed for targets that cannot be screened for with traditional methods.

Conventional Plant Breeding

This continues to play the most significant part of providing the genetic diversity required for elite hybrid development with positive genetic gain, in both the private and public sectors. In some eyes the recent deterioration of the public research programs, especially in Eastern Europe has dampened the progress of sunflower research, although this has not been proved or widely agreed upon. In some situations the private seed companies have recruited some of the skilled researchers from the public system and have been responsible for a gap in this research segment. This situation has forced some public institutions to become more like private companies and market lines and hybrids accordingly, with royalty arrangements and technology transfer agreements becoming commonplace.

A precarious situation also exists at present among the international private seed company researchers. Company mergers and changing ownership will shape and determine the scope and direction of future research. There are four private companies involved in sunflower research in Australia, three of these companies are in the six major companies listed in the summary in Table 2. The development of this situation is being forced by several factors:

a) Access to Intellectual Property, differentiated product or trait.
b) Perceived competitive biotechnology position.
c) The high cost of research needed to remain competitive.
d) Industry alliances forcing changing research scope.

Biotechnology.

The debate over this technology having the ability to provide the genetic gains needed to match nutrition and population growth may never be clear. However, one thing is clear, unless we use this technology effectively, we as a nation or a crop will not be competitive without it. Other crops utilising this technology are providing better management systems and market driven traits that are causing sunflower to become uncompetitive. Safe, well regulated traits such as herbicide tolerance, modified oil profiles, insect and disease tolerance must be incorporated into sunflower's crops portfolio of characteristics if it is to grow and develop. Private research has to date, been the major delivery vehicle of this technology and if predictions are correct will continue to do so.

Molecular Markers. This technology has advanced at a very rapid and very expensive pace in recent times. Five marker systems and their relevant maps have been developed, evaluated and discarded in the past ten years. RAPD, RFLP, AFLP, SSR and SNP's have been evaluated by the private sector in recent times with relatively few commercial products on the market as a result of this technology. However, the focus of this technology is still being defined with utilisation different across the private sector. This technology is being used to incorporate gene recovery, gene position and linkage on the relevant chromosome, trait recovery in conversion programs, background recovery in backcross projects, accelerated breeding focus and fixation. SSR's or micro-satellites seem to be the main marker system now in use in the private sector.

Transformation: Three transgenic targets have been addressed successfully with a commercial outcome possible in sunflower.

i) *Herbicide resistance* (IMI and RR). This research target has been addressed with both mutation and transformation systems and is now in the final stages of evaluation. However, because of the industry concerns regarding the possibility of gene leakage into the wild species and the general GMO concerns in society it is unlikely the transgenic material will be available to the sunflower grower for some time. IMI resistance, sourced from wild species mutants is now available, but will be withheld until product registration and clearance for use of the chemical is provided by Government regulators.

ii) *Insect resistance*. A Bt insect tolerant event has been developed. However, because of the GMO concerns already mentioned and an unlikely financial income apparent, it remains fairly unlikely this trait will be made available to the farming community in the short term.

iii) *Sclerotinia tolerance*. One of the biggest problems sunflower producers around the world share is the fungal disease sclerotinia. It attacks over 350 species of plants and has proved to be the toughest challenge sunflower plant breeders have faced. Natural genetic resistance has not been strong enough to rely on when severe sclerotinia disease pressure exists.

A joint research project involving Advanta (Pacific Seeds), Syngenta and Pioneer targeted this disease, specifically the head rot infection phase. This project has been ongoing for several years and is referred to as OXOX and takes its name from the wheat oxalate oxidase gene that has provided the resistance mechanism not previously available in the sunflower plant. If the promising results continue and the regulatory clearances are forthcoming a far superior natural/transgenic sclerotinia safety net may soon be available to producers. This collaboration has been taking place across several continents throughout the world with a very encouraging level of success.

In trials carried out over the past few years, transgenic lines containing the OXOX genes have demonstrated significantly enhanced sclerotinia tolerance. Even more promising levels of tolerance have been recorded when natural resistance sources are combined with the OXOX resistance genes.

This technology may also help other crops, such as soybeans and canola that also have sclerotinia or similar disease problems, especially those diseases where the fungi produces oxalic acid, the pre-cursor to the sclerotinia fungi's development. The oxalic acid actually breaks down the plant cells by chelating calcium from the host cell walls. This weakens the cell wall thus allowing the fungal enzymes to further degrade the plant tissue. The oxalate oxidase enzymes provided by these transgenics actually degrade the oxalic acid before it seriously damages the plant tissue.

The focus of ongoing research work is to determine the ability of the gene to enhance the transgenic plant tolerance levels, especially when combined with natural genetic sources of tolerance. This joint research collaboration is breaking new ground in developing this technology and should in the near future, be in a position to provide producers an enhanced tolerance level or protection level, not previously available. However, acceptance of this technology is in a very sensitive evolutionary phase. Markets in Europe are especially cautious about this type of technology and the research partners involved in the various phases of this sensitive process are cautious not to endanger markets that demand GMO free purity. Responsible management of this technology is paramount to the collaborators in the project if this technology is to be utilised effectively. One of the major objectives of any research program whether it be public or private is to develop and deliver products that will benefit the producer and not restrict it's chances of success.

Collaboration Research

Collaborations and alliances between government research programs (exclusive and non-exclusive) and the private sector are growing rapidly. This has been a steady trend that should continue, although this has not been developed to any meaningful commercial level in the sunflower seed sector in Australia.

Alliances between downstream industry, biotechnology IT providers and the seed companies themselves are also becoming more commonplace.

***Table 2** : Summary - Private Company Sunflower Research*

	COMPANY					
Technology.	**Advanta**	**Soltis**	**Syngenta**	**Pioneer**	**Dow AgroSciences**	**Monsanto**
Traditional Breeding	Yes – 9 breeding programs with associated testing in an additional 12 countries	Yes – 5 breeding stations in France and Spain	Yes – 3 breeding programs	Yes – Currently conducted in nine countries	Yes – 4 breeding programs	Yes -8 breeding Programs
Molecular Markers	Yes – Labs in Belgium and Argentina	Yes – characterizatio n and M.A.S.	Yes – Lab in France. Strong direction to mol markers in breeding	Yes – in USA	Yes – Indianapolis Lab	Yes - Labs in France & Argentina
Transformatio n Capability	Yes – Labs in Rilland, Netherlands	Yes – through Biogemma company France	Yes – Lab in USA	Yes – in USA	None so far. System in development	Yes -Labs in St.Louis
Main Targets	Yield potential and stability thought improved drought and disease resistance with modified oil profiles	European market focus. High yield and disease resistance	Yield capacity and stability, disease resistance Modified oil profiles	Yield, oil %age and profile, disease/ pest resistance, agronomic traits	HO Sunflower. Confection Sunflower. Modified Oil profiles. Insect Resistance (Bt)	Yield, Disease resistance & Oil quality

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Dr Anibal Fernandez, Sunflower Research Director, Belgrano, Argentina.

Session 3

Wild Sunflowers – Genetic Gold

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Rush for Gold

The modern sunflower (*Helianthus annuus* L.) with its single stem, large solitary flower (monocephalic) and high oil content, is largely the product of breeding and selection carried out by Russian breeders during the late 18th century. A native plant of central and northern America, the sunflower in its natural state has a branching stem with multiple flowers however, a single flowered form had been utilised by native Americans for thousands of years, for food, medicines and rituals. The sunflower found its way to Europe early in the sixteenth century, transported by Spanish invaders keen to plunder the New World of more than just Incan gold. Admired as an ornamental plant of great stature and reportedly reaching an optimistic 12.2m high, its popularity spread throughout Europe, taking it eventually to Russia where its potential as a source of edible vegetable oil was recognised. Ironically, strict lenten regulations imposed by the Russian Holy Orthodox Church prohibiting many foods containing oil, but not including sunflower, led to commercial exploitation of what became early sunflower cultivars. During the 19th century, sunflower became a major agricultural crop in Russia undergoing intense selection for yield, oil content and insect resistance. By 1965, the father of modern sunflower breeding, VS Pustovoit, was selecting cultivars with oil content as high as fifty-five percent.

Historical events sometimes have a strange way of presenting themselves and, in what would now be considered as a clever marketing exercise, cultivars developed in Russia were introduced into Canada and the USA sometime in the late 18th century. These were predominately grown for silage but by the 1930s, dependency on imported vegetable oil prompted the Canadian government to promote the domestic oil industry. The sunflower industry continued to grow as global demand for oil following World War II increased. The Russians continued to dominate cultivar improvement and in the early 1960s, the cultivar Peredovik was released. Its high yield and oil content ensured its popularity and it soon displaced local cultivars in the USA and Canada.

Interest in sunflower as an oilseed crop in Asia, India, Africa, South America Europe and Australia continued to grow during the 19th century, with open-pollinated Russian cultivars such as Mammoth Russian, Mennonite and Peredovik dominating plantings. However, the renown of Russian breeders was to fade after the discovery of cytoplasmic male sterility (Leclercq, 1969) and the subsequent production in the USA and elsewhere, of high yielding hybrid cultivars.

What is remarkable about the story of the development of sunflower as an oilseed crop, is the fact that it was probably established from a limited selection of wild or semi-domesticated germplasm brought from the New World. It has become apparent since that time, that the large number of species of *Helianthus* present in America, comprise an extraordinary treasure of genetic gold that has unfortunately, been neglected and under-exploited by modern scientists.

Treasure Maps and Treasure Troves

The taxonomist C.B. Heiser is largely responsible for the current classification of *Helianthus*, describing some fifty species, all of which are present in the USA. Thirty-six perennial and fourteen annual species are reported. Some species are rare and endangered while others are thought to have become extinct during the last century. They occupy almost every conceivable habitat across the USA, from the deserts of the south to the marshes of the east, from as high as 8000feet in the Rocky Mountains to the expansive plains of the Mid-West. Some species are adapted to such a narrow range of environmental conditions that they can only be found in a single location, whilst others, such as the progenitor of modern sunflowers, *Helianthus annuus*, is so well adapted that it is found throughout the USA (Figure 1).

