Sunflower's – an important part of the tool kit for dryland farming

The challenges of growing sunflowers

- Since the Dunbar's last dryland sunflower crop in 2000, market competition has dropped from eight or nine potential buyers back to a limited number of companies. The family considers that their marketing options are now limited.
- Sunflower farmers, and the industry generally in the Central Highlands, have been aware of a problem with the crop since 1998. Despite trials on Tobacco Streak Virus (TSV), there is still limited agronomic evidence to place sunflowers back in the forefront of farming systems, despite their current potential high returns. Agronomy service providers are cautious in dealing with sunflowers, and Dunbars have relied heavily on advice from other farmers.
- Emerald has no bulk storage for sunflowers since TSV dropped the tonnage produced in the Highlands. Storage has been an issue for the Dunbar's this year – the crop did not leave the property when expected, and the storage still occupied by sunflower seed had been allocated for the incoming chickpea and wheat harvests.

Seeding system

This season the polyunsaturated hybrid Hysun 39 was sown. There are at present few seed suppliers in CQ as the majority of growers have not grown sunflowers for nine years, seed was purchased through Ag'N'Vet, Emerald.

- The past season's crop was replanted: Initially 250 hectares of crop was planted February 6 over three days in flood inundated country. But just after planting, Kingower was flooded again, and the crop didn't emerge.
- A total of 96 hectares was replanted on February 20, still within the recommended planting time for Central Queensland – essentially as soon as conditions had dried out enough for the growers to get a tractor on the paddock.
- Sunflowers are planted with a John Deere MaxEmerge 1700 disc planter at one metre row spacings with water

better OILSEEDS

This farmer case study has been compiled by Liz Alexander, Blue Dog Agribusiness, as part of the national *Better Oilseeds* project.

FARMERS
Scott and Alicia Dunbar with Jack, Kavan, Angus and Digby.
PROPERTY SIZE
Kingower, 3267 hectares.
LOCATION
Emerald, Central Highlands of Queensland
ENTERPRISES
• Irrigated cotton, wheat, sorghum, chickpeas and mungbeans 570 hectares; • Raingrown cropping; wheat and sorghum chickpeas, sunflowers 1010 hectares; and, • Store and fat cattle.
AVERAGE ANNUAL RAINFALL
637 mm – characterised by summer dominant rainfall in which 45 per cent of annual rainfall is received during December to February.
SOIL TYPE
• Self-mulching cracking clay – uniform clay soils; • Soil depth ranges from 60 cm to 12 m across the property; and, • Minimal slope on dryland country.
SOIL pH
Neutral to alkaline pH trend, averaging 7.5.
WHY GROW SUNFLOWERS?
Sunflowers provide an alternative rotation and source of income that can be grown in the Central Highlands region at two different times of the year. The end of February window extends growers' planting options for summer crops and if planting of winter crops such as corn or sorghum is delayed, it gives growers another option to plant spring sunflowers.

This sunflower case study has been compiled as part of the national *Better Oilseeds* project, an exciting initiative funded by the Grains Research and Development Corporation and the Australian Oilseeds Federation.

The *Better Oilseeds* project is addressing the urgent and critical need to lift the productivity of oilseed crops within Australia, specifically canola, sunflower and soybean, to ensure critical mass and consistency of production and to improve the quality of grain produced. The project began in 2006 and aims to increase the value of the Australian oilseeds industry through enhancing productivity and value.

A number of activities are encompassed within the project which includes practical on-farm demonstrations of pertinent agronomic issues for all three crops, field days and forums and grower case studies to share knowledge within the industry.

Watch for case study booklets – which will include technical information and case studies on sunflower and soybean growers from around Australia – to be released this summer.

Alicia Dunbar inspecting a sunflower head on Kingower.

injection into irrigated wheat stubble on raised beds. A GPS is used to allow inter-row cultivation if needed.

- The Dunbars planted 35,000 seeds per hectare and estimate a 95 per cent strike on the second plant.
- Beetle baiting was applied after the crop emerged due to soil insect pressure from earwigs and crickets.

