Cotton CRC

Cotton Research & Development

CRC Weed management

GRDC Grains Research & Development Corporation

Final Report:
A scoping study on weed issues and their economic impact in dryland cropping systems with cotton

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Introduction

Dryland cotton farming systems are complex and usually comprise of a number of different rotational crops in conjunction with summer and winter fallows. The standard system employed in dryland cotton production is the planting of cotton after a 10-month fallow from a winter cereal (Marshall 2002). However, there are a number of alternative planting options, such as sorghum, sunflowers or maize, which for reasons of price or available soil moisture may be planted in place of cotton. Although originating from hot arid regions and tolerant of long dry periods, modern cotton varieties require warm to hot growing conditions and reliable rainfall during the growing season. Cotton should be planted into a minimum of 60cm of wet soil, whereas in lower rainfall areas 90cm of wet soil is preferred to provide sufficient moisture between rainfall events (Bange *et al.* 2002). For these reasons, dryland cotton production tends to be limited to areas receiving greater than 600mm of rainfall annually, with approximately 40% of that rain falling during the summer growing season. Currently, cotton is grown commercially from Hillston in the south-west of NSW to Emerald in central Queensland, although trial plantings have been established in the Northern Territory and the north-west regions of Western Australia. Dryland production accounts for approximately 20% of the total area planted to cotton, with the major production regions in the lower and upper Namoi valley, Moree, the Darling Downs, south-west Queensland and central Queensland (Marshall *et al.* 2002).

Adequate soil moisture and the likelihood of receiving planting rains are critical factors for growers in deciding which crops they are likely to plant, particularly in the summer cropping phase. The critical nature of soil moisture to dryland production has seen the evolution of a number of different planting configurations, including solid, single skip row and double skip row planting that may be employed by growers to conserve soil moisture throughout the season.

Weed management in farming systems involving dryland cotton is then by nature equally complex. A number of the residual herbicides used in rotational crops may damage cotton, in particular the sulfonylurea and triazine herbicides such as chlorsulfuron and atrazine. Equally, a number of the common cotton herbicides have long plant backs to either winter cereals or other summer cereals used in rotation with dryland cotton. To preserve soil moisture, many dryland growers have adopted minimum or zero tillage systems that are almost solely reliant on herbicides for weed control. Control measures therefore must be flexible to allow last minute changes in the crops grown due to soil moisture limitations or price fluctuations and need to provide adequate levels of protection against weeds in the chosen crop, as well as in the planting configuration being used.

To better understand the weed management issues of this complex farming system and to provide direction for future research efforts, a scoping study was initiated in July 2001 by the Cotton Research and Development Corporation (CRDC), Australian Cotton CRC, Grains Research and Development Corporation (GRDC) and CRC for Australian Weed Management. The scoping study was a collaborative project involving scientists and technical staff from Queensland Department of Primary Industries and New South Wales Agriculture. An external agronomist with extensive experience in dryland cotton production, Mr Glenn Milne, was appointed on a part-time basis to help collect, collate and interpret data.

The primary aims of the scoping study were to determine:

- dominant and difficult-to-control weed species in each crop and fallow component of the different crop rotations used for dryland cotton production in the northern region;
- weed management practices, both non-chemical and chemical, being used for weed control in these systems;
- economic impact of theses weeds; and
- current practices exacerbating the weed problems.

The scoping study

The scoping study consisted of four components, starting firstly with a postal survey to dryland cotton growers. The mail survey was then followed up with detailed interviews of selected growers (10) who responded to the mail survey. The next component of the scoping study involved extensive field surveys on 34 paddocks in each of the rotation sequences of the 10 growers interviewed. Finally, an economic study was undertaken using data from the postal survey and other sources.

<u>Postal survey</u>

A postal survey, based on the survey of Jones *et al.* (2000), was distributed to 342 dryland growers in northern NSW, southern and central Queensland. The survey asked growers to provide information on the crop rotations, farming practices used in each component of the rotations for weed control, specific information on herbicides used for the main

weeds of each crop and fallow, costs and impact of weeds on production, as well as specifics on troublesome weeds within their cropping systems. Fifty-three completed forms were returned giving a 16% response rate, of which 11% were from central Queensland, 26% from northern NSW, and 63% from southern Queensland.

The postal survey identified that the cropping system involving dryland cotton is diverse. The crops grown in rotation with dryland cotton are winter cereals only (46% of the rotations), summer and winter cereals (18%), winter cereal plus pulse (9%), summer cereals only (8%), summer and winter cereal plus pulse (5%), whereas 11% grow dryland cotton only.

The common farming practices used for controlling weeds in dryland cotton and sorghum included crop rotation, long fallow preceding the crop, the use of pre- and post-emergence herbicides and pre-harvest desiccation. Dryland cotton also relied upon inter-row cultivation and the use of shielded sprayers between rows for increased weed control. The main herbicides were glyphosate, fluometuron and pendimethalin in dryland cotton, and atrazine, fluoxypyr and metolachlor in sorghum. Weed control in winter cereals was heavily reliant on post-emergent herbicides (metsulfuron-methyl, MCPA, clodinafop) with very little use of non-chemical options, apart from crop rotation and sometimes, long fallow. Both winter and summer fallows relied mostly on knockdown herbicides mainly glyphosate.

The weed spectrum is diverse, for example a total of 41 species were listed in the postal surveys as common weeds of dryland cotton. The most common weeds reported in each region for the main crops grown and summer and winter fallows are presented in the following table.

Region	Dryland cotton	Sorghum	Summer fallow	Wheat	Winter fallow
Northern NSW					
	Liverseed grass	Annual grasses	Annual grasses	Wild oats	Wild oats
	Barnyard grass	Rhyncosia	Noogoora burr	Turnip weed	Turnip weed
	Bindweed		Barnyard grass	Paradoxa grass	Paradoxa grass
	Noogoora burr		Caltrop	Black bindweed	Black bindweed
			Cowvine	Sowthistle	Sowthistle
			Liverseed grass		
Southern Queensland					
	Bladder ketmia	Bladder ketmia	Annual grasses	Turnip weed	Wild oats
	Caltrop	Caltrop	Bladder ketmia	Black bindweed	Sowthistle
	Annual grass	Thornapples	Sowthistle	Sowthistle	Black bindweed
	Amaranths	Liverseed grass	Caltrop	Wire weed	Turnip weed
	Sowthistle	Annual grasses	Liverseed grass	Wild oats	Wire wed
	Liverseed grass	Barnyard grass	Barnyard grass		
Central Queensland					
	Sesbania pea	Sesbania pea	Sesbania pea	Sowthistle	Sowthistle
	Annual grasses		Annual grasses		Parthenium weed
	Summer grass		Parthenium weed		
			Wild sunflower		
			Native jute		

The majority of the growers (40-100%) did not achieve consistent good control of bladder ketmia, Liverseed and barnyard grasses in summer fallows, sorghum or dryland cotton. Caltrop was not controlled in dryland cotton or sorghum, whereas black bindweed was not controlled in winter fallow and wheat. Sowthistle was reported as a problem weed in summer and winter fallows, dryland cotton, and wheat. In contrast, some weeds, such wild oats and paradoxa grass, were consistently well controlled by majority of growers in winter fallows.

However, there were regional differences. Sesbania pea is a problem weed in central Queensland. Bladder ketmia, caltrop and the annual grasses were reported to be more problematic in southern Queensland than northern NSW. Fleabane was noted as the second most difficult to control weed in NSW, although it was not listed by growers as a common weed. Sowthistle was reported to be a troublesome weed across all regions surveyed, indicating the adaptability of this weed to numerous geographical and climatic zones.

In total, growers listed 9 weed species in central Queensland, 16 species in northern NSW and 35 species in southern Queensland as major weeds that they were not satisfied with their level of control achieved.

Grower interviews

The agronomist interviewed 10 dryland cotton growers to validate the responses given in the postal survey and to provide any additional information relevant to weed management. The agronomist used a questionnaire similar to that used in the postal survey, but with additional questions to provide information on land preparation prior to crop sowing,

crop agronomy, water volume when spraying weeds and frequency of spray rig calibration, and reasons for choosing their crop and weed management options.

The range of crop rotations, which were similar to those listed in the postal surveys, was dependent on soil type, grower preference and commodity prices. Two main reasons for the chosen crop rotations are outlined. The majority of growers based their rotations to conserve soil moisture, while weed control was given as the next highest reason for adopting a particular crop rotation. To conserve moisture, most growers direct drill seed and many growers would prefer to adopt a zero tillage strategy. However, due to the necessity to pupae bust following harvesting and slashing of the dryland cotton crop, the majority of growers were classed as minimum tillage operators.

A wide range of planting configurations is used in dryland crop production. Machinery design and other crops forming part of the cropping system influenced the planting configuration adopted. One-meter skip row was the most common planting configuration used for dryland cotton. Crop sowing rates varied tremendously. Sowing rates for wheat were mostly low, ranging from 25 to 45kg/ha, while rates for dryland cotton ranged from 4.5 to 11kg/ha.

The farming practices used by the interviewed growers were generally consistent with the postal survey responses. Growers generally employed a wide range of weed control practices in the dryland cotton phase of the farming system, including inter-row cultivation, pre-emergent herbicides, shielded spraying, pre-harvest desiccation and the use of long fallows prior to planting the crop. In contrast, weed control options used in rotational crops were limited. Weed control in wheat was almost solely dependent on the use of post-emergent herbicides, and few if any weed control measures were employed in barley.

The interviewed growers generally calibrated their spray booms frequently with some calibrating their rigs every season, and the majority stating that they calibrated their booms prior to every spraying operation. Spray nozzles were replaced generally once per year, while some growers replaced spray nozzles twice per year. One disturbing trend coming out of the grower interviews was the water volume used when applying herbicides, with most growers used less than 60L/ha when applying herbicides.

Field surveys

Thirty-four paddocks were surveyed to determine the diversity and density of weeds present in the summer crops and fallows in the rotations used on the 10 farms. Monitoring was performed at the early stages of crop growth and fallow to determine the weeds being treated, and again later in the season prior to harvest or re-cropping to give an indication of the survivors with potential to replenish the seed bank. Weed counts were performed along 20 transects in each field.

The diversity of weeds ranged from 3 to 29 species per paddock. Overall, there were 68 summer weeds species identified in these paddocks. Initial infestations were generally less than 1 plant/m^2 for each species when averaged across the whole paddock, but patches often had more than 10 plants/m^2. The weeds encountered in the field surveys corresponded well with those listed in the postal surveys, and bladder ketmia was the most common weed, with 74% of surveyed fields infested with this weed.

All weed species counted prior to harvest in the cotton phase were seeding and therefore contributing to the soil seed bank. The most common weeds seeding were bladder ketmia, cowvine and sowthistle in dryland cotton, whereas bladder ketmia was also the main weed seeding in sorghum and fallows.

Many growers were under the impression that due to the dry finish of the 2001 season that the weeds would not have been competing with the cotton for moisture, and thus no money was spent to try and control them.

Economic analysis

An economic analysis is determining the total cost of weeds in the different crop rotations using the information supplied in the postal survey. The analysis is complex due to the number of different practices used on individual farms, the number of times an individual operation is performed and the variety of crops grown in rotations. However, the cost of weed control for each of the crops in the three regions surveyed and the yield loss due to weeds for each of the crops have been completed.

The average cost of weeds over the three regions in dryland cotton, not including the impact of residual weeds, has been calculated to be $345/ha. The average cost of weeds in sorghum and wheat was estimated to be $152/ha and $61/ha respectively. To validate the findings of this economic analysis, the cost of weeds in wheat was compared with the economic analysis by Jones *et al.* (2000), and the difference between these two surveys is less than one dollar per hectare for the same region.

The cost of weed control in summer and winter fallows is yet to be finalised, but it is envisaged that this will be completed by January 2003. Once these costs have been finalised, the full cost of weeds in each of the rotations used with dryland cotton production will be calculated on an annual basis.

Research and development issues

The scoping study provided a great deal of information about the various farming practices and issues facing growers in terms of weed management. After analysing the data collected in the scoping study, the following research and development issues were evident:

Weed issues

- Main weeds are bladder ketmia, sowthistle, caltrop, summer grasses (Liverseed and barnyard), and black bindweed
- Weed spectrum that needs to be managed is very diverse
- Weed spectrum differs considerably between regions
- Some emerging weed problems such as fleabane

Herbicide technology issues

- There is an over reliance on glyphosate for weed control in summer and winter fallows
- There is an over reliance on post emergence herbicides in winter cereals for weed control
- Residual herbicides may have role in controlling late flushes and still maintain rotation flexibility
- Weed control in sorghum is heavily dependant on atrazine and is variable in effectiveness
- Water volumes being applied are too low for consistent effective weed control
- Many growers delay spraying fallow fields when weeds first germinate and try to control the second flush with the one herbicide application, and thus creating difficult-to-control weeds
- There appears to be considerable variability in the efficacy of the herbicides used in a number of the cropping and fallow phases. This may be due to water volumes being used, the size of the weeds when sprayed or incorrect application of herbicides
- Database has a huge amount of information on all herbicides and mixtures used on each weed in different crops and fallows, as well as rates of application and levels of control achieved

Integrated weed management issues

- An overall integrated weed management plan for these dryland productions systems is lacking
- There appears to be a general lack of understanding of the importance of preventing seed set on surviving weeds
- Crop competition as a weed control option appears to be poorly understood, with many growers sowing at low densities and allowing weeds to germinate, competing for valuable moisture resources
- Residual winter weeds are setting seed and contributing to weed problems in subsequent fallows and crops.
- Summer crops are sown on wide row spacing and growers tolerate weeds in the skip row without recognising the value of controlling those weeds to prevent replenishment of the seed bank
- Weed control in maize and sunflowers tends to be poor, contributing to weed problems in other components of the rotation
- There appears to be an imbalance in weed management inputs for dryland cotton compared with the rotational crops.

Future research

The direction of future research will be determined in conjunction with the new research agronomist who will be appointed to the new project. Due to the complexity of dryland farming systems involving cotton, it is envisioned that some modelling or modelling framework will need to be employed. The use of a basic model framework such as Stellar® or Vensim® in conjunction with experimentation may allow some broad assumption about the dryland system to be developed particularly in relation to effects of crop competition and control strategies on the population dynamics of a number of weed species. Ultimately though the use of computer simulation models such as 'Apsim' that have the ability to account for factors such as sowing date, soil type, crop density and climatic variation would provide the most benefit to understanding the dryland system as a whole. This is particularly the case as dryland production systems involving cotton are spread over wide geographical and climatic regions.

Background to the project

A scoping study to assess the weed management issues of dryland farming systems involving cotton was commissioned by CRDC, Australian Cotton CRC, GRDC, and CRC for Australian Weed Management in July 2001. Dryland farming systems involving cotton are complex and usually comprise a number of different rotation crops, such as sorghum, sunflowers or maize as well as cotton in conjunction with summer and winter fallows. Adequate soil moisture and the likelihood of receiving planting rains are critical factors for growers in deciding which crops they are likely to plant, particularly in the summer phase. This has resulted in the evolution of a number of different planting configurations including solid, single skip row and double skip row planting that may be employed by growers to conserve soil moisture throughout the season. A number of the herbicides used in rotational crops may damage cotton in particular the sulfonylurea and triazine herbicides. Equally a number of the common cotton herbicides have long plant back periods to either winter or summer cereals used in rotation with dryland cotton. To preserve soil moisture, many dryland growers have adopted minimum or zero tillage systems and are almost solely reliant on herbicides for weed control. Control measures must therefore be flexible to allow last minute changes in the crops grown due to soil moisture limitations or price fluctuations and need to provide adequate protection against weeds in the chosen crop as well as in the planting configuration used.

Project objectives and the extent to which these have been achieved

The primary aims of the scoping study were to determine:

- Dominant and difficult to control weed species in each crop and fallow component of the different crop rotations used for dryland cotton production in the northern region;
- Weed management practices, both chemical and non-chemical, being used for weed control in these systems;
- Economic impact of these weeds; and
- Current practices exacerbating the weed problems.

These aims were achieved by distributing a postal survey widely to growers in the industry, interviewing selected growers, monitoring weed infestations in the field, and undertaking an economic analysis.

Influence on sustainability, profitability and international competitiveness, and/or people and community

The scoping study has provided a great deal of information pertaining to the management systems currently in place on a number of dryland farms involving cotton. This information details the rotation crops used, the weeds encountered in each phase of the rotation, the herbicides and farming practices currently employed by growers, and practices that may exacerbate the weed problems in the farming system. An improved understanding of the dynamics of the farming system and the issues that dryland growers are facing will provide a more focussed research approach to the dryland system improving the sustainability of weed management practices. The study also assessed the economic impact of weeds by region in the dryland farming system. The economic study not only looked at the cost of weed control, but also took into account yield loss due to weeds. The study demonstrated the importance of controlling weeds throughout each phase of the rotation to minimise recruitment and carry-over of weed seeds from one crop to another. The study also highlighted the high costs of weeds to the industry, estimated to be $61/ha for wheat, $152/ha for sorghum, and $345/ha for dryland cotton. Employing control measures to prevent residual carry-over of weed seeds will ensure more sustainable and profitable outputs by reducing future weed problems. This in turn will improve our international competitiveness by reducing production costs and yield losses.

Methodology

The scoping study consisted of four components, starting firstly with a postal survey to dryland cotton growers, followed by grower interview, field surveys, and economic analysis of data from the postal survey.

Postal survey

The postal survey, similar to the survey of Jones *et al.* 2000, was distributed to 342 dryland growers in northern NSW, southern and central Queensland. The survey asked growers to provide information on the crop rotations, farming practices used in each component of the rotations for weed control, specific information on herbicides used for the main weeds of each crop and fallow, as well as specifics on troublesome weeds within their cropping systems. As the intention was also to determine the economic impact of weeds in the dryland farming system, several questions were included to allow the economist to determine the overall cost of weeds in the dryland system. These questions included costs of weed control, yield losses due to weeds and the carryover of residual weeds into the different components of the dryland farming system. A copy of the survey form and covering letter is attached in **Appendix 1**.

Grower interviews

Ten dryland cotton growers were interviewed face-to-face by Glenn Milne to validate the responses given in the postal survey and to provide any additional information relevant to weed management. Eight of these growers were from southern Queensland, including Dalby, Pittsworth, Jimbour, Jondaryan, Goondiwindi and Warra, and two were from northern NSW at Gurley and Moree. Nine of these growers had completed the postal survey. The questionnaire used was similar to that used in the postal survey (**Appendix 2**), but had additional questions to provide information on land management, crop agronomy, herbicide spraying details, and reasons for choosing their crop and weed management options.

Field survey

The 10 growers selected for interviewing were also used for monitoring weed infestations in their crop rotations with dryland cotton. A total of 34 paddocks on these farms were monitored for weed density and diversity during the summer of 2001-02. The paddocks were fallow (19), dryland cotton (9), sorghum (4), maize (1) and sunflower (1). For each crop or fallow, monitoring was done at the early part of the season to give an indication of weeds being treated (December 2001), and later in the season prior to harvesting or re-cropping to give an indication of survivors with potential to replenish weed seed-bank (May 2002). Weeds were monitored in 20 transects in each paddock, which was divided into 4 sections, where 5 transects (10m x 1m) were made across each section. The presence and density of each species were noted in each transect. Weed numbers per species were rated using the rating scale of 1 = <10 plants per $10m^2$, 2 = 10 – 100 plants per $10m^2$, and 3 = >100 plants per $10m^2$.

Economic analysis

The postal survey data was analysed to calculate the costs of weed for the regions of central and southern Queensland and northern NSW. The cost of weed control for each crop and the yield loss due to weeds for each crop were determined using spreadsheet based analytical techniques. The costs of weed control were calculated using standardised herbicide prices, frequency of applications, rate of application and the cost of additives used with the herbicides. Similarly application costs were standardised (Scott 2001) to avoid discrepancies between farms. Up to date commodity prices in "The Land" (November 2002) were used in yield and price calculations to avoid the product price variation received by the farms. All price data has been carefully checked and prices were regionally representative.

Price calculations for fallow weed control are ongoing and will be used at a later date to determine the overall impact of weeds on different farming systems on an annual basis.

Results

Postal survey

Fifty-three completed forms were returned, of which 11% were from central Queensland, 26% from northern NSW, and 63% from southern Queensland. These growers sow on average 225ha of dryland cotton each, a total of 11 900 ha. This represents approximately 21% of the national production based on area grown in the previous 3 seasons.

The main soil was vertosol with 92% of respondents growing dryland cotton rotations on this soil type, whereas a small percentage uses red brown earths and river alluvium for their production systems.

The cropping systems with dryland cotton were rather diverse, with 8 broad crop rotations identified in the postal survey. The main crops grown in rotation with dryland cotton were winter cereals only (46%), summer and winter cereals (18%), winter cereals with pulse (9%), summer cereals only (8%), summer and winter cereals with pulse (5%), and pulse only (2%), whereas 11% did not grow any rotational crops. The main winter cereal was wheat with only a small area of barley grown. The main summer cereal was sorghum, and the main pulses were chickpea and mungbean.

The most common weeds in winter fallows were wild oats, sowthistle, black bindweed, turnip weed, paradoxa grass and wireweed. Sowthistle was found across the regions, whereas wild oats, black bindweed and turnip weed were predominantly in southern Queensland and northern NSW. Phalaris was more common in northern NSW, and wireweed in southern Queensland. The most common weeds in summer fallows were grasses (including Liverseed grass and barnyard grass), bladder ketmia, sowthistle and caltrop. Grasses were found across the regions. Caltrop was common in southern Queensland and northern NSW. Sesbania was common in central Queensland, and bladder ketmia in southern Queensland.

The weed spectrum was diverse in cotton and sorghum with 41 and 34 different species noted respectively. The most common weeds in these crops were bladder ketmia, caltrop and the summer grasses. The main weeds in wheat, chickpea and barley were turnip weed, sowthistle, black bindweed, wild oats, paradoxa grass and wireweed. Another 18 species were listed as infesting wheat but to a lesser extent. There were some regional differences, although sowthistle was generally found across the regions in the winter crops. In central Queensland, the main summer weed was sesbania, whereas bladder ketmia and caltrop were the most common summer weeds in southern Queensland, and in northern NSW they were mainly grasses.

Growers were highly reliant on the use of knockdown herbicides for fallow weed control, with all using knockdown herbicides at some stage during both the winter and summer fallow periods. Use of cultivation was reasonably common in both fallows but more so in winter. The opposite was reflected for residual herbicide use, with growers using more residual products during the summer, and likewise for spot spraying. Grazing was not used significantly for fallow weed control in these systems.

There was a high reliance across the farming systems on long fallows and herbicides for in-crop weed control. Pre-harvest desiccation appeared to be used for most crops, although less frequent than the practices above. Very few growers used high seeding rates, and none used wick wipers or spot spraying to assist with weed management. The other practices (inter-row cultivation, shielded sprayers, chipping, late applications of selective herbicide) appeared to be crop specific. For dryland cotton, the practices most widely used were long fallows preceding the cotton, pre-and post-emergent herbicides, shielded sprayers, inter-row cultivation and pre-harvest desiccation. Chipping was also common. For summer cereals, growers relied on long fallows, pre- and post-emergent herbicides and pre-harvest desiccation as the major practices for weed control. There was some inter-row cultivation, shielding spraying and late selective herbicide application used.

For winter cereals, growers relied strongly on long fallow prior to the cereal and post-emergent herbicides as the main practices for weed control. There was some use of pre-emergent herbicides, higher seeding rates and late applications of selective herbicide. Chickpea growers used pre-emergent herbicides and pre-harvest desiccation as the main practices for weed control, although some did use post-emergent herbicides as well, which may include the use of shielded sprayers.

Irrespective of fallow season, the use of glyphosate, either alone or in mixes, far exceeded any other herbicide. In both winter and summer fallows, 53-54% of growers used glyphosate alone, and 38-41% used glyphosate mixes, and less than 10% used other herbicides. The most common glyphosate mixes used in winter were 2,4-D or metsulfuron-methyl, while the mixes in summer included 2,4-D or fluroxypyr.

The effectiveness of herbicides in controlling common weeds in fallows varied greatly with weed species. In winter fallows, control of wild oats, turnip weed, paradoxa grass, wireweed and mustards was consistently very good, whereas control of sowthistle and black bindweed was in many situations only acceptable or variable. Bladder ketmia, Liverseed grass, barnyard grass and sowthistle were not controlled very well or consistently in summer fallows for majority of growers. In contrast, most growers achieved good control of other grasses, and the other main broadleaf weeds.

The range of herbicides and mixtures used in cotton and sorghum was extensive, with 30 and 12 combinations recorded in the survey respectively. In dryland cotton there was wide use of glyphosate alone, and fluometuron + prometryn with and without pendimethalin and / or glyphosate. These chemicals or specific combinations represented 56% of all recorded applications. Atrazine alone and mixes with fluroxypyr or metolachlor were the most widely used herbicides in sorghum, representing 72% of the uses.

Reliable good control of bladder ketmia, caltrop, Liverseed grass and barnyard grass was only achieved for less than 50% of cotton and sorghum growers. In contrast, many of the other broadleaf weeds, such as amaranths and cowvine, were normally well controlled in these crops. For the few maize growers, weed control was variable for all except one weed species.

The range of herbicides used in wheat was reasonably extensive, but fewer options were used in barley and chickpea. In wheat, MCPA applied alone or in mixes with various other herbicides accounted for 47% of the herbicide treatments. Similarly, the use of metsulfuron-methyl alone or in mixes accounted for 41% of uses, although many of these were in combination with MCPA. Other important herbicides were clodinafop, glyphosate, 2,4-D, and thifensulfuron plus metsulfuron-methyl. In barley, there were similar trends to wheat with MCPA and metsulfuron-methyl use. In chickpea, the most important herbicides were haloxyfop and combinations with simazine and / or prometryn.

Turnip weed and wild oat were controlled very well in wheat for most wheat and barley growers, but sowthistle and black bindweed was either only acceptable or variable for the majority of growers. Grass control in chickpea was generally good, but less so for most broadleaf weeds.

The most common difficult-to-control weeds for growers were sowthistle, black bindweed, bladder ketmia, cowvine, and wild oats. Other important weeds were the burrs (Noogoora and Bathurst), fleabane, Johnson grass, paradoxa grass and sesbania. These two groups accounted for two thirds of the responses of the 44 weed species listed by growers. There were, however, regional differences. In central Queensland, the main difficult-to-control weed was sesbania. In southern Queensland, they were sowthistle, bladder ketmia, and black bindweed, whereas the main difficult-to-control weeds in northern NSW were black bindweed and fleabane.

Growers nominated a total of 33 different cropping or farming practices that were possibly exacerbating their weed problems. The main identified practices were growing cotton particularly in zero tillage systems, as well as not being able to use 'hormone' herbicides in cotton areas, growing chickpeas and back-to-back wheat, weeds in fallow, and reduced tillage systems.

The full report of the results is given in **Appendix 3**.

Grower interviews

The rotations used by growers varied depending on region, soil type, growers' preferences and commodity prices. Approximately half the rotations were with winter cereals, mostly wheat. The other main rotations were either dryland cotton only or rotated with sorghum. Fallow length after cotton varied from double cropping with no fallow to long fallow for 3 seasons. Although there was a mixed response to question on reasons for crop rotations, moisture conservation was the highest priority and weed management was the second most important reason. The low rating for opportunity cropping indicates that cotton is a planned crop in the rotation.

Direct drilling is a major part of land preparation. However, due to pupae busting required after cotton, the systems are classed as minimum tillage, although many growers would be zero tillage if this operation was not necessary. There are large variations in row spacing and sowing rates used for each crop. Approximately 40% of the growers sow cotton in 90 or 100cm rows as solid planting, 20% as single skip, and the rest on double skip. Wheat is sown in row spacings from 15 to 35cm. Sorghum and maize are sown mostly in 90 or 100cm rows. Sowing rates for cotton varied from 4.5 to 11 kg/ha, and the majority of growers sow wheat and barley at 40 kg/ha or less. Cotton and maize crops aimed for a certain crop stand, but others were just based on seeding rate without consideration for final crop stand. Maize was considered as a weakness in the rotation, as weeds grow and seed in late part of crop after maturity and before harvest.

The responses to farming practices used for managing weeds in fallows were very similar to those from the postal survey. In addition, some growers use chipping to control weed survivors in fallows. In summer crops, the main differences were that the interviewed growers used less crop competition and follow-up herbicide applications on

surviving weeds, but used more of pre-harvest desiccation in cotton. Options used in sorghum were very similar. However, with winter cereals, there were large differences particularly with use of long fallow, inter-row cultivation, shielded spraying, chipping and pre-harvest desiccation.

Weed control with the different herbicides used by the interviewed growers was similar to that in the postal survey for most situations. The exceptions were better control by the interviewed growers of barnyard and Liverseed grass in cotton, and bladder ketmia and Liverseed grass in fallows. The opposite was evident for cowvine in cotton and fallow, and caltrop in sorghum.

The most common difficult-to-control weeds were bladder ketmia, cow vine, sowthistle, and a problem weed of the future fleabane. These were similar to those cited in the postal survey, apart from the greater importance by interviewed growers for pigweed and less for wild oats.

The full report of the results is given in **Appendix 4**.

Field survey

A total of 68 species were recorded in the field survey, with more species in fallows than in crops. The diversity of weeds in paddocks varied from 3 to 29 species per paddock. The most common weeds found in this field survey were very similar as those highlighted in the postal survey. The most common weed was bladder ketmia, which was found in 74% of the paddocks monitored. The other common weeds were sowthistle (47% of paddocks), pigweed (47%), caltrop (44%), amaranths (42%), barnyard grass (38%), cowvine (32%) and Liverseed grass (29%). In addition to these weeds, volunteer crops such as wheat and cotton were often widespread.

The average density of weeds infesting the whole paddock was often less than 1 plant/m^2 for most weeds, although the weeds were often in patches of heavy infestations, with some at densities of greater than 10 plants/m^2. Despite the different weed management strategies, most paddocks with cotton and sorghum and to a lesser extent fallow had surviving weeds at the end of the season. Densities were usually low when averaged across the paddock, but there were some patches of higher densities. The majority of the residual weeds had or were seeding, and thus replenishing the seed-bank.

The report listing weed species and density in each paddock of the rotations are presented in **Appendix 5**, and the full report by Glenn Milne is presented in **Appendix 6**.

Economic analysis

The average cost of controlling weeds in each crop grown in rotation with dryland cotton is presented in the table below. These costs include the costs of herbicides, herbicide application, cultivation and manual chipping where appropriate. The costs associated with weed control are very similar for northern NSW and southern Queensland, although the costs for weed control in central Queensland were quite different from the other two regions. This is likely to be due to the poor return of surveys from this region resulting in a much smaller sample pool from which to calculate the average costs.

Region	Crop	Cost ($/ha)
Northern New South Wales	Chickpea	45
	Cotton	220
	Sorghum	59
	Sunflowers	12
	Wheat	35
Southern Queensland	Barley	7
	Chickpea	35
	Cotton	221
	Maize	15
	Mung bean	132
	Sorghum	59
	Sunflowers	53
	Wheat	35
Central Queensland	Cotton	99
	Sorghum	33
	Sunflowers	15
	Wheat	12

Growers were asked in the postal survey to provide details of the reduction in yield due to weeds in their crops. The reported yield losses were averaged for each of the crops across the regions and are presented as the percentage yield loss due to weeds in the table below. The percentage yield loss was converted into dollar equivalents using current regional prices for the crops and the average yield obtained across all regions for the particular crop grown. The total cost of weeds for each crop was calculated taking into account impact of weeds on yield and the cost of weed control in each of the crops. The cost of weed control was averaged across the regions with the exception of cotton in central Queensland, as it is believed that this is not a true reflection of the cost of weed control in this region. The cost of weed control in summer crops is very high particularly in cotton and sorghum, reflecting the impact and importance of weeds in these systems.

Crop	Yield loss due to weeds (%)	Yield loss due to weeds ($/ha)	Total cost of weeds ($/ha)
Barley	5.44	30.76	37.76
Corn	4.80	64.19	79.19
Cotton	6.56	125.40	345.20
Pulses	4.21	19.70	65.70
Sorghum	7.02	93.24	152.24
Sunflowers	7.09	42.54	69.21
Wheat	4.56	33.93	61.26

Discussion

The weed spectrum in cropping systems with dryland cotton is very diverse with 68 different species recorded in the field survey and growers nominating 44 difficult-to-control species. The situation is more complex with regional differences.

The most common weeds that growers are having difficulty in controlling are bladder ketmia, sowthistle, caltrop, summer grasses such as barnyard grass and Liverseed grass, and black bindweed, although the importance of these weeds differed with the cropping situations. Bladder ketmia, and summer grasses were problems in all aspects of the summer phases of the rotations, black bindweed in all winter phases, and sowthistle a problem irrespective of season.

In general, the grower interviews and the field surveys supported the findings of the postal survey. The most abundant weeds recorded in the field survey were bladder ketmia, sowthistle, caltrop and pigweed in approximately half or more of the monitored paddocks.

An important emerging weed problem is fleabane, which was identified as one of the most difficult to control weed by growers. Fleabane has been reported in other surveys by Dr Ian Taylor as a weed that is becoming more significant on a number of cotton farms. Several interviewed growers made similar comments on fleabane, and it was detected in several paddocks in the field survey although not in large numbers.

In each of the regions, the troublesome weeds in crop were also those weeds that are the most common in the fallow, suggesting that consistent good control is not being achieved in either the fallow or cropping phase of the rotation. The reasons for poor control of these main species requires further in depth exploration in light of the herbicides and farming practices being used. Whilst an extensive range of herbicide treatments and other weed management tools was listed in the survey, weed control is largely reliant on a few herbicides, particularly glyphosate and atrazine, and not based on sound integrated weed management principles. As well, the information from the grower interviews indicates that there is a need for improvements in herbicide application technology.

Weed control in summer and winter fallows relies primarily on knockdown herbicides and some cultivation. As water conservation is of upmost importance to dryland growers, the use of cultivation for weed control is likely to be minimal. The transition of many growers to minimum or zero tillage for soil conservation thus places a great deal of reliance on knockdown herbicides as the primary means for weed management in summer and winter fallows. Glyphosate is the main herbicide being used for weed control in both summer and winter fallows (90%). This survey demonstrates the importance of glyphosate as a herbicide to dryland growers but also suggests perhaps that there is an over-reliance on glyphosate for weed management. The widespread use of glyphosate only for weed control in fallows increases the

selection pressure for herbicide resistance on the weed spectrum as well as perhaps being the primary causal agent for species shift. Glyphosate was also the main herbicide used for weed control in dryland cotton. The introduction and adoption of Roundup Ready® cotton varieties in dryland production systems will only increase the use patterns of glyphosate. A number of pre-emergent and pre-plant herbicides, such as fluometuron, prometryn and pendimethalin, were also used for weed control in cotton. Atrazine was the most commonly used herbicide in sorghum with 72% of surveyed growers using this herbicide in combination or on its own.