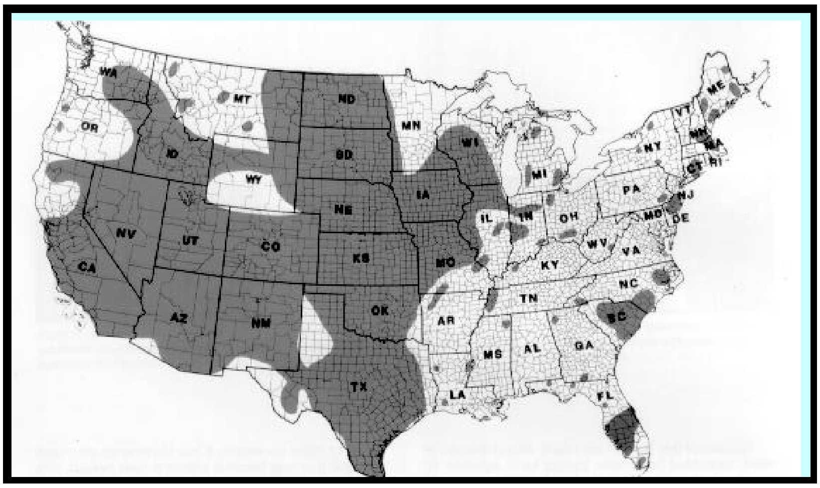


Figure 1: *The geographic range of wild sunflower (*Helianthus annuus*) in the United States (dark shaded areas)*

The distribution and locations of populations of all fifty species were mapped and presented in a publication by Rogers *et al* in 1982. Since then, several researches, including botanist Gerald Seiler of the United States Department of Agriculture, have contributed seed from collection trips to the National Seed Bank located at Ames, Iowa. Although some two thousand accessions have now been catalogued, only a small proportion of these are available for public access due to low seeds stocks. Indeed, wild sunflower species have highly erratic germination and low self-compatability and therefore present certain logistical problems to those trying to maintain seedstocks. An obvious outcome is that the genetic base of the original collection may become narrower with repeated seed increases, thereby diminishing its value. Nevertheless, these collections constitute a trove of genetic diversity that would otherwise be unavailable to the global community and there is an assurance that at least some of this diversity will be preserved.

Populations of wild sunflower are also located in Australia (Figure2). The origins and age of these populations are unknown, but some may be as old as one hundred years and may have resulted from seed present in stockfeed or bird-mixes or may simply have come from commercial crops and reverted to wild characters over time. Three species are recognised, *H. annuus, H. debilis and H. argophyllus* with *annuus* forming the majority of populations.

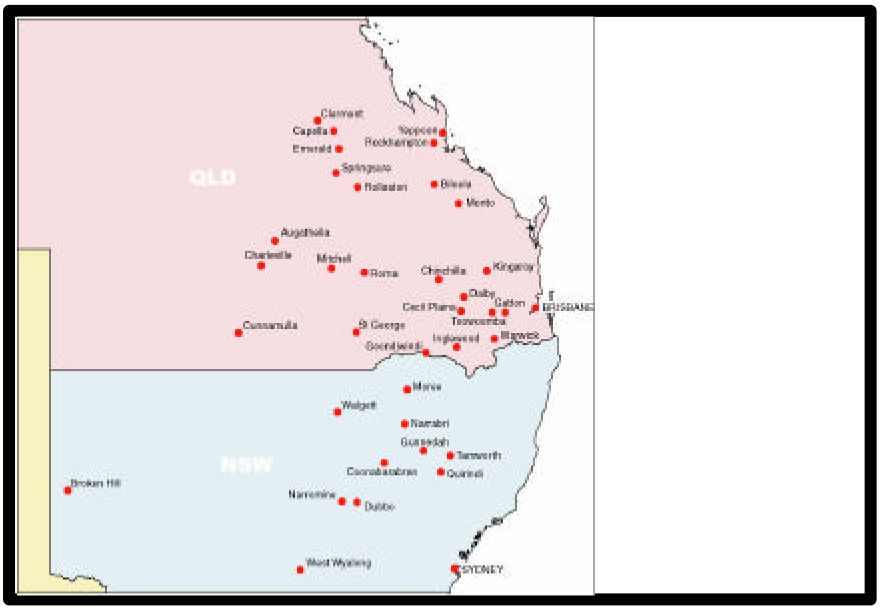


Figure 2. *Wild sunflower populations are located at or near each of the towns indicated. All populations consist of* Helianthus annuus *except for several populations of* Helianthus debilis*, located at Chinchilla and numerous populations of* Helianthus argophyllus *found growing in the dunes from Yepoon to Kepple Sands.*

These populations can be regarded in two opposing ways. On the one hand, they represent a source of genetic diversity that could be used for crop improvement. On the other hand, they provide a haven in which pathogens can breed and evolve new strains (pathotypes). Therefore, the study of the pathotypes present in these populations can provide important information leading to strategies that might benefit resistance of commercial crops. At the same time, an understanding of the resistance genes (R-genes) present in these populations can be determined, but R-genes sourced from local wilds should be used carefully, and only in conjunction with information relating to pathotypes.

Quest for Genetic Gold

Plant breeders are continually searching for new sources of germplasm. This is the basis of crop improvement. Whilst advancement in such characteristics as yield and oil content continue at a steady pace through recombination of the genetic pool currently available in domesticated germplasm worldwide, there is a constant need to find new sources of resistance to pathogens which are continually changing. Each major sunflower producing country with its own set of unique environmental conditions has, as a result of these conditions, a unique disease problem. In the USA, Sclerotinia and Downy mildew are major diseases. In Europe, Downy Mildew and Phomopsis are important, whilst India and Brazil suffer from Alternaria, South Africa from Albugo and Australia from rust.

Australian growers have, for a number of years now, enjoyed relatively high levels of resistance to rust among commercial hybrids. This situation is becoming increasingly difficult to sustain due to the rapid rate of evolution currently detected in the rust pathogen population. In the past five years, the number of pathotypes (races) of rust identified by QDPI has risen from twenty-three to more than eighty. These new pathotypes place enormous pressure on the resistance genes currently available, such that not only are better management strategies for the management of rust resistance genes needed but as well, the pool of resistance genes must be replenished.

The greatest source of new or previously undiscovered genes will be found among the populations of wild sunflower that exist in various parts of the world., The USA, as the centre of origin of sunflower, is likely to yield by far the greatest amount of genetic diversity and is therefore, the preferred location for exploration.

Exploration

In 1999, the decision was taken to undertake an expedition to the USA to obtain wild sunflower seed as a means of increasing the genetic diversity available to the Australian sunflower industry. There were several reasons why this option was preferred to that of simply accessing previously collected seed from the National Seed Bank. Firstly, seed could be collected from preferred sites and plants, including those that appeared resistant to local diseases; secondly, no limit would be placed on the number of seeds and hence potential genetic diversity that could be obtained and thirdly, notes and descriptions of each population could be gathered by the collector for future reference.

The exploration was carried out in collaboration with Dr Tom Gulya, USDA sunflower pathologist from Fargo, North Dakota and was funded by the Grains Research and Development Corporation (GRDC). A pilot study was conducted prior to establishing a route for collection. Dr Gulya was supplied with a mix of Australian rust pathotypes that he inoculated onto plants grown from seed obtained from a range of wild sunflower locations throughout the USA. As expected, levels of resistance to the Australian mix were found among populations derived from the arid southern states, whose climates are conducive to the rust pathogen and may therefore have accumulated genes for resistance.

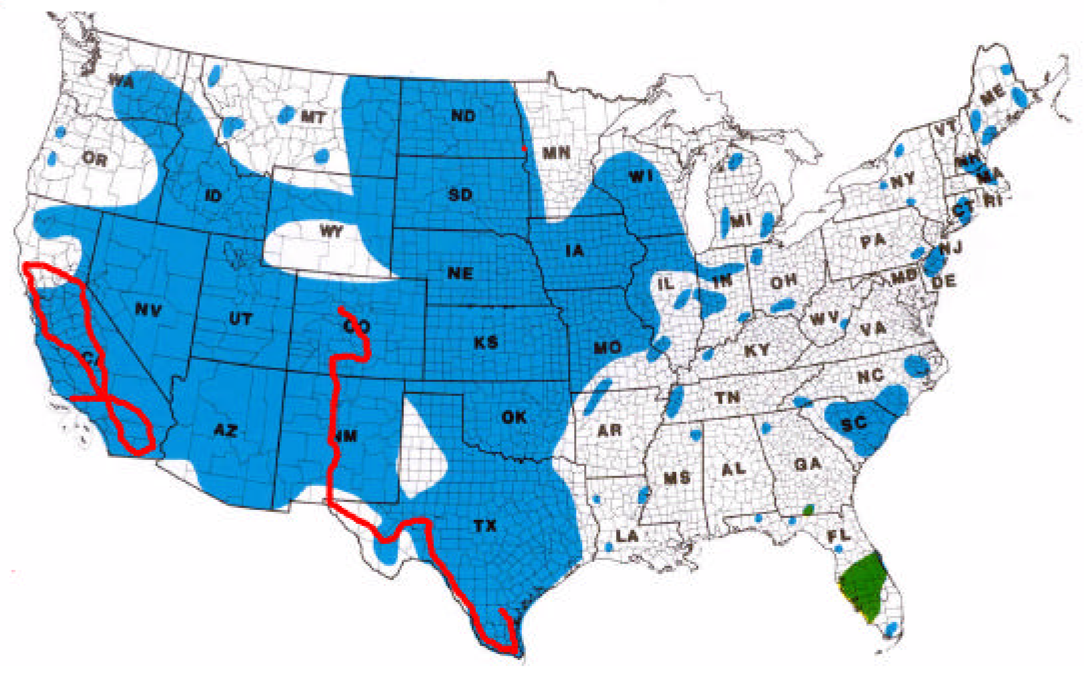


Figure 3. *Exploration through Texas, New Mexico and Colorado completed in August, 1999. Exploration through California completed in September, 2000.*

In September of 1999, I traveled 5000km across Texas, New Mexico and Colorado and collected seed from seventy-four wild sunflower populations (Figure 3). In 2000, I returned to the USA after obtaining funding from the Organisation for Economic Cooperative Development (OECD) and again traveled 5000km through California obtaining seed collections from sixty-two wild sunflower populations, including several rare and endangered species.