Harvesting equipment and management

Sweet Victory Contract Harvesters (Andrew Keily and Sam Dawson) were contracted for the harvest. They use a rotary header with sorghum fingers.

In past years the Dunbars have waited for the crop to dry right down to nine per cent. This year they trialled harvest at a slightly higher moisture content (11 to 12 per cent) but not so moist that the seed required drying. After discussion with other growers, the aim of higher moisture harvesting was to avoid wastage out the back of the header.

But the Dunbars plan to return to nine per cent moisture for their spring sunflower crop as their harvest contractors reported that the crop fed better into the header front at this level.

Management of sunflower residue

The Dunbars planned to slash the sunflower stubble to leave it as ground cover, and then after sufficient rain, plant a spring or summer sorghum crop.

Nutrition

- No pre-plant fertiliser was used.
- Water injection at planting with MAP (and Regent).
- Growers generally undertake in-crop sap tests as opposed to pre-soil test to calculate crop nutrition requirements.
- Sunflowers are planted into country which is periodically inundated by Retreat Creek in flood. Sunflowers have yielded well without fertiliser which the Dunbars attribute to sediment dropped by floodwaters.

Kingower sunflowers at May 26, 2008.

Fertiliser use efficiency

The Dunbars consider sunflowers' deep tap root improves their soil structure by opening up soil at depth, and provides a break from cereal crops which have a higher nitrogen requirement.

Weed control

- One week before plant – Glyphosate (generic) at 750 ml/ha with ammonium sulphate, 2,4–D (Cobber) at 600 ml/ha, wetter at 0.02 per cent (200 ml per 100 litres of water) by air.
- No inter-row cultivation or spraying after emergence.
- Due to the sunflowers being planted in flood country, the Dunbars were unable to control weeds, such as the TSV host parthenium, around paddock boundaries prior to planting.

Pest management

- Spread beetle bait after planting – (treated cracked sorghum).
- Key pest management to control thrips as they are suspected TSV carriers.
- Two Dimethoate sprays at label rates have been applied to control thrips – once at 4-leaf, and once after 10 and within 14 days from the initial spray.
- The Dunbars sprayed 15 days earlier than suggested thrip threshold, on advice from other Central Highlands growers.
- They recommend aiming to control thrips early in the vegetative stage of the crop, rather than relying on an insect number threshold.
- Rutherglen bugs have been recorded but number have been below threshold.
- They use Spackman and Associates, Emerald for agronomic advice – checks are carried out weekly by agronomists, and also by growers.

Disease management

The crop has been essentially disease-free. Less than five per cent of the crop was affected with TSV. Local growers deem an acceptable loss. Powdery mildew was noticed in the crop but not controlled. The Dunbars feel that in the future powdery mildew would be controlled and are seeking chemical options to be used if it is found again.

Sunflower yield

The crop yielded a total of 78.5 tonnes from 93 hectares averaging a yield of 0.84 tonnes per hectare.

Producing for the bird seed market, the Dunbars sought independent assessments of the test weights, producing above current NACMA standards of 39 kg/hl. The crop was sold for $800 per tonne on-farm, giving a gross income of $62,800 or $675 per hectare.

Gross margin

Dunbars lost their tractor in the floods and needed to hire a contractor to plant, but estimate little difference in planting costs taking their own labour into account.

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TABLE 1: Central Highlands dryland cropping gross margins summary (May 2008)

Crop	Gross price at depot (d), gin(g) or farm (f) $/bale or $/t		Yield (t/ha or bales/ha)	Direct growing costs ($/ha)	Gross margin ($/ha)
Sorghum (single-skip or 1.5m rows)	205	d	2.5	237	240
Mungbeans	700	d	0.8	235	142
Sunflower (mono)	800	f	0.8	164	436
Sunflower (poly)	774	f	0.8	167	414
Corn (feed)	250	d	2.0	261	211
BGII RR Cotton (super single)	440	g	1.8	623	241
Wheat	300	d	2.0	211	361
Chickpea	620	f	1.2	322	422

Source: Graham Spackman and Associates Pty Ltd.