The lack of implementation of integrated weed management techniques may be due to little understanding of the techniques available to growers or because the techniques being promoted are not practical to this system. Inter-row cultivation (cotton and sorghum) and crop rotations were two alternative forms of weed control commonly used. However, when examining the herbicides used in the rotations and also in the fallows, there may be little benefit afforded in preventing the development resistance by adopting these crop rotations.

A number of growers suggested that their weed problems were exacerbated by growing cotton or monoculture cotton in conjunction with zero or minimum tillage operations. Additionally, field observations suggest that residual weeds were being poorly controlled thus contributing to future weed problems. These findings suggest that the development of a comprehensive integrated weed management plan would greatly assist growers to better manage weeds in dryland systems involving cotton.

Weeds in dryland cropping systems with cotton are economically damaging. The costs associated with weeds are much higher than previously realised, particularly in dryland cotton ($345/ha) and sorghum ($152/ha). Dryland cotton production in the last 3 years was estimated to be 57 000 ha Australia wide, thus the cost of weeds to the dryland cotton industry alone was close to $20 million. This is somewhat disturbing, as productivity has fallen from 3.83 to 2.82 bales/ha (Cotton Year book 2001), which would be making it more difficult for growers to cover variable costs. Growers, who are able to implement well-defined integrated weed management strategies, that over time will reduce weed pressure, stand to make substantial savings in costs of production as well as increased profits due to greater yields. Good weed management, though, is not restricted to a single crop or component of the farming system. The field surveys indicated that many weeds are being allowed to carry over from one cropping phase into another, and therefore weed management strategies need to be designed to account for all components of the farming system to realise savings in all of the rotations commonly used.

The objectives of the scoping study were not only to identify the major problem weeds and farming practices exacerbating weed problems but also to identify future research and development issues. These issues are summarised below:

Weed issues

- Main weeds are bladder ketmia, sowthistle, caltrop, summer grasses (Liverseed and barnyard), and black bindweed
- Weed spectrum that needs to be managed is very diverse
- Regional differences
- Some emerging weed problems such as fleabane

Herbicide technology issues

- There is an over reliance on glyphosate for weed control in summer and winter fallows
- There is an over reliance on post emergence herbicides in winter cereals for weed control
- Residual herbicides may have role in controlling late flushes and still maintain rotation flexibility
- Weed control in sorghum is heavily dependant on atrazine and is variable in effectiveness
- Water volumes being applied are too low for consistent effective weed control
- Many growers delay spraying fallow fields when weeds first germinate and try to control the second flush with the one herbicide application, and thus creating difficult-to-control weeds
- Appears to be considerable variability in the efficacy of the herbicides used in a number of the cropping and fallow phases. This may be due to water volumes being used, the size of the weeds when sprayed or incorrect application of herbicides

Integrated weed management issues

- An overall integrated weed management plan for these dryland productions systems is lacking
- Appears to be a general lack of understanding of the importance of preventing seed set on surviving weeds
- Crop competition as a weed control option appears to be poorly understood, with many growers sowing at low densities and allowing weeds to germinate, compete for valuable moisture resources
- Residual winter weeds are setting seed and contributing to weed problems in subsequent fallows and crops.

- Summer crops are sown on wide row spacing and growers tolerate weeds in the skip row without recognising the value of controlling those weeds to prevent replenishment of the seed bank
- Weed control in maize and sunflowers tends to be poor, contributing to weed problems in other components of the rotation
- Appears to be an unbalance in weed management inputs for dryland cotton compared with the rotational crops.

Plan for future to develop or to exploit the project technology

The directions of the research project over the next three years will be determined in conjunction with the agronomist appointed to the project. The following research, development and extension activities have been identified by the project team from the scoping study and it is expected that the future research will be a sub-set of these main issues.

Weed control in fallow

- Develop collaborative links with current projects on fallow weed control - Weeds CRC project 2.2.2.1, GRDC project DAS293, and GRDC project CFI6, and incorporate appropriate information from these projects into BWM strategies
- Identify any important gaps needing future research

Weed control in winter cereals

- Build on previous research on improving competitiveness of wheat and barley for suppressing weed seed production, and incorporate into BWM strategies
- Investigate options for use of residual herbicides that maintain cropping flexibility, building on previous research

Weed control in sorghum

- Research manipulation of crop agronomy, such as row spacing, stay green character, cultivar maturity, sowing date, and herbicide technology, such as improved efficacy with atrazine, pre-harvest desiccation, other options, for improving weed control and suppressing weed seed production
- Develop collaborative links with APSRU researchers on modelling sorghum

Weed control in dryland cotton

- Research options for preventing seed set on weed survivors, particularly in the skip row areas
- Develop collaborative links with weed scientists in Cotton CRC researching weed control in irrigated cotton

Weed biology

- Compile appropriate information on biology / ecology of identified key weeds for use in BWM strategies, such as research on sowthistle and bladder ketmia
- Identify any important gaps, particularly for weed seed persistence in soil seed-bank, and develop new research protocols

Key weeds

- Some key weeds identified, such as bladder ketmia, Liverseed grass and barnyard grass, need improved BWM strategies across the rotations
- Other key weeds, such as sowthistle, caltrop, and black bindweed, need improved BWM strategies for certain components of the rotations

Herbicide technology

- The large amount of information on herbicides use and efficacy needs to be compiled into separate tables for each weed. These will useful as a potential extension guide for the best options for consistent good efficacy
- Possible reasons for variation in efficacy of key treatments need to be identified, and develop new research protocols if needed
- Promote extension campaign with Industry Development Officers for improving herbicide reliability where current information is available, particularly with issues on water volume, weed size and alternate options

Modelling

- Due to the complexity of the cropping systems, weeds issues, and geography, the project team envisage that some modelling or modelling framework will be needed to simulate the long-term impacts of newly developed BWM strategies.
- A basic model framework, such as Stellar® or Vensim®, could be used in conjunction with experimentation to simulate the impacts various chemical and non-chemical control strategies on the population dynamics of key weed species.

- Ultimately computer simulation models, such as Apsim, that have the ability to account for agronomic and climatic factors would provide the most benefit to understanding the dryland production systems involving cotton spread over wide geographical and climatic regions.

Field research

- Sites will be in central Queensland, Darling Downs in southern Queensland, and the Border Rivers in northern NSW to account for differences in weed spectrum, rotations and climate

Future presentation and dissemination of the project outcomes

A Technical Bulletin is currently being prepared for distribution with the key findings and outcomes from the dryland scoping study. The technical bulletin will provide information to agronomists, growers and researchers with the key weed issues, and the economic impact of weeds in the dryland farming system. As well, papers and articles are planned to be published in several scientific journals, proceedings of Australian Economics Conference and Australian Cotton Conference, and Australian Cotton Grower.

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Plain English summary

Weeds, their management practices and associated issues in dryland cotton farming systems are diverse and complex. This was confirmed in a scoping study that was initiated in July 2001 by the Cotton Research and Development Corporation, Australian Cotton CRC, Grains Research and Development Corporation and CRC for Australian Weed Management.

The overall aim of the scoping study was to achieve a better understand the weed management issues of this complex farming system and to provide direction for future research efforts. Specifically, it aimed to determine the dominant as well as the difficult-to-control weed species in each component of the dryland cotton rotations; the different weed management practices, both non-chemical and chemical, being used for weed control in these systems; the economic impact of these weeds; and the current practices exacerbating these weed problems.

The scoping study consisted of 4 components, starting firstly with a postal survey to over 300 dryland cotton growers. The mail survey was followed up with detailed interviews of 10 growers, and extensive field surveys on 34 paddocks in each of the rotation sequences of these interviewed growers. The final component of the scoping study was an economic analysis of weeds in these systems.

The crop rotations with dryland cotton comprised a number of different crops in conjunction with several summer and winter fallows of different lengths. The standard system involved growing dryland cotton after 1 or several wheat crops, although there were many alternative rotations with sorghum, chickpeas, barley, mungbean, sunflowers, peanuts, or maize.

The main weeds that were infesting these cropping systems were bladder ketmia, sowthistle, caltrop, Liverseed grass, barnyard grass, black bindweed, cow vine and pigweed. Apart from these main weeds, the weed spectrum needing to be managed was very diverse with 68 different species identified in the field survey, with distinct regional differences from northern NSW to central Queensland. Whilst not common, there were some major emerging weed problems, such as fleabane, which was listed as the second most difficult-to-control weed by growers in northern NSW.

Herbicides were the main tool used for weed control in these cropping systems, with a large reliance on glyphosate for summer and winter fallows, and atrazine in sorghum. As well, post emergence herbicides, but not residual herbicides, were mostly used in wheat. Many of the key herbicides had considerable variability in their efficacy and reliability, which may be due to water volumes being used, the size of the weeds when sprayed, incorrect rate or herbicide. Many growers delayed spraying fallow fields when weeds first germinate and try to control the second flush with the one herbicide application, and thus creating difficult-to-control weeds.

There was much less focus on an overall weed management plan to minimise the long-term impact of weeds using IWM principles with both chemical and non-chemical methods. Some of the 'weak-links' in the current management systems are not preventing seed set on surviving weeds, especially for summer crops sown in wide row spacing, and poorly competitive winter cereals. Consequently, residual weeds are setting seed and contributing to weed problems in subsequent fallows and crops. Weed control in maize and sunflowers tends to be poor in general, and thus contributing to weed problems in other components of the rotation. Overall, there seemed to be an imbalance in weed management inputs in the cropping systems with greater emphasis on weed control in dryland cotton than in the rotational crops.

The project team, along with the new research agronomist, are determining the directions of the new research project. The main focus will be developing Best Weed Management (BWM) strategies for the identified key weeds for the different cropping systems with dryland cotton. It will involve field studies on weed biology, improved herbicide technology and non-chemical options to minimise the replenishment of the weed seed-bank. Due to the complexity of these cropping systems and weeds issues, the project team envisage that some modelling will be done to simulate the long-term impacts of the newly developed BWM strategies.

The proposed research is important, as the cost of weeds was estimated for current practices to be $345/ha for dryland cotton, $152/ha for sorghum and $61/ha for wheat. The full cost of the cropping systems will be finalised once the costs of weeds in fallows has been finalised.

The scoping study was a collaborative project involving scientists and technical staff from Department of Primary Industries, Queensland and New South Wales Agriculture.

Appendix 1

Postal survey form

Cotton CRC

C.R.D.C.

CRC Weed management

GRDC Grains Research & Development Corporation

Are weeds a problem on your farm?

The Cotton CRC, CRDC, Weeds CRC, and GRDC are keen to fund research focusing on improved management of weeds in dryland cotton and grains farming situations.

We need your help...
By completing this survey, you will help us learn more about weeds in your farming system. The information will assist in formulating research strategies aimed at reducing the costs of weeds on your farm. Your cooperation and time are greatly appreciated. It should only take about 20 minutes to fill in this survey. Responses will be treated with strictest confidence.

Prize...

By completing this survey, you will be entered into the draw to win

$300 worth of gift vouchers for any Flag Choice Hotel in Australia.

The vouchers are valid for 12 months and can be used for accommodation and meals at any location, including Sydney, Coffs Harbour, Snowy Mountains, Port Macquarie, Brisbane, Airlie Beach, Cairns, Sunshine Coast, Gold Coast, and Port Douglas. The survey must be returned by **30 September 2001** to be eligible for this prize.

Any queries...

Please contact

Ian Taylor	NSW Agriculture, Narrabri	02 6799 2409	iant@mv.pi.csiro.au
Steve Walker	QDPI, Toowoomba	07 4639 8838	walkers@dpi.qld.gov.au
Michael Widderick	QDPI, Toowoomba	07 4639 8856	widderm@dpi.qld.gov.au
Vikki Osten	QDPI, Emerald	07 4983 7406	ostenv@dpi.qld.gov.au

Please return in the reply-paid envelope provided (no stamp needed), or address to:

Weeds Survey (Vikki Osten)
Dept of Primary Industries
LMB 6
Emerald Qld 4720

Queensland Government
Department of Primary Industries

NSW Agriculture

WEED SURVEY
DRYLAND COTTON AND GRAIN FARMING SYSTEMS
(September 2001)

Questions 2-13 relate to fields where dryland cotton is grown as part of your rotations.

Q1. What is the total cropping area of your farm (all crops)? _____ ha

Q2. What are the predominant soil(s) on which you grow dryland cotton?
Please tick the most appropriate option(s) listed below, or specify your soil type if not listed.

- ☐ Grey, brown, black cracking clay
- ☐ Red-brown earths
- ☐ Light sandy soils
- ☐ River alluvium
- ☐ Other (please specify) _____

Q3. On fields where you sometimes grow dryland cotton, what are your preferred crop rotation(s) involving dryland cotton? Please estimate the percentage of your total cropping area that each rotation would normally be grown on your farm.

EXAMPLE

Rotation	% of farm
1. *wheat / wheat / dryland cotton*	*40*
2. *sorghum / long fallow / wheat / dryland cotton*	*10*
3.	

PLEASE FILL IN

Rotation	% of farm
1.	
2.	
3.	
4.	

INCROP WEED CONTROL

Q4. Please indicate how often you use each of the following practices for weed control in your main crops grown in rotation with dryland cotton? Tick the most appropriate option for each practice, even if that practice is not used primarily for managing weeds.

FARMING PRACTICE	CROP 1: DRYLAND COTTON			CROP 2:		
	Rarely or not used	Sometimes used	Often used	Rarely or not used	Sometimes used	Often used
Rotation of summer & winter crops						
Long fallow preceding crop						
Pre-emergent herbicides						
Higher than normal seeding rates						
Post-emergent herbicides						
Late selective herbicide application to control of escapes or late flushes						
Inter-row cultivation						
Shielded spraying between rows						
Wick wiping / roller wipe / blanket						
Chipping						
Pre-harvest desiccation						
Other (specify)						

FARMING PRACTICE	CROP 3:			CROP 4:		
	Rarely or not used	Sometimes used	Often used	Rarely or not used	Sometimes used	Often used
Rotation of summer & winter crops						
Long fallow preceding crop						
Pre-emergent herbicides						
Higher than normal seeding rates						
Post-emergent herbicides						
Late selective herbicide application to control of escapes or late flushes						
Inter-row cultivation						
Shielded spraying between rows						
Wick wiping / roller wipe / blanket						
Chipping						
Pre-harvest desiccation						
Other (specify)						

Q5. **For each major crop listed in Q4, please complete the details in the following table.**
For residual weeds (survivors), high density = greater than 1 plant per m^2, medium density = less than 1 plant per m^2, light density = scattered isolated plants.

Crop & area (ha)	Main weeds sprayed (up to 5)	Herbicides normally used and rate (for each weed)	Control normally achieved			Area of residual weeds (ha)		
			Very good	Acceptable	Variable	High density	Medium density	Light density
Example: *Wheat 500 ha*	1. *wild oats*	*Wildcat at 500ml/ha*			√	20	150	150
	2. *paradoxa grass*	*as above*		√		40	90	70
	3. *turnip weed*	*Harmony M at 35 g/ha*	√			0	0	10
	4. *climbing buckwheat*	*as above*		√		0	50	100
	5. *mustard*	*as above*	√			0	0	10
	1.							
	2.							
	3.							
	4.							
	5.							
	1.							
	2.							
	3.							
	4.							
	5.							
	1.							
	2.							
	3.							
	4.							
	5.							
	1.							
	2.							
	3.							
	4.							
	5.							

FALLOW WEED CONTROL

Q6. Please indicate how often you use each of the following practices for weed control in fallows? Tick the most appropriate option for each practice.

FARMING PRACTICE	SUMMER FALLOW			WINTER FALLOW		
	Rarely or not used	Sometimes used	Often used	Rarely or not used	Sometimes used	Often used
Residual herbicides						
Knockdown herbicides						
Cultivation						
Grazing						
Spot spraying						
Other (specify)						

Q7. Please indicate your main weeds and the herbicides used on these weeds in each winter and summer fallow. Tick control normally achieved, and estimate area of residual weeds (survivors). High density (greater than 1 plant per m^2); Medium density (less than 1 plant per m^2); Light density (scattered isolated plants).

Fallow & area (ha)	Main weeds sprayed (up to 5)	Herbicides normally used and rate (for each weed)	Control normally achieved			Area of residual weeds (ha)		
			Very good	Acceptable	Variable	High density	Medium density	Light density
Winter fallow -------- ha	1. 2. 3. 4. 5.							
Summer fallow -------- ha	1. 2. 3. 4. 5.							

COST OF WEED CONTROL

Q8. Please complete for each of the main crops listed in Q5.

Crop	What is the average crop yield, given the residual weeds listed in Q5? (tonnes per ha)	What yield would you expect, if the paddocks were totally weed-free? (tonnes per ha)

Q9. Do you normally have any weed contamination in your crops? Please tick.

Yes ☐

No ☐ .... go to Q12.

Q10. Do you normally receive any penalty (lower price or grading cost) for weed contamination when selling your crops? Please tick.

Yes ☐

No ☐ .... go to Q12.

Q11. Please provide the following details for any crops that you paid a penalty for weed contamination.

Crop	How many tonnes or bales were contaminated?	What was the average price reduction of crop contaminated? ($ per tonne or bale)	What was the extra processing cost for grading or ginning ($)

GENERAL

Q12. Given your weed management plan, what are the major weeds (if any) not controlled to your satisfaction? Please list below in order of importance, starting with the most important.

1. _____
2. _____
3. _____
4. _____
5. _____

Q13. Are there any particular crops or farming practices that you believe exacerbate the above weed problems? Please list below.

1. _____
2. _____
3. _____

Q14. We would like to explore some of these weed issues further. Would you like to be involved with a face-to-face interview or a small meeting?

Yes ☐

No ☐

Please return promptly.
The draw for the prize is on 30 September.
Thank you for your cooperation

Appendix 2

Grower interview form and field monitoring form

WEED SURVEY

DRYLAND COTTON & GRAIN FARMING SYSTEMS (2001)

Queensland Government
Department of Primary Industries

NSW Agriculture

Cotton CRC

C.R.D.C.

CRC Weed management

GRDC
Grains Research & Development Corporation

CONTACT DETAILS

Name: _____

Address: _____

_____

_____ Postcode

Phone: _____

Facsimile number: _____

E-mail: _____

LAND PREPARATION

Q1. What are your preferred crop rotation(s) involving dryland cotton?

Please estimate the percentage of your total cropping area that each rotation would normally be grown on your farm.

Rotation	% of farm
1.	
2.	
3.	
4.	

Q2. What are the main reasons for crop rotations?

Reason for rotation	Major	Minor
Better disease control		
Better weed control		
Moisture conservation		
Management of soil fertility		
Opportunity cropping		
Seasonal conditions		
Other (please specify)		

COMMENTS _____

_____

_____

_____

_____

Q3. Which of the following options that best describes your land preparation for your main crops.

Land preparation options	Crop 1: dryland cotton	Crop 2:	Crop 3:	Crop 4: .....
1. Direct drilling into standing stubble except for sowing				
2. Direct drilling with removal of stubble prior to sowing				
3. Minimum tillage, no burning of stubble,				
4. Conventional cultivation, stubble worked into soil, > 2 workings				
5. Conventional cultivation with removal of stubble by burning &/or grazing, then ploughing				
6. Other (please specify)				

Q4. What is the main row spacing used for each crop?

Crop 1: dryland cotton	Crop 2:	Crop 3:	Crop 4: .....

Reasons for row spacing _____

_____

_____

_____

Q5. What is the main sowing rate for each crop?

Crop 1: dryland cotton	Crop 2:	Crop 3:	Crop 4: .....

Reasons for sowing rates _____

_____

_____

_____

INCROP WEED CONTROL

Q6. Please indicate how often you use each of the following practices for weed control in your main crops grown in rotation with dryland cotton?

Farming Practice	Crop 1: Dryland Cotton			Crop 2:		
	Rarely or not used	Sometimes used	Regularly used	Rarely or not used	Sometimes used	Regularly used
Long fallow preceding crop						
Pre-emergent herbicides						
Higher than district average seeding rates						
Post-emergent herbicides						
Late selective herbicide application to control of escapes or late flushes						
Inter-row cultivation						
Shielded spraying between rows						
Chipping						
Pre-harvest desiccation						
Other (specify)						

Farming Practice	Crop 3:			Crop 4:		
	Rarely or not used	Sometimes used	Regularly used	Rarely or not used	Sometimes used	Regularly used
Long fallow preceding crop						
Pre-emergent herbicides						
Higher than district average seeding rates						
Post-emergent herbicides						
Late selective herbicide application to control of escapes or late flushes						
Inter-row cultivation						
Shielded spraying between rows						
Chipping						
Pre-harvest desiccation						
Other (specify)						

ANY COMMENTS?_____

_____

_____

Q7. For each major crop listed in Q3-6, please complete the following table.

Crop & area (ha)	Main weeds sprayed (up to 5)	Herbicides normally used and rate (for each weed)	Control normally achieved		
			Very good	Acceptable	Variable
Example: *Wheat 500 ha*	1. *wild oats* 2. *paradoxa grass* 3. *turnip weed* 4. *climbing buckwheat* 5. *mustard*	*Wildcat at 500ml/ha* *as above* *Harmony M at 35 g/ha* *as above* *as above*	 √ √	 √ √ 	√
	1. 2. 3. 4. 5.				
	1. 2. 3. 4. 5.				
	1. 2. 3. 4. 5.				
	1. 2. 3. 4. 5.				

Q7. (continued)

COMMENTS ON CHOICE OF HERBICIDE AND REASONS FOR DIFFERENCES IN LEVEL OF CONTROL

FALLOW WEED CONTROL

Q8. Please indicate how often you use each of the following practices for weed control in fallows?

Farming Practice	Summer Fallow			Winter Fallow		
	Rarely or not used	Sometimes used	Regularly used	Rarely or not used	Sometimes used	Regularly used
Residual herbicides						
Knockdown herbicides						
Cultivation						
Grazing						
Spot spraying						
Other (specify)						

Q9. Please indicate your main weeds and herbicides used on these weeds in each fallow.

Fallow & area (ha)	Main weeds sprayed (up to 5)	Herbicides normally used and rate (for each weed)	Control normally achieved		
			Very good	Acceptable	Variable
Winter fallow -------- ha	1. 2. 3. 4. 5.				
Summer fallow -------- ha	1. 2. 3. 4. 5.				

Q9. (continued)

ANY COMMENTS ON HERBICIDE CHOICE AND DIFFERENCES IN LEVEL OF CONTROL

_____

_____

_____

_____

_____

_____

_____

_____

_____

HERBICIDE APPLICATION

Q10. How do you apply herbicides, and what volume of water is used?

Application	Volume of water (L/ha)
1. Ground by farm staff or yourself	
2. Ground by contractor	
3. Aerial	

Q11. How often do you calibrate your boom and change nozzles? _____

Q12. How do you normally monitor the effectiveness of your weed spraying? Please circle the most appropriate option.

1. Regular field inspections by your consultant
2. Regular field inspections by yourself or staff
3. Observations from a vehicle
4. None
5. Other (specify) _____

WEED PROBLEMS

Q13. What are the weeds (if any) not controlled to your satisfaction?
Please list below in order of importance, starting with the most important.

1. _____
2. _____
3. _____
4. _____
5. _____

Q14. Are there any particular crops or farming practices that you believe exacerbate the above weed problems? Please list below.

1. _____
2. _____
3. _____

ANY COMMENTS ON Q13 & Q14?

_____

_____

_____

MONITORING

Paddocks are to be selected for monitoring weeds (density and diversity) in each component of the rotation(s) with dryland cotton. For each crop or fallow, monitoring will be done at the early part of the crop or fallow (ie indication of weeds being treated), and later prior to harvesting or re-cropping ((ie survivors with potential to replenish weed seed-bank).

Weed species and density will be recorded for each paddock at 4 times:

1. late spring: residual weed species and density at end of winter crops and fallows
2. early summer: weed species and density infesting summer crops and fallows
3. early autumn: residual weed species and density towards end of summer crops and fallows
4. early winter: weed species and density infesting winter crops and fallows.

A total of 20 transects will be done for each paddock. Each paddock will be divided into 4 sections, where 5 (10m by 1m) transects will be made across each section. The presence and density of each species are noted. Weed numbers per species are rated using the following scale.

Weed number per transect ($10m^2$)	Rating
0	0
<10	1
10 - 100	2
>100	3

Weed species and density ratings for each paddock are to be recorded in the attached tables.

PADDOCK _____ DATE _____

CROP / FALLOW _____ HERBICIDE HISTORY _____

Weed species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean

COMMENTS

Appendix 3

Postal survey results

Response rate for mail survey

A total of 342 survey forms (Appendix 1) were sent to dryland cotton growers in northern NSW, southern and central Queensland. We received 56 responses, of which 53 were useable as the other 3 either did not grow cotton or grew only irrigated cotton.

The response rate of 16% was satisfactory, given the complexity of the survey and timing of the mail-out in September and October, when growers are busy with planting.

Soils used for growing dryland cotton

The main soil was vertosol (grey, brown, black cracking clay) with 92% of respondents having this soil type (Table 1).

Crop rotations

The cropping systems with dryland cotton were rather diverse, with 8 broad crop rotations identified in the mail survey (Table 2).

The main crops grown in rotation with dryland cotton were winter cereals only (46%), summer and winter cereals (18%), winter cereal with pulse (9%), summer cereals only (8%), summer and winter cereals with pulse (5%), and pulse only (2%), whereas 11% did not grow any rotational crops.

The main winter cereal was wheat with only a small area of barley grown. The main summer cereal was sorghum, and the main pulses were chickpea and mungbean.

Main weeds in fallows

The most common weeds in winter fallows were wild oats, sowthistle, turnip weed, black bindweed, paradoxa grass and wireweed (Table 3). Sowthistle was found across the regions (Table 4). Wild oats, black bindweed and turnip weed were predominantly in southern Queensland and northern NSW. Paradoxa grass was more common in northern NSW, and wireweed in southern Queensland.

The most common weeds in summer fallows were grasses (including Liverseed grass and barnyard grass), bladder ketmia, sowthistle and caltrop. Grasses were found across the regions. Caltrop was common in southern Queensland and northern NSW. Sesbania was common in central Queensland, and bladder ketmia in southern Queensland.

Main weeds in summer and winter crops of the rotations

The weed spectrum was rather diverse in sorghum and cotton with 34 and 41 different species noted respectively (Table 5). The most common weeds in sorghum and cotton were bladder ketmia, caltrop and grasses. In central Queensland the main weeds were sesbania and grasses (Table 7). In southern Queensland they were bladder ketmia and caltrop, whereas in northern NSW they were mainly grasses.

The main weeds in wheat were turnip weed, sowthistle, black bindweed, wild oats, paradoxa grass and wireweed (Table 6). Sowthistle was across the regions, whereas turnip weed, wild oats, black bindweed were common in both southern Queensland and northern NSW.

Farming practices used for weed management in fallows

Growers were highly reliant on the use of knockdown herbicides for fallow weed control (Table 8), with all using knockdown herbicides at some stage during both the winter and summer fallow periods. Use of cultivation was also fairly common in both fallows but more so in winter. The opposite was reflected for residual herbicide use, with growers using more residual products during the summer, and likewise for spot spraying. Grazing, chipping and pupae busting practices did not feature for fallow weed control in these systems.

Farming practices used for weed management in-crop

There was a high reliance across the farming systems on crop rotations, long fallows, and herbicides for weed control (Tables 9 and 10). Pre-harvest desiccation appeared to be used for most crop species, but the frequency of use was less compared to practices above. Very few growers were using high seeding rates (crop competition), wick wipers or spot spraying to assist with weed management. All other practices (inter-row cultivation, shielded sprayers, chipping, late applications of selective herbicide) appeared to be crop specific.

For dryland cotton (Table 9), the practices most widely used included rotation of summer and winter crops, use of long fallows preceding the cotton, pre-and post-emergent herbicides, shielded sprayers, inter-row cultivation and pre-harvest desiccation. Chipping was also common. Very few growers used crop competition (high seeding rates), late selective herbicide applications, spot spray or employ wick wipers.

Growers of summer cereals (Table 9) relied on crop rotation, long fallows and pre- and post-emergent herbicide use and pre-harvest desiccation as the major practices for weed control. There was some inter-row cultivation, shielding spraying and late selective herbicide application used. Very few used high seeding rates, wick wipers, spot spraying or legume specific rotations.

Crop rotations, long fallows and herbicides (pre- and post-emergent) were the main practices used for weed control in sunflower (Table 9). Some growers used inter-row cultivation but very few used high seeding rates, shielded sprayers, late herbicide applications, wick wipers, chipping or pre-harvest desiccation as management tools.

Mungbean growers relied on crop rotation, pre- and post-emergent herbicides, inter-row cultivation, and pre-harvest desiccation for weed control (Table 9). Use of high seeding rates, long fallows (like chickpea mungbean is an opportunistic crop), shielded sprayers, wick wipers and chipping were not widely used.

For winter cereals (Table 10), growers relied strongly on crop rotation, followed by long fallow prior to the cereal and post-emergent herbicides as the main practices for weed control. There was some use of pre-emergent herbicides, higher seeding rates and late applications of selective herbicide. Very little inter-row cultivation, shielded spraying, chipping, pre-harvest desiccation, spot spraying or wick wiping was used. Specific rotation to legume was not practiced for weed control purposes.

Chickpea (Table 10) growers used crop rotation, pre-emergent herbicides and pre-harvest desiccation as the main practices for weed control, although some did use post-emergent herbicides as well, which may include the use of shielded sprayers. Very few used long fallow (chickpea tends to be an opportunistic crop), high seeding rates, late applications of selective herbicide, inter-row cultivation, or chipping for weed management.

Level of control of fallow weeds

The effectiveness of herbicides in controlling common weeds in fallows is presented in Table 11. Bladder ketmia, Liverseed grass and barnyard grass were not controlled very well or consistently in summer fallows for majority of growers. In contrast, most growers achieved good control of other grasses and sowthistle.

In winter fallows, control of wild oats, turnip weed and paradoxa grass was consistently very good, but control of sowthistle and black bindweed was in many situations only acceptable or variable.

Level of control of crop weeds

Control of bladder ketmia, caltrop, Liverseed grass and barnyard grass was either only acceptable or variable for 50-70% of cotton and sorghum growers (Table 12).

Turnip weed and wild oat were controlled very well in wheat for most growers, but sowthistle and black bindweed was either only acceptable or variable for 40 to 65% of growers (Table 12).

The effectiveness of herbicides in controlling common weeds in minor crops is presented in Table 13.

Herbicides used in fallows

Irrespective of fallow season, the use of glyphosate, either alone or in mixes, far exceeded any other herbicide (Table 14). Of all the herbicide treatments nominated by growers, 54% used glyphosate alone, 36% used glyphosate mixes, and other herbicides and mixtures made up the remaining 10%. Closer scrutiny of the seasons showed this trend altered

very slightly for winter fallow (glyphosate alone 54%, glyphosate mixes 34%, others 12%), but in the summer fallow glyphosate mixes increased to 39%, glyphosate on its own 53% and the other herbicides drops to 8%.

The most common glyphosate mixes used in winter were 2,4-D or metsulfuron-methyl, while the mixes in summer included 2,4-D or fluroxypyr. The other herbicides applied but not necessarily in a mix with glyphosate included MCPA, fluroxypyr, 2,4-D, metsulfuron-methyl and dicamba for winter fallow, and atrazine, fluroxypyr, 2,4-D, metsulfuron-methyl, dicamba, imazapyr, triclopyr and diquat plus paraquat for summer fallow.

Herbicides used in crops

The herbicides used across all crops were variable as expected (Tables 15 and 16).

In dryland cotton (Table 15) there was wide use of glyphosate alone, and fluometuron + prometryn with and without pendimethalin and / or glyphosate. These chemicals or specific combinations represented 51% of all recorded applications. There was some use of pyrithiobac, pendimethalin, prometryn and diuron on their own and in mixes. Metolachlor, fluroxypyr, trifluralin, 2,4-D (assume pre-plant), triclopyr, oxyfluorfen, the grass herbicides, haloxyfop and fluazifop, and several others only had minor use.

Atrazine and mixes of atrazine with fluroxypyr or metolachlor were the most widely used herbicides in sorghum (Table 15) representing 72% of the uses. Fluroxypyr and metolachlor applied on their own or in a mix were sometimes used (18%) and chemicals such as 2,4-D, picloram and glyphosate, alone or in mixes, were minor uses.

Sunflower (Table 15) growers relied fairly much equally on pendimethalin with glyphosate, glyphosate alone, trifluralin and fluazifop for chemical weed control.

Maize growers relied predominantly on atrazine (Table 15).

MCPA applied alone or in mixes with various other herbicides accounted for 47% of the herbicide used in wheat (Table 16). Similarly, the use of metsulfuron-methyl alone or in mixes accounted for 41% of uses, but bear in mind that 60% of the metsulfuron-methyl use was in combination with MCPA. Metsulfuron-methyl with MCPA, clodinafop, metsulfuron-methyl and MCPA on their own, glyphosate, 2,4-D, thifensulfuron plus metsulfuron-methyl, and MCPA plus picloram were the major herbicides used in wheat, accounting for 71% of the herbicides used. Chemicals, such as fluroxypyr, fenoxaprop, dicamba and chlorsulfuron, only had minor uses.
In barley (Table 16) there were similar trends to wheat for MCPA and metsulfuron-methyl use, although the major herbicides used (61%) were MCPA plus fluroxypyr with or without picloram and 2,4-D, and metsulfuron-methyl own its own.

Faba bean growers relied equally on simazine and haloxyfop (Table 16).

Weeds not controlled to growers satisfaction

In central Queensland, the main difficult-to-control weed was sesbania (Table 17).

In southern Queensland, they were sowthistle, bladder ketmia, black bindweed, cowvine, Liverseed grass, wild oats, Johnson grass, bellvine, and Noogoora burr, although another 26 species were also nominated by growers but to a lesser extent.

In northern NSW, the main difficult-to-control weeds were black bindweed, fleabane, cowvine, sowthistle, paradoxa grass, wild oats and Noogoora burr.

Cropping or farming practices possibly leading to weed problems

Growers nominated a total of 33 different cropping or farming practices that were possibly exacerbating their weed problems (Table 18).

The main 2 identified practices were growing cotton particularly in zero tillage systems. Other practices include not being able to use 'hormone' herbicides in cotton areas, growing chickpeas and back-to-back wheat, weeds in fallow, and reduced tillage systems. To a lesser extent, lack of rain, poor farm hygiene, sowthistle growing in all seasons, and over reliance on glyphosate were seen as leading to their weed problems.