Panning for Gold – with old technology

Wild germplasm, being what it is, has many attributes that are agronomically undesirable from a commercial point of view. Our aim then, is to somehow sift out the genes of importance by identifying the characters that they control and move them into germplasm that has a domesticted background.

This is relatively simple for characters that are easy to observe, but unfortunately, the processes required for identifying new sources of disease resistance are time-consuming and often tedious. Firstly, all seed introduced from outside Australia must complete a generation in a plant quarantine facility and pass rigorous inspection for prohibited pests and diseases. Normally, the process of selecting for disease resistance could not commence until completion of the quarantine step, delaying research by as much as a year. Fortunately, AQIS has given us a concession that allows us to screen for rust resistance during this quarantine phase. Consequently, we are able to complete a cycle of selection almost immediately.

Once resistant plants are selected, selfing or inbreeding would be the fastest method for fixing the genes of interest. A major problem with wild germplasm is that it is generally self-incompatible and must be crossed to another individual before it will set seed. Therefore, the breeding strategy we have to use is one of mass selection where the resistant progeny selected from each population is inter-crossed to produce a new population. The process is repeated and, after several cycles, genes for resistance should become concentrated. At this stage, resistant plants from respective populations can be crossed with a domesticated line and cycles of selection and selfing applied. During this process, some form of F2 analysis or progeny test can be applied to determine the genetics of the resistance and DNA marker technology can be applied to tag genes conferring resistance.

Altogether, the process of introgressing and studying genes from wild sunflowers is lengthy and one would hope that the rewards would warrant the effort required. There may however, be ways of using the new molecular technologies to hasten the process and improve current efficiencies.

Panning for gold - with new technologies.

The process described above can be greatly improved through the application of molecular techniques. For instance, the genetic gold we seek is contained somewhere within the enormous amount of wild germplasm available. Whilst a source of resistance can be easily sorted from a population of wild plants by using strains of the pathogen, the identity of that resistance is still largely unknown. Whether the resistance is the same or different to a source already identified, whether it is genetically linked to other resistance genes or characters and whether it is controlled by one or several genes, are important questions that must be answered if the resistance is to be used efficiently and effectively. The answers to these questions can be determined through careful genetic experiments involving crossings and testing with strains of the pathogen, all of which take time and much effort. If we could apply a simple test that enabled us to identify and select R-genes from the original population, then a considerable short-cut would be made. Moreover, if these genes could then be tracked with the test, following every cross that is made with the resistant parent, then the process of plant selection would be greatly accelerated and efficiencies multiplied.

With this in mind, we applied the molecular markers we have already identified, to populations of wild sunflower from both the USA and Australia. For example, Figure 4

Table 1: *Presence (shaded cells) or absence (blank cells) of SCAR markers in DNA of plants from wild sunflower populations collected from sites in Australia and Texas, USA.*

	Resistance Gene Locus					
Location	**R_1**	**R_2**	**R_4**	**R_5**	**R_{Adv}**	**R_{SX53}**
Breeza	■	■		■		■
Edgeroi	■	■			■	
Gunnedah#1	■	■		■		
Gunnedah#2						
Mullaley	■	■		■		
Narrabri	■	■		■	■	
Moree	■	■				
Peak Hill		■				
Bellatta						
Warwick	■	■		■		■
Dalby#1	■					
Dalby#2					■	
Springsure	■	■				
Roma E	■	■				
Goondoowindi	■					
Biloela	■					
Bowenville					■	
Kinka Beach		■		■		
TX1		■				
TX4						
TX9						
TX10	■	■		■	■	
TX12	■	■				
TX18	■					■
TX22	■	■		■		■
TX27	■	■		■	■	
TX29						
TX36	■	■		■	■	■
TX39	■	■				■
TX42		■				■
TX57						

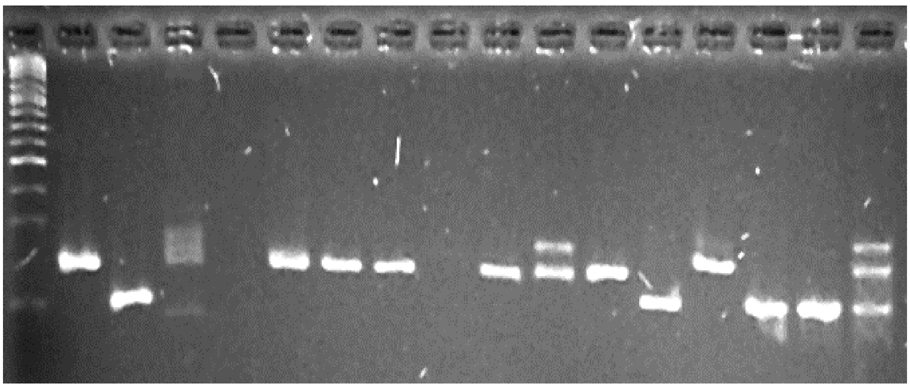
shows the presence or absence of a marker in individual plants, that identifies a gene at the R_{Adv} locus. The markers identify loci (locations) on chromosomes where R-genes are known to occur. The information derived (Table 1) gives us an indication of the relative frequency of R-gene loci present in various populations.

Figure 4: *R_{Adv} gene SCAR PCR. Presence of the diagnostic fragment (arrowed) that indicates the presence of the R_{Adv} gene has been assessed in a range of Australian wild sunflower plants. The plants represented in this picture were collected from Warwick North and Gunnedah. The plants that have the marker and possibly the gene are indicated with the H symbol.*

A large amount of genetic information can be obtained from this kind of study. For instance, the presence of a particular marker may indicate either the presence of a known gene at a specific locus or alternatively, the presence of a different, previously unidentified gene at the same locus. The latter can be easily verified by testing with strains of the pathogen. The frequency of specific genetic markers in these populations may also give a clue to the origin or source of the population. For example, in this study, we found that the R_4 resistance locus is not present in any of the plants tested. The R_4 locus is thought to have originated from Argentinian germplasm and has been the most important source of rust resistance genes used by Australian breeders for more than a decade. These data imply that Australian wild populations are probably not Argentinian in origin and more importantly, have not interbred with commercial crop plants containing this important locus. On the other hand, both the R_1 and R_2, which are common in US wilds, are also found frequently amongst Australian populations, suggesting a North American origin for our wilds, although we would need to test Argentinian wilds to confirm this.

A further application of molecular technology to this study was in DNA fingerprinting using Single Sequence Repeat (SSR) markers or what are commonly called, microsatellites. These markers are generated without having any known linkage to any particular trait however, if sufficient markers are tested against a particular trait, some linkage may be found. Regardless of trait linkage, these markers can be used to generate a DNA fingerprint, simply by their presence/absence, for individuals in any population (Figure5). Careful analysis of these fingerprints can reveal genotypic relationships between individuals and indeed populations. This measure of relatedness gives some indication of the origins and spread of populations and an overall picture of gene flow. In the search for genetic gold, this genotypic information may give some clues about where to look for R-genes and what genes we might find. In this sense, the technology again improves the efficiency and accuracy of the search for R-genes.

A



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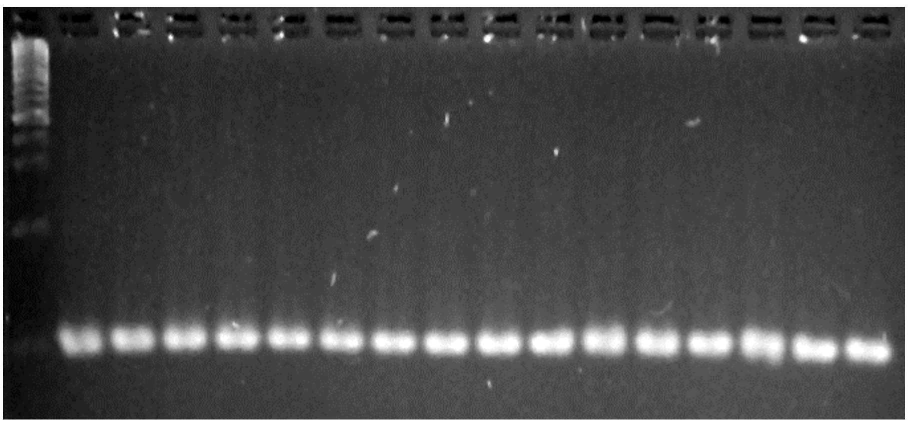

Figure 5: *This picture illustrates how one microsatellite primer* ***(A)*** *can detect differences between different sunflower plants and how a second marker* ***(B)*** *cannot. The same plants are represented in both photos and were collected from Gunnedah and Narrabri East.*

Although this study is incomplete, some preliminary findings look promising for this use of the technology. For example, fingerprints in general, have revealed a high level of genotypic diversity both between and within wild sunflower populations and have been able to link certain populations despite their geographic separation. Conversely, populations in close proximity seem genetically separate. We anticipate that these data will enable us to target certain populations for testing hopefully saving both time and effort.