KINGOWER SUNFLOWER GROSS MARGIN 2008	
Expenses	Actual ($/ha)
Pre-plant fallow weed control	35
Treated seed	65
In-crop insect control	34
Harvest	64
Income	
Harvest Income (hectare contract on-farm)	675
TOTAL	$477/ha

The gross margin above does not include fuel and labour costs.

Sunflower gross margins compared extremely well to other dryland crops in the Central Highlands this season.

The gross margins local summary (Table 1) assumes average conditions, does not include labour or fuel costs, and provides long-term average yields. It is also assumes that farmers are harvesting their own crops, with the exception of corn and cotton.

Economic benefit from growing sunflowers

At the current price, sunflowers provide very competitive returns when compared to high yielding grain crops.

Reliability and robustness of sunflowers

"Our first irrigation crop," points out Alicia Dunbar, "was seed sunflowers in 1999, a Pioneer trial, and they were absolutely terrific. Prior to TSV, sunflower was always a main summer crop at Kingower. Even when yields were lower, we found there was a better potential gross margin than grains." ■

ALICIA'S TAKE HOME MESSAGES

- Sunflowers provide an important option for summer and spring dryland plantings.
- We aim to manage TSV damage to five per cent of total crop as an acceptable loss.
- Sunflowers are a low input crop which can provide superior returns to high yielding grain crops.
- Be aware of contract conditions (eg. NACMA standards) and also be aware of who the contracts are actually with – keep a 1.0 to 2.5 kg sample bag of each and every load taken away, so you can seek independent quality assessments if needed.

Safflower breeding and future challenges

By Hans-Henning Mündel

Genetic improvement in safflower has aimed at improving yield, oil and other agronomic characteristics, including resistance to diseases, insects and abiotic stresses. It has relied on exploiting the existing variability in commercial cultivars and land races, and to a limited extent also on crosses with closely related species, *Carthamus oxyacanthus* and *Carthamus lanatus*.

India is the major producer of safflower and for decades, safflower research in India was in the hands of individual government centres or agricultural universities, as well as private sector research such as at Maharasthra Hybrid Seeds (Mahyco) at Jalgaon and the Nimbkar Agricultural Research Institute (NARI) at Phaltan in Maharashtra State.

Using mass-selection at Niphad, in the former Bombay State, the first commercial safflower, N-630 was released in 1942. At Annigeri, in 1969, A-1 was released following a pedigree breeding method.

The All India Coordinated Research Project on Oilseeds (AICORPO) included safflower projects from 1972. Aside from developing high yielding cultivars for the diverse regions growing safflower, these programs have developed a wide range of plant types, including appressed, semi-compact and spreading. Over 18 high-yielding cultivars and four hybrids of regional and multi-regional importance, have been released.

Safflower yields in India averaged less than 200 kg per hectare in the years just preceding this coordination. By the 1990s, countrywide yields ranged from 500 to 650 kg per hectare. Cultivar improvement has been a major contributing factor to these increased yields. But oil content has remained constant, around 28–30 per cent, with only an occasional cultivar reaching to 35 per cent oil.

To facilitate the introduction of safflower in non-traditional areas, A.R. Sawant, at the Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV) in Indore, bred high-yielding spineless safflower, JSI-7, released in 1990. He was assisted for some years by the International Development Research Centre (IDRC) from Canada.

A decade later, the spineless NARI-6 was released by NARI, providing a dual income to farmers, as the florets can easily be collected from non-spiny safflower after the crop matures and is sold for food and textile dye.

Hans-Henning Mündel delivering his keynote address.

Spreading safflower worldwide

Decades of studies at UC–Davis, by international graduate students and local technicians, under the mentorship of Paulden Knowles, spread safflower knowledge worldwide. Paulden worked out the cytotaxonomic relationships among not only most of the safflower species but also between these species and their wild relatives.

His interests ranged from the breeding, genetics, cytogenetics, to the germplasm conservation of safflower. The widely-used USDA World Collection owes most of its safflower lines to Paulden's collecting efforts from the 1950s to 1970s.

Three alleles at one locus were found to govern the levels of linoleic and oleic acid, with the intermediate levels being temperature sensitive in the 1960s. Starting with the release of UC-1 from Knowles program, high oleic cultivars were developed around the world – for example, S-317 from SeedTech in California and Rinconada in Spain.

