



## Growing safflower in Australia: Part 1 - History, experiences and current constraints on production

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### Abstract

Safflower (*Carthamus tinctorius*) production commenced in Australia during the 1950's, but the area sown annually has been erratic and has never exceeded one percent of the total cropped area. Historically, this has been attributed to disease, unsuitable cultivars, unfavourable seasons, unstable markets and competition from more profitable crops. However, safflower is adapted to the higher rainfall broadacre cropping zones of Australia and regularly sown by growers in some regions when conditions are suitable. Growers generally find that safflower fits easily into cereal based cropping systems without the need to purchase additional equipment. Compared to other winter crops, the later sowing and maturity of safflower can be beneficial in managing herbicide resistant weeds and in spreading sowing and harvesting workloads. Aside from being grown as a cash crop, safflower can also be used strategically to manage salinity and water logging in subsequent crops by de-watering wet soil profiles. Whilst safflower is a relatively easy crop to grow and harvest, growers indicate all the historic factors mentioned above are still limiting production today. Compared to more widely grown oilseeds like canola, safflower has received little investment in research and development in Australia resulting in limited information on agronomic management options and a narrow range of registered pesticides.

**Key words:** Cash crop – opportunity crop – strategic crop – adapted cultivars – markets

### Introduction

The broadacre cropping systems of Australia are dominated by the rainfed production of cereals grown in rotation with a range of pulse and oilseed crops. These systems rely heavily on chemical fertilisers and pesticides and are highly mechanised. Soil type and rainfall vary greatly between regions, but for much of the traditional wheat belt average annual rainfall ranges from 350 to 550 mm. Despite a run of seasons with below average rainfall in many regions over the past decade, market conditions have contributed to an increase in cropping activity with fewer fallows and pasture leys. This combined with rising input costs and the need to conserve soil and water has driven a shift towards reduced tillage cropping systems and stubble retention.

Safflower (*Carthamus tinctorius*) can be incorporated into these cropping systems using existing machinery and increasing the diversity of crop choices available can increase strategic pest and weed control options, management flexibility and help mitigate production and economic risks. For example, sowing safflower in spring provides an opportunity to generate income from fields that receive additional cultivations or other controls to manage herbicide resistant winter weeds and this later sowing and harvest than traditional winter crops can help spread peak workloads over a longer period of time. Despite these and other potential benefits, the area sown annually to safflower has been erratic and less than one percent of the total cropped area in Australia.

This paper presents selected information on the history of safflower in Australia, discusses grower experiences with this crop and explores issues which are currently limiting production. The information is derived from published literature, a survey of safflower growers (SGs) and non growers (NGs) in southern Australia (Wachsmann *et al.* 2001) and the authors' experiences in working with growers producing commercial crops over a range of environments. The results of a series of agronomic experiments and suggestions to increase yields and production are presented in Part 2 of this paper (Wachsmann *et al.* 2008, these proceedings).



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### Selected History of Safflower Production in Australia

Australia began to investigate safflower in the 1940's amid concerns for drying oil shortages in the paint and resin industries (Smith 1996). Several cultivars were subsequently introduced from overseas, allowing small scale commercial production to commence in the mid 1950's. The cultivar Gila was introduced in the early 1960's and with higher seed and oil yields the safflower industry expanded to 42,000 ha by 1968 (Smith 1996). At this time, safflower was mainly grown in Queensland, but production subsequently declined due to droughts in 1968 and 1969, followed by several seasons of above average rainfall which favoured the disease *Alternaria* (*Alternaria carthamii*). Production continued in Queensland and expanded into other states at varying levels, but in 1975 grower confidence was again lost by a severe outbreak of *Alternaria* in Queensland (Smith 1996). During the 1960's and 1970's cotton (*Gossypium hirsutum*) and hybrid sunflower (*Helianthus annua*) industries also developed creating competition to the safflower industry. The abolishment of quotas on the use of vegetable oils for margarine production in 1976 led to increased interest in oilseed production and in the following seasons record prices were paid for safflower (Smith 1996). The area sown in Australia subsequently peaked in 1979 with 74,688 ha, but then declined presumably due to volatile prices and competition from other oilseed crops (Smith 1996).