Conclusions

The enormous genetic diversity contained in the various species and innumerable populations of wild sunflower found throughout the world is clearly a greater a treasure to the future of sunflower breeding than the El Dorado gold the Spanish conquistadors sought in vain. Mindful prospecting and preservation of this great resource will be our challenge, as so much of the genetic diversity of the plant kingdom is forever lost through thoughtlessness and waste. While many technologies in the past have served only to accelerate this loss, it is hoped that the techniques of biotechnology together with contemporary wisdom, may help to salvage a greater part of the worlds genetic diversity and protect it from certain erosion.

Despite the fact that the application of this technology can raise further genetic questions, it does have the power to quickly answer difficult questions and to point to directions that would be otherwise unknown.

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Acknowledgements

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Breeding sunflower for improved drought tolerance in Australia.

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Abstract

A germplasm enhancement program has been initiated for the development of sunflower hybrids with improved drought tolerance for Australian production environments. Based on data from computer simulations and research in other crops we have focused our efforts on selection for improved transpiration efficiency (TE- dry matter production per unit water transpired) in sunflower. Significant genetic variation for TE, as measured by the surrogate trait carbon-isotope-discrimination (delta), has been found. Genetic crosses segregating for delta have been established to construct a genetic linkage map of sunflower to identify molecular markers linked delta. To date three independent RFLP markers linked to delta have been identified. Using an alloplasmic set of sunflower lines a cytoplasmic effect on delta has been shown. The yield advantage of hybrids selected for improved TE (by indirect selection for delta) was tested by top-crossing low and high segregates from our mapping population to a common female. These experimental hybrids were tested at three locations and the high delta pool out-yielded the low delta pool by 35% in the droughted environments (2 of 3 environments). High TE material being developed by this project is currently being introgressed by the private seed companies.

Introduction

Exposure to moisture stress is one of the major limitations to productivity of sunflower in Australia. We have initiated a germplasm enhancement program to underpin development of sunflower hybrids with improved drought tolerance for Australian production environments. We are using crop modeling (see Wang *et al* these proceedings), plant breeding and molecular genetics to achieve this objective.

Using an enhanced sunflower crop simulation model developed in this project, six major types of moisture stress patterns were identified across nine locations from northern NSW to central Qld using 100 years of weather records. The most common stress pattern was the terminal stress pattern where little or no rainfall was received after sowing. Simulation runs over the same locations and 100 year weather record indicated that a 10% increase in TE would lead to a yield improvement of 10-15% in most years (Chapman *et al.* 1999). These simulations suggest that improving TE is a worthwhile objective for sunflower germplasm enhancement, consequently, selection for improved TE has been the focus of our breeding program.

Selection for TE in wheat conducted by our colleagues at CSIRO Plant Industry Canberra has successfully produced varieties with improved drought tolerance. For a group of 30 BC_2F_4 high TE Hartog lines grown across eight environments (1995-8) there was up to an 11% advantage over 30 BC2F4 low TE Hartog lines (Rebetzke *et al* 2001).

Carbon-isotope discrimination

Significant genetic variation for TE, as measured by the surrogate trait carbon-isotope discrimination (delta), has been found in sunflower (Lambrides *et al* 1999). A glasshouse study has confirmed the association between TE and delta (r = 0.60) and also between TE and specific leaf weight (r = 0.65) (Chapman *et al* 2000). Based on selection for delta, material has been identified with potentially greater TE than exists in private sector germplasm. This material represented a diverse range of genetic backgrounds including several accessions selected from wild x cultivated crosses (Seiler 1991).

Molecular markers for TE

A cross between the high TE parent, HAR4, and the low TE parent, SA52, has been used to develop a population for the construction of a framework genetic linkage map to identify markers linked to low delta (high TE). Molecular markers aim to assist in plant breeding programs by making selection more efficient and cheaper.

Based on phenotypic data collected from the F_3 generation grown in a single replicate field experiment, three RFLP markers accounting for 8.9, 12.8 and 12.0 % of the variation for delta, respectively, have been identified (Table 1). The population HAR4xSA52, currently at the F4 stage, is being inbred to develop a recombinant inbred population that will allow more accurate phenotyping and more precise molecular marker linkages to be obtained.

Table 1 *Mean delta (per mil) values for the genotypic classes for three markers mar 41, mar 46 and mar 63 associated with delta in the F2 population HAR4 (maternal parent) x SA52 (paternal parent).*

marker	AA homozygous maternal	AB heterozygous	BB Homozygous paternal	AB or BB	Pr>F	R^2 (% of total variation)
mar 41	20.63 (12) ≈			20.86 (62)	0.0096***	8.9
mar 46	20.65 (17)	20.83 (39)	20.95 (20)		0.0048***	12.8
mar 63	20.67 (14)	20.82 (50)	21.01 (18)		0.0059***	12.0

≈ number of observations for each genotypic class

Cytoplasmic effects

Using a set of alloplasmic sunflower lines (lines have the same nucleus but different cytoplasms) we determined that cytoplasmic effects also influence TE (Lambrides *et al* 2000). One cytoplasm, MAX1, reduced TE significantly in the presence of several different nuclear genomes. However, our screening of five additional cytoplasms was unable to detect any superior TE over cytoplasms currently used in commercial hybrid production. The opportunity still exists to find variation though, given that the genus *Helianthus* consists of almost 50 wild species and is a potentially rich source of cytoplasmic diversity and variation for delta.

Yield testing of CSIRO experimental hybrids selected for improved TE.

To test the value of delta as a trait to enhance drought tolerance we selected 6 low delta F3 segregates and 6 high delta segregates from the mapping population HAR4 x SA52 and top-crossed these to a common genetic male sterile tester (supplied by Pacific seeds). These hybrids were then evaluated at three locations during autumn 2000.

One trial was sown in the field under a 30 m x 10 m rainout shelter located at Gatton Qld. The trial was watered up with 50 mm of irrigation and given an additional 50 mm during the early vegetative phase. No additional moisture was provided to the plot. Location two, planted at Gatton at the same time and adjacent to the rainout shelter, was rain-fed and given supplementary irrigation as needed. Location three was planted in the Central Highlands Qld at Capella under dry-land conditions. The Capella location was severely water stressed from shortly after planting until flowering. The Gatton locations included three replicates of each hybrid sown in single-row 3 m plots. The Capella trial included two replicates of two-row 6m plots.

Delta signatures were determined from all hybrids sown at Gatton. Grain yield, oil content and days to first flower were obtained for all hybrids at each location. Statistical contrasts were then used to detect differences between the low delta *vs*. high delta pools.

At both Gatton locations the low *vs*. high delta pools of experimental top-cross hybrids were significantly different for delta by an average of 0.35 per mil, indicating that the phenotyping of the F3 individuals used as male parents was accurate (Table 2). This mean difference indicated that we were successful in developing pools of hybrids differing for delta. While not measured, we expect that the difference for delta between the pools would also have been observed at Capella given the low genotype by environment interaction observed for this trait.

Table 2 *Mean delta values (per mil) for low vs high delta pools of experimental top-cross hybrids made from F3 segregates of the population HAR4 x SA52 and evaluated at two Gatton locations in autumn 2000.*

	Gatton irrigated	N (no of obs)	Gatton dryland	N (no of obs)
High delta pool	20.66	18	21.97	18
Low delta pool	20.32	18	21.61	18
Pr > F	0.0022***		<0.0001***	

*** P< 0.005

The low delta pool significantly out-yielded the high delta pool in the two droughted locations by 35% (Table 3). There was no significant difference in grain yield between the pools at the well-watered location in Gatton (Table 3). There was also no significant difference between the pools for oil content and maturity (data not shown) indicating that the delta trait does not appear to be associated with these key agronomic traits. Yield evaluations of experimental hybrids from low and high delta parents are being conducted this season (2000-1) and will be repeated next season (2001-2).

Table 3 *Grain yield (t/ha) for low vs high delta pools of experimental top-cross hybrids made from F3 segregates of the population HAR4 x SA52 and evaluated at three locations in autumn 2000.*

	Gatton irrigated	N (no of obs)	Gatton dryland	N (no of obs)	Capella dryland	N (no of obs)
High delta pool	0.82 (100) ≈	18	0.48 (100)	18	1.01 (100)	12
Low delta pool	0.89 (108)	18	0.65 (135)	18	1.37 (135)	12
Pr > F	0.52 ns		<0.0246*		0.0098 **	

≈ percentages given in parentheses are relative to the high delta group
*P<0.05 **P<0.01

It should be noted that these preliminary experiments were carried out with unadapted material, consequently, the 35% yield difference observed between the two pools may not be the yield advantage expected in adapted commercial material with the high TE trait added. The yield advantage expected for commercial material might be closer to the 15% as indicated by our computer simulation studies.

The current results suggest three important features of hybrids selected for low delta (high TE): firstly, there appears to be a clear benefit of the delta trait under moisture stress conditions; secondly, the trait does not carry a yield penalty under more favorable moisture conditions; and thirdly, the delta trait is not negatively associated with the important agronomic traits oil content and maturity.

Introgression of the TE trait into private sector breeding programs.

We have aligned our breeding project closely with those in each of the three private sector sunflower breeding programs (Agseeds, Pacific and Pioneer) operating in Australia. Material identified in this project as having higher TE has been crossed with elite parental lines from the private sector to introgress this trait into those programs. In addition, we are now crossing our best TE lines with elite private sector female lines to make experimental hybrids that will be yield tested under dryland conditions in many of the sunflower production areas of Australia. All yield testing of hybrids developed from CSIRO material will by carried out by the three private programs.

Conclusion

Considerable progress has been made in developing sunflower germplasm with enhanced drought tolerance for Australian production environments. The benefits of this research should reach the market place in the next five years.