Table 1. The different soils used for dryland cotton production by growers in response to the postal survey Question 2. The majority of dryland cotton is grown on the grey, brown or black cracking clays (vertosol).

Soil types	Number of responses
Grey, brown, black cracking clay	50
Red brown earths + grey, brown, black cracking clay	2
River alluvium + grey, brown, black cracking clay	1
Red-brown earths	1
Light sandy soils	0
Total	54

Table 2. The different rotations with dryland cotton used by growers in the postal survey (Question 3). The rotations are grouped into 8 broad categories, and then subdivided based on the main crop components of each rotation. Note that many respondents recorded more than one rotation. The most common rotation is dryland cotton with wheat.

Rotation category	Crops grown with dryland cotton	Number using the rotations
Long fallow only	None	9
Pulse only	chickpea	1
	mungbean	1
Summer cereal only	sorghum	6
	maize	1
Winter cereal only	1 or less wheat crops per cotton crop	28
	2 or more wheat crops per cotton crop	7
	wheat + barley	4
Summer cereal + winter cereal	wheat + barley + sorghum	3
	wheat + sorghum	11
	barley + sorghum	1
Winter cereal + pulse	wheat + chickpea	4
	wheat + barley + mungbean	1
	wheat + peanuts	1
	wheat + mungbean	2
Summer cereal + winter cereal + pulse	sorghum + wheat or barley + chickpea	3
	maize + chickpea + wheat + mungbean	1
Other	sunflower	1

Table 3. The list of weeds recorded as infesting winter and summer fallows in the postal survey (Question 7). A total of 35 and 47 weed species were listed for winter and summer fallows respectively, with wild oats, sowthistle and turnip weed the most common winter weeds, and summer grasses, bladder ketmia, sowthistle and caltrop the most common summer weeds.

Weeds in winter fallow	Number of responses	Weeds in summer fallow	Number of responses
Wild oats	34	Grasses	20
Sowthistle	33	Bladder ketmia	17
Turnip weed	23	Sowthistle	15
Black bindweed	17	Caltrop	12
Paradoxa grass	10	Liverseed grass	11
Bindweed	8	Barnyard grass	10
Wireweed	8	Datura	9
Wild turnip	5	Cowvine	8
Mustard	4	Pigweed	8
Prickly lettuce	4	Johnson grass	6
Thistles	4	Sesbania	6
Broadleaf weeds	3	Amaranthus	5
Deadnettle	3	Burrs	5
NZ spinach	3	Melons	5
Variegated thistle	3	Noogoora burr	5
African turnip	2	Turnip weed	5
Bladder ketmia	2	Bellvine	3
Fleabane	2	Black bindweed	3
Grasses	2	Fleabane	3
Marshmallow	2	Rhyncosia	3
Parthenium	2	Summer grass	3
Burrs	1	Wild oats	3
Caltrop	1	Broadleaf weeds	2
Clover	1	Devil's claw	2
Cowvine	1	Ipomea	2
Johnson grass	1	Mintweed	2
Melons	1	Parthenium	2
Potato weed	1	Thistles	2
Ryegrass	1	Wild sunflower	2
Scotch thistle	1	Bathurst + noogoora burr	1
Summer grass	1	Bathurst burr	1
Vetch	1	Bindweed	1
Volunteer summer crop	1	Castor oil	1
Wheat	1	Caustic weed	1
Wild radish	1	Chinese gooseberry	1
Wild sunflower	1	Chinese harlon	1
		Cotton	1
		European bindweed	1
		Jute	1
		Marshmallow	1
		Native jute	1
		Nutgrass	1
		Polymeria	1
		Potato weed	1
		Variegated thistle	1
		Vines	1
		Volunteer crop	1
		Wandering jew	1
		Yabilla grass	1

Table 4. List of the most common weeds recorded as infesting winter and summer fallows (as in Table 3), but divided into the three regions of the postal survey. The data are given as % for each weed of total number of entries of each region, which was 10 and 16 for central Queensland, 121 and 127 for southern Queensland, and 58 and 56 for northern NSW in winter and summer fallows respectively.

Region	Weeds in winter fallow	%	Weeds in summer fallow	%
Central Queensland				
	Sowthistle	20	Sesbania	19
	Parthenium weed	20	Grasses / summer grass	19
	African turnip weed	10	Wild sunflower	13
	Johnson grass	10	Parthenium weed	13
	Mustards	10	Native jute	13
	Summer grass	10	Johnson grass	6
	Wild sunflower	10	Nutgrass	6
	Wild turnip	10	Pigweed	6
			Vines	6
Southern Queensland				
	Sowthistle	21	Bladder ketmia	12
	Wild oats	17	Grasses	10
	Black bindweed	15	Sowthistle	9
	Turnip weed	11	Caltrop	7
	Wireweed	6	Barnyard grass	6
	Thistles	3	Datura	6
	Mustards	3	Liverseed grass	6
	Prickly lettuce	3	Pigweed	4
	NZ spinach	3	Amaranths	4
	Wild turnip	2	Cowvine	4
Northern NSW				
	Wild oats	22	Grasses	9
	Turnip weed	17	Noogoora burr	9
	Paradoxa grass	16	Barnyard grass	5
	Black bindweed	12	Caltrop	5
	Sowthistle	10	Cowvine	5
	Variegated thistle	5	Melons	5
			Sowthistle	5
			Rhyncosia	5
			Liverseed grass	5

Table 5. The list of weeds recorded as infesting summer crops in the postal survey (Question 5). A total of 34 and 41 weed species were listed infesting sorghum and cotton respectively. Although the spectrum is diverse, the most common weeds were bladder ketmia, caltrop and summer grasses.

Sorghum	No	Cotton	No	Mung bean	No	Sunflowers	No	Maize	No
Bladder ketmia	14	Bladder ketmia	23	Grasses	3	Caltrop	2	Amaranths	1
Caltrop	11	Caltrop	16	Barnyard grass	2	Grasses	2	Bellvine	1
Grasses	10	Grasses	12	Mintweed	2	Johnson grass	2	Bladder ketmia	1
Datura	7	Liverseed grass	10	Turnip weed	2	Amaranths	1	Bullhead	1
Liverseed grass	7	Amaranths	9	Amaranths	1	Barnyard grass	1	Caltrop	1
Amaranths	5	Barnyard grass	8	Bladder ketmia	1	Cowvine	1	Johnson grass	1
Barnyard grass	5	Burrs	7	Pigweed	1	Datura	1		
Cow vine	5	Sowthistle	7	Liverseed grass	1	Phalaris	1		
Burrs	4	Cowvine	6			Summer grass	1		
Pigweed	4	Noogoora burr	6			Liverseed grass	1		
Summer grasses	4	Pigweed	5			Wild oats	1		
Sowthistle	3	Datura	5						
Mintweed	3	Sesbania	4						
Broadleafs	2	Melons	4						
Rhyncosia	2	Bathurst burr	4						
Sesbania	2	Johnson grass	4						
Bellvine	1	Summer grass	4						
Black pigweed	1	Turnip weed	4						
Blue grass	1	Castor Oil	3						
Boree Myall	1	Bell vine	3						
Climbing buckwheat	1	Climbing buckwheat	3						
Devils claw	1	Wild oats	3						
Ipomea	1	Devils claw	2						
Johnson grass	1	Physalis	2						
Melons	1	Broadleaf weeds	2						
Millet grass	1	Mintweed	2						
Native jute	1	Phalaris	2						
Parthenium	1	Thistles	2						
Phalaris	1	Bindweed	1						
Physalis	1	Couch grass	1						
Potato weed	1	Paddy melon	1						
Turnip weed	1	Potato weed	1						
Wild oats	1	Ipomea	1						
Wild sunflower	1	Flannel weed	1						
		Fleabane	1						
		Mustard	1						
		Native jute	1						
		Rhyncosia	1						
		Vetch	1						
		Volunteer sorghum	1						
		Yellow vine	1						

Table 6. The list of weeds recorded as infesting winter crops in the postal survey (Question 5). A total of 24 weed species were listed infesting wheat with turnip weed, sowthistle, black bindweed and wild oats the most common weeds in wheat and chickpea.

Wheat	No	Barley	No	Chickpeas	No	Faba beans	No
Turnip weed	31	Sowthistle	4	Wild oats	9	Black bindweed	1
Sowthistle	23	Black bindweed	3	Turnip weed	6	Paradoxa grass	1
Black bindweed	22	Turnip weed	2	Sowthistle	6	Turnip weed	1
Wild oats	17	Deadnettle	1	Black bindweed	4	Wild oats	1
Paradoxa grass	11	Scotch thistle	1	Paradoxa grass	3	Wireweed	1
Wireweed	11	Wild oats	1	African turnip	2		
Mustard	5	Wireweed	1	Broadleaf weeds	1		
NZ spinach	4			Mexican poppy	1		
Deadnettle	3			Mustard	1		
Wild radish	3			Prickly lettuce	1		
African turnip	2			Shepherd's purse	1		
Bindweed	2			Vetch	1		
Mexican poppy	2			Wild turnip	1		
Prickly lettuce	2			Wireweed	1		
Thistles	2						
Variegated thistle	2						
Bladder ketmia	1						
Broadleaf weeds	1						
Cowvine	1						
Johnson grass	1						
Parthenium	1						
Scotch thistle	1						
Wild sunflower	1						
Wild turnip	1						

Table 7. List of the most common weeds recorded as infesting cotton, sorghum, wheat and chickpea as in Tables 5 and 6, but divided into the 3 regions of the postal survey. The data are given as % for each weed of total number of entries of each region, which was 11, 7, 12, and 2 for central Queensland, 128, 84, 96, and 25 for southern Queensland, and 40, 18, 49 and 11 northern NSW in cotton, sorghum, wheat and chickpea respectively.

Region	Cotton	%	Sorghum	%	Wheat	%	Chickpea	%
Central Queensland	Sesbania	27	Sesbania	29	Sowthistle	25	African turnip weed	50
							Sowthistle	50
Southern Queensland	Bladder ketmia	16	Bladder ketmia	15	Turnip weed	22	Wild oats	24
	Caltrop	11	Caltrop	12	Black bindweed	19	Sowthistle	16
	Grasses	8	Thornapples	7	Sowthistle	17	Turnip weed	16
	Amaranths	8	Liverseed grass	7	Wireweed	9	Black bindweed	12
	Sowthistle	6	Grasses	6	Wild oats	7	Mustards	8
	Liverseed grass	5	Barnyard grass	6	Mustards	6		
	Barnyard grass	4	Amaranths	6	NZ spinach	3		
	Cowvine	4	Burrs	5	Wild radish	3		
	Thornapples	4	Pigweed	5				
	Bellvine	3	Mintweed	4				
Northern NSW	Liverseed grass	10	Grasses	22	Wild oats	22	Wild oats	27
	Barnyard grass	8	Rhyncosia	11	Turnip weed	20	Paradoxa grass	18
	Black bindweed	8			Paradoxa grass	18	Turnip weed	18
	Noogoora burr	8			Black bindweed	14		
	Bathurst burr	5			Sowthistle	8		
	Burrs	5			Wireweed	6		
	Caltrop	5						
	Castor oil	5						
	Paradoxa grass	5						
	Pigweed	5						
	Turnip weed	5						

Table 8. The different farming practices used for weed management in summer and winter fallows by growers in the postal survey (Question 6). The data are given as number of responses.

Farming practice	Summer fallow			Winter fallow		
	Rarely or not used	Sometimes used	Often used	Rarely or not used	Sometimes used	Often used
Residual herbicides	25	15	7	30	8	8
Knockdown herbicides	0	8	45	0	6	45
Cultivation	19	17	15	11	26	13
Grazing	31	6	0	32	5	0
Spot spraying	14	23	5	20	15	3

Table 9. The different farming practices used for weed management in summer crops by growers in the postal survey (Question 4). The data are given as number of responses.

Farming practice	Dryland cotton			Summer cereal (sorghum & maize)		
	Rarely or not used	Sometimes used	Often used	Rarely or not used	Sometimes used	Often used
Rotation of summer & winter crops	2	8	38	2	7	28
Long fallow preceding crop	3	5	42	5	9	22
Pre-emergent herbicides	4	10	37	6	9	22
Higher than normal seeding rates	34	3	4	25	6	3
Post-emergent herbicides	7	13	31	8	12	18
Late selective herbicide application to control of escapes or late flushes	19	15	9	18	10	6
Inter-row cultivation	10	13	28	16	9	11
Shielded spraying between rows	5	9	34	14	14	6
Wick wiping / roller wipe / blanket	42	1	1	30	0	0
Chipping	12	25	13	28	4	0
Pre-harvest desiccation	6	13	29	9	13	13

Farming practice	Sunflower			Mungbean		
	Rarely or not used	Sometimes used	Often used	Rarely or not used	Sometimes used	Often used
Rotation of summer & winter crops	0	1	5	0	2	2
Long fallow preceding crop	1	2	3	2	0	1
Pre-emergent herbicides	1	2	1	1	1	2
Higher than normal seeding rates	4	1	0	2	0	0
Post-emergent herbicides	2	2	2	0	1	2
Late selective herbicide application to control of escapes or late flushes	4	1	0	1	1	1
Inter-row cultivation	2	0	3	1	1	2
Shielded spraying between rows	4	0	1	1	0	1
Wick wiping / roller wipe / blanket	4	1	0	2	0	0
Chipping	3	2	0	2	0	0
Pre-harvest desiccation	4	1	0	1	1	2

Table 10. The different farming practices used for weed management in winter crops by growers in the postal survey (Question 4). The data are given as number of responses.

Farming practice	Winter cereal (wheat & barley)			Chickpea		
	Rarely or not used	Sometimes used	Often used	Rarely or not used	Sometimes used	Often used
Rotation of summer & winter crops	0	5	44	0	4	8
Long fallow preceding crop	6	19	21	7	2	3
Pre-emergent herbicides	29	10	8	1	3	8
Higher than normal seeding rates	25	13	5	8	4	0
Post-emergent herbicides	8	15	28	3	5	4
Late selective herbicide application to control of escapes or late flushes	27	12	7	9	1	2
Inter-row cultivation	37	0	1	9	2	1
Shielded spraying between rows	35	0	1	6	6	0
Wick wiping / roller wipe / blanket	38	0	0	12	0	0
Chipping	31	6	0	7	3	1
Pre-harvest desiccation	35	1	2	2	3	6

Table 11. The categories of control level achieved with herbicides for the most common weeds in summer and winter fallow. The data are given as number of responses from Question 7, averaged for all herbicide treatments used on each weed. A list of herbicides used for fallow weed control is presented in Table 14, and a full matrix listing the level of control achieved for each herbicide treatment on each main weed will be produced in the proposed technical bulletin.

Fallow	Weeds	Number	Control category			
			Very Good	Acceptable	Variable	No Rating
Summer fallow	Grasses	20	16	0	2	2
	Bladder ketmia	17	6	5	4	2
	Caltrop	12	9	2	0	1
	Sowthistle	12	6	2	0	4
	Liverseed grass	11	6	4	0	1
	Barnyard grass	10	6	2	1	1
	Datura	9	6	2	0	1
	Cow vine	8	6	1	0	1
	Pigweed	8	6	2	0	0
	Sesbania	6	4	1	0	1
	Johnson grass	6	2	3	1	0
Winter fallow	Wild oats	33	29	2	1	1
	Sowthistle	33	19	7	4	3
	Turnip weed	23	17	2	1	3
	Black bindweed	17	7	4	4	2
	Paradoxa grass	10	10	0	0	0
	Bindweed	8	3	2	2	1
	Wireweed	8	6	0	1	1
	Mustard	4	4	0	0	0
	Prickly lettuce	4	2	1	1	0
	Thistles	4	3	1	0	0

Table 12. The categories of control level achieved with herbicides for the most common weeds in cotton, sorghum and wheat. The data are given as number of responses from Question 5, averaged for all herbicide treatments used on each weed. A list of herbicides used for fallow weed control is presented in Tables 15 and 16, and a full matrix listing the level of control achieved for each herbicide treatment on each main weed will be produced in the proposed technical bulletin.

Crop	Weeds	Number	Control category			
			Very Good	Acceptable	Variable	No Rating
Cotton	Bladder ketmia	23	6	7	8	2
	Caltrop	16	6	4	5	1
	Grasses	12	7	1	2	2
	Liverseed grass	10	3	2	2	3
	Amaranths	10	7	1	0	2
	Barnyard grass	8	3	2	1	2
	Burrs	7	1	3	2	1
	Cow vine	6	4	1	1	0
	Sowthistle	6	3	2	1	0
	Noogoora burr	6	4	0	1	1
Wheat	Turnip weed	31	26	2	1	2
	Sowthistle	23	13	7	1	2
	Black bindweed	22	7	9	4	2
	Wild oats	17	12	2	2	1
	Paradoxa grass	11	6	3	1	1
	Wireweed	11	7	2	2	0
	Mustard	5	3	0	0	2
	NZ Spinach	4	3	0	0	1
	Deadnettle	3	1	1	1	0
	Wild radish	3	2	1	0	0
Sorghum	Bladder ketmia	14	7	3	2	2
	Caltrop	11	5	4	1	1
	Grasses	10	2	7	0	1
	Datura	7	5	1	0	1
	Liverseed grass	7	3	1	2	1
	Amaranths	6	6	0	0	0
	Barnyard grass	5	0	2	1	2
	Cow vine	5	4	0	0	1
	Burrs	4	2	1	0	1
	Pigweed	4	3	0	1	0
	Summer grass	4	3	0	0	1

Table 13. The categories of control level achieved with herbicides for the most common weeds in barley, chickpea, sunflower, mung bean, faba bean and maize. The data are given as number of responses from Question 5, averaged for all herbicide treatments used on each weed. A list of herbicides used for fallow weed control is presented in Table 14, and a full matrix listing the level of control achieved for each herbicide treatment on each main weed will be produced in the proposed technical bulletin.

Crop	Weeds	Number	Control category			
			Very Good	Acceptable	Variable	No Rating
Barley	Sowthistle	4	2	1	1	
	Black bindweed	3	0	2	1	0
	Turnip weed	2	2	0	0	0
	Deadnettle	1	0	1	0	0
	Scotch thistle	1	0	0	1	0
	Wild oats	1	1	0	0	0
	Wireweed	1	1	0	0	0
Chickpea	Wild oats	9	6	2	1	0
	Turnip weed	6	3	1	1	1
	Sowthistle	5	2	2	0	1
	Black bindweed	4	1	2	0	1
	Paradoxa grass	3	3	0	0	0
Sunflower	Caltrop	2	1	0	1	0
	Grasses	2	1	0	1	0
	Johnson grass	2	2	0	0	0
Mungbean	Grasses	3	1	1	0	1
	Barnyard grass	2	1	0	0	1
	Mintweed	2	1	0	0	1
	Turnip weed	2	2	0	0	0
Faba bean	Black bindweed	1	0	1	0	0
	Paradoxa grass	1	1	0	0	0
	Turnip weed	1	0	1	0	0
	Wild oats	1	1	0	0	0
	Wireweed	1	0	1	0	0
Maize	Amaranths	1	0	0	1	0
	Bellvine	1	0	0	1	0
	Bladder ketmia	1	0	0	1	0
	Bullhead	1	0	0	1	0
	Caltrop	1	0	0	1	0
	Johnson grass	1	1	0	0	0

Table 14. Herbicides used in winter and summer fallows by growers in the postal survey (Question 7). Data are given as number of responses. A total of 20 and 21 different herbicides were used for winter and summer fallow weed control respectively, with 53-54% of growers using glyphosate alone and another 38-41% using glyphosate mixtures.

Fallow	Herbicides	Number
Winter	Glyphosate	98
	Glyphosate + 2,4-D amine	25
	Glyphosate + metsulfuron-methyl	14
	2,4-D amine	9
	Glyphosate + dicamba	6
	Glyphosate + 2,4-D or dicamba	6
	MCPA + metsulfuron-methyl	3
	Glyphosate + oxyfluorfen	2
	Glyphosate + metsulfuron-methyl or 2,4-D	2
	Glyphosate + fluroxypyr	2
	Glyphosate + 2,4-D amine + metsulfuron-methyl	2
	Fluroxypyr	2
	Dicamba	2
	Picloram	1
	MCPA	1
	Glyphosate + MCPA + clopyralid (Lontrel)	1
	Glyphosate + dicamba + 2,4-D amine	1
	Fluroxypyr + dicamba	1
	2,4-D ester	1
	2,4-D + metsulfuron-methyl	1
Summer	Glyphosate	103
	Glyphosate + 2,4-D	36
	Glyphosate + fluroxypyr	14
	Glyphosate + metsulfuron-methyl	5
	Glyphosate + atrazine	4
	Glyphosate + 2,4-D amine + metsulfuron-methyl	4
	Atrazine + fluroxypyr	3
	Glyphosate + triclopyr	3
	Glyphosate + MCPA or dicamba	3
	Glyphosate + dicamba + trilienuron-methyl (Express)	3
	2,4-D amine	2
	Metsulfuron-methyl	2
	Fluroxypyr + dicamba	2
	Fluroxypyr	2
	Atrazine	1
	Imazapyr	1
	Triclopyr	1
	Glyphosate + oxyfluorfen (Goal)	1
	Diquat + paraquat	1
	Glyphosate + metsulfuron-methyl or 2,4-D	1
	Glyphosate + metsulfuron-methyl or fluroxypyr	1

Table 15. Herbicides used in summer crops by growers in the postal survey (Question 5). Data are given as number of responses. A total of 30 and 12 different herbicides were used for cotton and sorghum weed control respectively. The most common herbicides used in cotton were glyphosate and mixtures involving fluometuron, prometryn and pendimethalin accounting for 56% of the recorded treatments. Atrazine alone or mixed with fluroxypyr or metolachlor represented 72% of treatments used in sorghum.

Crop	Herbicides	Number
Cotton	Glyphosate	40
	Fluometuron + prometryn	18
	Fluometuron + prometryn + pendimethalin	11
	Fluometuron + prometryn + glyphosate	8
	Pyrithiobac	7
	Pendimethalin	7
	Fluometuron + prometryn + diuron	5
	Diuron + prometryn	5
	Pendimethalin + fluometuron + prometryn + diuron	5
	Diuron	4
	Diuron + pyrithiobac + prometryn	4
	Metolachlor + glyphosate	4
	Glyphosate + fluroxypyr	4
	Trifluralin + fluometuron + prometryn	4
	2,4-D + glyphosate	3
	Convoy	3
	Fluometuron + prometryn + 2,4-D or glyphosate + 2,4-D	3
	Prometryn	3
	Glyphosate or prometryn	3
	Haloxyfop	3
	Metolachlor + pendimethalin + diuron + haloxyfop	2
	Diquat + paraquat	2
	Trifluralin	2
	Fluometuron + prometryn + pendimethalin + pyrithiobac	1
	Fluometuron + prometryn+ trifluralin	1
	Fluometuron + prometryn + glyphosate + oxyfluorfen	1
	Metolachlor	1
	Fluazifop	1
	Triclopyr	1
	Triclopyr + glyphosate	1
Sorghum	Atrazine	35
	Atrazine + fluroxypyr	26
	Atrazine + metolachlor	15
	Fluroxypyr	8
	Metolachlor	7
	Metolachlor + fluroxypyr	4
	2,4-D + glyphosate + atrazine + fluroxypyr	3
	Atrazine + picloram + 2,4-D	3
	Picloram + 2,4-D	2
	Glyphosate	1
	Glyphosate + atrazine + metolachlor	1
	Atrazine + picloram + 2,4-D + fluroxypyr	1
Sunflower	Pendimethalin + glyphosate	5
	Glyphosate	3
	Trifluralin	3
	Fluazifop	3
Maize	Atrazine	5
	Glyphosate	1

Table 16. Herbicides used in winter crops by growers in the postal survey (Question 5). Data are given as number of responses. A total of 21 different herbicides were used for wheat weed control. The most common herbicides used in wheat were metsulfuron-methyl and MCPA alone or as mixtures.

Crop	Herbicide	Number
Wheat	Metsulfuron-methyl + MCPA	19
	Clodinafop	14
	Metsulfuron-methyl	13
	MCPA	12
	Glyphosate	11
	2,4-D	10
	Thifensulfuron + metsulfuron-methyl	10
	Picloram + MCPA	10
	MCPA + fluroxypyr	7
	Fenoxaprop	6
	Picloram + MCPA + metsulfuron-methyl	5
	Dicamba	4
	Picloram + MCPA or metsulfuron-methyl + MCPA	4
	Chlorsulfuron + MCPA + metsulfuron-methyl	3
	Picloram	3
	Picloram + MCPA or fluroxypyr + MCPA	3
	Thifensulfuron + metsulfuron-methyl + MCPA	2
	Metsulfuron-methyl + MCPA or dicamba	1
	Chlorsulfuron	1
	Chlorosulfuron + MCPA	1
	Fenoxaprop + chlorsulfuron	1
Barley	MCPA + fluroxypyr	3
	MCPA + fluroxypyr or picloram + 2,4-D	3
	Metsulfuron-methyl	2
	Tralkoxydim	1
	Metsulfuron-methyl + thifensulfuron + MCPA	1
	Metsulfuron-methyl + MCPA or dicamba	1
	Metsulfuron-methyl + MCPA	1
	Metsulfuron-methyl + thifensulfuron	1
Chickpea	Haloxyfop	8
	Simazine	7
	Prometryn + isoxaflutole	4
	Simazine + prometryn + isoxaflutole	4
	Simazine + imazethapyr	3
	Simazine + prometryn	2
	Fluazifop + butroxydim	1
	Trifluralin	1

Table 17. Weeds listed in by growers (Question 12) as not controlled to their satisfaction in the different regions. A total of 44 weed species were listed, with the most important weeds differing between regions.

Region	Weed	Number
Central Queensland	Sesbania	3
	Wild sunflower	2
	African turnip	1
	Bitterbark	1
	Couch grass	1
	Flannel weed	1
	Johnson grass	1
	Nutgrass	1
	Sowthistle	1
Southern Queensland	Sowthistle	15
	Bladder ketmia	11
	Black bindweed	9
	Cow vine	6
	Liverseed grass	4
	Wild oats	4
	Johnson grass	3
	Bellvine / Ipomea	3
	Burrs / Noogoora burr	3
	Caltrop	2
	Fleabane	2
	Marshmallow	2
	Paradoxa grass	2
	Prickly lettuce	2
	Amaranths	1
	Barnyard grass	1
	Bokhara clover	1
	Deadnettle	1
	Dinebra	1
	European bindweed	1
	Flannel weed	1
	Grasses	1
	Mexican poppy	1
	Nutgrass	1
	Onion weed	1
	Paddy melon	1
	Polymeria	1
	Potato vine	1
	Rhyncosia	1
	Sesbania	1
	Summer grass	1
	Thistles	1
	Vetch	1
	Wandering jew	1
	Wireweed	1
Northern NSW	Black bindweed	9
	Fleabane	4
	Cow vine	3
	Sowthistle	3
	Phalaris	3
	Wild oats	3
	Burrs / bathurst burr / Noogoora burr	3
	Rhyncosia	2
	Bladder ketmia	1
	Devil's claw	1
	Johnson grass	1
	Mexican poppy	1
	Native grasses	1
	Paddy melon	1
	Variegated thistle	1
	Wireweed	1

Table 18. Cropping or farming practices thought by growers in the postal survey to exacerbate weed problems (Question 13). Growing cotton in zero tillage system was the most identified practice leading to weed problems.

Practices	Number
Cotton	10
Zero Till	10
Limited use of hormone herbicides with cotton production	6
Chickpeas	3
Fallow	3
Back to back wheat	3
Minimum till / reduced tillage	3
Lack of rain in fallow period	2
Drought	2
Farm hygiene	2
Milk thistle grows all year round	2
Too much reliance on glyphosate	2
Mung beans	1
Corn	1
Legumes	1
They all have their problems	1
Tillage	1
Long fallow	1
Row cropping	1
Uncontrolled flood water	1
Back to Back cropping	1
Conservation farming	1
Different practice changes weed spectrum eg. No till increased fleabane	1
Machinery set up incorrectly	1
Summer fallow	1
Farmers who don't rotate herbicides or use any tillage	1
Farming creek beds above property	1
Mono culture	1
Dust behind sprayer from the tyres	1
Opportunity cropping instead of a set rotation	1
Farmers using incorrect chemical rates & applying at incorrect times. Operators should be BMP qualified	1
Control is difficult on larger sesbania	1

Appendix 4

Grower interview results

Methods

Ten dryland cotton growers were interviewed face-to-face to validate the responses given in the postal survey and to provide any additional information relevant to weed management. Eight of these growers were from southern Queensland, including Dalby, Pittsworth, Jimbour, Jondaryan, Goondiwindi and Warra) and two were from northern NSW at Gurley and Moree. Nine of these growers had completed the postal survey. The questionnaire used was similar to that used in the postal survey (Appendix 2), but had additional questions to provide information on land management, crop agronomy, herbicide spraying details, and reasons for choosing their crop and weed management options.

Rotations and crop agronomy

There was a wide range of rotations (Table 1), depending on region, soil type, growers' preference and commodity prices. Since the start of the survey and recent down turn in cotton prices, the rotations are likely to vary over the next few years. Approximately half the rotations were with winter cereals, mostly wheat. The other main rotations were either dryland cotton only or rotated with sorghum. Fallow length after cotton varied from double cropping with no fallow to long fallow for 3 seasons.

Although there was a mixed response to question on reasons for crop rotations, moisture conservation was the highest priority and weed management was the second most important reason (Table 2). The low rating for opportunity cropping indicates that cotton is a planned crop in the rotation.

Direct drilling is a major part of land preparation (Table 3). However, due to pupae busting required after cotton, the systems are classed as minimum tillage, although many growers would be zero tillage if this operation was not necessary.

There are large variations in row spacing (Table 4) and sowing rates (Table 5) used for each crop. Growers fit in with other crops and other machinery that they own. Growers are successfully growing dryland cotton and other crops in different row spacings. 40% sow cotton in 90 or 100cm rows as solid planting, 20% as single skip, and the rest on double skip. Wheat is sown in row spacings from 15 to 35cm. Sorghum and maize are sown mostly in 90 or 100cm rows. Sowing rates for cotton varied from 4.5 kg/ha to 11 kg/ha, and the majority of growers sow wheat and barley at 40 kg/ha or less. Cotton and maize crops aimed for a certain crop stand, but others were just based on seeding rate without consideration for final crop stand.

Maize was considered as a weakness in the rotation, as weeds grow and seed in late part of crop after maturity and before harvest.

Farming practices for weed management

The different farming practices used for controlling weeds in the different crops and fallows of the rotations are presented in Tables 6 to 9.

Responses to farming practices used for managing weeds in fallows were very similar to those from the postal survey. In addition, some growers use chipping to control weed survivors in fallows.

In summer crops, the main differences were that the interviewed growers used less crop competition and follow-up herbicide applications on surviving weeds, but used more of pre-harvest desiccation in cotton. Options used in sorghum were very similar. However, with winter cereals, there were large differences particularly with use of long fallow, inter-row cultivation, shielded spraying, chipping and pre-harvest desiccation.

Level of weed control

Weed control with the different herbicides used by the interviewed growers was similar to that in the postal survey for most situations (Tables 10 and 11). The exceptions were better control by the interviewed growers barnyard and Liverseed grasses in cotton, and bladder ketmia and Liverseed grass in fallows. The opposite was evident for cowvine in cotton and fallow, and caltrop in sorghum.

Herbicide application

The majority of growers were applying herbicides in water volumes less than 50 L/ha (Table 12). Frequency of boom calibration and nozzle changing was reasonably high (Table 13).

Weeds not controlled to growers' satisfaction

The most common difficult-to-control weeds were bladder ketmia, cow vine, sowthistle, and a weed of the future fleabane (Table 14). These were similar to those cited in the postal survey, apart from the greater importance by interviewed growers for pigweed and less for wild oats. Possible reasons for their weed problems are outlined in Table 15.

Suggestions by Glenn Milne

Fleabane is a problem weed that is getting more significant, and needs addressing. It appears to develop in the previous fallow where it seeds profusely and is only partially controlled with herbicide treatments, and then is very difficult to control later. Spraying when the weed is young and green is the key. It is being sprayed too big in the fallow.

A program of spraying small weeds is needed also for pigweed, bladder ketmia and sowthistle. The use of Starane with shielded sprayer in cotton has done a very good job in controlling pigweed. There is a perception in the industry that Starane is very volatile and dangerous for cotton, but some growers are using this technique successfully. Growers in Jimbour area are using Starane + atrazine in cotton for controlling cow vine successfully. Bladder ketmia is still one of the hardest to control weed, but Roundup Ready cotton appears to be improving control of this weed.

Table 1. Preferred crop rotations with dryland cotton by the 10 interviewed growers (Question 1). The most common rotation is dryland cotton with wheat.

Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Total
Cotton	Wheat or Barley or Chickpea	Fallow	Fallow	Cotton					5
Cotton	Fallow	Sorghum	Fallow	Cotton					1
Cotton	Fallow	Fallow	Fallow	Cotton					2
Cotton	Fallow	Fallow	Wheat	Fallow	Fallow	Cotton			3
Cotton	Fallow	Fallow	Fallow	Cotton	Fallow	Fallow	Fallow	Cotton	2
Cotton	Fallow	Fallow	Fallow	Corn	Fallow	Fallow	Fallow	Cotton	1
Cotton	Wheat	Fallow	Fallow	Sorghum	Fallow	Fallow	Fallow	Cotton	1
Cotton	Fallow	Sorghum	Fallow	Corn	Chickpea	Fallow	Fallow	Cotton	1
Cotton	Fallow	Fallow	Wheat	Fallow	Barley or Wheat	Fallow	Fallow	Cotton	4
Cotton	Fallow	Fallow	Wheat	Sorghum	Fallow	Fallow	Fallow	Cotton	1
Cotton	Fallow	Sorghum	Fallow	Fallow	Fallow	Cotton			1

Table 2. Reasons given by the interviewed growers for the choosing their crop rotations (Question 2). The majority rotate for conservation of soil moisture and to control weeds better.

Reason	Major	Minor
Moisture Conservation	9	1
Better Weed Control	7	3
Seasonal Conditions	6	4
Better Disease Control	4	6
Management of Soil Fertility	3	7
Opportunity Cropping	2	8
Other (Economic Decision)	2	0
Other (Price - Of Commodity)	1	0

Table 3. Land preparation for each crop in rotation used by the interviewed growers (Question 3), with the majority practicing minimum or zero tillage systems.

Land preparation	Dryland Cotton	Wheat (1st Crop)	Wheat (2nd crop)	Wheat or Barley	Sorghum	Maize
Direct drilling with stand stubble	3	1			1	
Direct drilling with stubble removed			2			
Minimum tillage with no burning	5	3	1	2	2	3
Conventional cultivation with > 2 workings	1			2		
Conventional cultivation, stubble removed						

Table 4. Row spacing used for each crop in rotation by the interviewed growers (Question 4).