In response to disease concerns, the Commonwealth Scientific and Industrial Research Organisation developed the cultivars Sironaria with resistance to *Alternaria* and Sirothora with resistance to the root pathogen *Phytophthora cryptogea*, which were released in 1987 (Harrigan 1987). However, this did not revive safflower production in Queensland, with production over the past two decades shifting largely to New South Wales and Victoria. During this period the Australian industry was based largely on Sironaria which has linoleic oil and is also suitable for birdseed markets. In comparison, dedicated oilseed cultivars with higher oil contents have been developed overseas. Some of these cultivars, including S555 (linoleic oil) and S517 (oleic oil) were introduced into Australia in the 1990's expanding market opportunities. Further cultivars have been imported by companies in recent years, but production is still limited due to irregular cultivar testing, seed propriety issues and the availability of commercial seed quantities.

Over time a number of companies have attempted to expand safflower production in Australia, but in recent decades the larger processors have tended to concentrate on other oilseeds like rapeseed/canola (*Brassica napus*), sunflower and cotton. Markets for safflower have therefore tended to be less stable than the major oilseeds resulting in greater price volatility. This combined with disease outbreaks, unsuitable cultivars, unfavourable seasonal conditions and competition from more profitable crops (Colton 1988; Kelleher 1994; Smith 1996) has resulted in the erratic production of safflower in Australia over the last 35 years (Figure 1a). Between 1970 and 2005 average annual production was 21.6 kt from 34.0 kha, but this has ranged from 1.9 to 57.7 kt from 3.6 to 74.7 kha (FAO 2008). In contrast, the area of canola harvested each year increased dramatically during the 1990's to become a major oilseed crop in Australia, although production has declined in recent years due to droughts (Figure 1b). Between 2000 and 2007 Australia exported between 2.8 and 13.6 (mean = 6.7) kt of safflower seed and between 0.0 and 0.4 (mean = 0.1) kt of safflower oil annually (ABARE 2007).

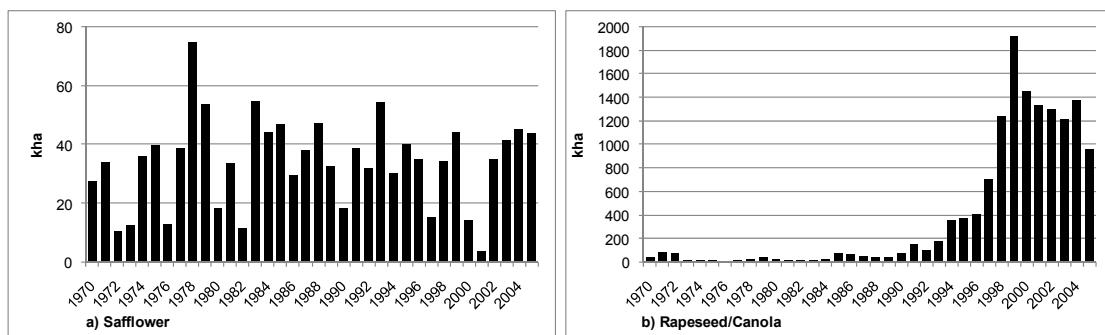


Figure 1. Area (kha) of a) safflower and b) rapeseed/canola harvested annually in Australia between 1970 and 2005 (FAO 2008 data).



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The Australian public and private sectors have invested considerable resources into the research and development of major crops like wheat and canola. As a result, seed yields have on average increased by 1.9% (wheat) and 2.9% (canola) per annum between 1970 and 2005 (Figure 2a). In contrast, improvements in the seed yield of safflower have only averaged 0.9% per annum over the same period and this can at least partly be attributed to limited funding being allocated to research and development. Since the mid 1980's, average safflower yields in Australia have only been about half of that achieved by canola. These trends in crop improvement in Australia between 1970 and 2005 are consistent with world data where on average annual improvements in the yield of wheat and canola have exceeded 1.9%, compared to only 0.3% for safflower (Figure 2b).