Acknowledgments

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APSIM – Sunflower:

A new sunflower simulation model for APSIM

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ABSTRACT

A new sunflower module was released in the Agricultural Production systems SIMulator - APSIM version 2.0 in February 2001. It has been developed using the generic crop module template with most of the model parameters externalised into a crop parameter file. This new design allows easy manipulation of parameter (trait) values in the parameter file and objective comparison of scientific hypothesis at component level. The new version of APSIM-sunflower is easy to update and maintain. It can serve as a powerful tool for performance evaluation of different cultivars under variable climate and choice of most suitable cultivars for certain region. It allows investigation of issues such as potential production regions, the impact of climate variability and change on sunflower production and the evaluation of environmental variability in plant breeding trials.

INTRODUCTION

Sunflower is an important summer opportunity crop in the north-eastern dryland farming region of Australia, with yields largely dependent on the variable climate conditions. Yield improvement through better management options and through development of better-adapted cultivars for different growing regions is essential for increasing and maintaining the reliable production that meets the industry requirements. GRDC's 5-year research & development plan 200-2001 emphasises the need for a wider geographic spread of oilseeds to ensure continuity of supply for target markets and provision of suitable cultivars in major production areas to meet current and emerging market needs.

Resource limitation and the relatively long growing period of most crops limit experimental approaches for assessment of decision options. Simulation analysis can be used to overcome this problem by providing meaningful evaluation or assessment on variations both in genetics and in environment. Model applications range from genetic trait evaluation, cultivar and crop choice, to the design of most suitable cropping systems under certain environmental and socio-economic constraints including issues such as climate variability and change. The sunflower model QSUN (Chapman et al, 1993) was developed to assist in these situations. An upgraded version of it was incorporated in APSIM (McCown et al, 1996) and used to describe the impact of climatic variability on sunflower production and to evaluate the performance of 'alternative' genotypes. The improvements reported here were done partly within a GRDC project to improve sunflower adaptation to drought environments (Chapman et al, 1999).

In APSIM 2.0 the newest version of APSIM-Sunflower was released for further improvement and enhancement. It takes full advantage of the generic crop module template in APSIM with many extended capabilities for both improving the physiological science and exploring new application fields (Wang et al., 2001). In this paper we report the new development of APSIM-Sunflower and discuss the potential application areas of the model.

THE APSIM CROP MODULE TEMPLATE

Increased use of crop models in agricultural systems research necessitates high transparency and rapid advances of modelling sciences. The multitude of potential crops in farming systems complicate the development of generically applicable crop models. Although the basic growth and developmental processes are similar across crops, previously developed crop models, eg QSUN, fail to capture these similarities. Relationships derived and implemented in these models are often crop- or species-specific with different models simulating different crop species. Many of these models do not share common process code and hence, the science behind the models is often not transparent, improvements can not be easily transferred between models. They are difficult to maintain and component level comparison is not possible.

A generic crop model template (GCT) has been developed in APSIM to capture unifying physiological principles across crops and to provide highly modular and efficient code for crop modelling (Hammer, 1998; Wang et al., 2001). It comprises a Generic crop Model Structure (GMS, Fig.1), a Standard Crop Interface (SCI) to the APSIM engine, a Crop Process Library (CPL), and a well-structured Crop Parameter File (CPF) (Fig.2). The CPL contains the major science underpinning the crop models and incorporates generic routines based on physiological principles for growth and development processes that are common across crops. It encodes scientifically accurate representations of physiological processes and enables APSIM to simulate more than 20 different crops using the same set of well-engineered code. GMS and CPF provide an easy way to test, modify, exchange and compare modelling approaches at process level without necessitating changes in the code. The SCI generalises the model inputs and outputs and makes all crop modules in APSIM behave in a similar way. The crop template serves as a convenient means to test new insights, while maintaining a focus on predictive capability.

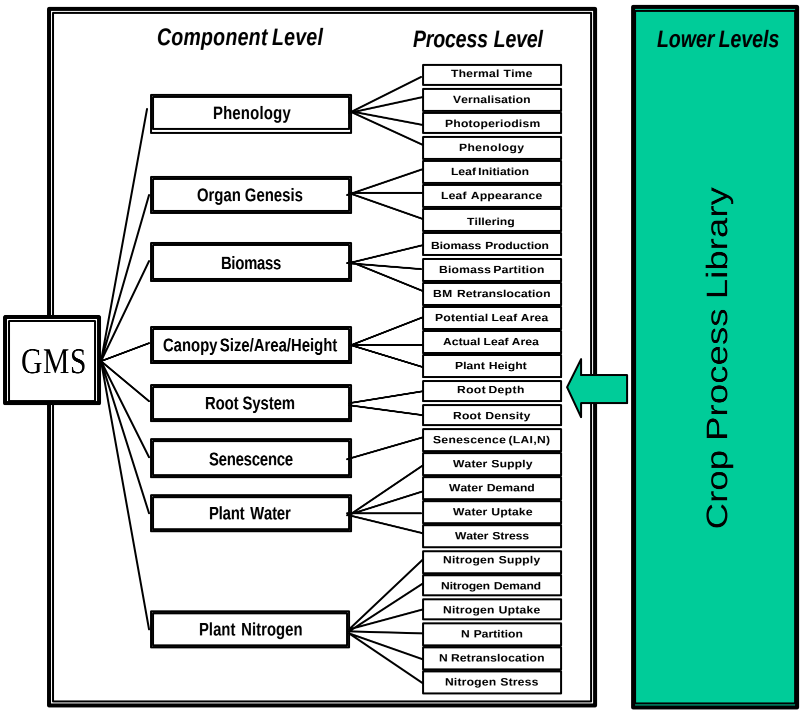

Figure 1. *The Generic Crop Model Structure in APSIM Crop Module Template. GMS calls process subroutines stored in the crop process library (CPL).*

Figure 1 also shows the model components, the simulated processes and the linkage between GMS and CPL. GMS together with SCI forms a standard crop template module (CTM) that can be used to create multiple instances (a process called instantiation) to simulate different crops (Fig.2). All the instantiated modules share the same code and each of them, together with a crop specific CPF (eg sunflower.ini for sunflower), simulates a given crop. This design overcomes problems in the crop-oriented models, enables high transparency of the science and prompt transfer of improvements. It also allows comparison of modelling approaches at component level and can grant rapid advancement of modelling science.

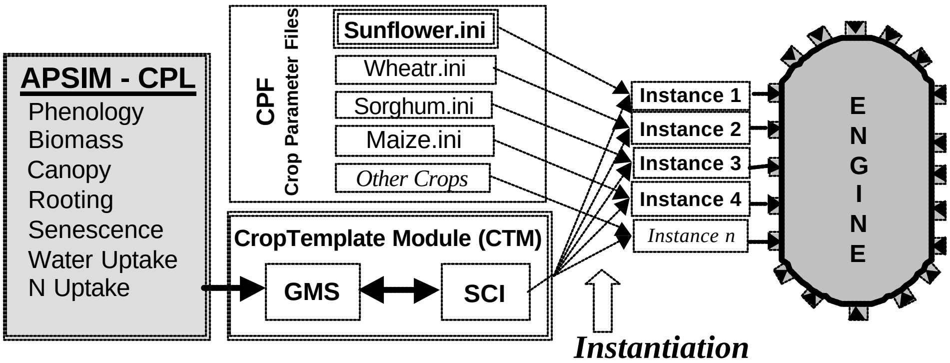

Figure 2 *Instantiation of the Crop Template Module (CTM) in APSIM. Several instantiated modules can be plugged in the APSIM Engine, each for one crop. APSIM-Sunflower is an instantiated module simulating sunflower crop using parameters contained in the SUNFLOWER.INI file.*

THE APSIM-SUNFLOWER MODULE

APSIM-Sunflower is an instantiated module from the Crop Template Module (Fig.2). A specific parameter file for sunflower (SUNFLOWER.INI) provides all the parameters the module needs. These parameters are organised in different sections corresponding to the model components and processes in GMS. It is easy to specify process switches in the parameter file to choose and test different modelling approaches at component/process levels. With this implementation, APSIM-Sunflower has been fully upgraded to the same level as all other APSIM crop modules. Any simulation scenarios designed for other crops can be easily adapted to sunflower.

Modelling approaches similar to those in QSUN (Chapman et al, 1993) are used for simulation of leaf area, biomass growth, yield formation, and crop water-relations. A new scale for phenological stages was implemented in line with other APSIM-crop models, which comprises 11 phases and 12 phenological stages from sowing to maturity and crop end. The majority of the parameters were adapted from QSUN with new derived values from experimental data for new cultivars. Table 1 lists the cultivars that can be readily simulated. New cultivars can be added into the parameter file, as parameters become available. Note that differences among cultivars are only implemented here in terms of differences in phenology. Other cultivar variation (especially harvest index and oil content/type) is not accounted for in the cultivar specifications, but could be included if data were available to do so.

Upgrading the sunflower module to the crop template standard enables APSIM-Sunflower to simulate crop-nitrogen relations. Crop nitrogen uptake is related to crop nitrogen demand and nitrogen available in the soil (supply). The model assumes that there are two processes that contribute to N uptake: passive and active uptake (van Keulen and Seligman, 1987). Passive uptake is the N intake with transpiration stream, also called mass flow, which is estimated as the product of transpiration and the nitrate concentration in soil solution. "Active uptake" represents a diffusive process and is estimated in terms of the rate at which plants can use nitrate and ammonium from soil. Nitrogen demand of vegetative organs is simulated using crop-specific N concentration limits. It assumes that the crop has a defined minimum, critical and maximum N concentration for each plant part. These concentration limits change with phenological stages (Jones et al, 1986; van Keulen & Seligman 1987; van Oosterom et al., 2001) and values for sunflower were derived from Bange et al (1997). Grain nitrogen demand is modelled using a temperature-driven approach and is met by re-translocating N from vegetative organs. If nitrogen uptake cannot meet demand, phenological development, leaf area development and biomass growth will be reduced from their potential rates with leaf expansion growth being the most sensitive and phenological development the least sensitive process. The nitrogen component allows simulation of grain quality.