Dryland cotton	No	Wheat	No	Maize	No	Sorghum	No
1m Double Skip	5	15cm	1	68cm	1	1m	2
90cm Solid	1	25cm	4	90cm	1	1m Single Skip	1
1m Single Skip	2	30cm	1	1m	1	68cm	1
1m Solid	3	35-37.5 cm	4			90cm	1

Table 5. Sowing rates (kg/ha) for each crop in rotation by the interviewed growers (Question 5).

Cotton	No	Wheat	No	Barley	No	Chickpea	No	Sorghum	No
4.5	1	25	1	25	1	30	1	3	2
5	1	33	1	40	1			4-5	1
6	3	38	1						
7	2	40	4						
8	1	45	1						
11	2	50-60	1						

Table 6. The farming practices used for weed management in dryland cotton and sorghum by the interviewed growers (Question 6). The data are given as number of responses,

Farming Practice	Cotton			Sorghum		
	Rarely used	Sometimes used	Regularly used	Rarely used	Sometimes used	Regularly used
Long fallow preceding crop	2	1	7	1	1	
Pre-emergent herbicides		1	9	1		2
Higher than average seeding rates	9		1	3		
Post-emergent herbicides	3	3	4		1	2
Late selective herbicide	8	2		2	1	
Inter-row cultivation	1	2	7	2	1	
Shield-spraying between rows			10		3	
Chipping	3	6	1	2	1	
Pre-harvest desiccation			10		1	2

Table 7. The different farming practices used for weed management in wheat and barley by interviewed growers (Question 6). The data are given as number of responses.

Farming Practice	Wheat			Barley		
	Rarely used	Sometimes used	Regularly used	Rarely used	Sometimes used	Regularly used
Long fallow preceding crop	4	2	2	1		
Pre-emergent herbicides	7	1		1		
Higher than average seeding rates	6		2	1		
Post-emergent herbicides	1		7		1	
Late selective herbicide	6	2		1		
Inter-row cultivation	8			1		
Shield-spraying between rows	8			1		
Chipping	7	1		1		
Pre-harvest desiccation	7	1		1		

Table 8. The different farming practices used for weed management in chickpea and maize by interviewed growers (Question 6). The data are given as number of responses.

Farming Practice	Chickpea			Maize		
	Rarely used	Sometimes used	Regularly used	Rarely used	Sometimes used	Regularly used
Long fallow preceding crop	1				1	1
Pre-emergent herbicides			1			2
Higher than average seeding rates	1			2		
Post-emergent herbicides	1			1	1	
Late selective herbicide	1			1	1	
Inter-row cultivation	1				2	
Shield-spraying between rows	1			1	1	
Chipping	1			1	1	
Pre-harvest desiccation		1		1	1	

Table 9. The different farming practices used for weed management in summer and winter fallows by interviewed growers (Question 8). The data are given as number of responses.

Farming practice	Summer fallow			Winter fallow		
	Rarely used	Sometimes used	Regularly used	Rarely used	Sometimes used	Regularly used
Residual herbicides	7	2	1	8	2	
Knockdown herbicides			10			10
Cultivation	3	5	2	3	6	1
Grazing	10			10		
Spot spraying	5	5		7	3	
Other						

Table 10. The categories of control level achieved by different herbicides and rates for the common weeds in crops (Question 7). Herbicides are applied pre-emergence (PRE), post-emergence overall (POST) or post-emergence with shielded sprayer (SS)

Crop	Weed	Herbicides Used	Herbicide Rates	Application	Control category		
					Very Good	Acceptable	Variable
Cotton							
	Amaranthus sp	Atrazine + Starane	1.0 + 0.35 L/ha	SS	1		
	Amaranthus sp	Cotogard + Diuron	4.0 + 1.5 L/ha	PRE	1		
	Amaranthus sp	Cotogard + Stomp	4.0 + 4.0 L/ha	PRE		1	
	Amaranthus sp	Prometryn	4.0 L/ha	PRE		1	
	Amaranthus sp	Prometryn + Diuron	1.3 + 1.3 L/ha	SS	1		
	Amaranthus sp	Roundup CT	1.5 L/ha	SS	1		
	Amaranthus sp	Staple	60 g/ha	POST	1		
	Barnyard grass	Dual	2.0 L/ha	PRE	1		1
	Barnyard grass	Dual Gold	1.0 + 0.35 L/ha	PRE	1		
	Barnyard grass	Roundup CT	1.5 L/ha	SS	1		
	Barnyard grass	Roundup CT	1.5 L/ha	POST	1		
	Barnyard grass	Trifluralin	2.1 L/ha	PRE		1	
	Barnyard grass	Verdict	0.15 L/ha	POST	2		
	Bathurst Burr	Cotogard	4.0 L/ha	PRE			1
	Bladder ketmia	Atrazine + Starane	1.0 + 0.35 L/ha	SS		1	
	Bladder ketmia	Cotogard	4.0-5.0 L/ha	PRE		3	1
	Bladder ketmia	Cotogard + Diuron	4.0 + 1.5 L/ha	PRE	1		
	Bladder ketmia	Cotogard + Stomp	4.0 + 4.0 L/ha	PRE			1
	Bladder ketmia	Prometryn	4.0 L/ha	PRE			1
	Bladder ketmia	Prometryn +diuron	1.3 + 1.3 L/ha	SS		1	
	Bladder ketmia	Prometryn +diuron	1.5 + 1.5 L/ha	SS		1	
	Bladder ketmia	Roundup CT	1.5 L/ha	SS		1	
	Bladder ketmia	Staple	60-120 g/ha	POST	useless		
	Caltrop	Cotogard	4.5-5.0 L/ha	PRE	1	2	
	Caltrop	Cotogard	2.0 L/ha	PRE			1
	Caltrop	Cotogard + Diuron	4.0 + 1.5 L/ha	PRE	1		
	Caltrop	Cotogard + Stomp	4.0 + 4.0 L/ha	PRE		1	
	Caltrop	Prometryn +diuron	1.5 + 1.5 L/ha	SS		1	
	Caltrop	Roundup CT	1.5 L/ha	SS	1		
	Caltrop	Staple	60-120 g/ha	POST		2	
	Caltrop	Trifluralin (480 g/l)	2.3 L/ha	PRE	1		
	Cow vine	2,4-D Amine	0.2 L/ha	SS	1		
	Cow vine	Atrazine + Starane	1.0 + 0.35 L/ha	SS		1	
	Cow vine	Cotogard	4.5-5.0 L/ha	PRE		1	1
	Cow vine	Cotogard + Diuron	4.0 + 1.5 L/ha	PRE		1	
	Cow vine	Prometryn	4.0 L/ha	PRE			1
	Cow vine	Prometryn +diuron	1.3 + 1.3 L/ha	SS			1
	Cow vine	Prometryn +diuron	1.5 + 1.5 L/ha	SS		1	
	Cow vine	Roundup CT	1.5 L/ha	SS			1
	Cow vine	Staple	60-120 g/ha	POST		2	
	Devil's claw	Cotogard	4.5 L/ha	PRE			1
	Devil's claw	Prometryn +diuron	1.5 + 1.5 L/ha	SS		1	
	Devil's claw	Staple	120 g/ha	POST			1
	Devil's claw	Starane	0.5 L/ha	SS	1		
	Liverseed grass	Dual	2.0 L/ha	PRE	1		1
	Liverseed grass	Roundup CT	1.5 L/ha	POST	1		
	Liverseed grass	Verdict	0.15 mL/ha	POST	1		
	Noogoora burr	Roundup CT	1.5 L/ha	SS	1		
	Paddy Melons	Garlon+R'upCT	0.06 + 1.5 L/ha	SS	1		
	Red pigweed	Cotogard	4.0-5.0 L/ha	PRE	1	1	1
	Red pigweed	Cotogard	2.0 L/ha	PRE			1
	Red pigweed	Cotogard + Diuron	4.0 + 1.5 L/ha	PRE	1		
	Red pigweed	Roundup CT	1.5 L/ha	SS			1
	Red pigweed	Staple	60 g/ha	POST		1	
	Red pigweed	Trifluralin (480 g/l)	2.3 L/ha	PRE	1		

	Sesbania	Cotogard	4.5-5.0 L/ha	PRE	1	1	
	Sowthistle	Cotogard	2.2 kg/ha	PRE	1		
	Sowthistle	Cotogard + Stomp	4.0 + 4.0 L/ha	PRE			1
	Sowthistle	Roundup CT	1.5 L/ha	SS			1
	Thornapple	Cotogard	4.5 L/ha	PRE			1
	Thornapple	Prometryn +diuron	1.5 + 1.5 L/ha	SS		1	
	Thornapple	Staple	120 g/ha	POST	1		
	Wild gooseberry	Cotogard	2.2 kg/ha	PRE	1		
	Wild gooseberry	Cotogard	2.0 L/ha	PRE			1
	Wild gooseberry	Roundup CT	1.5 L/ha	SS	1		
Wheat							
	African turnip	Ally + MCPA LVE	5 g/ha + 0.5 L/ha	POST		1	
	Mustards	2,4-D Amine	0.7 L/ha	POST	1		
	Paradoxa grass	Glean	20 g/ha	PRE	1		
	Paradoxa grass	Topik	95 ml/ha	POST	1		
	Prickly lettuce	Ally + MCPA LVE	5 g/ha + 0.5 L/ha	POST		1	
	Prickly lettuce	MCPA Amine	0.7-0.8 L/ha	POST	1		1
	Sowthistle	Ally	5-7 g/ha	POST	1		
	Sowthistle	Ally + MCPA LVE	5 g/ha + 0.5 L/ha	POST		3	
	Sowthistle	MCPA Amine	0.8 L/ha	POST	1		
	Turnip weed	Ally	5-7 g/ha	POST	1		
	Turnip weed	Ally + MCPA LVE	5 g/ha + 0.5 L/ha	POST	1		
	Turnip weed	MCPA Amine	0.8 L/ha	POST	1		
	Turnip weed	Starane + MCPA	0.5 + 0.5 L/ha	POST		1	
	Wild oats	Puma S	0.6 L/ha	POST	1		
	Wild oats	Topik	0.09-0.095 L/ha	POST	2		
	Wild oats	Ally + MCPA LVE	5 g/ha + 0.5 L/ha	POST			1
	Wild oats	Harmony M	45 g/ha	POST		1	
	Wild oats	Starane + MCPA	0.5 + 0.5 L/ha	POST		1	
	Wild oats	Tordon 242	1.0 L/ha	POST	1	1	
	Wireweed	Ally + MCPA LVE	5 g/ha + 0.5 L/ha	POST		1	1
Barley							
	Sowthistle	Ally + MCPA LVE	5 g/ha + 0.5 L/ha	POST	1		
	Turnip weed	Ally + MCPA LVE	5 g/ha + 0.5 L/ha	POST	1		
Chickpea							
	Sowthistle	Prometryn+S'zine	1.0 + 1.0 L/ha	PRE	1		
	Turnip weed	Prometryn+S'zine	1.0 + 1.0 L/ha	PRE	1		
	Wild oats	Prometryn+S'zine	1.0 + 1.0 L/ha	PRE		1	
Maize							
	Amaranthus sp	Atrazine	2.5 L/ha	PRE	1		
	Bladder ketmia	Atrazine	2.5 L/ha	PRE	1		
	Caltrop	Atrazine	2.5 L/ha	PRE	1		
	Cow vine	Atrazine	2.5 L/ha	PRE	1		
	Red pigweed	Atrazine	2.5 L/ha	PRE	1		
Sorghum							
	Amaranthus	Atrazine	4.0 L/ha	PRE			1
	Amaranthus	Atrazine + Starane	2.5 + 0.35-0.5L/ha	POST	1		
	Barnyard grass	Dual Gold	1.0 L/ha	PRE	1		
	Bathurst burr	Atrazine + Starane	2.0 + 0.5 L/ha	POST	1		
	Bladder ketmia	Atrazine	3.0 L/ha	PRE		1	
	Bladder ketmia	Atrazine	4.0 L/ha	PRE			1
	Bladder ketmia	Atrazine + Starane	2.5 + 0.35-0.5L/ha	POST	2		
	Caltrop	Atrazine	3.0-4.0 L/ha	PRE		1	1
	Caltrop	Atrazine + Starane	2.0 + 0.5-0.75L/ha	POST			
	Cow vine	Atrazine	3.0 L/ha	PRE		1	
	Cow vine	Atrazine + Starane	2.5 + 0.35-0.5L/ha	POST	1		
	Devil's claw	Atrazine	3.0 L/ha	PRE		1	
	Liverseed grass	Primextra	5.3 L/ha	PRE		1	
	Red pigweed	Atrazine + Starane	2.0 + 0.5 L/ha	POST	1		
	Sowthistle	Atrazine	4.0 L/ha	PRE			1
	Sowthistle	Atrazine + Starane	2.5 + 0.35-0.5L/ha	POST	1		
	Thornapple	Atrazine	3.0 L/ha	PRE		1	

Table 11. The categories of control level achieved by different herbicides and rates for the common weeds in fallows (Question 9).

Weeds	Herbicide	Herbicide rate	Control		
			Very Good	Acceptable	Variable
African turnip weed	Roundup CT	0.8 L/ha	1		
Amaranthus	Roundup CT+Surpass	1-1.5 + 0.8 L/ha	1		
Amaranthus	Roundup CT	0.8-1.5 L/ha	2		
Barnyard grass	Roundup CT + 2,4-D amine	1.2-1.5 + 0.1-0.2 L/ha	1		
Barnyard grass	Glyphosate CT	0.8-1.5 L/ha	4		
Barnyard grass	Spray.Seed	2.0 L/ha	1		
Black bindweed	Roundup CT	1.0-1.25 L/ha	1	1	
Black bindweed	Roundup CT + Starane/Ally				1
Black bindweed	Roundup CT + Surpass	1.0 + 1.0 L/ha	1		
Bladder ketmia	Roundup CT	0.8-1.5 L/ha	3		
Bladder ketmia	Spray.Seed	2.0 L/ha	1		
Bladder ketmia	Roundup CT+Surpass	1-1.5 + 0.8 L/ha	1		
Bladder ketmia	Roundup Ct + Starane	1.3-1.4 + 0.1 L/ha	1		
Burr medic	Glyphosate CT + Ester	1.2 + 0.8 L/ha		1	
Caltrop	Roundup CT+Surpass	1-1.5 + 0.8 L/ha	1		
Caltrop	Roundup CT	1.0-1.5 L/ha	2		
Cotton volunteer	Roundup CT	1.2-1.5 L/ha			1
Cow vine	Roundup Ct + Surpass	1-1.5 + 0.8 L/ha		1	
Cow vine	Roundup CT	2.0 L/ha			1
Cow vine	2,4-D amine	0.2 L/ha	1		
Datura	Roundup CT	1.2 L/ha	1		
Deadnettle	Roundup CT Extra	1.0 L/ha	1		
Devil's claw	Glyphosate CT	1.5 L/ha	1		
Devil's claw	Roundup CT+Surpass	1-1.5 + 0.8 L/ha	1		
Dock	Roundup CT	1-1.5 L/ha		1	
Fleabane	Roundup CT	1.2 L/ha			
Fleabane	Roundup CT + Ally/Surpass				
Johnson grass	Roundup CT Extra	1.2 L ha			
Liverseed grass	Glyphosate CT	1.0-1.5 L/ha	3		
Liverseed grass	Spray.Seed	2.0 L/ha	1		
Mustards	Roundup CT	1.25 L/ha	1		
Noogoora burr	Glyphosate CT	1.5 L/ha	1		
Paddy melons	Roundup CT + Garlon	1.2-1.5 + 0.06 L/ha	2		
Phalaris	Glyphosate CT	0.4 L/ha	1		
Prickly lettuce	Roundup+Tillmaster	1.2 L/ha + 0.6 L/ha		1	
Prickly lettuce	Roundup CT	0.8 L/ha	1		
Red pigweed	Roundup CT + 24Damine		1		
Red pigweed	Roundup CT + Ally	1.2 L/ha + 5 gm/ha	1		
Red pigweed	Roundup CT	1.0 L/ha	1		
Sesbania	Roundup CT + 24Damine		1		
Sesbania	Roundup CT	1.25 L/ha	1		
Sowthistle	Roundup CT	0.8-1.25 L/ha	3		
Sowthistle	Roundup CT + 24D amine	1.0 + 0.2-0.5 L/ha	1		
Sowthistle	Glyphosate CT	1.2 L/ha		1	
Sowthistle	Roundup CT + Surpass	1-1.5 + 0.8 L/ha		1	
Sowthistle	Roundup CT Extra	1.0 L/ha		1	
Sowthistle	Roundup CT	1.0 L/ha			1
Spear thistle	Roundup CT	1-1.5 L/ha		1	

Turnip weed	Roundup CT + 2,4-D amine	1.0 + 0.2-0.5 L/ha	1	
Turnip weed	Roundup Ct	0.4-0.5 L/ha	1	
Turnip weed	Roundup CT	0.8-1.5 L/ha	4	
Turnip weed	Roundup CT + Tillmaster	1.0 + 1.0 L/ha	1	
Wild gooseberry	Roundup CT	1.2-1.25 L/ha	2	
Wild oats	Roundup CT + 2,4-D amine	1.0 + 0.2-0.5 L/ha	1	
Wild oats	Roundup CT	0.8 L/ha	1	
Wild oats	Roundup CT	0.4-0.5 L/ha	3	
Wild oats	Roundup CT Extra	1.0 L/ha	1	
Wild oats	Roundup CT	1-1.5 L/ha	1	
Wireweed	Roundup CT	0.8-1.0 L/ha	2	
Wireweed	Roundup CT Extra	1.0 L/ha		1

Table 12. Volume of water used for herbicide application by interviewed growers or employed staff (Question 10).

Application equipment	Volume (L/ha)	Number
Ground rig	30-60	1
	35-45	2
	40-60	2
	50-60	1
	50-75	1
	30-100	1
Contractor	40	2
Aerial	40	1

Table 13. Frequency of spray boom calibration and nozzle changes, and method of monitoring of herbicide efficacy (Questions 11 and 12).

Boom calibration	Number	Nozzle changes	Number	Monitoring	Number
Once per season	2	Variation in output	1	Use consultant	2
Twice per year	1	Twice per year	2	Walk in paddock	8
Rarely but use spray monitor	1	Once per year	3	View from vehicle	2
Every spraying	6	Every 2 seasons	2		
		After 50-100 hours	1		
		Every 3 years (ceramics)	1		
		Look at pattern	1		

Table 14. Weeds listed by the interviewed growers as not controlled to their satisfaction (Question 13).

Weeds	Number
Bladder ketmia	7
Cow vine	5
Thistles	4
Fleabane	2
Black bindweed	2
Red pigweed	2
Cotton	2
Thornapple	1
Button grass	1
Bathurst burr	1
Melons	1
Clover	1
Sesbania	1

Table 15. Farming practices that are thought to be exacerbating the weed problems, and general comments on weed control by the interviewed growers (Question 14).

Farming practice	Number	General comments
Growing cotton	5	Atrazine good in sorghum, weeds have worsened with cotton
Monoculture cotton	1	If more profitable rotations would grow more rotations.
Growing cotton, sunflowers, and chickpea	1	A greater herbicide range would help control.
Flood Plain - Johnson grass	1	Zero-til has changed weed spectrum
Running a few cattle	1	Narrow Leaf Form of Bladder Ketmia very hard to control.
Summer cropping frequencies	1	
Monoculture cropping	1	
Zero-til	2	
Contractors - Sesbania	1	
Farming practice of previous owner	1	

Appendix 5

Field survey of weed species and density infesting paddocks in dryland cotton rotations

Methods

The 10 growers selected for interviewing were also used for monitoring weed infestations in their crop rotations with dryland cotton. A total of 34 paddocks on these farms were monitored for weed density and diversity during the summer of 2001-02 (Table 1). The paddocks were fallow (19), dryland cotton (9), sorghum (4), maize (1) and sunflower (1). For each crop or fallow, monitoring was done at the early part of the season to give an indication of weeds being treated (December 2001), and later in the season prior to harvesting or re-cropping to give an indication of survivors with potential to replenish weed seed-bank (May 2002).

Weeds were monitored in 20 transects in each paddock, which was divided into 4 sections, where 5 (10m by 1m) transects were made across each section. The presence and density of each species were noted in each transect. Weed numbers per species were rated using the rating scale of 1 = <10 plants per $10m^2$, 2 = 10 – 100 plants per $10m^2$, and 3 = >100 plants per $10m^2$.

Weed diversity

The diversity of weeds varied from 3 to 29 species per paddock. A total of 68 species were recorded, with the most species in the fallow (Table 2). There were 2 species of caltrop recorded, *Tribulus terrestris* in the northern NSW farms and *Tribulus micrococcus* in the southern Queensland farms.

The most common weeds found in this field survey were very similar as those highlighted in the mail survey. The most common weed was bladder ketmia, which was found in 74% of the paddocks monitored. The other common weeds were sowthistle (47% of paddocks), pigweed (47%), caltrop (44%), amaranths (42%), barnyard grass (38%), cowvine (32%) and Liverseed grass (29%). In addition to these weeds, volunteer crops such as wheat and cotton were often widespread.

Weed density

The average density of weeds infesting the whole paddock was often less than 1 plant/m^2 for most weeds, although the weeds were often in patches of heavy infestations, with some at densities of greater than 10 plants/m^2 (Tables 3-5).

Despite the different weed management strategies, most paddocks with cotton and sorghum and to a lesser extent fallow had surviving weeds at the end of the season (Tables 6-8). Densities were usually low when averaged across the paddock, but there were some patches of higher densities. The majority of the residual weeds had or were seeding, and thus replenishing the seed-bank.

In dryland cotton, the residual weeds were present just prior or after picking, and before the paddocks were cultivated for pupae busting. The most common weeds surviving were bladder ketmia, cowvine, pigweed and sowthistle. Due to the dry end to the summer season, many paddocks were quite clean of weeds on the whole. Where there some weeds, the growers had the attitude that the dry finish meant the weeds would not have competed for moisture, and therefore no money was spent controlling them.

The weeds in summer fallow were mostly controlled and prevented seeding. However, sowthistle was present in 10 paddocks, bladder ketmia and pigweed were in 6 paddocks, some as new seedlings whereas others were mature plants seeding.

An additional 50-page report has been compiled by Glenn Milne with details and photos of each paddocked monitored (Appendix 6). He made the following comments:

- All farmers would like to stop weeds from seeding. However there is a wide range of circumstances that allow weeds to seed on farms. All farmers had at least one weed that they felt was not controlled to their satisfaction. Most of this dissatisfaction was in having only one herbicide that gave acceptable control.

- What is causing the weed problem? The weeds are germinating and allowed to seed, and thus are self-generating in most cases. There may be the odd instance where floodwaters bring in weed seeds, but in all farms assessed weeds were seeding at some stage during the assessment period.

- The best way to overcome the weed problem is not to let weeds produce seeds. There are a number of strategies that Glenn employs with farmer clients and he feels that their weed problems are being reduced.

- Spray weeds when they are small, usually in the first 2-4 weeks after they emerge. Weeds are easier to kill when they are small, they are usually more actively growing, usually have not seeded and often hard to kill weeds can be killed with glyphosate alone when they are small.
- Always use an in-crop herbicide with the aim to have a clean paddock at harvest time.
- Spray around roads and edges of paddocks, as often weeds will start here and work their way into the rest of the paddock.
- Chip surviving weeds before they seed or remove seeding plants from the paddock.

- Some hard-to-kill weeds that were mentioned in the project become hard to kill in the fallow when they are considered large weeds. Fleabane, pigweed, bladder ketmia, sesbania and sowthistle are all weeds that can be controlled very well with Glyphosate CT when applied to young actively growing weeds. If these weeds are allowed to grow into large plants, then herbicide mixes are usually required to obtain good control.

- In the Jimbour area, most growers on average are spraying their paddocks once per month during the summer. From the farm monitoring most farmers are spraying every 2 months with at least a 2-way mix of herbicides. Also the Glyphosate rates are 1.2-1.5 L/ha while we try to use 0.6-1.0 L/ha of Glyphosate CT.

- There is never a perfect farm and weather, family commitments can cause weeds to get away. The biggest reason why weeds tend to get away is when growers are waiting for a second germination and then it does rain and stays wet for a long period allowing weeds to seed. If weeds are allowed to seed they have that weed for between 2-7 years depending on the type of weed.

- Most weed problems in the monitored cotton crops have resulted from the weeds seeding in a fallow prior to the cotton crop. Fleabane may have been old plants that have regrown in some places, as it is a perennial plant.

Glenn Milne's take home message is to keep fallows clean, spray young weeds, chip surviving weeds.

Table 1. The 34 paddocks (A1 to J2) used for field monitoring with their position in the different rotations used by the 10 interviewed growers. The crops in italics were grown instead of planned dryland cotton.

Grower	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
Cook	Cotton **(A1)**	Fallow	Fallow **(A2)**	Fallow	Cotton				
Higton	Cotton	Fallow	Fallow **(B2)**	Fallow	Cotton **(B1)**				
	Maize	Fallow	Fallow	Fallow	Cotton **(B3)**	Fallow	Fallow	Fallow	Cotton
Kent	Cotton	Fallow	Fallow **(C2)**	Fallow	Cotton **(C1)**				
	Cotton	Fallow	Fallow	Fallow	Sorghum **(C3)**				
Matthews		Wheat	Fallow	Fallow	*Sunflower* **(D1)**				
		Wheat	Fallow **(D2)**	Fallow	Cotton				
	Maize	Fallow	Fallow	Fallow	*Maize* **(D3)**				
	Cotton	Fallow	Fallow **(D4)**						
McVeigh	Sorghum **(E2)**	Fallow	Fallow **(E3)**	Fallow	Cotton **(E1)**				
	Cotton	Fallow	Fallow **(E4)**	Fallow	Sorghum				
	Cotton	Fallow	Fallow **(E5)**	Fallow	Cotton				
		Wheat	Fallow	Barley	Fallow **(E6)**	Fallow	Cotton		
Patterson		Wheat	Fallow **(F1)**	Wheat	Fallow **(F4)**	Fallow	Cotton **(F3)**	Fallow	Fallow **(F2)**
Stirling		Wheat	Fallow **(G2)**	Fallow	Cotton **(G1)**	Wheat	Fallow	Fallow	Cotton
	Cotton	Fallow	Sorghum **(G3)**	Fallow	Cotton				
Taylor		Wheat	Fallow **(H3)**	Wheat	Fallow **(H1)**	Fallow	Cotton **(H2)**		
	Cotton	Barley	Fallow **(H4)**	Fallow	Cotton				
Venz	Sorghum	Barley	Fallow **(I1)**	Wheat	Fallow	Fallow	*Sorghum* **(I2)**		
		Wheat	Fallow	Barley	Fallow **(I3)**	Fallow	Cotton		
Wunsch	Cotton **(J1)**	Fallow	Fallow **(J2)**	Fallow	Cotton				

Table 2. List of weeds found in the field survey of 34 paddocks, 9 with dryland cotton, 6 with summer crops mainly sorghum, and 19 as summer fallow, given as number of paddocks where each weed was found in 20 x 10m^2 quadrats

Preferred common name	Botanical name	Cotton (Dec 01)	Cotton (May 02)	Sorghum (Dec 01)	Sorghum (May 01)	Fallow (Dec 01)	Fallow (May 02)
African turnip weed	Sisymbrium thellungii	1				4	
Argentine peppercress	Lepidium bonariense						1
Australian bindweed	Convolvulus erubescens	4		4	1		4
Barnyard grass	Echinochloa crus-galli	3	3	2	2	8	4
Black bindweed	Fallopia convolvulvus	1				3	1
Black pigweed	Trianthema portulacastrum	1	1				
Bladder ketmia	Hibiscus trionum	8	6	5	4	12	6
Blue bells	Wahlenbergia spp					1	
Boggabri weed	Amaranthus mitchelli	2	1			5	2
Burr gherkin	Cucumis anguria					6	1
Burr medic	Medicago polymorpha	3				1	1
Button grass	Dactyloctenium radulans		1			1	1
Caltrop	Tribulus terrestris	3	3	3	3	9	3
Caltrop (spineless)	Tribulus micrococcus						
Caustic weed	Chamaesyce drummondii	2	3	1		7	3
Chenopodium sp.	Chenopodium sp.		1			1	1
Clock weed	Gaura parviflora			1			
Cobbler's pegs	Bidens pilosa					1	
Cow vine	Ipomoea lonchophylla	4	5	1	1	6	3
Cudweed	Gamochaeta pensylvanica			1	1	2	
Deadnettle	Lamium amplexicaule	1					
Devil's claw	Martynia annua	2	2				
Digitaria sp.	Digitaria sp.	1					
Dock	Rumex spp					1	
Dwarf amaranthus	Amaranthus macrocarpus	4	2	3	3	7	2
Emu foot	Cullen tenax	3	3	1		1	1
Eragrostis (weeping lovegrass)	Eragrostis parviflora					1	
Feathertop Rhodes grass	Chloris gayana			1		1	1
Fleabane	Conyza bonariensis	2	1	1	1	3	3
Green amaranthus	Amaranthus viridis					3	
Guinea grass	Panicum maximum	1					
Liverseed grass	Urochloa panicoides	2		2	1	6	1
Malvastrum	Malvastrum americanum	1		1		5	3
Mintweed	Salvia reflexa	1	2			3	2
Native sensitive weed	Neptunia gracilis	1	1	2	2	2	2
New Zealand spinach	Tetragonia tetragonioides	1					
Noogoora burr	Xanthium occidentale					1	
Oxalis sp	Oxalis sp						1
Panicum sp.	Panicum sp.			1		2	
Paradoxa grass	Phalaris paradoxa					1	
Polymeria	Polymeria pusilla	1		2		2	2
Prickly lettuce	Lactuca serriola					1	1
Red flinders grass	Iseilema vaginiflorum			1		1	
Red pigweed	Portulaca oleracea	6	5	2		8	6
Redshank	Amaranthus cruentus	3	1	1		1	3
Regrowth cotton						3	3
Rhynchosia	Rhynchosia minima	1		1		2	2
Sesbania	Sesbania cannabina	2					
Slender celery	Ciclospermum leptophyllum					1	
Small flowered mallow	Malva parviflora					1	
Sowthistle	Sonchus oleraceus	5	5	2	1	9	10
Spear thistle	Cirsium vulgare	1		1		1	
Spiny sida	Sida spinosa						1
Stink grass	Eragrostis cilianensis			1		1	1
Swamp grass	Paspalidium spp	2				1	
Thornapple	Datura ferox		1			2	1
Tree pear	Opuntia monacantha	1					
Turnip weed	Rapistrum rugosum	1		1		2	
Vigna (Maloga bean)	Vigna lanceolata	1		1		2	
Volunteer barley						1	2
Volunteer cotton		4		1	2	10	5
Volunteer sorghum				2	1	2	
Volunteer sunflower						1	
Volunteer wheat		1				8	1
Wild gooseberry	Physalis minima	1	1		1	5	3
Wild oats	Avena spp			1		3	1
Wireweed	Polygonum aviculare					2	
Yabila Grass	Panicum queenslandicum	2	1	2	2	2	1

Table 3. Weeds infesting 9 paddocks with dryland cotton crops (A1 – J1) in December 2001. Data are mean rating scores of infestation (20 quadrats) for each weed species, where 1 = <1 weed/m^2, 2 = 1-10 weeds/m^2, 3 = >10 weeds/m^2, with range in brackets.

	A1		B1		B3		C1		E1		F3		G1		H2		J1	
African turnip weed	0.30	(0-2)																
Australian bindweed					0.35	(0-1)	0.35	(0-1)	0.10	(0-1)					0.10	(0-1)		
Barnyard grass											0.25	(0-3)	0.20	(0-1)	0.05	(0-1)		
Black bindweed													0.05	(0-1)				
Black pigweed																	0.10	(0-1)
Bladder ketmia	0.55	(0-2)	0.55	(0-2)	0.25	(0-2)	0.90	(0-2)	0.20	(0-1)			0.55	(0-1)	0.05	(0-1)	0.25	(0-1)
Boggabri weed			0.15	(0-1)	0.80	(0-1)												
Burr medic					0.05	(0-1)							0.05	(0-1)	0.05	(0-1)		
Caltrop	0.05	(0-1)	0.05	(0-1)					0.30	(0-1)								
Caustic weed	0.45	(0-2)			0.05	(0-1)												
Cow vine					0.15	(0-1)	0.25	(0-1)	0.05	(0-1)							0.10	(0-1)
Deadnettle					0.05	(0-1)												
Devil's claw									0.25	(0-1)					0.15	(0-1)		
Digitaria sp															0.20	(0-1)		
Dwarf amaranthus	0.15	(0-1)					0.80	(0-2)					0.15	(0-1)	0.10	(0-1)		
Emu foot					0.15	(0-2)	0.10	(0-1)							0.05	(0-1)		
Fleabane											0.65	(0-1)			0.30	(0-1)		
Guinea grass	0.05	(0-1)																
Liverseed grass											0.15	(0-1)			0.05	(0-1)		
Malvastrum															0.10	(0-1)		
Mintweed	0.05	(0-1)																
Native sensitive weed					0.50	(0-1)												
NZ spinach															0.10	(0-1)		
Polymeria																	0.05	(0-1)
Red pigweed	0.03	(0-2)			0.05	(0-1)					0.10	(0-1)	0.55	(0-2)	0.90	(0-2)	0.55	(0-2)
Redshank	0.10	(0-1)	1.20	(0-3)	0.20	(0-1)												
Rhynchosia					0.05	(0-1)												
Sesbania	0.05	(0-1)															0.05	(0-1)
Sowthistle	1.15	(0-2)	0.30	(0-1)			0.05	(0-1)			0.10	(0-1)			0.15	(0-1)		
Spear thistle			0.05	(0-1)														
Swamp grass			0.10	(0-1)	0.10	(0-1)												
Tree pear											0.05	(0-1)						
Turnip weed					0.05	(0-1)												
Vigna																	0.15	(0-2)
Volunteer cotton	0.45	(0-1)	0.45	(0-1)									0.05	(0-1)			0.35	(0-1)
Volunteer wheat											0.30	(0-1)						
Wild gooseberry	0.30	(0-2)																
Yabila grass							0.10	(0-1)	0.15	(0-1)								

Table 4. Weeds infesting 6 paddocks with sorghum (C3, E2, G2, I2), sunflower (D1) and maize (D3) crops in December 2001. Data are mean rating scores of infestation (20 quadrats) for each weed species. where 1 = <1 weed/m^2, 2 = 1-10 weeds/m^2, 3 = >10 weeds/m^2, with range in brackets.