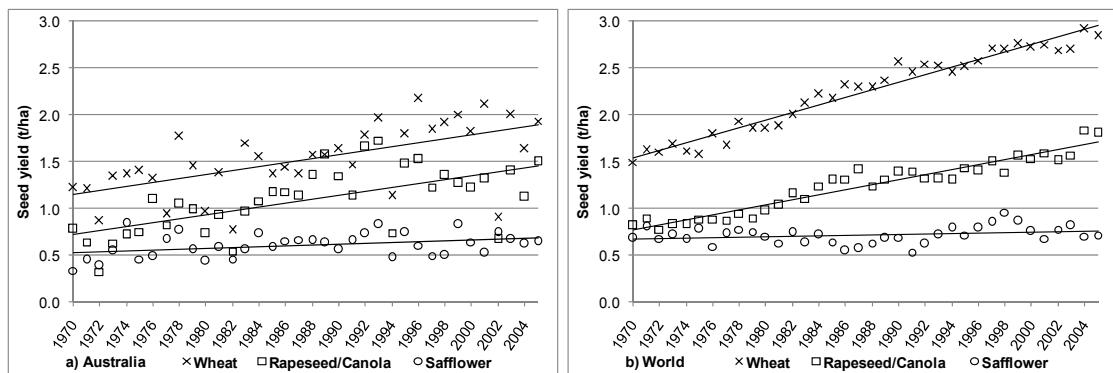


Figure 2. Mean seed yield (t/ha) of wheat, rapeseed/canola and safflower in a) Australia and b) the world between 1970 and 2005 (FAO 2008 data).

### Grower Experiences with Safflower Production in Australia

To better understand the role, production and issues with safflower in south-eastern Australia, a survey consisting largely of open ended questions was conducted in 2000. A total of 65 useable survey forms were returned from 41 SGs and 24 NGs. The SGs provided a total of 380 years of safflower growing experience (range = 1 to 25 years) on different soil types in regions with an average annual rainfall of 270 to 750 mm (mean = 469 mm).

All respondents indicated that the main factors influencing crop selection in rotations were weed control, adaptation and the disruption of pathogen life cycles. Threats to farm sustainability included declining terms of trade, herbicide resistant weeds and soil degradation. SGs planted safflower in rotations to control weeds (39%), spread sowing and harvesting workloads (22%), break disease life cycles (20%), dewater wet soil profiles (15%), for financial gain (15%) and to open soil with roots (12%). Several SGs (10%) used safflower strategically in rotations specifically to control herbicide resistant weeds by delaying sowing until spring providing additional opportunities to control problem winter weeds with broad-spectrum herbicides or by non chemical methods. The dewatering of wet soil profiles can help reduce water logging in subsequent crops and benefit the management of dryland salinity. Thirty nine percent of SGs mainly sowed safflower as an *opportunity crop* in spring to capitalise on favourable late rainfall or where conditions had prevented the establishment of traditional winter crops. These results indicate that safflower is not only being grown in south-eastern Australia as a *cash crop* when conditions favour it, but also as a *strategic crop* within rotations with wider benefits to whole farming systems.

The majority of SGs (56%) reported planting only the cultivar, Sironaria. A further 31% sowed a combination of Sironaria, Saffola (S555 and S517) and/or Gila, but no other cultivars were mentioned. Sowing time ranged from July to December, with the majority of SGs sowing in August and September (late winter and early spring). Post sowing weed control was reported as a production issue by 37% of SGs, especially for broadleaf weeds. Red-legged earth mites (*Halotydeus destructor*) during establishment and Rutherglen bugs (*Nysius vinitor*) around



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anthesis were frequently encountered pests, but problems that are easily controlled with pesticides.

Safflower was mostly harvested in summer with minimum yields ranging from 0.0 to 1.7 t/ha (mean = 0.7 t/ha) and maximum yields ranging from 0.3 to 3.0 t/ha (mean = 1.7 t/ha). At the time of the survey, 60% of SGs reported they sold seed solely to birdseed markets with remaining SGs also selling to oil markets. Only 19% of SGs believed the economic viability of safflower to be currently good, with 48% mentioning variable or marginal and 29% stating that economics were good in previous years, but are currently poor. Eighty percent of SGs believed that markets were inadequate. More than half of NGs had either grown or considered growing safflower in the past. Reasons cited for not growing safflower included yield, market and/or price issues, unsuitable environmental conditions and lack of agronomic and market information. Most NGs indicated they would consider safflower if issues pertaining to gross margins improved (46%), if environmental conditions were more suited to the crop (25%), a need arose for a spring-sown crop (17%) or more adapted cultivars were available (13%).