Table1. *Sunflower cultivars that can be simulated by APSIM-Sunflower*

Default	Old cultivars in QSUN	New added in APSIM-Sunflower
Quick, Medium, Slow	*Sunfola68-2, Hysun32, SunGold, Suncross52, Suncross150*	*Advantage, SunOleic2, Suncross53, Assett, Hyoleic31, Monosun140, Pacific25, Pacific36, Pacific45, Suncross41, Suncross42*

Other new developments include the evaluation of likely climate change effects on crop growth. With increase CO_2 level crop radiation use efficiency, transpiration efficiency and leaf critical nitrogen level will change (Reyenga et al, 1999). Incorporating these factors allows the assessment of climate change (together with increasing temperature and changed rainfall patterns) impacts on future production potential. Within APSIM, an arbitrator module also allows sunflower to be intercropped with other crops. A Manager module provides the capability to specify a set of (management/action) rules using conditional logic during simulations to control the actions of modules within APSIM. Soil water and nitrogen dynamics are simulated by separate APSIM soil water and soil nitrogen modules (Soilwat2, SoilN2).

PREDICTIVE CAPABILITY OF APSIM-SUNFLOWER

The new version of APSIM-sunflower has not yet been fully tested for biomass and yield responses under different environmental conditions and with diverse N treatments. Experimental data are being analysed and new research is ongoing to further improve the model. Simulation results against the data sets used in QSUN showed that the new model performs similarly to QSUN in terms of LAI, biomass and yield predictions. Comparison of simulated and observed data from Myall Vale and Tatura experiments in 1981 are shown in Figures 3 and 4. Use of the model for predicting leaf area, biomass and stress indices in a GRDC project to improve sunflower adaptation to drought environments provided satisfactory results (Chapman et al, 1999). However, discrepancies between some of the simulated and observed values indicate the need for further improvement and testing, especially for new cultivars (for parameters other than phenology) and for situations with limited nitrogen availability.

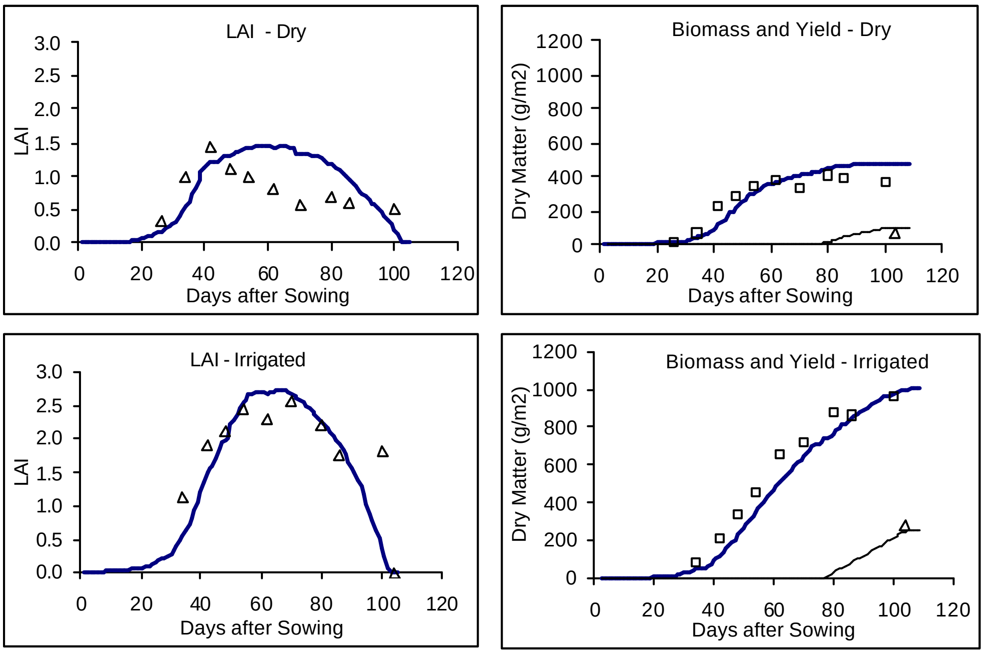

Figure 3. *Comparison of simulated and observed values for LAI, biomass and yield from Myall Vale experiment with dry and irrigation treatments in 1981. Sowing date: 21 Jan. Cultivar: Suncross52.*

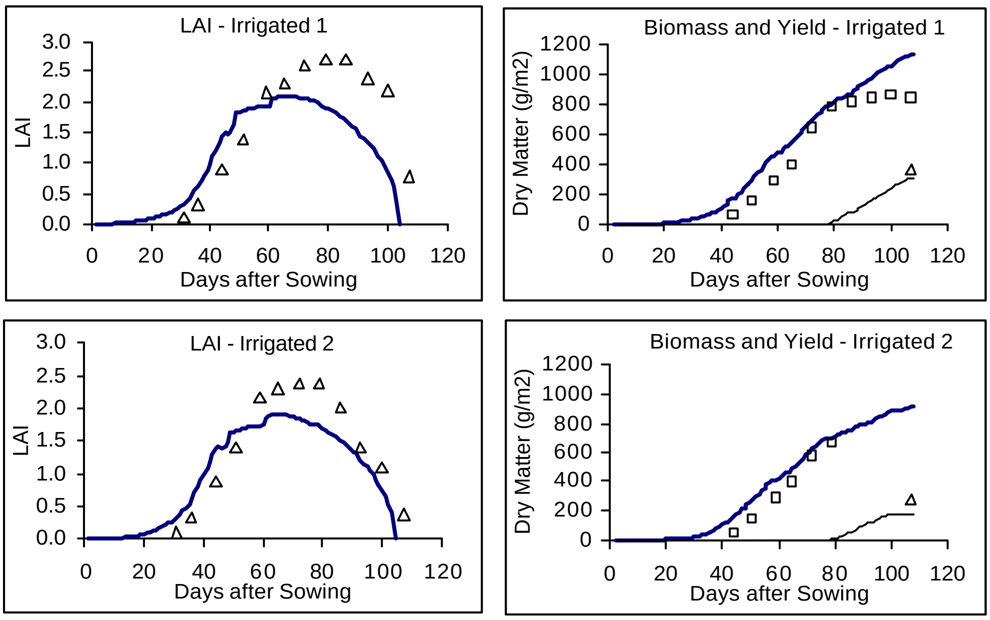

Figure 4. *Comparison of simulated and observed values for LAI, biomass and yield from Tatura experiment with weekly and fortnightly irrigation treatments in 1981. Sowing date: 26 Nov; Cultivar: Sungold.*

POTENTIAL APPLICATION AREAS

Use of the CPL and the GMS substantially increased the scientific transparency of APSIM-Sunflower and other crop models. The constant/parameter externalisation allows the user to easily modify parameter values. This accelerates the development, testing and validation process. The code sharing in the crop module template enables hypotheses to be tested not only on sunflower, but also on other crops. Further, any simulation senarios designed for other crops can be easily adaped to sunflower. Potential application areas of the APSIM-Sunflower include:

- On-farm tactical management decisions by simulating production risks in variable environments (Meinke et al, 1993, Meinke and Hochman, 1999)
- Economic and environmental assessment of cropping system including sunflower as an opportunity crop.
- Evaluation of cultivar performance in major production areas and explore potential production opportunities.
- Improving breeding programs through the use of simulation models for environment characterisation and trait simulation (similar to Hammer *et al.*, 1996; Robertson *et al.*, 1998; Chapman et al, 1999, Chapman et al, 2000)
- assessing global change impacts on sunflower production in the future (similar to Reyenga *et al.*, 1999)

CONCLUSION

The new APSIM-Sunflower module takes full advantage of the generic APSIM crop template with high modularity, science transparency and sound component science. It is able to simulate growth, development and yield formation of sunflower crop under variable environment. Experimentation is required to derive the basic coefficients for new cultivars needed by the model and to further validate the model. A well-validated sunflower model allows evaluation of cultivar performance and management options for many more cultivars, years and locations than experimentation would be feasible. Relatively small investment in sunflower model development can pay off quickly through the conduct of virtual experiments in many application areas, eg: genetic trait evaluation, cultivar and crop choice, and design of most suitable cropping systems.

ACKNOWLEDGEMENTS

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Session 4

World Trends and Technology in Sunflower Production, Crushing and Consumption

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Focus

- World production trends
- Implications on oilseed processing
- Production viability
- Sunflowers for the future

World Oilseed Trends

Soybeans dominate world oilseed production

Increased World Oilseed Production 1981-2000

Growth in canola production has outstripped other oilseeds

World Sunflower Production

Argentina is the single largest producer but production can swing significantly

Sunflower Production in Major Countries 1981 -2001-06-07

With the exception of Argentina, production has seen limited growth

Why has Sunflower Production Lagged?

- Poor gross margins verses competing crops
- Rapid growth in palm production over the past 2 decades

- Steady growth in other oilseed crops such as soybean and canola
- Sunflower oil has been substituted with other vegetable oils

World Yields Trends

Sunflower yields have remained stagnant for the past 20 yrs

World Vegetable Oil Consumption

Major changes since 92/93:-

Palm +6%, Soybean +2%, Rapeseed +2% but Sunflower –2% and Ccotton seed -2%

World Vegetable Oil Production Trends

The dramatic increase in palm oil production has increase competitive pressures on other oilseeds. PO has increased by 480% in past 20 yrs.

World Oil Values

Sunflower oil is a premium oil but drops to SBO values once intrinsic demand is covered

Implications for Oilseed Processors

- Polyunsaturated oil market for sunflower oil has been eroded by canola
- There has been good growth in high oleic sunflower oil but from a low base
- Relatively low meal contribution to crush returns.
- Managing production swings with seasonal conditions

Contributions to Crush returns

Low SFM values detract from total crush revenues for sunflowers

Domestic Oil Demand

- Domestic SFO demand is capped.
- Sunflower oil demand has been eroded by the growth in canola.
- SFO demand has stabilised at approx. 40K mt / year (margarine & branded oils).
- High oleic SFO is displacing some tallow/palm in the food services sector.