	C3 (sorghum)		D1 (sunflower)		D3 (maize)		E2 (sorghum)		G3 (sorghum)		I2 (sorghum)	
Australian bindweed	0.40	(0-1)	0.05	(0-1)	0.10	(0-1)					0.10	(0-1)
Barnyard Grass									1.10	(0-2)	1.15	(0-3)
Bladder ketmia	1.00	(0-2)	0.60	(0-2)	0.85	(0-2)	0.20	(0-1)	0.95	(0-2)		
Caltrop			0.70	(0-2)	0.15	(0-1)			0.10	(0-1)		
Caustic weed			0.50	(0-1)								
Clock weed			0.05	(0-1)								
Cow vine	1.10	(0-2)										
Cudweed											0.05	(0-1)
Dwarf amaranthus	0.55	(0-2)	0.30	(0-1)							0.05	(0-1)
Emu foot			0.15	(0-1)								
Feathertop Rhodes grass											0.05	(0-1)
Fleabane											0.40	(0-2)
Liverseed grass							0.15	(0-1)	0.05	(0-1)		
Malvastrum			0.05	(0-1)								
Native panic											0.20	(0-1)
Native sensitive weed	0.20	(0-1)							0.05	(0-1)		
Polymeria			0.05	(0-1)					0.05	(0-1)		
Red pigweed									2.00	(2-2)		
Red flinders grass											0.05	(0-1)
Redshank			0.10	(0-1)								
Rhynchosia			0.50	(0-2)								
Sowthistle			0.10	(0-1)							0.05	(0-1)
Spear thistle			0.05	(0-1)								
Stink grass											0.10	(0-1)
Turnip weed			0.05	(0-1)								
Vigna			0.10	(0-1)								
Volunteer Cotton									1.55	(0-2)		
Volunteer Sorghum					0.05	(0-1)					0.10	(0-1)
Wild oats			0.10	(0-1)								
Yabila Grass	0.10	(0-1)					0.20	(0-1)				

Table 5. Weeds infesting 19 paddocks in summer fallow (A2 – J2) in December 2001. Data are mean rating scores of infestation (20 quadrats) for each weed species, where 1 = <1 weed/m^2, 2 = 1-10 weeds/m^2, 3 = >10 weeds/m^2, with range in brackets.

	A2		B2		C2		D2		D4		E3		E4		E5		E6		F1	
Australian bindweed							0.05	(0-1)												
Barnyard grass	0.05	(0-1)																	0.60	(0-3)
Black bindweed	0.05	(0-1)																		
Bladder ketmia	1.70	(0-3)	0.55	(0-2)	1.65	(0-2)	1.45	(0-2)	1.30	(0-2)	0.35	(0-1)	1.45	(1-2)	0.70	(0-1)	0.30	(0-1)		
Blue bells																				
Boggabri weed	0.05	(0-1)	0.15	(0-1)			0.85	(0-2)												
Burr gherkin							0.10	(0-1)											0.05	(0-1)
Burr medic																				
Button grass																				
Caltrop	0.45	(0-2)	0.05	(0-1)			0.10	(0-2)	0.10	(0-1)			0.40	(0-1)					0.05	(0-1)
Caustic weed	0.50	(0-2)							0.05	(0-1)										
Chenopodium sp.																				
Cobbler's pegs																				
Cow vine					1.70	(0-2)					0.45	(0-2)			0.90	(0-2)	0.35	(0-2)		
Cudweed																				
Devil's claw																				
Digitaria sp.																				
Dock																				
Dwarf amaranthus	0.95	(0-2)			0.75	(0-2)							0.15	(0-1)						
Emu foot																				
Erogrostis																				
Feathertop Rhodes grass																				
Fleabane																				
Green amaranthus	0.3	(0-1)	1.20	(0-3)			0.05	(0-1)												
Liverseed grass																			0.50	(0-3)
Malvastrum																				
Mintweed	0.10	(0-1)																		
Native sensitive weed					0.15	(0-1)					0.10	(0-1)								
New Zealand spinach																				
Noogoora burr																				
Panicum sp.																				
Paradoxa grass																				
Polymeria	0.5	(0-2)																		
Prickly lettuce																				
Red flinders grass																				
Red pigweed	0.70	(0-2)																	0.25	(0-3)
Redshank							0.60	(0-2)												
Regrowth cotton															0.50	(0-1)				
Rhynchosia							0.10	(0-1)												

Slender celery																				
Small flowered mallow																				
Sowthistle			0.30	(0-1)							0.15	(0-1)							0.25	(0-1)
Spear thistle			0.05	(0-1)																
Stink grass																				
Swamp grass			0.10	(0-1)																
Thornapple																				
Turnip weed							0.05	(0-1)												
Vigna	0.05	(0-1)					0.05	(0-1)												
Volunteer Barley																	0.55	(0-2)		
Volunteer Cotton	2.00	(2-2)	0.45	(0-1)	1.50	(0-2)			0.55	(0-1)			2.00	(2-2)	1.50	(1-2)				
Volunteer Sorghum																				
Volunteer Sunflower							0.05	(0-1)												
Volunteer Wheat							3.00	(3-3)											3.00	(3-3)
Wild gooseberry	0.10	(0-1)																		
Wild oats																				
Wireweed																				
Yabila Grass											0.25	(0-1)								

Table 5 (continued).

	F2		F4		G2		H1		H3		H4		I1		I3		J2	
Australian bindweed							0.20	(0-1)					0.45	(0-2)	0.05	(0-1)		
Barnyard grass	0.40	(0-2)	1.45	(0-3)	2.10	(0-3)					0.45	(0-1)	0.10	(0-2)	1.70	(0-3)		
Black bindweed					0.05	(0-1)							0.15	(0-1)				
Bladder ketmia					1.90	(0-3)							0.15	(0-1)			1.70	(0-2)
Blue bells													0.20	(0-2)				
Boggabri weed					0.40	(0-2)									0.20	(0-1)		
Burr gherkin			0.10	(0-2)	0.05	(0-1)					0.10	(0-1)	0.05	(0-1)				
Burr medic													0.20	(0-1)				
Button grass			0.15	(0-3)														
Caltrop			0.05	(0-1)	0.55	(0-2)							0.05	(0-1)				
Caustic weed	0.30	(0-1)	0.05	(0-1)							0.10	(0-1)			0.02	(0-1)	0.40	(0-1)
Chenopodium sp.													0.05	(0-1)				
Cobbler's pegs													0.30	(0-1)				
Cow vine													0.65	(0-1)			0.35	(0-1)
Cudweed													0.10	(0-1)	0.02	(0-1)		
Devil's claw																		
Digitaria sp.																		
Dock													0.05	(0-1)				
Dwarf amaranthus	0.05	(0-1)	0.10	(0-1)									0.50	(0-1)	0.05	(0-1)		
Emu foot													0.10	(0-1)				
Erogrostis			0.85	(0-3)														
Feathertop Rhodes grass															0.05	(0-1)		
Fleabane	0.05	(0-1)											0.05	(0-1)	0.20	(0-1)		
Green amaranthus																		
Liverseed grass	0.05	(0-1)	0.45	(0-3)	1.85	(0-3)							0.10	(0-1)	0.20	(0-1)		
Malvastrum			0.10	(0-1)			0.20	(0-1)			0.05	(0-1)	0.10	(0-1)	0.15	(0-2)		
Mintweed	0.60	(0-2)			0.20	(0-2)												
Native sensitive weed																		
New Zealand spinach																		
Noogoora burr											0.05	(0-1)						
Panicum sp.													0.05	(0-2)	0.20	(0-1)		
Paradoxa grass											0.05	(0-1)						
Polymeria					0.05	(0-1)												
Prickly lettuce													0.20	(0-1)				
Red flinders grass															0.05	(0-1)		
Red pigweed	1.25	(0-3)	0.90	(0-3)	1.30	(0-3)							0.90	(0-1)	0.45	(0-2)	0.75	(0-2)
Redshank																		
Regrowth cotton	0.55	(0-1)									1.00	(0-2)						
Rhynchosia													1.15	(0-2)				

Slender celery													0.05	(0-1)				
Small flowered mallow							0.05	(0-1)										
Sowthistle	0.10	(0-1)			0.05	(0-1)	0.05	(0-1)			0.10	(0-1)	0.10	(0-2)	0.75	(0-2)		
Spear thistle																		
Stink grass															0.10	(0-1)		
Swamp grass																		
Thornapple					0.05	(0-1)									0.02	(0-1)		
Turnip weed											0.05	(0-1)						
Vigna																		
Volunteer Barley																		
Volunteer Cotton	0.60	(0-1)			0.55	(0-2)					1.00	(0-2)					2.00	(2-2)
Volunteer Sorghum													0.30	(0-1)	0.10	(0-1)		
Volunteer Sunflower																		
Volunteer Wheat			2.65	(1-3)	0.10	(0-1)	2.90	(2-3)	2.75	(2-3)			2.90	(2-3)	2.9	(0-2)		
Wild gooseberry	0.15	(0-1)									0.35	(0-1)	1.15	(0-2)	0.35	(0-2)		
Wild oats											0.70	(0-2)	0.10	(0-1)	0.45	(0-1)		
Wireweed													0.30	(0-2)	0.75	(0-3)		
Yabila Grass															0.05	(0-1)		

Table 6. Residual weeds in 9 paddocks with dryland cotton in March – April 2002. Data are mean rating scores of infestation (20 quadrats) for each weed species, where 1 = <1 weed/m^2, 2 = 1-10 weeds/m^2, 3 = >10 weeds/m^2, with range in brackets. Ratings for density of weeds initially infesting these paddocks are given in Table 3.

	A1		B1		B3		C1		E1		F3		G1		H2		J1	
African turnip weed																		
Australian bindweed																		
Barnyard grass	0.10	(0-1)									0.15	(0-2)	0.85	(0-2)				
Black bindweed																		
Black pigweed																	0.05	(0-1)
Bladder ketmia	0.10	(0-1)	0.15	(0-1)	0.05	(0-1)	0.25	(0-1)	0.05	(0-1)			0.30	(0-1)				
Boggabri weed					0.05	(0-1)												
Burr medic																		
Button Grass																	0.40	(0-1)
Caltrop	0.10	(0-1)	0.10	(0-1)					0.05	(0-1)								
Caustic weed	0.40	(0-2)			0.05	(0-1)											0.25	(0-1)
Cow vine	0.05	(0-1)			0.05	(0-1)	0.15	(0-1)	0.05	(0-1)							0.10	(0-1)
Chenopodium sp													0.05	(0-1)				
Deadnettle																		
Devil's claw									0.05	(0-1)					0.05	(0-1)		
Dwarf amaranthus							0.20	(0-1)					0.25	(0-2)				
Emu foot					0.05	(0-1)	0.10	(0-1)							0.20	(0-1)		
Fleabane											0.85	(0-1)						
Guinea grass																		
Liverseed grass																		
Mintweed	0.15	(0-1)															0.15	(0-1)
Native sensitive weed					0.10	(0-1)												
Polymeria																		
Red pigweed	0.15	(0-1)	0.05	(0-1)									0.75	(0-2)	0.25	(0-1)	1.80	(1-2)
Redshank			0.05	(0-1)														
Rhynchosia																		
Sesbania																		
Sowthistle	0.05	(0-1)	0.05	(0-1)	0.20	(0-1)	0.20	(0-1)					0.75	(0-2)				
Spear thistle																		
Swamp grass																		
Thornapple									0.05	(0-1)								
Tree pear																		
Turnip weed																		
Vigna																		
Volunteer cotton																		
Volunteer wheat																		
Wild gooseberry	0.05	(0-1)																
Yabila grass															0.10	(0-1)		

Table 7. Residual weeds in 7 paddocks with sorghum, sunflower and maize in April – May 2002. Data are mean rating score of infestation (20 quadrats) for each weed species, where 1 = <1 weed/m^2, 2 = 1-10 weeds/m^2, 3 = >10 weeds/m^2, with range in brackets. Ratings for density of weeds initially infesting these paddocks are given in Table 4, apart from paddock E4 which was originally a summer fallow (Table 5).

	C3 (sorghum)		D1 (sunflower)		D3 (maize)		E2 (sorghum)		E4 (maize)		G3 (sorghum)		I2 (sorghum)	
Australian bindweed	0.40	(0-1)												
Barnyard Grass											1.15	(0-2)	0.45	(0-2)
Bladder ketmia	1.00	(0-2)					0.20	(0-1)	1.45	(1-2)	0.15	(0-1)		
Caltrop			0.20	(0-1)					0.4	(0-1)	0.05	(0-1)		
Cow vine	1.10	(0-2)												
Cudweed		0.10	(0-1)											
Dwarf amaranthus	0.55	(0-2)							0.15	(0-1)	0.05	(0-1)		
Feathertop Rhodes grass														
Fleabane													0.35	(0-2)
Liverseed grass							0.15	(0-1)						
Native sensitive weed	0.20	(0-1)									0.05	(0-1)		
Polymeria														
Red pigweed														
Red flinders grass														
Sowthistle											0.05	(0-1)		
Stink grass														
Volunteer Cotton									2.00	(2)	0.55	(0-1)		
Volunteer Sorghum													0.80	(0-2)
Wild Gooseberry													0.15	(0-2)
Yabila Grass	0.10	(0-1)					0.20	(0-1)						

Table 8. Residual weeds in 18 paddocks in summer fallow in April – May 2002. Data are mean rating scores of infestation (20 quadrats) for each weed species, where 1 = <1 weed/m^2, 2 = 1-10 weeds/m^2, 3 = >10 weeds/m^2, with range in brackets. Ratings for ensity of weeds initially infesting these paddocks are given in Table 5.

	A2	B2		C2	D2		D4	E3		E5		E6		F1
Argentine peppercress														
Australian bindweed								0.05	(0-1)					
Barnyard grass														
Black bindweed														
Bladder ketmia		0.25	(0-1)		0.20	(0-1)		0.25	(0-1)	0.10	(0-1)	0.35	(0-1)	
Blue bells														
Boggabri weed					0.10	(0-1)								
Burr gherkin														
Burr medic										0.05	(0-1)			
Button grass														
Caltrop		0.05	(0-1)											
Caustic weed														
Cobbler's pegs														
Cow vine								0.05	(0-1)	0.05	(0-1)			
Cudweed														
Devil's claw														
Digitaria sp.														
Dock														
Dwarf amaranthus														
Emu foot														
Erogrostis														
Feathertop Rhodes grass														
Fleabane														
Liverseed grass														
Malvastrum					0.05	(0-1)								
Mintweed														
Mung Bean														
Native sensitive weed					0.05	(0-1)								
New Zealand spinach														
Noogoora burr														
Oxalis														
Panicum sp.														
Paradoxa grass														
Polymeria														
Prickly lettuce														
Red flinders grass														
Red pigweed														
Redshank		0.60	(0-2)			(0-2)								
Regrowth cotton														

Rhynchosia					0.1	(0-1)	0.05	(0-1)		
Slender celery										
Small flowered mallow										
Sowthistle	0.05	(0-1)	0.05	(0-1)	0.05	(0-1)			0.05	(0-1)
Spear thistle										
Spiny Sida										
Stink grass										
Swamp grass										
Thornapple										
Turnip weed										
Vigna										
Volunteer Barley										
Volunteer Cotton	0.25	(0-1)					0.20	(0-1)		
Volunteer Sorghum										
Volunteer Sunflower										
Volunteer Wheat										
Wild Gooseberry										
Wild oats										
Wireweed										
Yabila Grass										

Table 8 (continued).

	F2		F3		G2		H1		H3		H4		I1		I3		J2	
Argentine peppercress					0.05	(0-1)												
Australian bindweed					0.15	(0-1)	0.40	(0-1)					0.15	(0-1)				
Barnyard grass	0.25	(0-1)			1.10	(0-2)	0.10	(0-2)							0.50	(0-2)		
Black bindweed						(0-1)												
Bladder ketmia					0.10	(0-1)												
Blue bells																		
Boggabri weed					0.05	(0-1)												
Burr Gherkin															0.05	(0-1)		
Burr medic																		
Button grass																	0.05	(0-1)
Caltrop					0.55	(0-2)											0.05	(0-1)
Caustic weed	0.15	(0-1)	0.05	(0-1)													0.35	(0-1)
Chenopodium sp					0.1	(0-2)												
Cobbler's pegs																		
Cow vine																	0.20	(0-2)
Cudweed																		
Devil's claw																		
Digitaria sp.																		
Dock																		
Dwarf amaranthus					0.30	(0-2)	0.10	(0-2)										
Emu foot							0.05	(0-1)										
Erogrostis																		
Feathertop Rhodes grass					0.05	(0-1)												
Fleabane			0.10	(0-1)									0.05	(0-1)	0.45	(0-1)		
Liverseed grass					0.55	(0-2)												
Malvastrum					0.15	(0-1)	0.05	(0-1)										
Mintweed	0.10	(0-1)			0.20	(0-2)												
Mung Bean					1.15	(0-2)												
Native sensitive weed					0.20	(0-1)												
New Zealand spinach																		
Noogoora burr																		
Oxalis					0.05	(0-1)												
Panicum sp.																		
Paradoxa grass																		
Polymeria						(0-1)	0.05	(0-1)										
Prickly lettuce					0.35	(0-1)												
Red flinders grass																		
Red pigweed	0.25	(0-2)			1.05	(0-2)	0.20	(0-1)					0.10	(0-1)	0.2	(0-1)	0.25	(0-1)
Redshank					0.15	(0-1)												
Regrowth cotton	0.10	(0-1)									0.15	(0-1)						

Rhynchosia																		
Slender celery																		
Small flowered mallow																		
Sowthistle	0.05	(0-1)	0.25	(0-1)	1.30	(0-2)	0.40	(0-1)					0.45	(0-2)			0.2	(0-1)
Spear thistle																		
Spiny Sida							0.1	(0-1)										
Stink grass			0.25	(0-1)														
Swamp grass																		
Thornapple						(0-1)												
Turnip weed																		
Vigna																		
Volunteer Barley											0.4	(0-1)	0.2	(0-2)				
Volunteer Cotton	1.05	(0-2)			0.45	(0-1)											0.95	(0-2)
Volunteer Sorghum																		
Volunteer Sunflower																		
Volunteer Wheat						(0-1)												
Wild Gooseberry									0.05	(0-1)	0.05	(0-1)			0.05	(0-1)		
Wild oats					0.2	(0-2)												
Wireweed																		
Yabila Grass															0.05	(0-1)		

Appendix 6

Report by Glenn Milne on grower interviews and field monitoring

Farm 1 – Rob Cook –Kupunn (Near Dalby)

Rob's rotation has been Cotton – Long fallow – Cotton. Dryland cotton growers for maximum profitability have followed this rotation, however stubble cover and long term organic matter percentage is a concern. That is why Rob is trying to incorporate wheat into his rotation, however dry winters for the last 2 years has seen Rob revert back to the Cotton – Long Fallow – Cotton rotation.

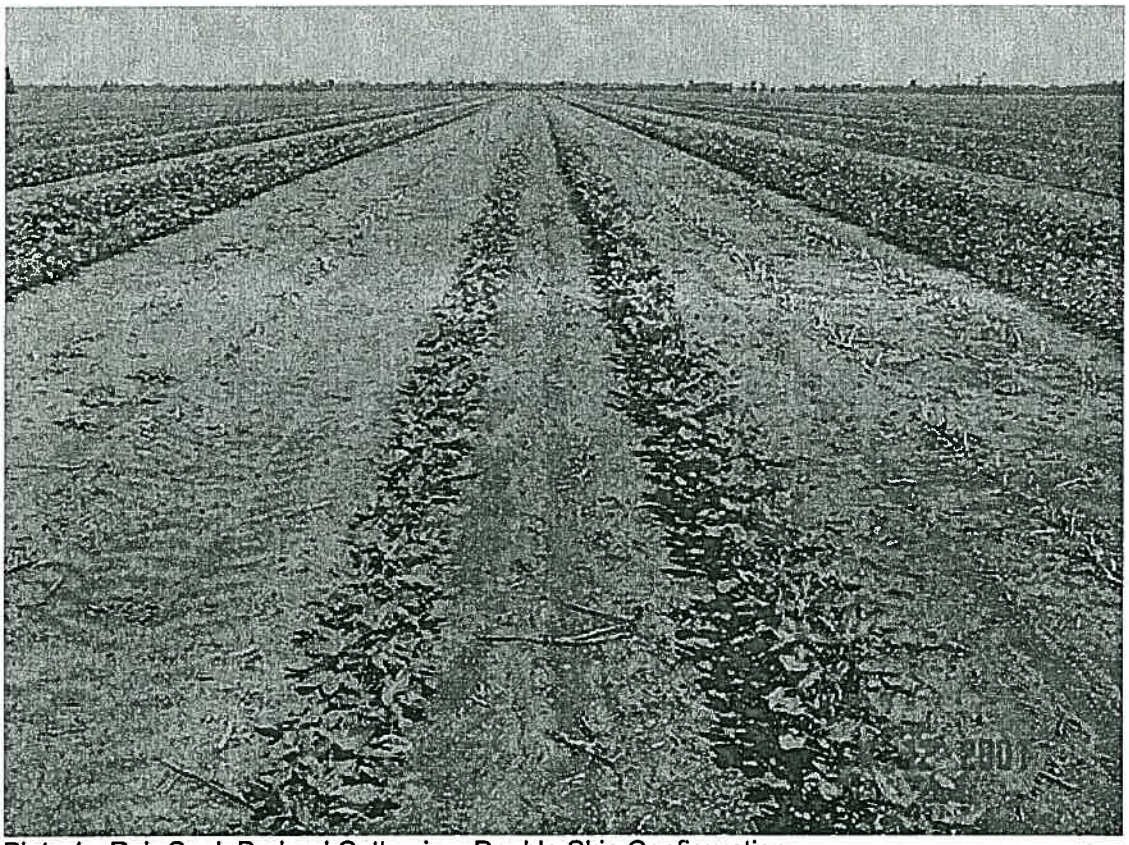

Plate 1 - Rob Cook Dryland Cotton in a Double Skip Configuration.

Plate 1 shows Rob's Cotton Crop planted into Cotton Stubble from the previous crop from 2 years ago. Rob applies trifluralin in a band over the row and cultivates the rest of the area.
Plate 2 shows the weeds growing outside the trifluralin band and the clean band in the cotton row. The first weed count was done at this stage just before in was inter-row cultivated. The main weed growing here is Red Pigweed. Even though Red Pigweed is a high-density weed – Rob feels there are options available to control it in the cotton crop.
Plate 3 shows Rob Cook's hardest to control weed – Bladder Ketmia. The main reason Bladder Ketmia is Rob's worst weed is because at times he allows it to seed in the fallow period.

Plate 2 – Rob Cook's dryland Cotton – Showing weeds growing outside the trifluralin band.

Plate 3 – Rob Cook's Cotton with a Bladder Ketmia growing outside the flurometuron, trifluralin herbicide band.

From the 4th December 2001 till the 9th May 2002, the cotton paddock had a;

- inter-row cultivation (5-6th December 2001),
- Shield spraying with Glyphosate @ 1.2 lt/ha + Starane @ 0.1 lt/ha (20-21st December 2001)
- Picked, Slashed, Root cut - April 2002,
- Sprayed early May – glyphosate1.3 lt/ha + Surpass 0.5 lt/ha.
- Monitored 1-5-2002
- Weeds observed in the paddock that had seeded
  - Bladder Ketmia
  - Redshank
  - Red Pigweed

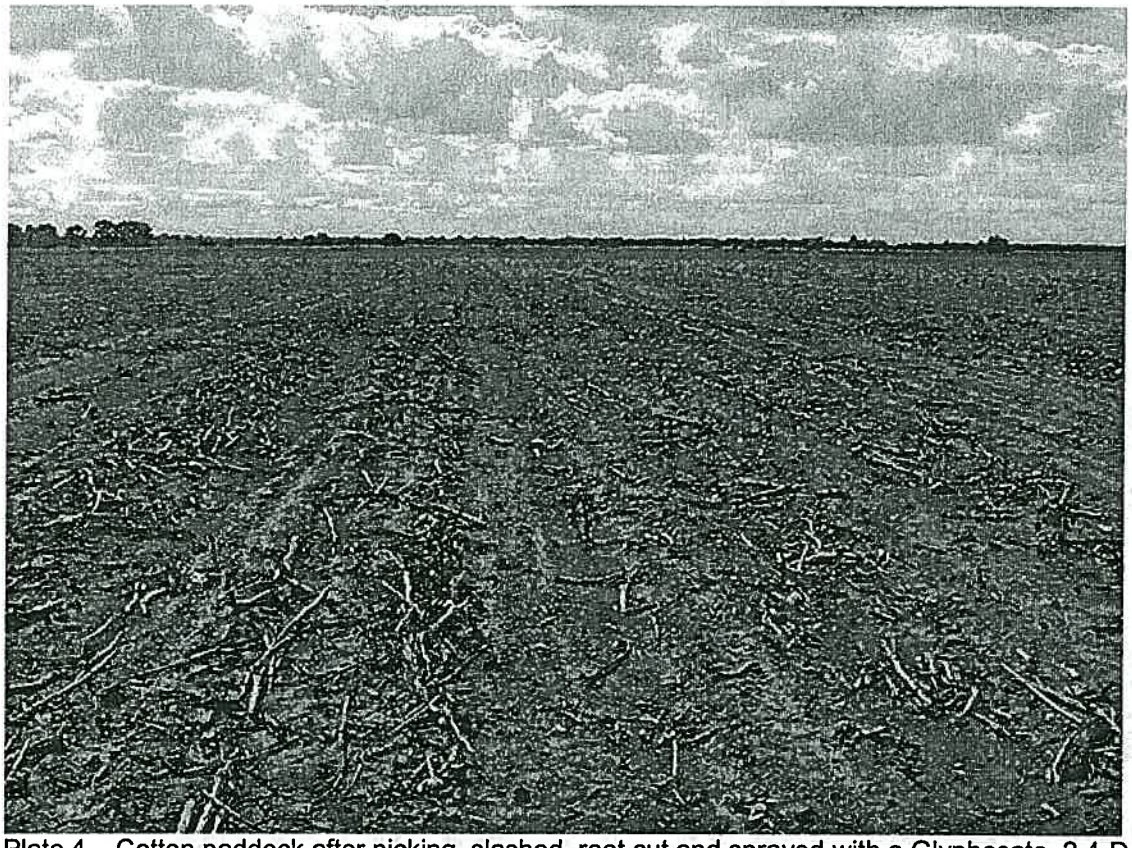

Plate 4 – Cotton paddock after picking, slashed, root cut and sprayed with a Glyphosate, 2,4-D mix but prior to the Pupae Busting Cultivation.

Plate 5 – Fallow paddock after last years Cotton crop, showing the high density of Bladder Ketmia. Paddock was monitored just prior to a Fallow spray.

Plate 5 shows the density of Bladder Ketmia Rob is dealing with. This particular paddock went to seed while he was in hospital having an operation. This happened about 4 years ago and Rob is still fighting the problem.

From the 4th December 2001 to 2nd May 2002 the fallow paddock had the following operations:

- 28th November 2001 – Roundup MAX – 1.4 lt/ha + Starane – 50 ml/ha
- 28th December 2001 – Wideline Cultivation
- 21st February 2002 – 1.1 lt/ha Glyphosate CT + 300ml/ha Starane
- 18th March 2002 – Wideline Cultivation – Nitrogen Fertiliser
- 17th April 2002 – 1.2 lt/ha Glyphosate CT + 500 ml/ha Surpass (1/2 Paddock)
- 23rd April 2002 - 1.2 lt/ha Glyphosate CT + 500 ml/ha Surpass (1/2 Paddock)
- 2nd May 2002 – Monitored Paddock. Very Clean of weeds – no plants had seeded.

Rob was conscious of the Bladder Ketmia problem in this paddock and was keen not to let the weeds seed. Volunteer Cotton was one of the hardest to kill weeds. Even though it was not considered a problem it did get through a lot of the operations.

Plate 6 – Fallow paddock – 2nd weed monitor.

Summary

Rob has been growing dryland cotton successfully for over ten years and has a weed program for his weed spectrum. Bladder Ketmia is the one weed, which is still a problem in his cotton crops. Herbicides available in cotton are weak on Bladder Ketmia because it is in the Hibiscus family as is cotton. This farm has shown the importance of controlling weeds in the fallow period. Weed density in the cotton crop is usually a result of the weeds escaping and seeding in the fallow period.

Farm 2 – Christopher Higton – Pittsworth

Two Cotton paddocks were monitored on Christopher's farms. One cotton crop was grown in the Cotton – Long Fallow – Cotton rotation; the other cotton paddock was grown in a long fallow after corn. The fallow paddock monitored was from cotton last year and was being fallowed to another cotton crop with a summer fallow in between.
Bladder Ketmia, Cow vine, Red pigweed and Volunteer Cotton were the weeds not controlled to Christopher's satisfaction.
As seen by Plate 8, even after a banded herbicide and inter-row cultivation Bladder Ketmia is still a problem. Staple Herbicide will control the Amaranthus, which are showing in Plate 7, however Staple does not control Red Pigweed or Bladder Ketmia. As mentioned earlier because Bladder Ketmia is in the hibiscus Family (As is Cotton), the range of Cotton herbicides do not offer good control of Bladder Ketmia.
Red Pigweed is becoming more of a problem in dryland cotton as growers move into reduced tillage. In conventional tillage growers can use trifluralin and cultivate it in the soil. With reduced tillage growers are keeping the stubble and are reluctant to remove it and use trifluralin.
Volunteer cotton was mentioned as a weed on Christopher's property and it showed up at a lot of the farms and was said in passing that it was hard to kill.

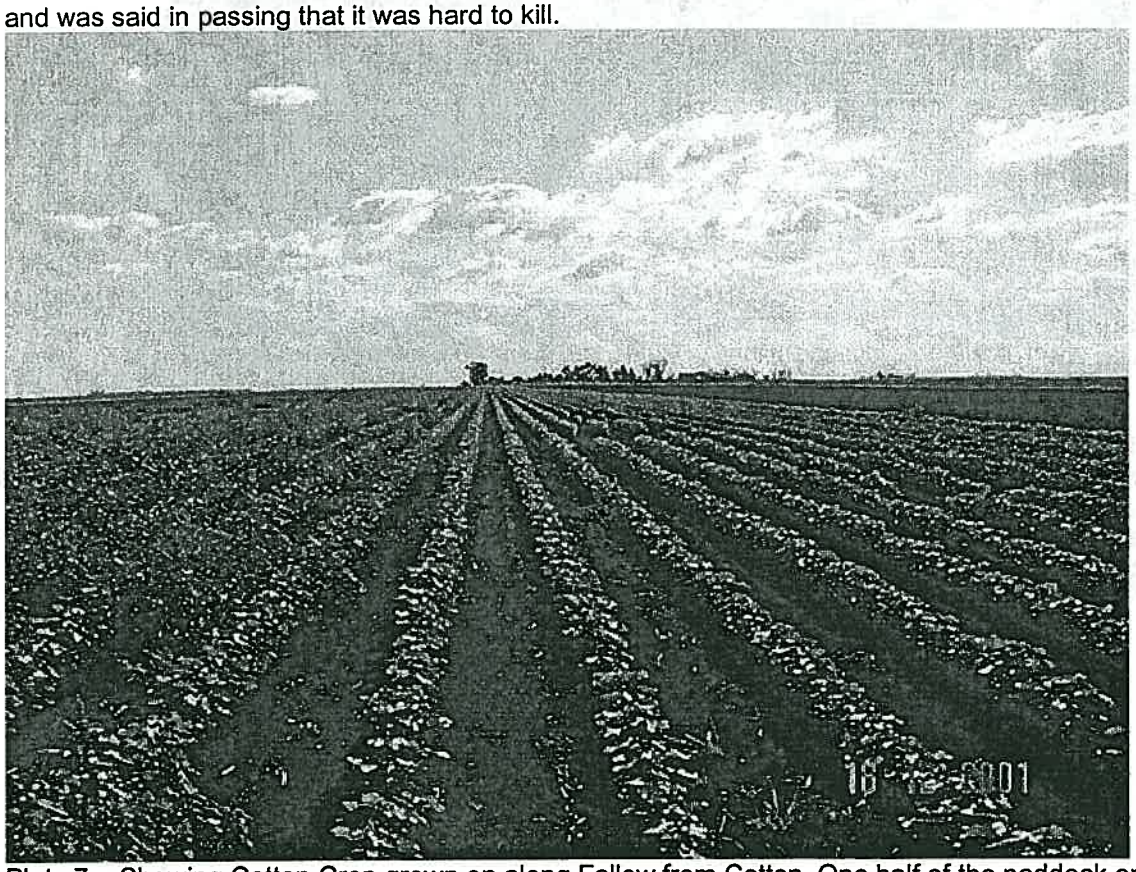

Plate 7 – Showing Cotton Crop grown on along Fallow from Cotton. One half of the paddock on the right had been cultivated while the half on the left had yet to be cultivated due to rain interrupting.

Plate 8 – Cotton after inter-row cultivation showing Bladder Ketmia left in the row of Cotton.