Perceptions of safflower strengths are listed in Table 1. A larger proportion of NGs mentioned flexible time of sowing, disease break, deep tap root and low input requirements as major strengths. SGs tended to mention improvements to soil structure and the spread of workloads more frequently. Both SGs and NGs had similar views on the ability of safflower to use water and dry soil profiles. SGs mentioned poor or variable yields (41%), price/market issues (29%), pests (7%) and poor establishment/early vigour (7%) as being major weaknesses of the crop.

Table 1. Major strengths and research priorities raised by surveyed respondents for safflower.

Major strengths	Mentions (%)		Research priorities		Mentions (%)	
	SGs	NGs	SGs	NGs	SGs	NGs
Improves soil structure	24	17	Increasing markets/price	55	25	
Good weed control tool	19	17	Increasing yield	55	21	
Water use/profile drainage	17	17	New cultivars	29	21	
Flexible time of sowing	19	21	Modifying seed/oil quality	10	13	
Low input/cheap to grow	12	17	Pest/disease resistance	10	8	
Easy to grow	12	4	Increasing seedling vigour	10	0	
Disease break	10	17	Fertiliser requirements	7	17	
Spread workloads	7	4	Time of sowing	12	13	
Deep tap root	0	17	Rotation benefits	0	13	
Non cereal/pulse option	2	4	Environmental adaptation	13	13	

The main research priorities for safflower identified by survey respondents are also listed in Table 1. Further issues mentioned included herbicide options, sowing rates, water logging tolerance, modification of growing season, improved crop establishment, quantification of soil benefits and pest thresholds. Increasing yield, markets and seed price, therefore gross margins, appear to be very important issues to SGs. Participants suggested improving seed quality by reducing the proportion of husk, increasing oil content, changing the oil profile and finding new end uses for safflower as possible means of resolving marketing issues. Many of these research priorities could be at least partially addressed through plant breeding or access to new cultivars.

A number of additional insects including cutworms (*Agrotis* spp.), mirids (*Creontiades dilutus*) and plague locusts (*Chortoicetes terminifera*) have been observed by the authors. Whilst these pests are not specific to safflower, information on control options and control thresholds in this crop is limited. Safflower crops are frequently infected by rust (*Puccinia carthami*), especially the older leaves later in the season, but this does not appear to cause significant economic losses. There have been several reports of safflower's late finish coinciding with summer storms, particularly in northern Australia, resulting in severe losses due to lodging and/or pre-harvest sprouting. Experience has shown that maintaining the purity of seed when harvesting safflower can be challenging in hot and dry conditions as branches and receptacles tend to shatter and become difficult to separate from seed. This problem can be partly overcome by harvesting during cooler or more humid times of the day. Periodic cleaning of machinery may also be



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required to remove capitula bristles from radiators and hot engine components to reduce the risk of fire. Compared to most other broadacre crops, safflower can have higher transport costs due to the relatively low bulk density and higher volume requirements.

### **Constraints on Safflower Production in Australia**

Safflower requires more water than other crops commonly grown in the traditional wheat belt to produce comparable yields (see Part 2 of this paper). It has found a strategic niché in some wetter situations where it is regularly sown by some growers, but in general the run of seasons with below average rainfall over the last decade have not favoured the inclusion of safflower in cropping rotations. Notwithstanding this issue, production history, the grower survey and the authors' experiences indicate that a number of other constraints have and continue to restrict safflower production in Australia. These relate to the availability of suitable cultivars, production practices and the economic viability of safflower to growers.