Meal Specification Comparison

High crude fibre and lower protein and energy levels makes sunflower less valuable in animal feeds

Limitations of Domestic Sunflower Demand

- Intrinsic oil demand is 100K mt seed equivalent however some of this is serviced from imported SFO.
- The combination of low SF gross margins, high internal transport and logistics costs and competition from other meals and oils is limiting the polyunsaturated SF crush to 65K mt in recent years.
- SFM is sold into the ruminant market and demand varies with weather conditions.
- High oleic SFO is displacing some tallow/palm in the food services sector which has established new demand for SFO.

Factors Influencing Viability of Sunflower Production

- Relatively low yields and higher agronomic risks than other crops.
- High internal logistic and transport costs to get SF to crush and products to market.
- Competition from other vegetable oils and protein meals.

Crop Yields for Sunflower, Wheat and Sorghum

Sunflower have not seen similar yield gains as competing crops.

Oil Value Comparisons

SFO traditionally trades at a premium to other oils

Gross Margin Comparison

Data from DPI dry land trials 200/2001 indicate low yields mean that sunflowers do not compare favourably to other crops in gross margin.

Australian Sunflower and Sorghum Area by Region

CQ production levels have fluctuated with seasonal conditions

Seed Production and Oil Demand Comparison

Distances between production and demand areas adds to high logistics and handling costs

The Future of Sunflower Production in Australia

- Need to increase GM returns for sunflower production.

- This can be done by:
  - Increasing yields
    - Bridge the gap with competing crops
  - Increased oil values
    - Specialty oils
    - Heath attributes
  - Increasing meal values
    - Processing advances

- Breeding opportunities
-

Australian Consumers – Healthy, Confused, or Just Don't Care?

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Heart and blood vessel disease in Australia

Cardiovascular disease is the leading cause of death in Australia, claiming a life every 10 minutes. Thirty Australians below the age of 70 die each day of heart and blood vessel disease (eg, heart attack, angina, stroke, heart failure, rheumatic heart disease). Australians are 34% more likely to die of cardiovascular diseases than from cancers[1].

The major preventable risk factors for cardiovascular disease are:

- tobacco smoking;
- high blood pressure;
- high blood cholesterol;
- overweight;
- insufficient physical activity;
- high alcohol use; and
- type 2 diabetes[1].

The Heart Foundation is an independent Australia-wide, non-profit health organisation, funded almost entirely by donations from Australians. The Heart Foundation's purpose is to improve the cardiovascular health of all Australians and to reduce disability and death from heart disease and stroke by:

- promoting and conducting research to gain and apply knowledge about cardiovascular disease, its prevention and treatment; and
- promoting and influencing policy and behaviour which improves health by conducting education, rehabilitation and other programs, directed at health professionals, those with heart disease and the Australian community at large.

The Heart Foundation's position on dietary fats

High intakes of fat, especially saturated fat, are associated with elevated blood cholesterol levels, overweight and increased death from cardiovascular disease in populations where levels of physical activity are low[1]. For Australians, total dietary fat currently contributes about 32% of total food energy consumed[2]. This is comprised of 13% saturated fat, 12% monounsaturated fat, and 5% polyunsaturated fat (these figures do not add up to total fat because of rounding and the contribution of non-fatty acid components).

Saturated fat in the diet is the main factor that raises blood cholesterol levels. Heredity also affects blood cholesterol levels. Major food sources of saturated fat in the Australian diet are dairy milk, cheese, frozen dairy products (eg, ice cream), pastries, meat, and potatoes (from saturated fat added in the cooking and preparation of potatoes such as in hot chips, potato salad, and mashed potato)[2].

Polyunsaturated and monounsaturated fat on the other hand, can help lower blood cholesterol if meals are low in saturated fat. Major food sources of poly- and monounsaturated fat include poly- and monounsaturated margarines, sunflower, safflower, olive and canola oils, nuts and seeds, and avocadoes. Australian consumers however, currently eat poly- and monounsaturated fats from margarine, breads, buns and muffins, potatoes, nuts, milk and lean meat[2].

Dietary cholesterol increases blood cholesterol, but substantially less so than saturated and trans fatty acids. Major sources of cholesterol in the Australian diet are dairy products, meat, and eggs[2]. Dietary cholesterol is only found in animal foods and is not naturally present in plant foods. Trans fats are produced during manufacturing, when converting soft or liquid oils to hard oils.

In 1999 the Heart Foundation reviewed its position on the relationship between dietary fat and cardiovascular disease[3]. The Heart Foundation now recommends that:

- saturated fatty acids and trans fatty acids together contribute no more than 8% of total energy intake;
- omega-6 polyunsaturated fatty acids contribute 8 – 10% of total energy intake;

- at least 2 fish (preferably oily fish) meals are consumed per week;
- plant omega-3 polyunsaturated fatty acids intakes should be at least 2g per day;
- a proportion of dietary saturated fatty acids should be replaced by monounsaturated fatty acids; and
- people at low coronary risk can reasonably eat moderate quantities of cholesterol rich foods, while people with blood cholesterol levels greater than 5.0mmol/L or other risk factors should restrict their intake of cholesterol rich foods.

In practical terms, this means the *type* of dietary fat is of greater importance than the amount of dietary fat when it comes to cardiovascular disease. Thus, the Heart Foundation recommends that people enjoy healthy eating by choosing:

- mostly plant-based foods such as bread, cereals, rice, pasta, vegetables, fruits and legumes;
- moderate amounts of lean meats, poultry, fish, eggs, nuts, and reduced fat dairy products and alternatives; and
- moderate amounts of polyunsaturated and monounsaturated fats (such as those from polyunsaturated and monounsaturated margarines, sunflower, olive, canola and soybean oils, nuts and seeds, and avocadoes).

The Heart Foundation, takeaway food and sunflowers – A winning match?

The Heart Foundation uses its policies as a base for working with the food industry to encourage healthier choices for consumers. For example, the Heart Foundation has been working with the takeaway food industry since 1996 in an attempt to increase the demand for and availability of, healthy food choices. Australian's spend more than one third of their total food bill on eating out and takeaway food with the most popular food products purchased from takeaways being sandwiches, hot potato chips, hamburgers, cakes and pastries, meat pies, pizza, fried rolls, donuts, BBQ chicken and fruit salad[4]. As much of this food is high in saturated fat, it is of major concern to the Heart Foundation.

The sunflower industry provides the food and foodservice industries with a healthy alternative for use in takeaway and other foods via deep and shallow fry oils, salad oils, margarines and seeds. The Heart Foundation has worked to promote the use of such foods via programs and projects such as the Food Information Program (Pick the Tick), the Takeaway Food Project[5,6,7,8,9,10] (including Shell trial, Spotless trial, and the Premium Oils Project), and Heartline (phone information service).

Of particular interest has been the work surrounding the use of high oleic sunflower oils for deep frying hot potato chips. The Heart Foundation recommends the foodservice market use deep-frying fats with a saturated plus trans fatty acid level less than or equal to 20%. Currently four oils on the market have the Heart Foundation Tick of Approval. All of these oils have high oleic sunflower oil as a major, if not sole, ingredient.

The Heart Foundation has conducted several projects that have investigated the use of these oils in a variety of settings, including independent takeaway stores, Shell Roadhouses, and worksite canteens supplied by Spotless Services Ltd. Results of these projects have indicated:

- retailers are impressed with the quality and performance of the oil, noting improvements in taste, texture, colour and greasiness of end products (particularly chips) when compared with their usual oil;
- debate continues as to whether the potential increased fry life of such oils is sufficient to overcome the higher cost of the oil;
- very few independent takeaway retailers currently use, or indeed are aware of, high oleic sunflower oils (in NSW 4% and in Qld 3% of independent retailers use the oils);
- young adult consumers prefer the taste of chips cooked in sunflower or blended vegetable oil compared with beef tallow;
- older customers are more interested in having a choice of healthy takeaway foods than younger customers, although few customers are willing to ask their retailer to use Heart Foundation approved oils;
- customers largely support the use of the Heart Foundation Tick on hot chips cooked in Heart Foundation approved oil;

- customers do not largely understand that “tick chips” are low in saturated fat but not necessarily total fat; and
- the Tick on chips has the potential to influence purchasing behaviour of consumers.

One of the major barriers to the widespread use of Heart Foundation approved oils amongst retailers is the cost of the product. Other barriers that have been identified include being satisfied with their current product, limited promotion by distributors, availability (particularly in rural and remote areas), and disposal of packaging[9].

The consumer and dietary fat – healthy, confused, or just don’t care?

While the work of the Heart Foundation in the takeaway food industry has been positive, it has indicated considerable consumer confusion, as well as a degree of apathy, particularly with respect to the issue of dietary fat. Qualitative research regarding consumption of dietary fat has revealed a number of barriers to the promotion of meaningful and effective messages regarding dietary fat[11].

Firstly, there are significant pressures on consumers that impact on their decisions regarding food selection, its preparation and cooking. These include:

- lifestyle pressures such as work and family commitments;
- economic pressures, particularly for the lower socio-economic groups; and
- emotional and psychological pressures from the variety of functions food performs, eg pleasure, social and personal benefits, satisfying hunger, and taste preferences.

Consumers are also subject to a barrage of confusing and conflicting information sources regarding food. Marketing and advertising focuses on satisfying consumer needs and desires, and resolving pressures and stresses on time, money, taste, and family acceptance. The health sector on the other hand is often asking consumers to restrain their intake or limit their choice of foods that are often promoted in this way.