Weed control treatments between 18th December 2001 and 29th April 2002 in the cotton crop were:
October – Planting Cotogard @ 3.5 lt/ha + Diuron @ 1.0 lt/ha
November – Staple @ 60 gm/ha 50% band over row
December – Inter-row cultivation
18th December – 1st weed assessment
29th April – 2nd weed assessment

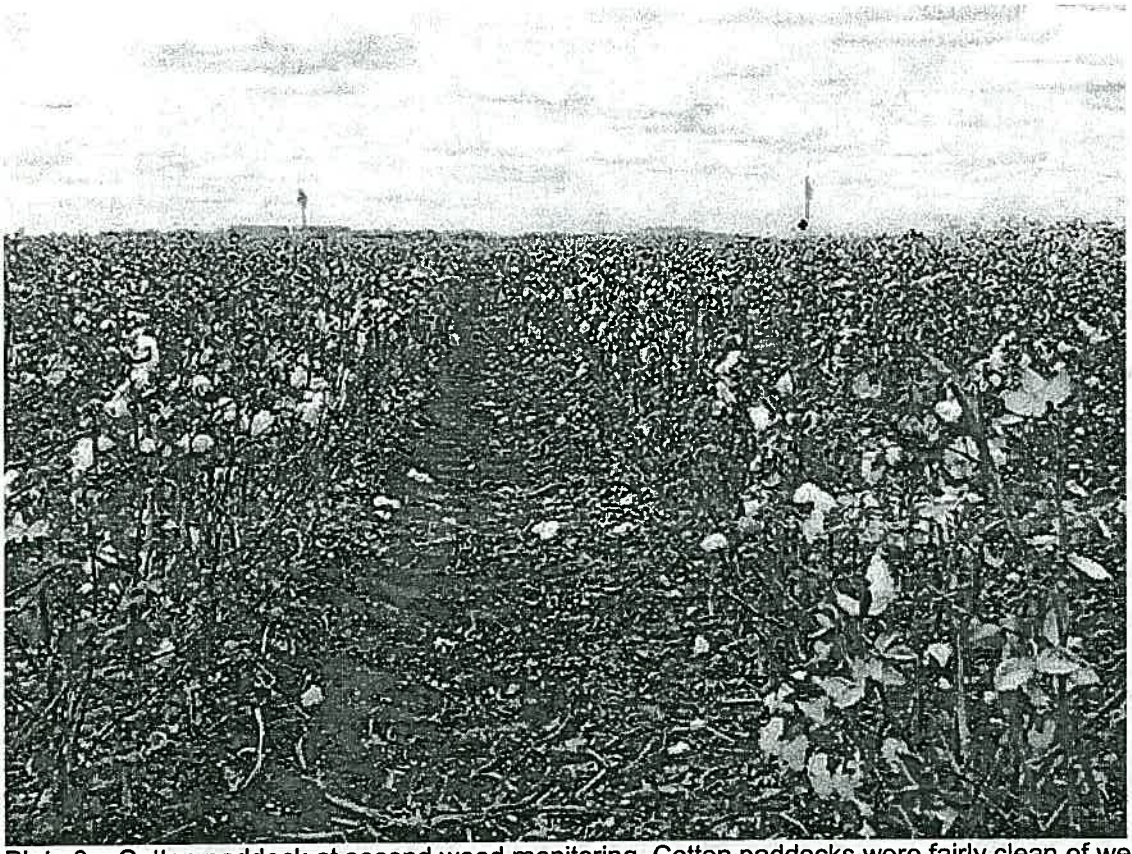

Plate 9 – Cotton paddock at second weed monitoring. Cotton paddocks were fairly clean of weeds due to the particularly dry end to the summer season. Any weeds that were present were seeding at time of inspection

Field 25 – Fallow Paddock

Paddock was fallow from Cotton 2000-2001.

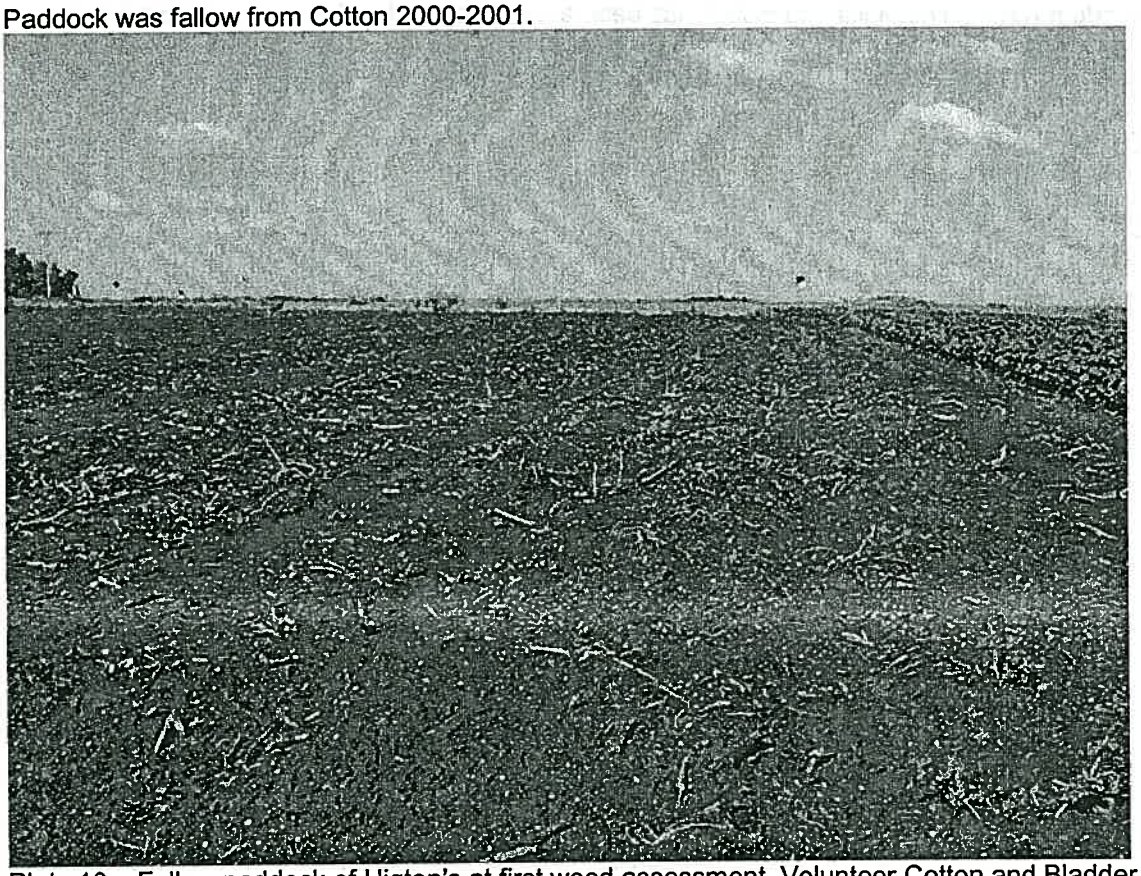

Plate 10 – Fallow paddock of Higton's at first weed assessment. Volunteer Cotton and Bladder Ketmia were the main weeds present.

Plate 11 – Higton's Fallow paddock showing Bladder Ketmia at various stages.

Plate 10 &11 - show Higton's fallow paddock where it has been worked after the last cotton crop. The high numbers of Bladder Ketmia seedlings suggests it has been allowed to seed in the previous cotton crop. There were high numbers of cotton seedlings in the paddock.
Treatments from the 18th December 2001 to 29th April 2002 on the Fallow paddock were;
18th December – 1st weed assessment
January – Chisel Ploughed
February – Chisel Plough
April – Glyphosate 1.5 lt/ha
29th April – 2nd weed assessment

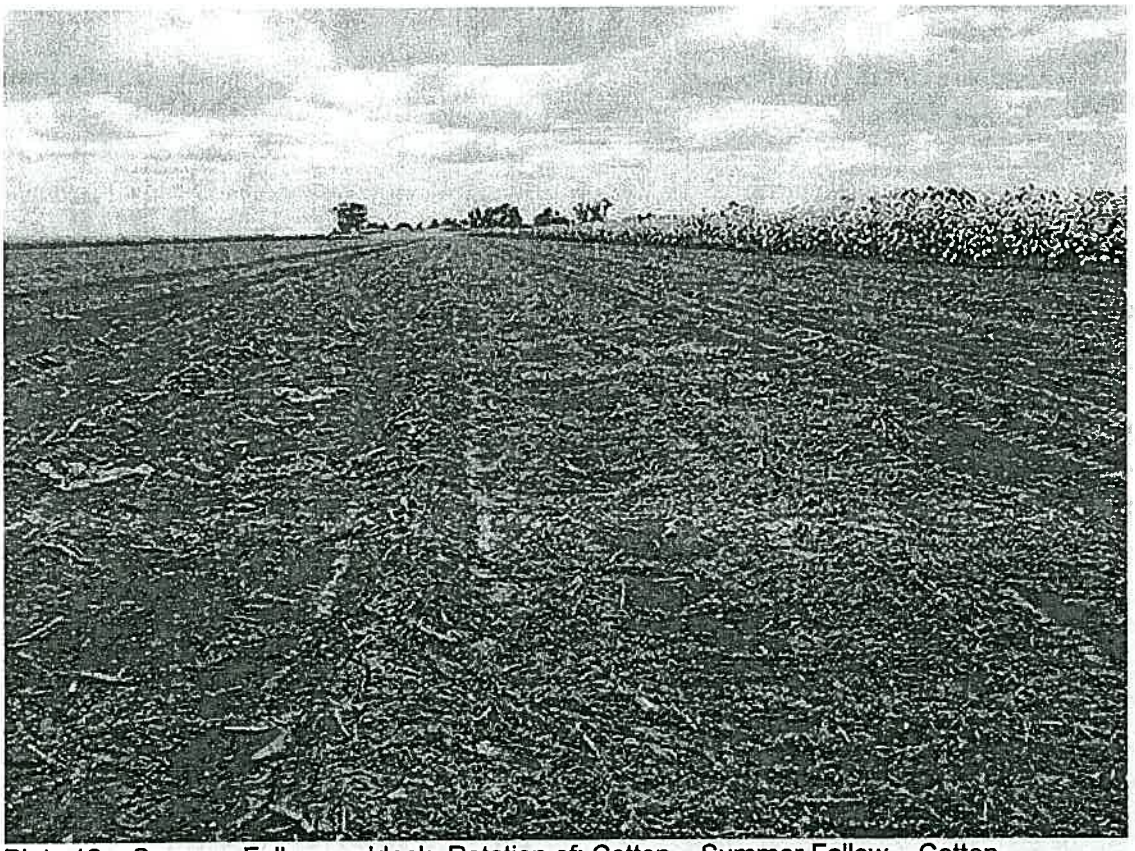

Plate 12 – Summer Fallow paddock. Rotation of; Cotton – Summer Fallow – Cotton.

Plate 13 – Fallow paddock showing that Dwarf Amaranthus produced seed before the plant was killed.

The Fallow paddocks show the problem with Dwarf Amaranthus in that it runs to seed very quickly. Fortunately in cotton there is a range of herbicides available that controls Amaranthus species very well.

Farm 3 – St John Kent – Jimbour

Cotton – Strip 20

No initial photos of St John's farm, as it was one of the first farms monitored.
Worst weeds in cotton are Bladder Ketmia and Cow Vine, while regrowth cotton and Milk Thistles (Sow Thistles) are the hardest to kill weeds in the fallow.

Operations in the cotton crop were:
01-11-01 - Herbicide at planting – Gesagard – 4.0 lt/ha over row in a 40% Band
12-12-01 – 1st Inter row cultivation
31-12-01 – 2nd Inter row cultivation
December – January – Chipping
January – Shielded Spraying – Spraying between Cotton rows
- 1 lt/ha Glyphosate CT + 0.35 lt/ha Starane

Paddock is being planted to wheat (12-7-01) for ground cover and long fallowed to cotton.

Plate 14 – St John Kent's Single Skip Cotton crop – Picked and Slashed prior to being planted to wheat.

Cotton Fallow – Strip 19

Paddock had cotton in 2000-2001 season and is being fallowed to cotton in 2002-2003 season.
Herbicide treatments since start of monitoring were:

5-12-01 – Roundup MAX @ 1 lt/ha + Starane @ 0.5 lt/ha
13-1-02 – Touchdown @ 0.94 lt/ha + Starane @ 0.47 lt/ha
24-1-02 – 2,4-D amine 600 @ 0.24 lt/ha
5-3-02 - Glyphosate CT @ 0.95 lt/ha + Surpass 300 @ 1.4 lt/ha
12-4-02 – Glyphosate CT @ 0.6 lt/ha + 2,4-D amine 600 @ 0.2 lt/ha
18-5-02 - Glyphosate CT @ 0.8 lt/ha + 2,4-D amine 100 @ 0.2 lt/ha

From Plate 15 it shows that some of the cotton plants had some size about them before they were controlled. The Roundup + Starane mix was not controlling the cotton plants very well but growers were trying alternatives to 2,4-D as they were using standard nozzles and they are worried about drift onto cotton. The use of surpass with Glyphosate using rain-drop nozzles to reduce drift seemed the best option for control.

Strip 3 - Sorghum Crop

4-12-01 – Planted to sorghum.
4-12-01 – 25% Band of Atrazine @ 2 lt/ha over the sorghum row.
4-12-01 – Post-plant, pre-emergent application – Roundup MAX @ 1 lt/ha + 2,4-D amine 600 @ 0.1 lt/ha.
18-3-01 – Pre-harvest application Glyphosate CT @ 1.5 lt/ha.
Early April – Sorghum Harvested.
12-4-02 – Glyphosate CT @ 0.6 lt/ha + Surpass 300 @ 0.2 lt/ha.

Plate 15 – St John Kent's Strip 19 - Cotton fallow showing dead Cotton Plants.

Plate 16 – St John Kent's Strip 3 - Single Skip sorghum

Plate 17 – St John Kent's Strip 3 – Single skip sorghum showing seeded Bladder Ketmia.

The skip row sorghum allows light to penetrate and there appeared more weeds in the skip. In solid sorghum crops there appeared to be less weeds due to the canopy cover of the sorghum. To overcome this problem a high clearance sprayer would have to apply a herbicide late in the growth of the crop to prevent late germinating weeds to seed before the Pre-harvest application of Glyphosate.

Farm 4 – Rick Matthews – Jondaryan

Rick Matthews grew cotton in the 2000-2001 season and there was a cotton fallow paddock to monitor. Rick did not grow cotton in the 2001-2002 season and grew Sunflowers and corn in the paddocks designated for cotton due to the drop in cotton price.

Strip 5 – Cotton Fallow

This strip will be fallowed to Cotton in 2002-2003 or another summer crop depending on commodity prices. Cotton picked in 2001. Since then cotton had been cultivated (Pupae busted), sprayed with Roundup CT Extra @ 1 lt/ha, and cultivated again.
Weeds monitored 13-12-01.

Although the paddock looks clean, close inspection as shown in the Plate 19 shows the large number of Bladder Ketmia germinated. Again this is usually because Bladder Ketmia is hard to control and seeded in the cotton crop.

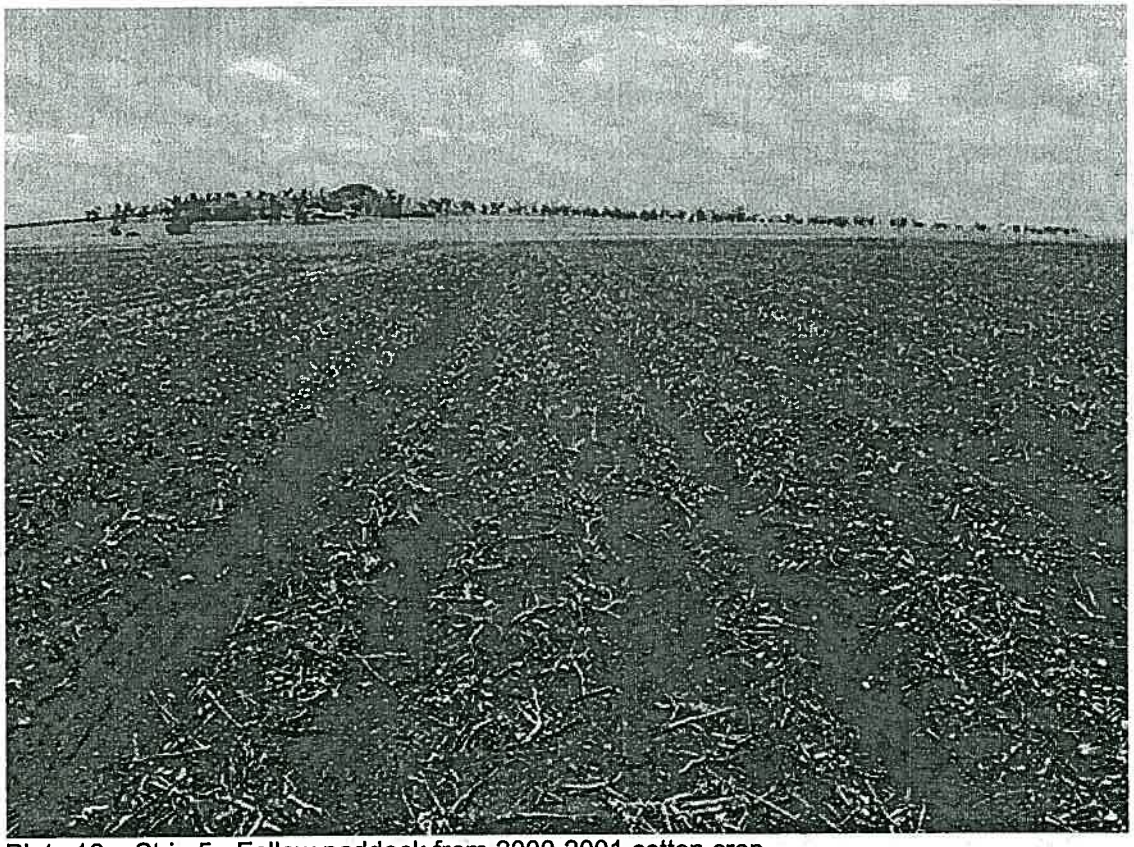

Plate 18 – Strip 5 - Fallow paddock from 2000-2001 cotton crop.

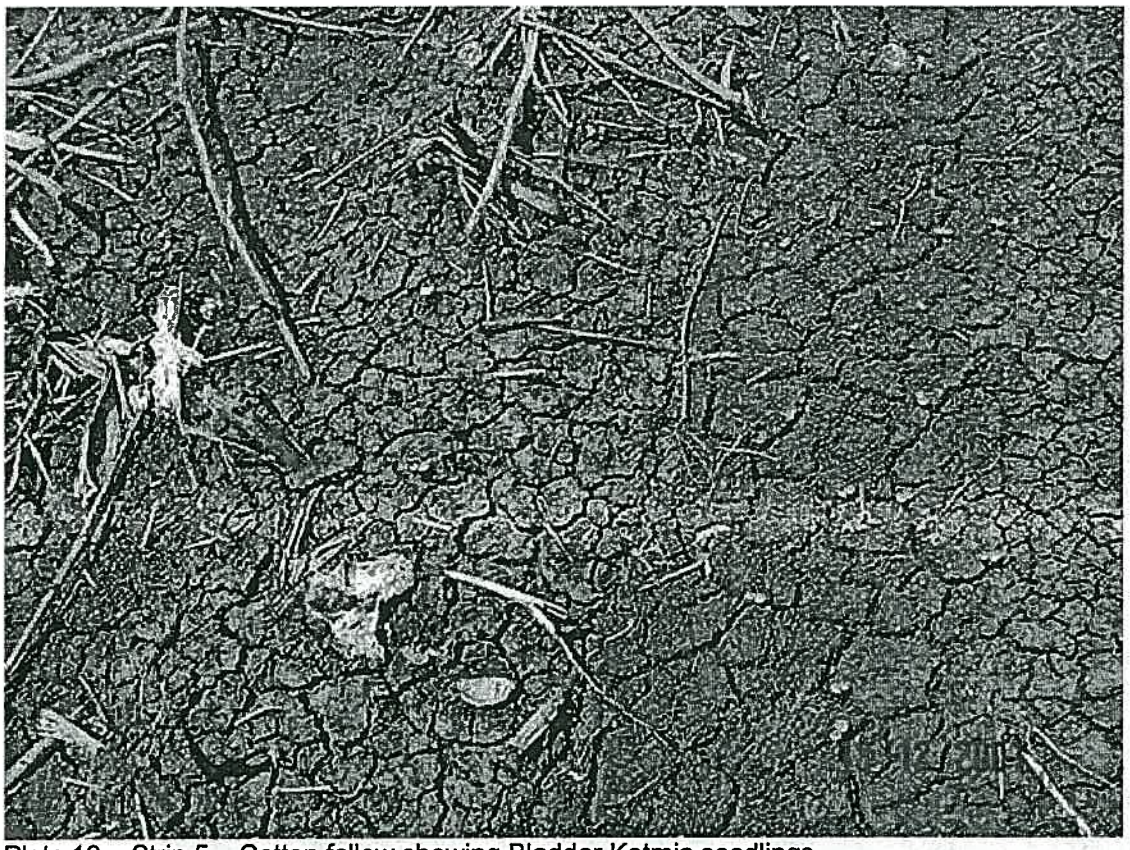

Plate 19 – Strip 5 – Cotton fallow showing Bladder Ketmia seedlings.

Weed control between two inspections:

- February – 1 lt/ha Roundup MAX
- Early April – Cultivated.

Even after the cultivation large Sow Thistles as shown in Plate20 Often are not controlled and if left to seed, adding to the seed bank.

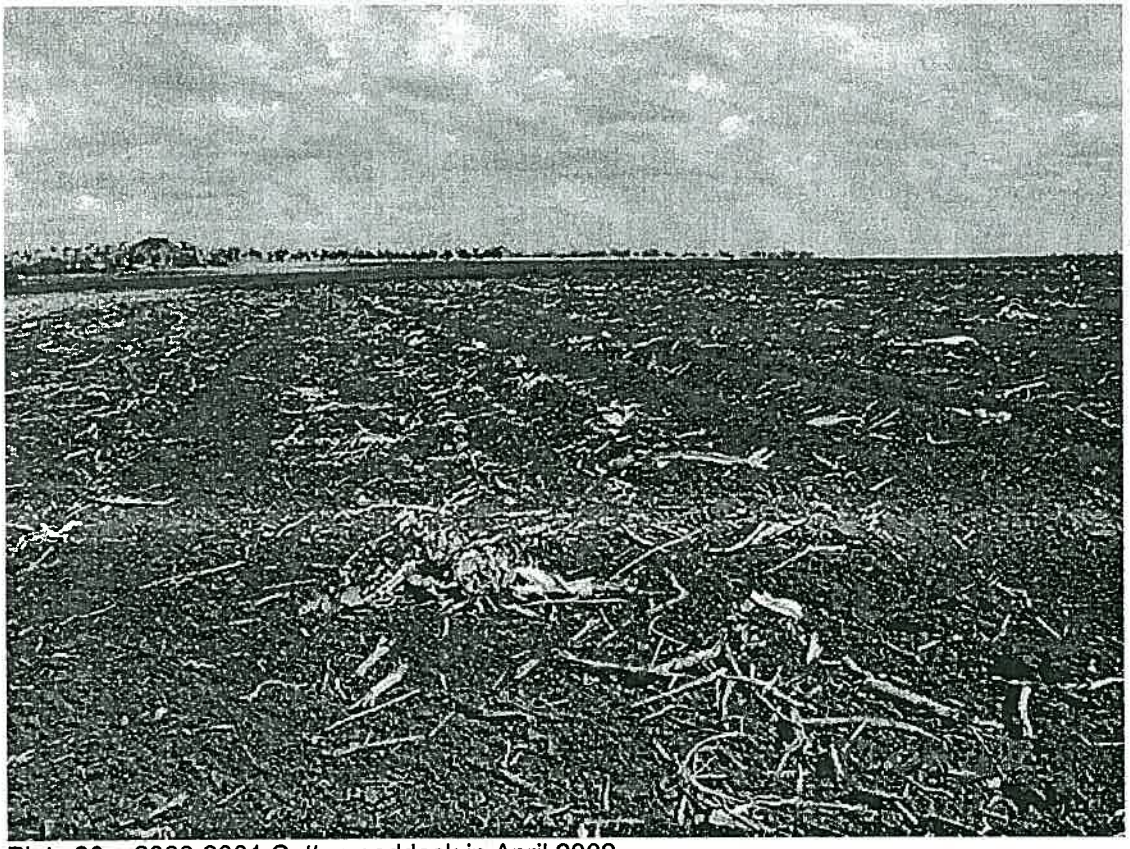

Plate 20 – 2000-2001 Cotton paddock in April 2002.

Strip 4 Corn 1999-2000 planted to Corn December 2001.

The paddock was fallowed for cotton but due to low cotton prices grower did not plant cotton this year.

This paddock was planted to Corn on the 5th December. The paddock received 4 lt/ha Atrazine at planting which was the only weed control during the growth of the crop. At time of weed monitoring small weeds were present and were showing yellowing due to Atrazine. Bladder Ketmia and Yellow Vine have a habit of germinating below the Atrazine layer and surviving to produce seed.
The weed assessment in April 2002 of this paddock showed that Yellow Vine and Bladder Ketmia did survive the Atrazine treatment and seeded.

Plate 21 – Strip 4 – showing young corn establishment

Plate 22 - Strip 4 on Rick Matthews farm showing mature Bladder Ketmia plants, which have produced seed.

Strip 2 - Sunflowers.

This paddock would have been planted to Cotton but due to the price Rick Matthews decided to plant Sunflowers into this strip. Initial weed assessment in the sunflowers as shown in Plate 23 shows small Yellow Vine in the crop. The Sunflower crop received 1 lt/ha Roundup CT and 3.5 lt/ha Stomp at planting to control weeds that were present and to control weeds in the crop. The Stomp did not control Yellow Vine as shown in the initial assessment.

Treatments on Strip –2 where the Sunflowers were grown were;

- Crop Harvested
- Immediately sprayed with 1 lt/ha roundup MAX plus 0.05 m lt/ha 2,4-D amine plus 0.05 m lt/ha Tordon 75-D.

Bladder Ketmia, Rynchosia, Yellow Vine, Amaranthus sp. that were recorded in the weed count all seeded before harvest. This highlights the problems with weed control in sunflowers, which adds weed seeds to the seed bank for future crops.

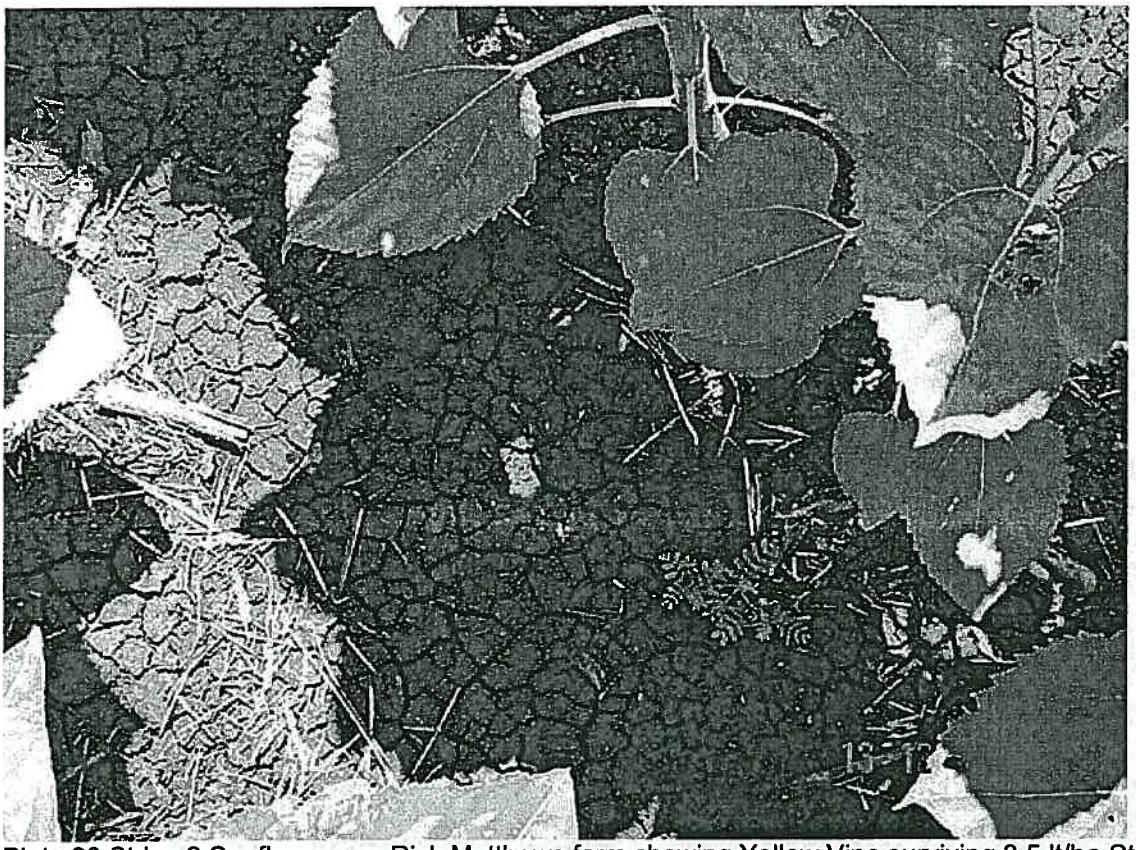

Plate 23 Strip –2 Sunflowers on Rick Matthews farm showing Yellow Vine surviving 3.5 lt/ha Stomp treatment.

Plate 24 – Strip 2 Sunflower paddock after harvest.

Strip 3 –Wheat 2001 – Fallow Paddocks

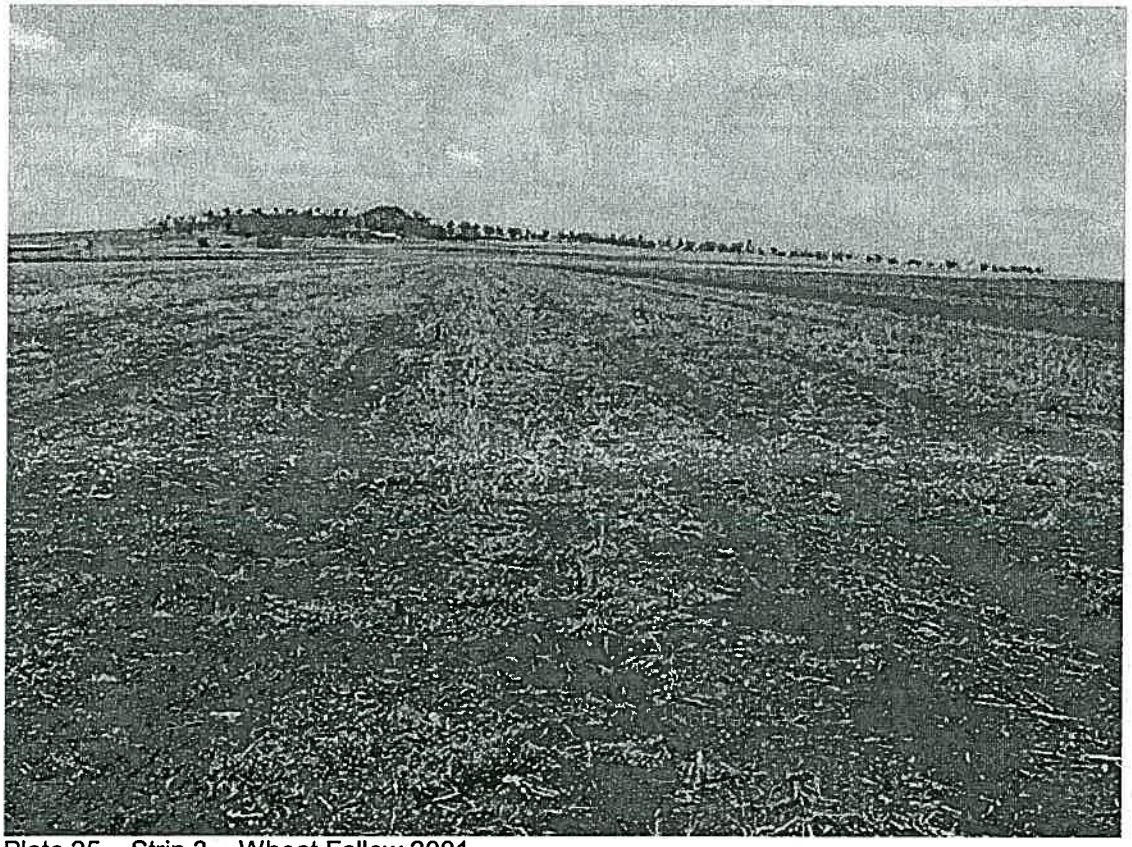

Plate 25 – Strip 3 - Wheat Fallow 2001
Wheat had no in-crop rain and just prior to assessment the paddock received:
Roundup MAX @ 1 lt/ha. The Bladder Ketmia and yellow vine had seeded prior to the spraying.

10-12-01 – Paddock sprayed with Roundup MAX @ 1 lt/ha
13-12-01 – Paddock monitored for weeds.
1-2-02 - Paddock sprayed with Roundup MAX @ 1 lt/ha + Dicamba 500 @ 0.05 lt/ha
3-4-02 - Paddock sprayed with Roundup MAX @ 1 lt/ha + Dicamba 500 @ 0.05 lt/ha
29-4 02 – Weed assessment.

Plate 26 shows that the weeds were quite advanced prior to the last spraying and hence some weeds had seeded. Weeds that had seeded were Bladder Ketmia, Sow Thistles and Amaranthus sp.

Plate 26 Strip 3 – Showing summer weeds seeded before being controlled with herbicide.

Farm 5 – Pat McVeigh – Jimbour

Pat McVeigh has flexibility in his cropping rotation, hence the large number of rotations and different cropping histories. The Jinbour Plain has dryland cotton as a main crop in the rotation; therefore it was important to try to capture the different weed densities in the different rotations.

Strip C-2 - Cotton 2001-2002

October - Cotton planted with – Cotogard @ 4.5 lt/ha in 50% Band over the row.
Early December – Staple 120gm/ha 50% band over row + Inter-row cultivation
17-12-01 – First weed assessment
December – January – Cotton crop was chipped for weeds in the row that survived the Staple herbicide and cultivation.
January – shielded spray Gesagard @ 2 lt/ha + diuron @ 2.0 lt/ha
27-3-02 – second weed assessment.

Plate 27 shows the weeds that survived the application of Staple over the row and the inter-row cultivation. The main weeds were Devil's Claw and Yellow Vine.

Due to dry period at the end of the summer, the cotton crop remained quite clean of weeds as shown in Plate 28 which was taken just after picking.

Plate 27 – Strip C-2 Pat McVeigh's cotton crop.

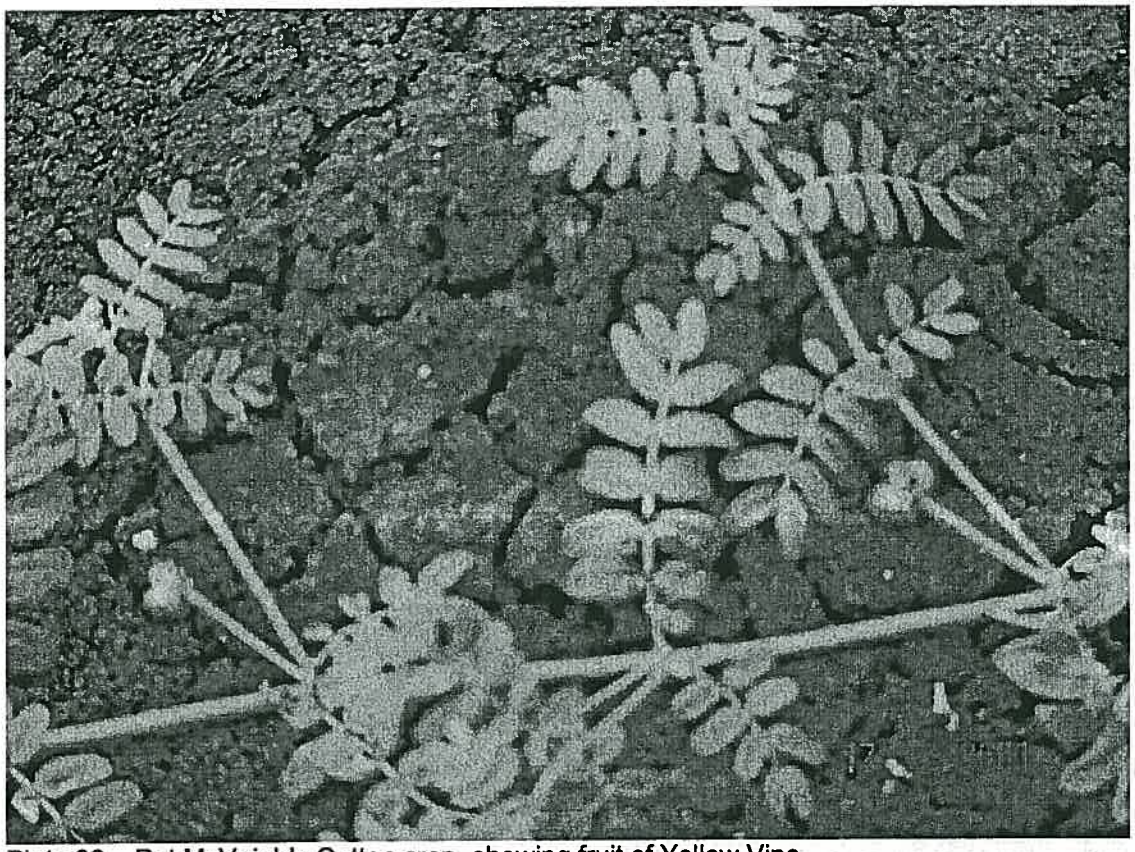

Plate 28 – Pat McVeigh's Cotton crop- showing fruit of Yellow Vine

Plate 29 – Strip C-2 – Cotton crop showing clean of weeds just after picking.