Working in Arizona, Dave Rubis released 'Gila', in 1958. This was an F3-derived cultivar which showed wide global adaptability. Gila became popular in Mexico, Australia and Argentina for much of the next three decades. Gila was reputed to have been grown in more countries and covered more area than any other single cultivar. It has been incorporated in many future cultivars by crossing and backcrossing, in numerous countries.

Disease resistances

A series of cultivars was released with resistance to alternaria leaf blight (caused by the fungus *Alternaria carthami*. Cultivars such as Girard were developed by mass-selection of resistant plants from crossing of existing cultivars in a disease nursery initiated in the early 1960s from fields naturally infested with a multitude of diseases in Sidney, Montana, US.

This produced cultivars with improved field resistance to several diseases.

In Canada, Saffire was developed at Lethbridge, Alberta, by mass-selection from a bulk derived from selections from India, having good field resistance to head rot, caused by *Sclerotinia sclerotiorum*. This cultivar is almost the only safflower cultivar currently grown in Canada, as a high quality (solid white) birdseed.

As infection with safflower rust (caused by *Puccinia carthami* Cda) at the seedling stage can cause serious yield reduction in warm soils, five improved safflower lines (PCA, PCM-1, PCM-2, PCN, and PCOy) have been developed, each carrying a different dominant gene for rust resistance.

Biotechnological advances

Safflower has become the focus for several innovative biotechnological endeavours including the production of insulin by SemBioSys in Canada and Unusual Fatty Acids by CSIRO, Plant Industry in Australia.

SemBioSys' system involves the genetic attachment of commercially viable target proteins to oleosin, the primary protein coating the oil-containing vesicles (oilbodies) of the seed. While the range of products being developed by SemBioSys are on the S-317 background, newer, more disease resistant will be needed in the future to facilitate this 'molecular farming' over a range of agro-ecological niches.

With the development of protocols for genetic transformation of safflower based on callus-mediated regeneration of seedling explants in India, major contributions towards the use of biotech in safflower breeding can be expected there, specifically, the development of transgenic cultivars with resistance to aphids and herbicides, as well as cultivars with tocopherol content with improvements in both antioxidant activity and vitamin E content.

Nandini Nimbkar who is the president of the Nimbkar Agricultural Research Institute based at Phaltan, India, inspecting safflower plots in India.

Development of safflower hybrids

Advancements have been underway in both the US and India in producing safflower hybrids. Barney Hill, working for Cargill at the time, initiated a safflower hybrid program in 1972. This system for the development of cytoplasmic male sterile lines relies on the use of the wild safflower, *C. oxyacanthus* as female and the domestic safflower, *C.tinctorius* as restorers of CMS and as recurrent males.

His Safftech Hybrid Safflower is linked with the Montana-based Safflower Technologies International, with Jerry Bergman and group, in the production of birdseed safflower hybrids.

It is expected that this partnership will produce high oil hybrids (well above 40 per cent) which can be globally commercialised over the next few years.

In India, a Maharasthra private seed company, MAHYCO, has not only developed the male sterility maintainer genotype for the sterile cytoplasm but has also developed and is commercialising the first Cytoplasmic Male Sterile-based safflower hybrid in India, MRSA-521, expressing high wilt resistance.

It is expected that hybrid seed will be made available much more cheaply compared to the seed of Genetic Male Sterility-based hybrids in safflower. This should lead to the rapid expansion of the hybrid safflower area in India.

This is an edited version of a keynote address given by Dr Hans Henning Mündel at the 7th International Safflower Conference, November3–6, 2008.
Copies of the proceedings are available from www.australianoilseeds.com ■

FUTURE CHALLENGES

To continue to deliver new and improved cultivars for the global safflower industry it will be important to:

- Continue to develop cultivars from promising germplasm;
- Fully utilise the world collection;
- Further study and expand the medicinal uses of safflower; the use of biotechnology for pharmaceutical purposes could greatly assist such expansion;
- Integrate the latest biotechnology advances into safflower breeding programs; and,
- Develop robust hybrid systems to increase the productivity of safflower.