#### *Availability of Suitable Cultivars*

In recent years the Australian safflower industry has relied on Sironaria and a handful of cultivars imported from the United States. Whilst these are adequate to service linoleic oil, oleic oil and birdseed markets, they are not adapted to the broad range of environments within the wheat belt, particularly in respect to differences in average annual rainfall between regions. In contrast, the wide range of canola cultivars available offer choice in length of growing season, disease resistance and herbicide tolerance increasing the adaptability of this crop. Australia has no dedicated scheme for multiplying or maintaining the planting seed of safflower cultivars like Sironaria which are in the public domain. The main source of these cultivars is therefore 'farmer saved seed' which is of uncertain genetic integrity as a result of genetic drift and/or contamination over time. A further issue is that some newer cultivars recently imported from overseas may only become available on 'closed loop' arrangements limiting access to growers wishing to pursue alternative markets. Additionally, many growers have experienced price volatility and during the 1990's some growers had additional problems in trading successfully with some marketing companies. These experiences have not helped the position of safflower as a *cash crop* in Australia.

#### *Production Practices*

Safflower has gained a reputation as being a summer or opportunity crop and as such, it is not always sown at the optimum time or with adequate inputs contributing to poor or variable yields. In at least some situations, this indicates a poor understanding about safflower production requirements and the half-hearted attitude of some growers and agronomists towards the crop. It is not uncommon to hear comments similar to 'safflower, yeah, I sowed it once, it grew well, but I harvested nothing but fluff'. These observations may be related to limited research into safflower production in Australia and issues with the dissemination of available information.

Compared to more widely grown crops, post-emergence weed control options in safflower crops are limited making paddock selection and pre-sowing control critical, especially given its poor early vigour. Several products containing diclofop-methyl and propaquizafop are registered for the control of grass weeds, but there are currently only limited options for the post-emergence control of broadleaf weeds. In general, there are fewer insecticides registered for use in safflower than other crops and there has been limited research on establishing pest thresholds or assessing the effectiveness of modern fungicides on diseases like Alternaria. The narrow range of options for pest, weed and disease control may also be restricting safflower production in Australia.

#### *Marketing and Profitability*

Outlets for Australian safflower can be broadly divided into two distinct markets, birdseed and vegetable oil. Birdseed markets are relatively small and easily saturated due to the speculative nature of production leading to large price variations between seasons. To some extent, the more structured production of vegetable oil has improved price stability, but seasonal influences have disrupted the continuity of supply which could reflect on Australia's ability to supply export markets. This supply issue is amplified by safflower being a minor crop with little carry over



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stock held in reserves, making the whole industry highly sensitive to unforeseen production or marketing issues.

To be competitive with other *cash crops*, growers would like to achieve similar gross margins from safflower and this has not always been the case. Safflower requires an extra ~120 mm of water to produce similar yields to canola (see Part 2 of this paper) and in July 2008, the indicative market price for safflower and canola delivered to Melbourne was AU\$555/t and AU\$770/t, respectively (TWT 2008). Given that safflower has a higher water requirement and a lower price, at present it may not be competitive with canola as a *cash crop* unless some strategic value can be gained by including safflower in rotations.

### Conclusions

Safflower has attributes that make it a useful rotation option in some situations within the broadacre cropping regions of Australia, especially where water availability is high. These include a deep tap root allowing water to be extracted from deep in the soil profile and the ability to produce economic yields when sown in spring under favourable conditions. Safflower is therefore not only being grown as a *cash crop*, but also as a *strategic crop* in rotations to manage issues such as water logging, herbicide resistant weeds and peak workloads. It can also be utilised as an *opportunity crop* where safflower is sown to substitute winter crops that fail to establish or to capitalise on good spring rainfall. Despite these benefits, safflower remains a minor crop in Australia and production can vary substantially from year to year. Historically this has been attributed to disease outbreaks, unsuitable cultivars, unfavourable seasonal conditions and competition from other crops. These problems are still restricting safflower production today and further issues identified by surveyed growers included limited pest control options and price volatility resulting from smaller, hence often less stable markets.

In the 1980's the area of safflower harvested in Australia was broadly similar to canola. The following decade saw the canola industry expand rapidly with substantial resources being invested into developing cultivars adapted to a range of environments, production techniques and markets. Consequently, between 1970 and 2005 average annual improvements in canola yields have been three times higher than for safflower. In its current form safflower is likely to remain a minor crop with certain niché applications in cereal growing regions. Expansion of the safflower industry in Australia will require considerable investment into research addressing the agronomic, economic and related marketing issues previously outlined. Some suggestions on how this might be achieved are provided in Part 2 of this paper.

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