Strip PL-2 – Sorghum – 2nd Summer Cereal

This crop is the 2nd summer crop cereal, which is normally long fallowed to Cotton. Due to the long fallow period at the end of the sorghum crop Pat Mcveigh decided to plant the paddock to Barley to obtain stubble cover. Therefore instead of remaining fallow till cotton as per the rotation 3 suggested in Pat McVeigh's survey it was double cropped into Barley.

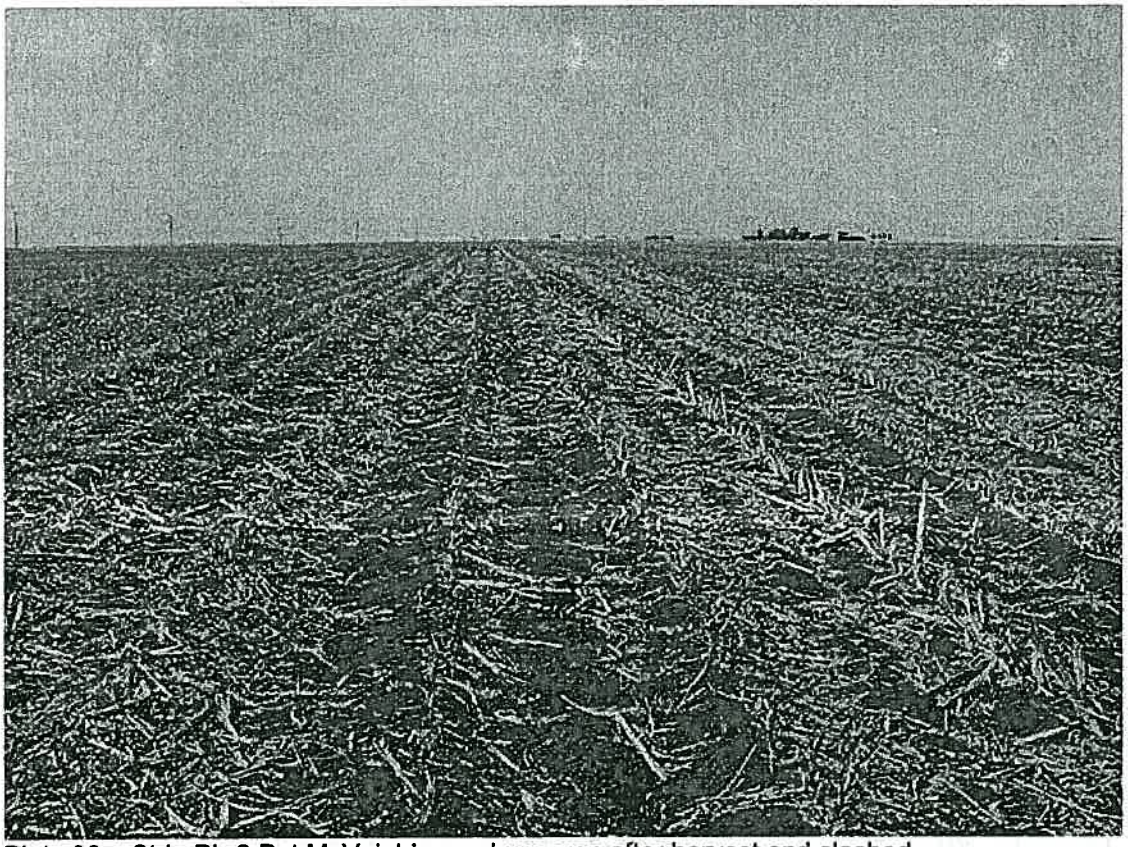

Plate 30 – Strip PL-2 Pat McVeigh's sorghum crop after harvest and slashed.

Plate 31 – Strip PL-2 - Sorghum crop double cropped into Barley.

October – Sorghum Planted.
October – Post-plant, Pre-emergent – Atrazine @ 4.0 lt/ha
March – Harvested, slashed.
27th March – paddock monitored for weeds.
April – Paddock cultivated.
June – paddock planted to Barley.

10-7-02 – weed assessment – no weeds in the paddock due to cultivation at planting time.

Strip PL – 5 – First Summer Cereal

Rotation – Cotton – **Corn** – Sorghum – Summer Fallow – Cotton

Paddock monitored at the stage when corn was growing.

Cotton was picked in 2001 and had been cultivated to keep weeds clean of weeds. December 2001 – Roundup CT @ 1.5 lt/ha + Starane @ 0.75 lt/ha
17-12-01 – Weed Assessment
Corn Planted end of December 2001
January -Corn inter-row cultivated for weed control.
Corn Harvested and slashed in June/July 2002
Due to dry finish to the summer season, the crop stayed clean of weeds. Regrowth cotton is still a problem as shown in Plate 34. Even though Bladder Ketmia is small it has managed to throw up a seedpod, as shown in Plate 35.

Plate 32 – PL – 5 Volunteer Cotton in the first weed assessment. Weeds slightly affected from spray.

Plate 33 – Strip PL –5 Corn after harvested and slashed.

Plate 34 – Strip PL-5 showing regrowth cotton still surviving after corn crop has been harvested and slashed.

Plate 35 – Strip PL-5 Bladder Ketmia plant in harvested corn paddock.

Strip G2-A – Cotton Fallow

Rotation for this paddock:
Cotton 2000-2001 – **Summer Fallow 2001-2002** – Cotton 2002-2003??

The summer fallow was kept clean of weeds and will be planted to cotton next summer season depending on cotton prices.

Paddock had been cultivated since the last cotton crop to control weeds.

Early December – Sprayed
17-12-01 – 1st weed Assessment.
January - Roundup CT @ 1.2 lt/ha + Surpass 300 @ 0.2 lt/ha
February – Roundup CT @ 1.2 lt/ha + Surpass 300 @ 0.2 lt/ha
February – Fertilised – Minimum till application of urea.
March – Cultivated with Gyral.
May - Roundup CT @ 1.2 lt/ha + Surpass 300 @ 0.2 lt/ha
14th May – Weed assessment. Weeds present affected by last spray, no weeds seeded.
June – Planted to wheat.

Paddock was in similar condition to PL-5 as in Plate 32. Treatment has been similar up to this stage as they were both Cotton in 2000-2001 season.

Paddock was destined to cotton but due to the low cotton price and the paddock not having a lot of moisture the paddock was planted to wheat. As there is not usually a lot of rainfall over the winter period, there was a low chance of adding enough moisture to ensure a cotton plant. This highlights that some farmers do not have a rigid rotation but have the flexibility to plant a crop when the weather permits.

Strip G2 – Barley Fallow

Rotation for this paddock will be Barley Stubble into Cotton.

17-12-01 – Initial weed assessment
January - Roundup CT @ 1.2 lt/ha + Surpass 300 @ 0.2 lt/ha
February – Roundup CT @ 1.2 lt/ha + Surpass 300 @ 0.2 lt/ha
February – Fertilised – Minimum till application of urea.
March – Cultivated with Gyral.
May - Roundup CT @ 1.2 lt/ha + Surpass 300 @ 0.2 lt/ha
14th May – Weed assessment. Weeds very isolated and affected by last spray. None of these weeds have seeded.

Paddock is fairly clean of weeds. Due to no weeds seeding during the fallow, it would suggest that this paddock would be a good paddock to manage in a crop of cotton.

Strip G-6A – Sorghum Fallow

17-12-01 – Initial weed assessment
January - Roundup CT @ 1.2 lt/ha + Surpass 300 @ 0.2 lt/ha
February – Roundup CT @ 1.2 lt/ha + Surpass 300 @ 0.2 lt/ha
February – Fertilised – Minimum till application of urea.
March – Cultivated with Gyral.
April – Glyphosate CT @ 1.2 lt/ha + Surpass @ 0.2 lt/ha
May – Cultivated with Gyral
June planted to wheat.

This is another paddock that was to be planted to cotton. When Cotton prices are very high, paddock are tended to be fallowed for longer. With the drop in Cotton price Pat McVeigh has not held as many paddock over for Cotton.

Contact with the farmer has made it obvious that rotations are not set in concrete. The cropping program has changed a number of times during the assessment period. Prices and moisture availability are the main factors that govern what crop is planted rather than likely weed problem.

Farm 6 - Mac Patterson – Goondiwindi

Mac Patterson in contrast to Pat McVeigh has a rigid cotton rotation. Fleabane was considered the worst weed where there was not satisfactory control.

The cotton rotation is:
Wheat – Summer Fallow – Wheat – S/F- W/F – Cotton Winter Fallow – S/F.
The four paddocks monitored were:

1. - The fallow after the first year wheat,
2. – The fallow after the second year wheat
3. – The summer fallow after cotton and
4. – The cotton crop.

MC Block 6B – 1st Year Wheat Fallow

The wheat crop had been sprayed for weeds and the paddock was in good order except for volunteer wheat and a few patches of Barnyard grass, Urochloa and Red Pigweed. The paddock had not been sprayed or cultivated since harvest.

November – Wheat harvested
6th December – First weed assessment
9th December – Roundup CT @ 1.4 lt/ha + Garlon @ 0.05 lt/ha
20th February – Roundup CT @ 1.2 lt/ha
March – Fire Harrowed and Fertilised – Urea 80 kg/ha – Direct drilled (Minimal disturbance)
21st March – 2nd weed assessment – No weeds due to harrow burning.
22nd April – Roundup CT @ 1.2 lt/ha
5th June - Roundup CT @ 0.08 lt/ha
10th June – Wheat Planted – minimum disturbance.
28th June – 3rd Weed assessment – No weeds crop emerging.

No weeds out of control. Paddock in very good order. Dry summer so weeds should not have been out of control as there was plenty of time to control weeds between rains.

TD Gravel Pit – 2nd year Wheat Fallow

Although there were no records of Fleabane in the weed count, however there were scattered plants in the paddock as shown in Plate 37.
These plants were flowering and if they were not controlled would add seed to the seed bank and be a problem in the future.

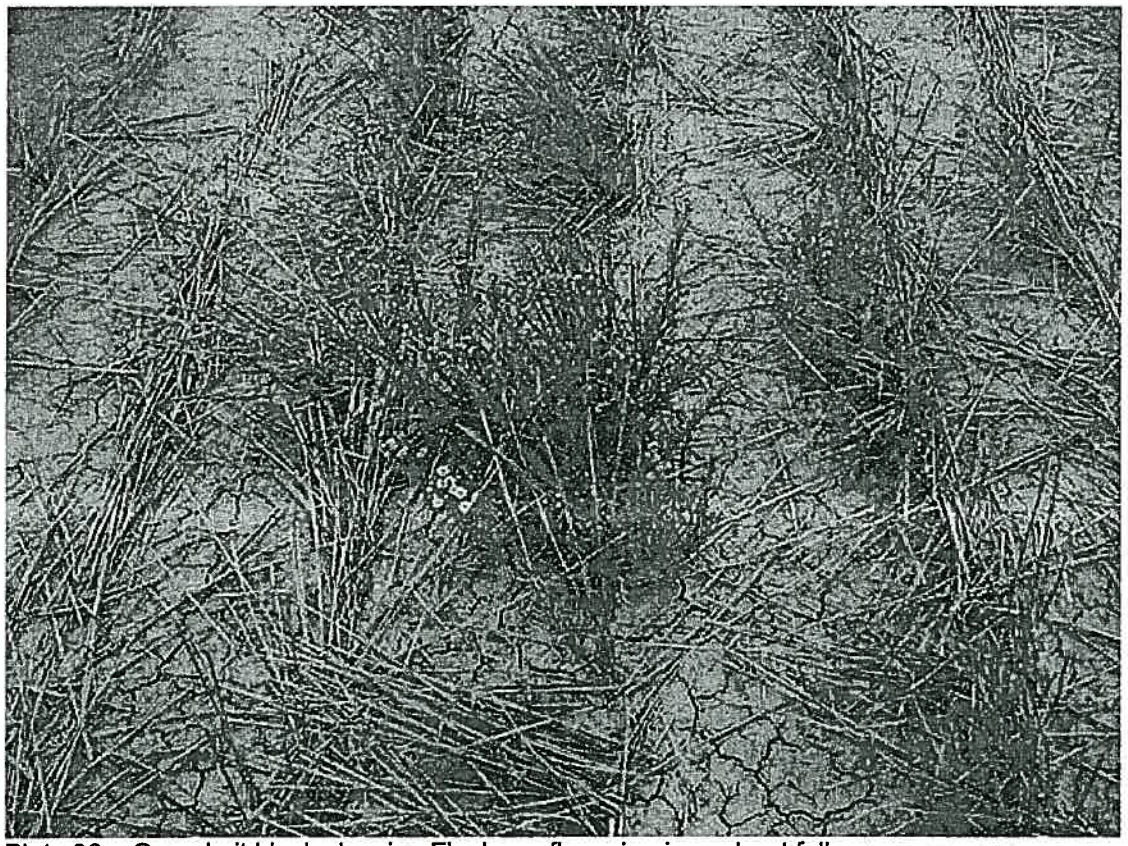

Plate 36 – Gravel pit block showing Fleabane flowering in a wheat fallow.

November – Wheat harvested
5th December – 1st weed assessment
9th December – Roundup CT @ 1.5 lt/ha + Ally @ 7 gm/ha
20th February – Roundup CT @ 1.5 lt/ha
17th April – Roundup CT @ 1.4 lt/ha
21st March – 2nd Weed Assessment
21st June – Roundup CT @ 0.8 lt/ha + Surpass 300 @ 1.2 lt/ha

Paddock kept in good order except for odd fleabane that seeded, which showed up in the second weed count.

Block 3 – Summer Fallow after Cotton

Paddock had a scattering of weeds that were seeding, except the volunteer cotton, at time of assessment.

Cotton picked – April May 2001
Paddock had been ploughed during the winter as a pupae-busting operation.
4th December 2001 – 1st summer spray fro summer weeds.

- Roundup CT @ 1.7 lt/ha +Surpass 300 @ 1.7 lt/ha + Ally 5 gm/ha

5th December – 1st Weed assessment
19th January 2002 – Roundup CT @ 1.5 lt/ha
End of January – Urea applied 175 kg/ha – Full Cultivation
18th March – Roundup CT @ 1.5 lt/ha + Surpass 300 @ 1.0 lt/ha
21st March – 2nd Weed Inspection
17th April – Roundup CT @ 1.2 lt/ha + Ally @ 5 gm/ha
24th April – Deep Planted Wheat – Sunlin.
28th June – 3rd Weed assessment – No weeds present.

Paddock clean of residual summer weeds and no sign of winter weeds on the 3rd assessment.

TD Block W3 – Cotton Crop

October 2001 – Cotton planted Cotogard + Dual in the row.
15th November – Shield spray – Roundup CT @ 1.5 lt/ha
5th December 2001 – 1st Weed assessment.
15th December – Verdict 520 @ 0.15 lt/ha + Uptake Crop Oil
18th December – Spray.Seed @ 1.5 lt/ha + Diuron @ 2.5 lt/ha
21st March 2002 – 2nd Weed assessment

The fleabane growing in the cotton crop as shown in Plate 36, has escaped a spray and has branched out and usually very hard to control at this stage. Usually high rates of Glyphosate Ct are not enough to control the weed. A mix of Glyphosate CT and 2,4-D and Ally does a good job at controlling the weed, however the addition of 2,4-D and Ally is not practical in a growing cotton crop. The cotton crop is clean of other weeds however the amount of Fleabane in the cotton crop allowed to seed is a concern for future crops. Also it would add a lot of expense to the fallow costs having to spray for Fleabane.

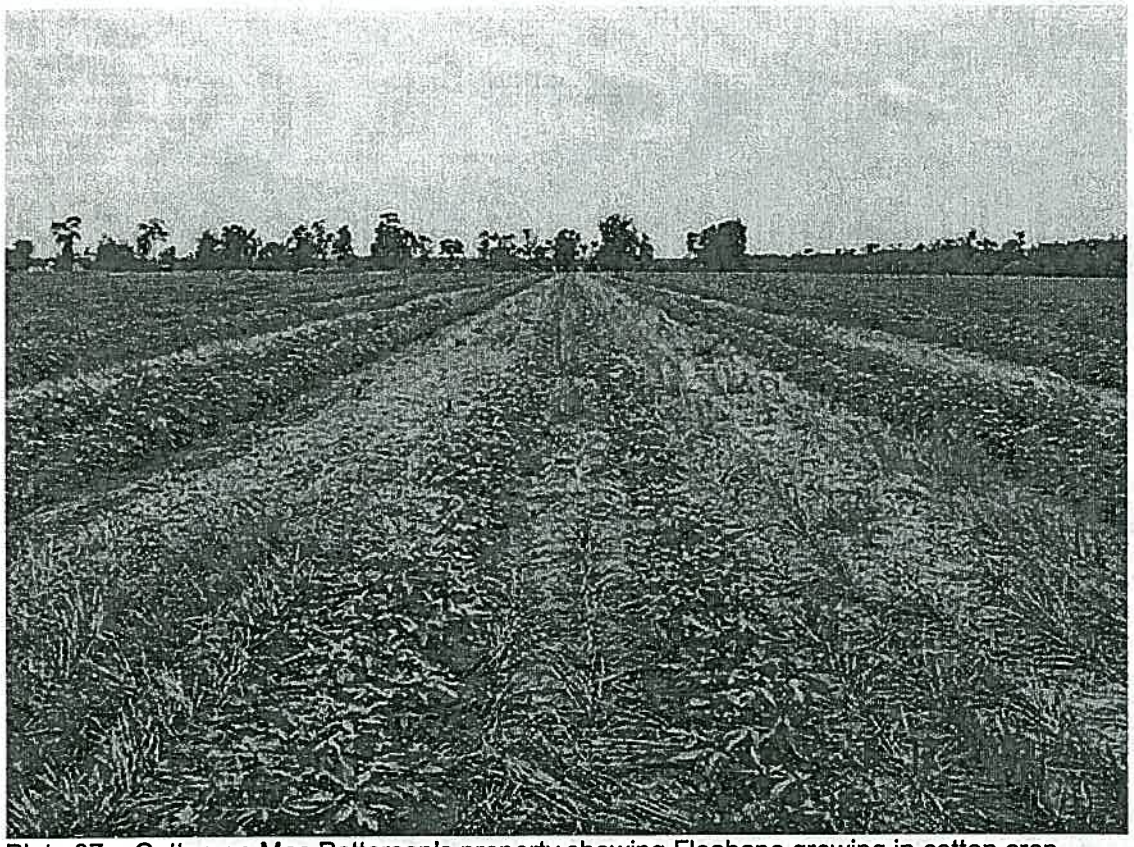

Plate 37 – Cotton on Mac Patterson's property showing Fleabane growing in cotton crop.

Plate 38 – Mac Patterson's cotton crop showing a healthy Fleabane plant growing.

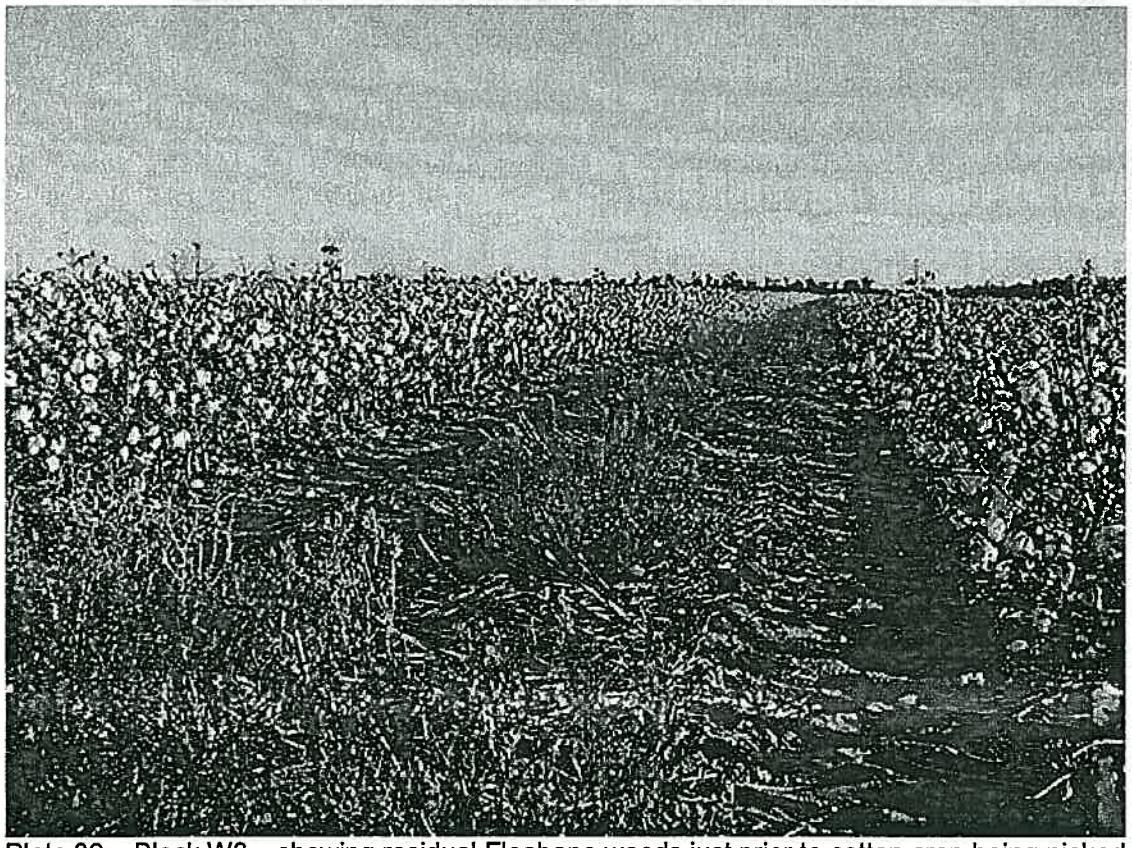

Plate 39 – Block W3 – showing residual Fleabane weeds just prior to cotton crop being picked.

The use of Spray.Seed and Diuron does not seem to do an adequate job of controlling Fleabane as seen in Plate 39.

Farm 6 – Stuart Stirling – Pittsworth

Stuart Stirling has been growing dryland cotton for a number of years. He grows dryland cotton every year and his cropping rotations are done to maximise his cotton profitability. His normal rotation is:
Cotton – Wheat – Summer Fallow – Winter Fallow – Cotton
Due to the dry winter last year he did no plant wheat and therefore the paddock was planted to sorghum instead and then next summer he will plant it back to cotton. One paddock where he planted wheat this year into last years cotton ground and then double cropped mung beans back into the wheat straw. This is due to a paddock of cotton doing well where it had been planted after a legume crop.
Stuart's property is on a lighter soil and the main weeds are Bladder Ketmia, Bathurst Burr and Buckwheat in the winter.

Strip 3A - Cotton

Plate 40 – Sturt Stirling's cotton showing patches of Red Pigweed.

Red Pigweed was a weed mentioned by Stuart but not as weed that was not controlled satisfactory. While inspecting Stuart's crops Red Pigweed stood out to be not adequately controlled this summer period in the cotton and fallow. It is a weed that is hard to control if treflan cannot be used due to too much stubble.
This was a block of Roundup Ready cotton and Stuart said it has revolutionised the way they control Bladder Ketmia.

October – Cotton Planted
November – Roundup @ 1 kg/ha over the top of the cotton – 2 to 4 leaf stage
13th December – 1st weed assessment
January – Shield spray – Roundup @ 1 kg/ha
29th April – 2nd weed assessment

Plate 41 – Cotton paddock on Stuart Stirling's property showing Red Pigweed growing in the cotton after one Roundup application.

Plate 41 shows some new germinations of Red Pigweed and weeds not controlled fully by the Roundup application.

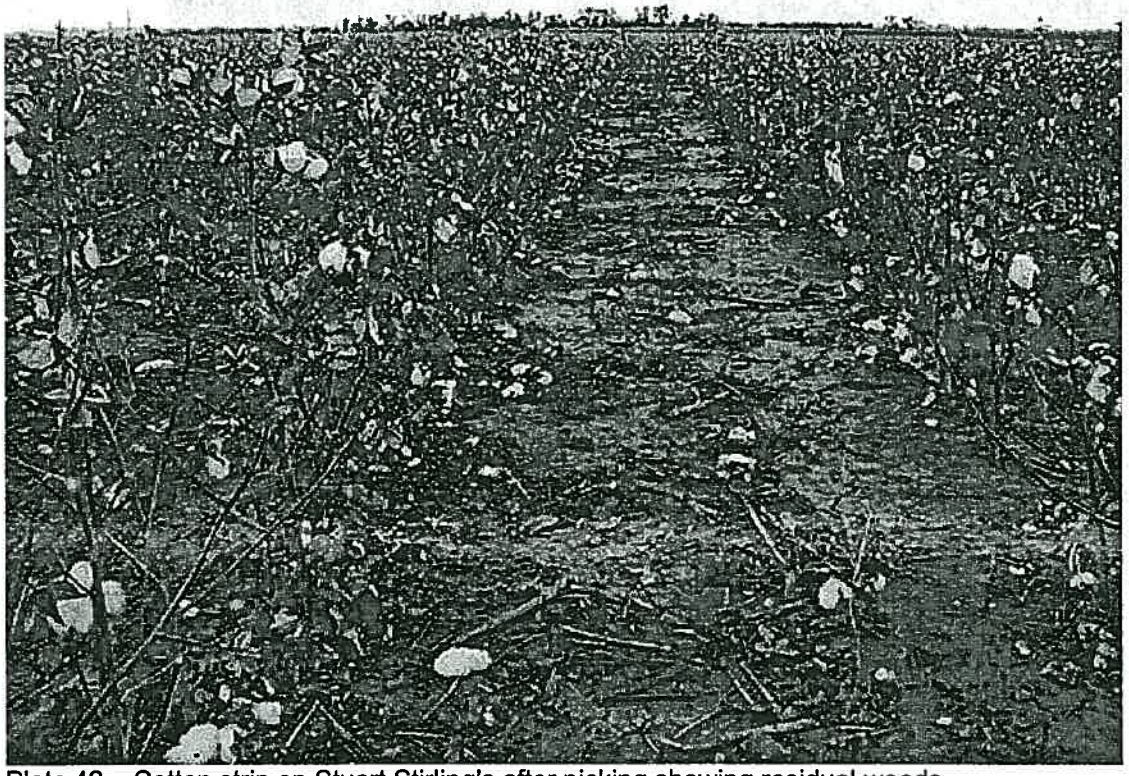

Plate 42 – Cotton strip on Stuart Stirling's after picking showing residual weeds.

Plate 42 shows weeds present at picking time. If paddock is cultivated or sprayed soon after picking, most weeds would not seed.

Strip 1 – Sorghum

Sorghum was planted into cotton ground from the previous summer as there was no winter cereal planted in the winter.

October – Sorghum planted
November – sprayed with Atrazine @ 1.5 lt/ha + Starane @ 0.5 lt/ha
13th December – 1st weed assessment
March – Pre-harvest application RoundupCT @ 2.0 lt/ha
Early April – Crop Harvested
Mid April – sprayed with Roundup CT @ 1.o lt/ha
29th April – 2nd weed assessment

Plate 43 – Sorghum paddock on Stuart Stirling's property showing weeds at the early stage of sorghum.

In the sorghum crop even though there seems to be a lot of Red Pigweed present the Atrazine + Starane would have done a good job at controlling the weed and giving residual for the rest of the crop. This is highlighted by the fact there was no Red Pigweed in the sorghum crop at the 2nd assessment. However there was barnyard grass in the sorghum crop that had seeded as shown in Plate 44.

Plate 44 – Sorghum on Stuart Stirling's property showing Barnyard grass seeding after harvest.

Strip 2 Cotton Fallow

Wheat was planted into the cotton stubble of the 2000-2001 cotton crop. The wheat was planted late and therefore it was very late maturing. As a result the spring rains caused a lot of summer weeds to germinate before the wheat had been harvested. The crop was sprayed before harvesting but most of the weeds had already seeded.

August – wheat planted
September – Ally @ 5 gm/ha + MCPA @ 0.5 lt/ha + Starane @ 0.5 lt/ha
1st December – Roundup MAX @ 1 lt/ha
13th December – 1st weed assessment
December – wheat Harvested
January – Planted Mung Beans as a soil conditioner
March – Mung Beans sprayed out at 1st Pod
29th April – 2nd Weed Assessment

A lot of weeds seeded in this paddock but the grower was not concerned due to the use of Roundup ready cotton. The main weeds were Sow Thistles, Bladder Ketmia, Urochloa and Barnyard grass.

On Stuart's property it appears the problem of weeds are being treated rather than looking for the cause of the weeds and working on that to stop them seeding.

Plate 44 – Stuart Stirling's property showing the weeds in the wheat crop. This is a missed strip from the roundup spray that was applied to the wheat crop before it was harvested.

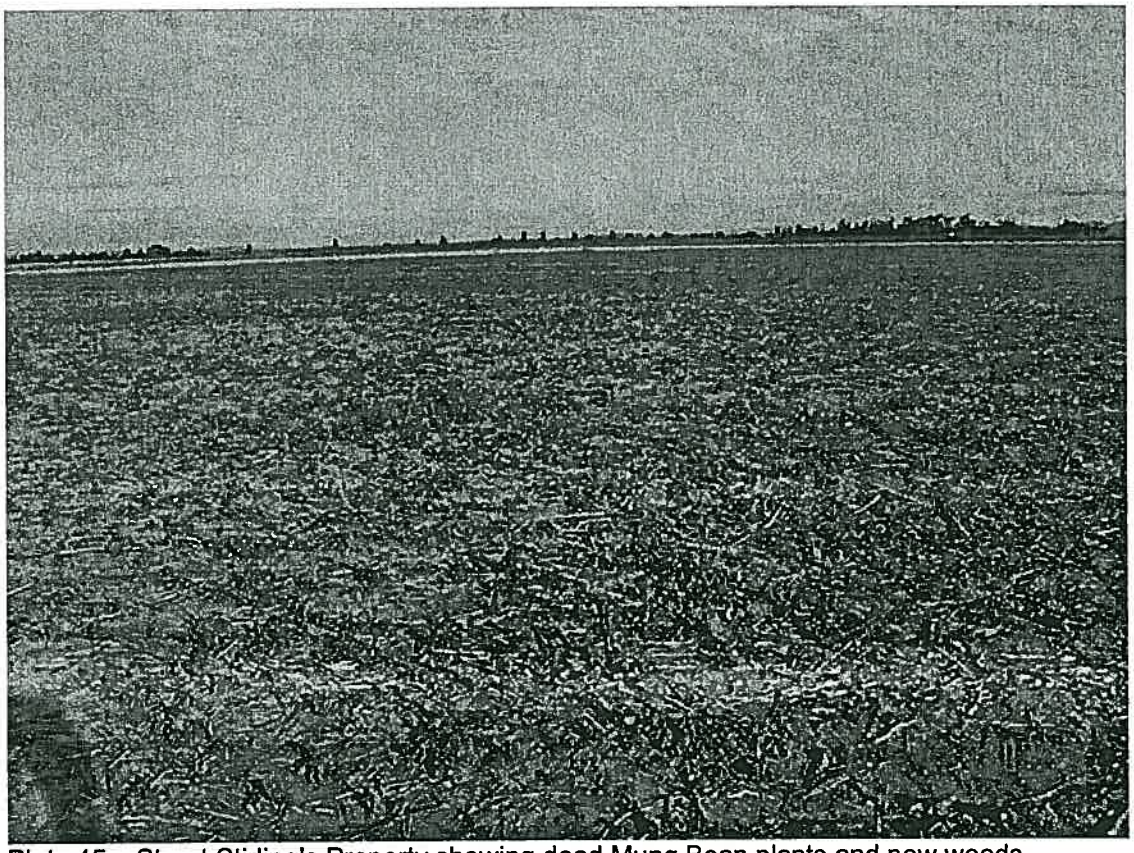

Plate 45 – Stuart Stirling's Property showing dead Mung Bean plants and new weeds.

Plate 46 – Strip 2 on Stuart Stirling's property showing close up of weeds.

Farm 8 – Peter Taylor – Gurley NSW

Peter's main rotation has been:
Wheat – Summer Fallow – Wheat – S/F – Winter Fallow – Cotton – W/F – S/F

In 2001 Peter has tried to double crop barley into cotton stubble to shorten the rotation.

Cotton – Barley – S/F – W/F – Cotton

The only cotton paddock from the 2000/2001 to be monitored had barley double cropped into it.

Field 54 – Cotton

October - Planted Cotton. No Banded Herbicide
November – Roundup 1.5 kg/ha spray over the top of the crop
December – Roundup 1.0 kg/ha spray over the top of the crop
12th December – 1st weed assessment
January – Shield Spray – Spray.Seed @ 1.0 lt/ha + Gesagard @ 1.5 lt/ha
21st March – 2nd Weed Assessment
No cultivation or spray since Spray.Seed & Gesagard mix.

On Peter Taylor's property the weeds not controlled satisfactorily in his opinion are:
Melons, Sow Thistles, Devil's Claw, Peach Vine (Ipomea), Clover and Sesbania.
Fleabane was not mentioned as a problem weed. This is usually how Fleabane starts out as it is usually scattered plants that seed and the problem is worst next year.