Another problem for consumers is that they tend to seek information that confirms or reinforces their existing attitudes and behaviours. This is because health messages usually ask people to do something they do not want to do, but also because even within the health sector, messages about food are changed or modified causing consumers to reject or re-interpret the message in keeping with their desires.

Finally, when it comes to fat specifically, consumers are considerably unaware, as well as confused and misinformed. People don't understand the benefit of fat, they don't understand the different types of fat and their roles in food and nutrition, and most importantly, they tend to think all fat is bad fat.

Working towards healthy and informed consumers

The Heart Foundation is currently working towards providing consistent consumer messages, particularly with respect to dietary fat. For example, the Heart Foundation was a strong lobby voice in the recent Australian and New Zealand Food Authority review of food labelling laws. It was extremely pleasing to note that nutrition information panels on foods will not only become compulsory, but will now have to state the amount of saturated fat in food products.

Other current work of the Heart Foundation is research surrounding Australian eating patterns. This involves comparing the current typical Australian meal pattern with recommendations regarding dietary fat, and looking for foods, that when substituted with other choices, improve the fatty acid profile of the meal. The final result enables us to have a more "user-friendly" message regarding dietary fat, to guide consumers in their daily food choices.

Once developed and tested these messages will be included in our consumer information brochures and distributed via Heartline, GPs and other health professionals, media releases and so on. Health professionals will be updated via workshops, seminars and conference presentations.

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Sunflower Products: Good Nutrition for Consumers?

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Consumption of traditional sunflower oil is in decline in Australia. “Good nutrition” advice is one of several factors contributing to this fall. Consumer perceptions of dietary fats are generally poor and awareness of the nutritional properties of sunflower oil is low. This paper explores the potential role of nutrition as a tool for the promotion of sunflower-based products.

Margarine Market Trends

Historically the major use for sunflower oil in the Australian market has been in margarines and margarine-spreads. Consumption of spreads over the last decade has fallen substantially, by about 25 per cent, and further declines are expected. There are several factors driving this decline. For example, bread - the major vehicle for margarine consumption, was once a staple food for Australians, but its consumption is now in decline. Consumers are demanding more alternatives. Whereas once sandwiches were the preferred option for lunch, the city food halls now offer an exciting array of cuisines from around the world, often with rice or pasta as a base. Hamburger buns and pizza bases are now major uses for flour but are not complemented with margarine.

Although breakfast remains the major opportunity for spread consumption, again change is afoot. Fewer people now consume breakfast. For those who do, there are increasing numbers of alternatives to traditional foods such as bread with margarine. A muffin with coffee is standard fare for North Sydney office workers. Breakfast now comprises an increasing proportion of MacDonalds business.

Modern nutrition advice is one of the most negative influences on margarine consumption. "Eat less fat" is a nutrition message which has struck home with consumers and margarine is particularly vulnerable to it. 'Visible' fats, such as margarine and oils, are easy targets for fat reduction unlike 'hidden' fats found in baked goods, snack foods, take-aways and cheese. “Reduced-fat spreads” may meet consumers’ demands for less fat but are not good news for the sunflower industry.

Nutrition arguments do not just revolve around the total amount of fat consumed but also the type of fat. Sunflower oil was the dominant oil used in vegetable oil-based spreads when polyunsaturated oils were launched in Australia in the 1970s. This dominant position came under significant challenge with the development of the canola industry and the launch of canola spreads into the Australian marketplace a decade or so ago. More recently olive oil has been used in premium margarines and spreads. Canola and olive oils were positioned with strong health benefits. This was not countered by similar arguments in favour of sunflower oil. In consumers' minds canola and olive oils are the healthier options.

Good Nutrition: Threat or Opportunity?

Superficially "good nutrition" appears to be a threat to the sunflower industry. Closer analysis will reveal it is an opportunity. However, this opportunity will only be realised when consumers are adequately informed about the latest scientific information about the health implications of dietary fats, especially those rich in polyunsaturated fats such as sunflower oil. What are the facts? And who is responsible for distilling these down and disseminating them to consumers?

Dietary Guidelines for Australians

There are two major guiding influences on nutrition messages relating to dietary fat - the Dietary Guidelines for Australians and the nutrition policies of the National Heart Foundation.

The Dietary Guidelines for Australians are produced by the National Health and Medical Research Council and are updated every decade or so. They are designed as a series of nutrition messages aimed at improving the health of the population. When these were first promulgated in the early 80s the message about fat was a simple one - just "eat less fat". The implication was that fat was bad for health. Nutritionists passed this message on to their clients; women's magazines told the population at large; food companies reinforced it with nutrition claims on food packaging. However, there was a problem – the message was wrong.

The scientific rationale for the guideline was that the consumption of fat was associated with increased risk of coronary heart disease, breast cancer, bowel cancer and obesity. By today's standards the evidence supporting these disease links was weak. When bigger and better scientific studies were conducted dietary fat was turned out to be a relatively benign component of the diet. One such study was the famous Nurses Health Study involving a cohort of over 80,000 nurses in the United States which has now been followed up for over 20 years. The researchers found no associations between fat intake and cancer of the breast or bowel. Also, no association was found between total fat intake and coronary heart disease. However, the *type* of fat was found to be related to heart disease - saturated fat increasing risk and polyunsaturated fat *decreasing* risk.

Findings that polyunsaturated oils, such as traditional sunflower oil, decrease the risk of coronary heart disease were not new. In fact, these results were entirely in line with earlier findings on the effects of dietary fatty acids on blood cholesterol - a major risk factor for coronary heart disease. Saturated fatty acids increase blood cholesterol, polyunsaturated fatty acids decrease it - well researched in the 1950s and 1960s but unfortunately not incorporated into our first dietary guidelines. Why? Because of the complexity of the issues and the difficulty in communicating them. One major problem with nutrition guidelines has been the tendency to oversimplify messages to promote consumer understanding. The unintended consequence of this was to misrepresent the role of dietary fat in human nutrition.

Fortunately the NHMRC has slowly set about getting the story right. Ten years ago the Dietary Guidelines for Australians were reviewed and the fat guideline was changed to increase the emphasis on fat type. The new guideline read "eat a diet low in fat and, in particular, low in saturated fat". More recently dietary guidelines for both children and older Australians were developed which did not mention any need to restrict total fat, just saturated fat.

The Dietary Guidelines for Australians are currently under review and the early indications are that the fat guideline will have two elements – a moderate (rather than low) intake of total fat and a restriction of saturated fat. The slow evolution of our dietary guideline for fat away from a focus on total fat in favour of fat type has been positive for vegetable oils. However, unsaturated oils are still perceived as "less bad" than saturated fats rather than good in their own right.

Heart Foundation Policies

While the Dietary Guidelines for Australians still do not specifically advocate increased intakes of polyunsaturated fats, this step has now been taken by the National Heart Foundation. The Foundation's recent review on dietary fats and coronary heart disease is the most rigorous ever conducted in Australia and, importantly, employed an evidence-based approach. The Heart Foundation found polyunsaturated fatty acids to be the most protective class of fatty acids against heart disease and recommended that they comprise 8-10 per cent of dietary energy. This compares with the current content of polyunsaturated fatty acids in the Australian diet of just 5 per cent of energy. In other words, the Heart Foundation is recommending an increase in the polyunsaturated fat content of the Australian diet of between 80 and 100 per cent.

The major source of polyunsaturated fatty acids in the Australian diet is sunflower-based margarines and spreads. Dietary modelling by the Heart Foundation has demonstrated that, in order to consume 8-10 per cent of dietary energy as polyunsaturated fat, people need to consume a sunflower-based spread regularly. This represents a rare opportunity for the sunflower industry. The most respected source of nutrition information for consumers in Australia is advocating regular consumption of sunflower-based spreads. If this information can be effectively communicated to both health professionals and consumers sunflower oil will gain respect for its nutritional qualities.

Fat-Soluble Nutrients

The general public is largely unaware that the polyunsaturated fatty acids, linoleic acid and alpha-linolenic acid, are actually essential nutrients in the diet. These are not the only essential nutrients found in sunflower-based spreads. Sunflower oil is an excellent source of vitamin E and it is not surprising that sunflower-based spreads are the major source of vitamin E in the Australian diet. Spreads are also rich in vitamins A and D, making spreads a major source of no less than five essential nutrients in the diet. How many other foods can make such a claim?

In the United States health authorities have developed a comprehensive new set of recommended dietary nutrient intakes for a healthy population. They urge increased intakes of vitamin E and, especially, vitamin D. How will such recommendations be implemented in Australia if the general public consumes less of the best source of these nutrients in our diet - spreads? Currently our intakes of vitamins D and E are falling in line with the decline of spreads consumption.

Expert opinion and consumer understanding about fats and fat-soluble nutrients are out of kilter. There is a compelling case for increased consumption of sunflower-based spreads by the Australian population. Only the Heart Foundation is really primed to take this message to the general public. Perhaps the sunflower industry and margarine companies should consider assisting the Heart Foundation in its educational activities about dietary fats.

Sunflower Products for the Future

Unilever's Flora pro-activ provides a good example of a sunflower-based product of the future. It has a strong health positioning. Flora pro-activ's novel component is plant sterols, which inhibit the absorption of cholesterol from the intestine. The result is a clinically proven cholesterol-lowering effect. The decision as to which oil should form the base of Flora pro-activ was not a difficult one – traditional sunflower oil, rich in vitamin E, rich in the polyunsaturated fats advocated by the Heart Foundation, cholesterol-lowering in its own right.

Flora pro-activ was the first new polyunsaturated sunflower-based spread launched by Unilever in Australia for many years and it has been a remarkable success in the Australian marketplace. Since its launch in June 1999 Flora pro-activ's sales have steadily climbed such that it now commands a value share of the spreads market of 13.8 per cent, the most successful launch of a margarine product for more than 25 years.

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