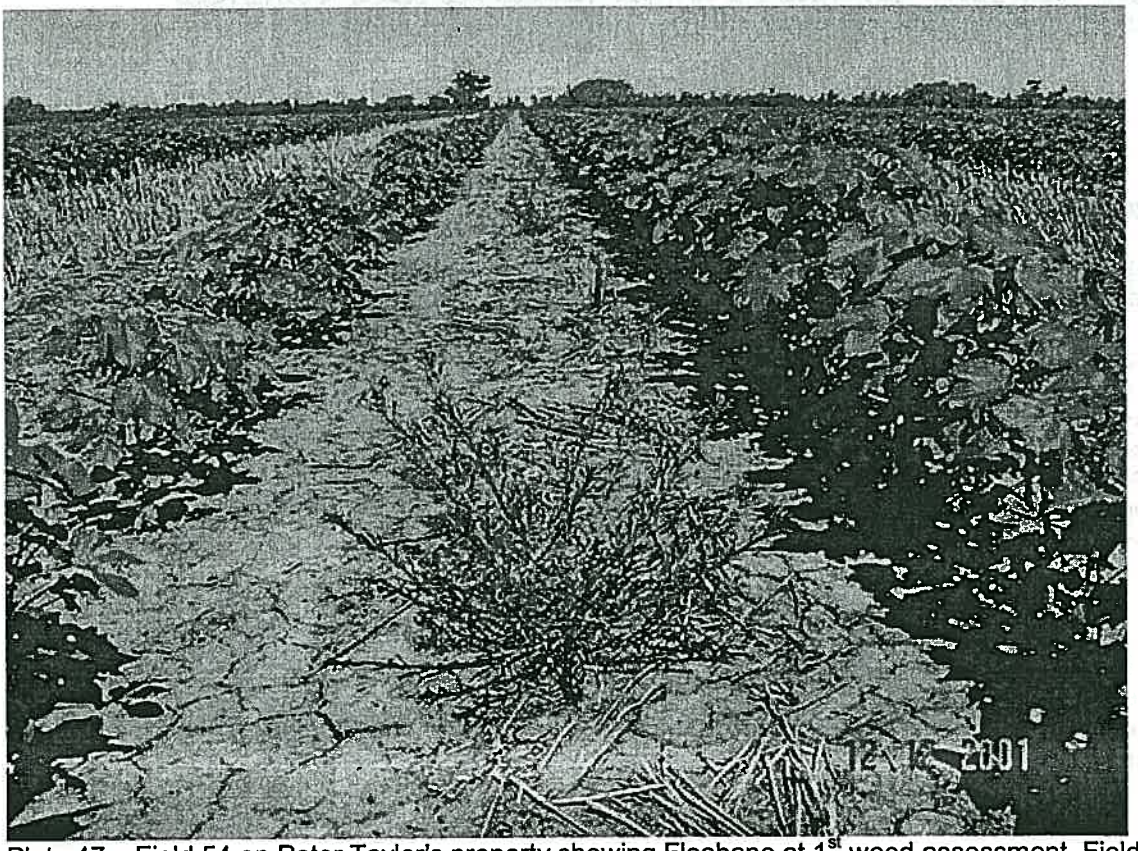

Plate 47 – Field 54 on Peter Taylor's property showing Fleabane at 1st weed assessment. Field clean of other weeds.

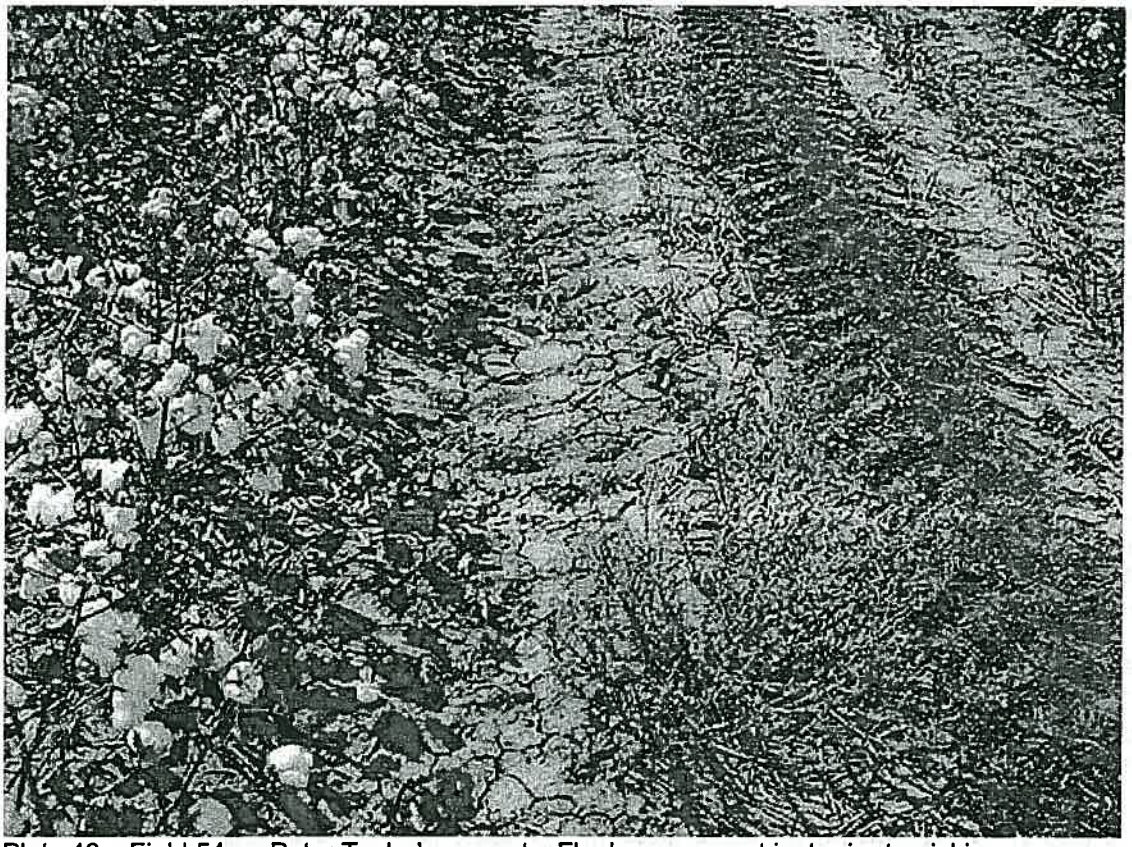

Plate 48 – Field 54 on Peter Taylor's property. Fleabane present just prior to picking.

Field 5 – 1st year Wheat – Fallow

The Fallow after the 1st wheat crop in this paddock was very clean of weeds. The only plants present were volunteer wheat seedlings.

May – wheat planted
July – Ally @ 5 gm/ha + MCPA @ 0.5 lt/ha
November – Harvested
12th December 2001 – 1st weed assessment
Jan – Feb – Paddock has been Harrow Burnt and Ploughed.
21st March 2002 – 2nd Weed Assessment
April – Planted wheat (Sunbrook) with full cultivation to control weeds
28th June – 3rd weed assessment – no weeds growing in wheat crop

This paddock has been kept very clean and no weeds have appeared to seed. There were scattered plants: Bladder Ketmia, Caltrop, Urochloa, Wild Gooseberry and Johnson grass, but none of the plants had seeded at the first weed assessment. At the second weed assessment the paddock had been burnt and ploughed. This was to remove stubble due to wheat disease concerns. At the third assessment the wheat crop had been planted and was very clean. One Burr medic was counted in the 3rd assessment.

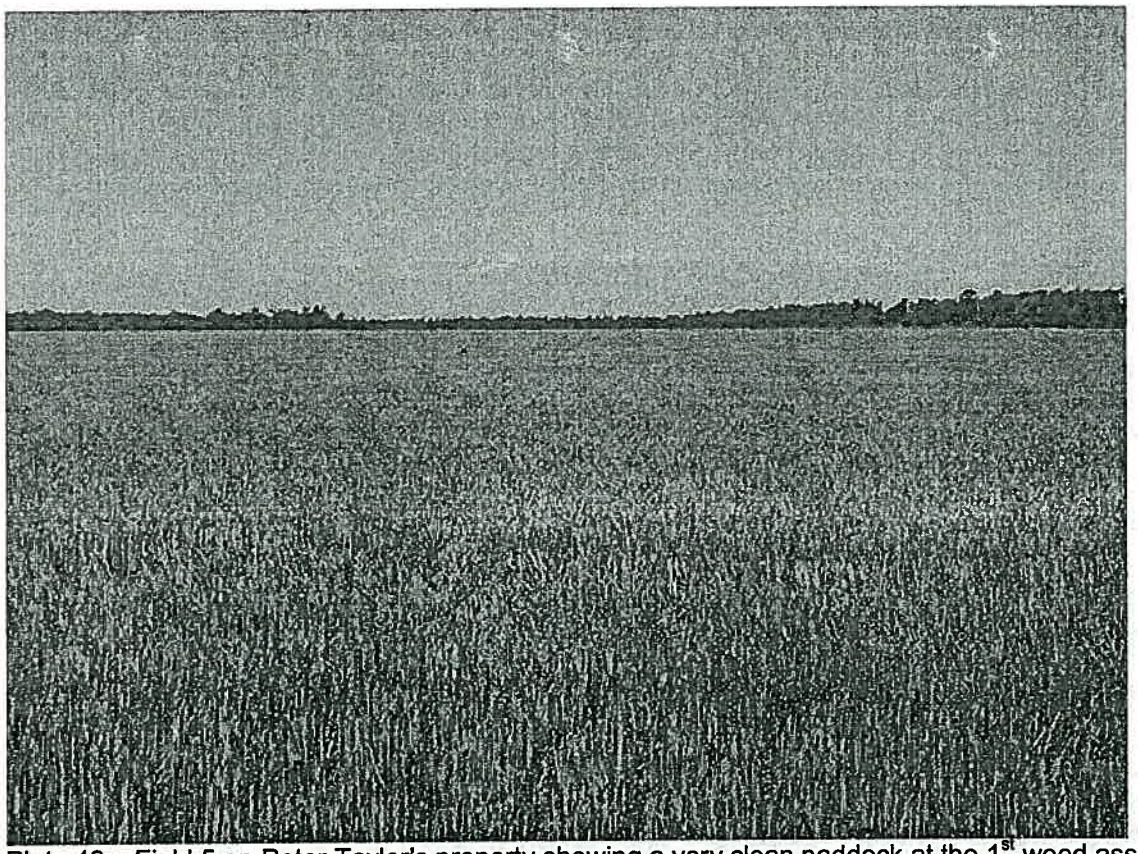

Plate 49 – Field 5 on Peter Taylor's property showing a very clean paddock at the 1st weed assessment.

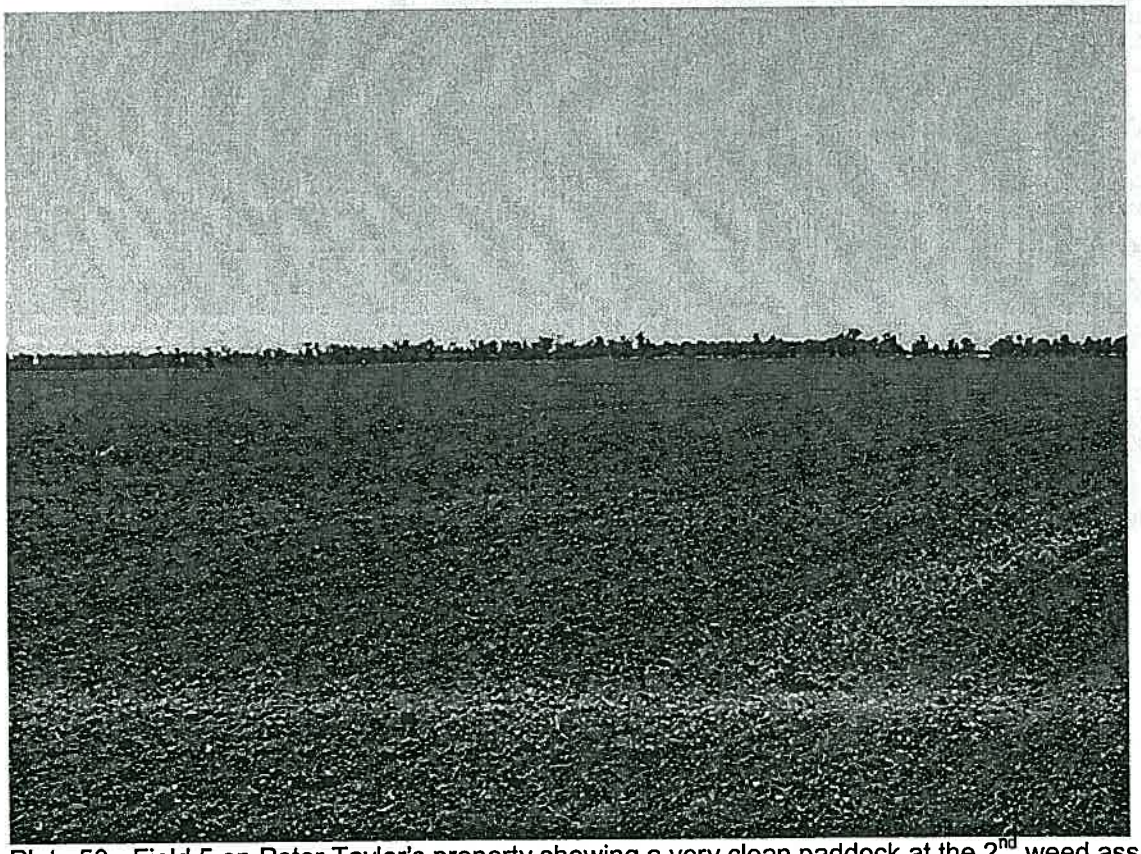

Plate 50 - Field 5 on Peter Taylor's property showing a very clean paddock at the 2nd weed assessment. Paddock had been burnt and ploughed.

Field 57 – 2nd Year Wheat Fallow

First assessment the paddock was very clean of weeds with only scattered weeds present. On the second weed assessment weeds had been let go and sprayed at a big stage and seeded before they were controlled. Large Red Pigweed, Bladder Ketmia, Barnyard grass and the odd Fleabane had seeded prior to the treatment and the Red Pigweed and the Fleabane look as though they may survive the treatment.

May – Wheat Planted
July – Topik @ 85 mls/ha + Ally @ 5 gm/ha + MCPA @ 500 mls/ha
November – Crop Harvested
12th December 2001 – 1st weed assessment
January – Sprayed Roundup CT @ 1.0 lt/ha
16th March 2002 - Sprayed Roundup CT @ 1.2 lt/ha + Surpass 300 @ .7 lt/ha
21st March 2002 – 2nd weed assessment

This paddock is a good example of being a clean paddock with scattered weeds and now that weeds were allowed to seed, will have future problem with Red Pig Weed and Fleabane.

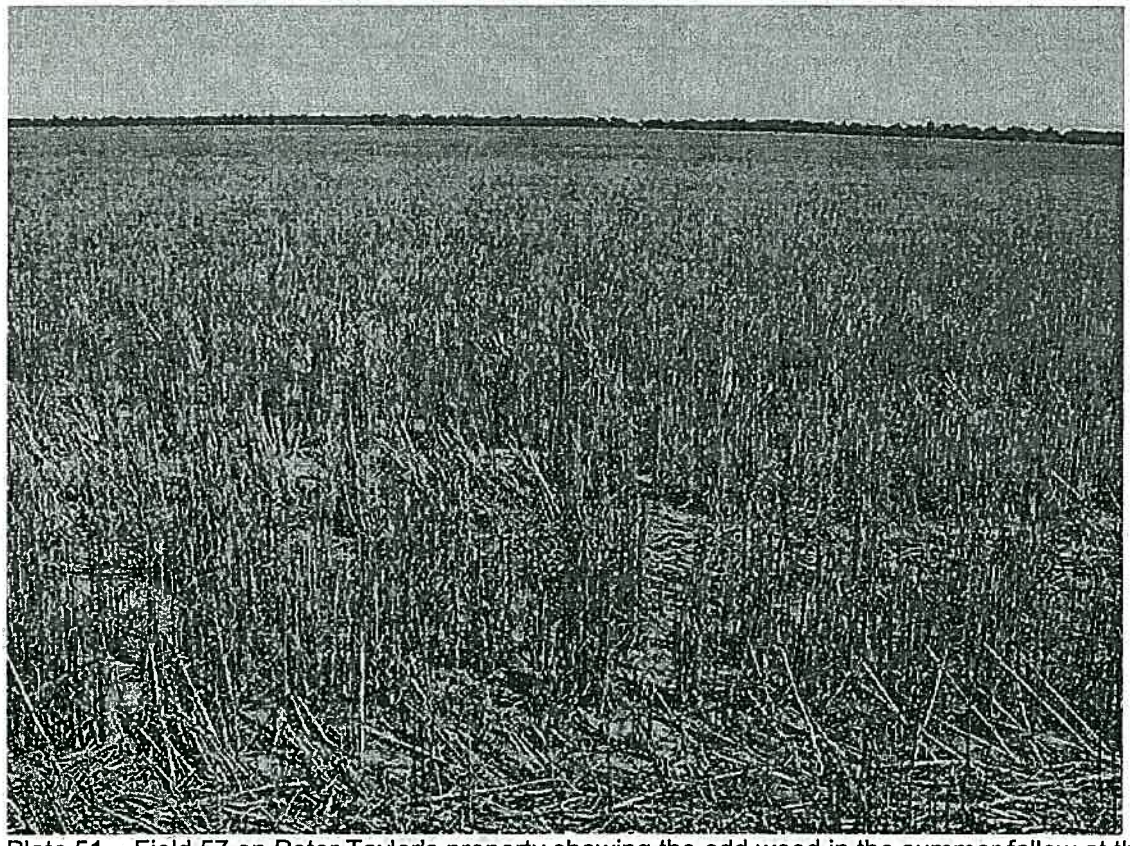

Plate 51 – Field 57 on Peter Taylor's property showing the odd weed in the summer fallow at the first weed assessment. This is 2nd year wheat and the next crop to be planted will be Cotton in 2002-2003 season.

Plate 52 – Field 57 on Peter Taylor's property at the second weed assessment, showing large weeds that have produced seeds prior to being sprayed.

Field 9 Barley Planted into Cotton Stubble

Plate 53 – Field 9 on Peter Taylor's property showing regrowth cotton in a barley crop. Crop was to be sprayed before harvest, however a lot of the summer weeds had already seeded.

April 2001 – Cotton picked
July – Barley double cropped into cotton stubble
12th December – 1st weed assessment
December – Sprayed with Roundup CT @ 1.5 lt/ha prior to Harvesting.
December – Barley harvested
February – cultivated with Flexicoil Cultivator
21st March 2002 – 2nd weed assessment
June – Sprayed with Roundup CT @ 1.2 lt/ha
June – Planted to Barley

Weeds did get away when crop of barley was growing. Regrowth cotton is a serious weed in that it takes a good cultivation to get good control or very high rates of herbicide are required making it expensive to control.

Barley is planted in the 2002 winter season that is the second winter cereal, and then the paddock will be fallowed and depending on commodity prices the plan would be to plant into Cotton 2003-2004 season.

Plate 54 – Field 9 – Peter Taylor's property at the 2nd weed assessment showing odd regrowth Cotton surviving the cultivation operation.

Farm 9 – David Venz – Gurley NSW

David has grown dryland cotton but due to the price and weather conditions has not grown cotton for the last 2 years. Sorghum was planted into these paddocks instead and the winter fallows designated for summer crop will be planted to either cotton or sorghum depending on the cotton price and weather conditions.

Field B – Summer Crop (Sorghum)

October 2001 - Sorghum Planted - Dual @ 2 lt/ha in 50% Band over sorghum row
- Atrazine @ 2.0 lt/ha broad acre application
9th December – Shielded sprayer between sorghum rows – Roundup CT @ 1.5 lt ha.
12th December – 1st weed Assessment
January 2002 – 2nd Shield Spraying – roundup CT @ 1.2 lt/ha
February – Pre-harvest sprayed Roundup CT @ 1.5 lt/ha
March – Harvested
21st March 2002 – 2nd weed assessment

The weeds in the first and second assessment were growing in higher density in the skip compared to the rows of sorghum. This is probably due to the Atrazine band and also due to the competition from the sorghum plants. Fleabane was a prominent weed and Plate 57 shows that that the Fleabane survived the shielded spray application of Roundup in the skip row. There was not a lot of Fleabane in the row of sorghum suggesting that the Atrazine band may have kept in clean or the competion from the sorghum reduced the weed density.

Plate 55 – Field B – David Venz's property showing sorghum grown in single skip configuration.

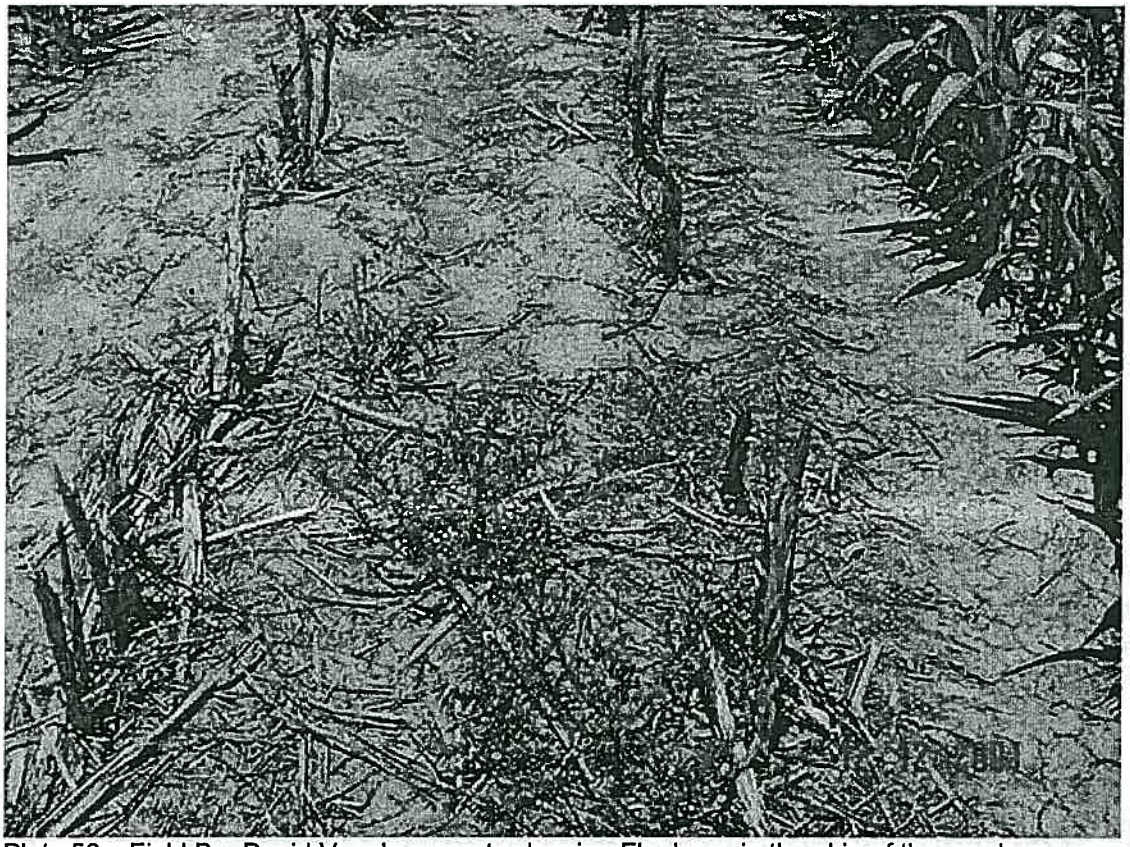

Plate 56 – Field B – David Venz's property showing Fleabane in the skip of the sorghum crop.

Plate 56 – Field B – David Venz's property showing residual Fleabane plants after harvesting the Sorghum.

Field 1 – 1st Year Winter Crop Fallow (Barley Straw)

This paddock was sprayed very late after harvest and there were a lot of weeds at the first assessment as shown in Plate 57. The second assessment was taken on the 21st March and Plate 58 shows only the odd big Milk Thistles were the main weed in the paddock.
Paddock was Barley in Winter 2001 and will be Wheat in 2002.

In-crop Herbicide – Ally @ 5 gm/ha + MCPA @ 0.5 lt/ha
November – 2001 – Barley harvested
12th December 2001 – 1st weed assessment
December – Roundup CT @ 1.5 lt/ha
February – Roundup CT @ 1.2 lt/ha + Surpass 300 @ 0.5 lt/ha
Mid-March – Paddock fertilised with urea
21st March 2002 – 2nd weed assessment
April – Planted to wheat
28th June – 3rd weed assessment – small Sow Thistles just emerging

Plate 57 – Field 1 – David Venz's property – Summer Fallow after first year of winter crop that in this case was Barley.

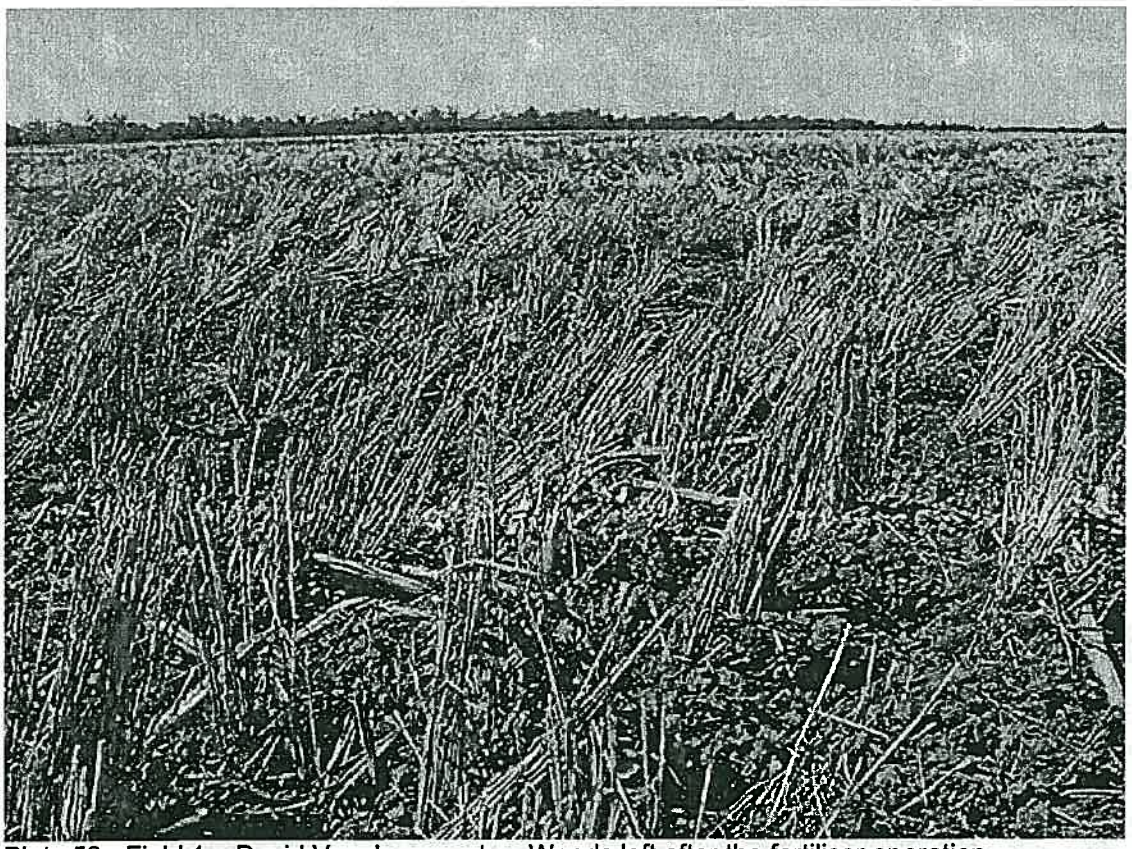

Plate 58 - Field 1 – David Venz's property – Weeds left after the fertiliser operation.

Field 3 – 2nd Year Winter Crop Fallow (Barley)

Paddock did not have as many weeds as Field 1 as it has had two winter crops and there were less summer weeds in the fallow, as shown on Plate 59. This highlights that crop rotation does control weeds to some degree.

Plate 59 – Field 3 – David Venz's property showing barley straw during summer fallow.

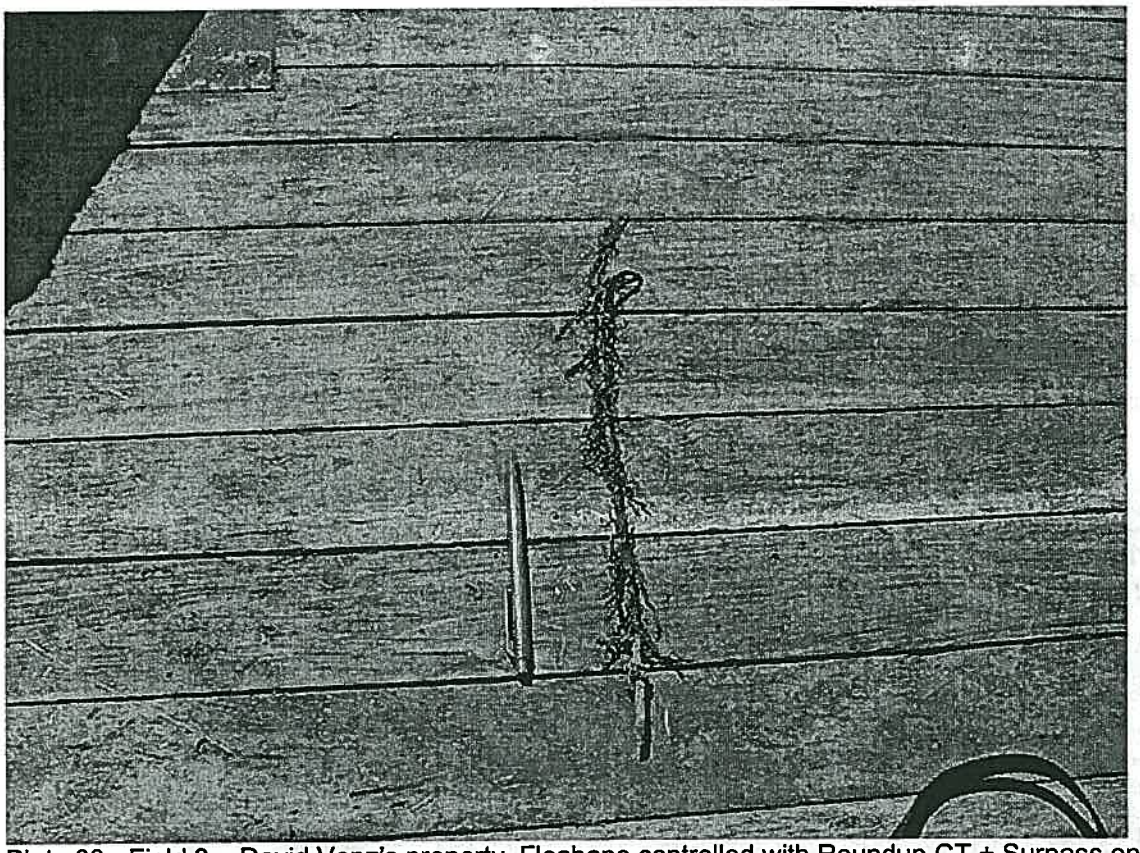

Plate 60 - Field 3 – David Venz's property. Fleabane controlled with Roundup CT + Surpass on second weed inspection (21st March 2002).
Fleabane is a problem weed but if Glyphosate and 2,4-D mixtures are used when it is young, good control can be obtained as in Plate 60.

In-crop Herbicide – Ally @ 5 gm/ha + MCPA @ 0.5 lt/ha
November – 2001 – Barley harvested
12th December 2001 – 1st weed assessment
December – Roundup CT @ 1.5 lt/ha
February – Roundup CT @ 1.2 lt/ha + Surpass 300 @ 0.5 lt/ha
21st March 2002 – 2nd weed assessment

Farm 10 – Steven Wunch – Warra QLD

Steven has been growing cotton for a number of years and grows Cotton every two years in the same paddock. As mentioned by a lot of the growers growing cotton has probably contributed to the weed problem. Rotation is similar to Rob Cook's and hence has a similar weed spectrum.

Cotton Crop – 2001-2002

October – Planted – Band of herbicide - Cotogard @ 5.0 lt/ha + Stomp @ 3.0 lt/ha
November – inter-row cultivation
4th December 2001 – 1st weed inspection
December – inter-row cultivation
April – Cotton Picked
18th April – 2nd weed assessment

Plate 61 - Cotton Paddock – Steven Wunch's property, showing a clean band in the cotton row and weeds outside the herbicide band.

Cotton paddock had some late weeds but did not get controlled, as they would not have affected final yield. Also due the second half of the summer being very dry, weeds did grow out of control near the end of the cotton season

Cotton Fallow

Main weeds were Volunteer Cotton, Bladder Ketmia and Red Pigweed.

April 2001 - Cotton Picked
2 deep workings prior to 4th December
4th December – 1st weed assessment
December – Roundup CT @ 1.2 lt/ha
February - Roundup CT @ 1.2 lt/ha
18th April – 2nd weed assessment
1st May – Roundup CT @ 1.2 lt/ha + 2,4-D amine 625 @ 0.1 lt/ha

Weeds were under control in this rotation as it was a very dry summer from the 1st January. Caustic weed showed up here in that when the paddocks are sprayed every 2 months this gives the weed time to geminate and produce seed.

Conclusions

All farmers would like to stop weeds from seeding, however there is a wide range of circumstances that allow weeds to seed on farms. All farmers had at least one weed that they felt was not controlled to their satisfaction. Most of this dissatisfaction was in having only 1 herbicide that gave acceptable control.

What is causing the weed problem?? The weed is germinating and allowed to seed so the weed is self-generating in most cases. There may be the odd instance where floodwaters bring in weed seeds, but in all farms assessed weed were seeding at some stage during the assessment period.

My personal view, as an agronomist, is the best way to overcome the weed problem is not to let weeds produce seeds. There are a number of strategies that I try to employ with farmer clients and I feel the weed problems are being reduced.

1. Spray weeds when they are small. I try to spray weeds in the first 2-4 weeks after they emerge. Weeds are easier to kill when they are small, they are usually more actively growing, usually have not seeded and often hard to kill weeds can be killed with Glyphosate alone when they are small.
2. Always use an in-crop herbicide with the aim to have a clean paddock at harvest time.
3. Spray around roads and edges of paddocks, as often weeds will start here and work there way into the rest of the paddock.
4. Chip surviving weeds before they seed or remove seeding plants from the paddock.

Some hard to kill weeds that were mentioned in the project that become hard to kill in the fallow when they are considered large weeds.

Fleabane, Red Pigweed, Bladder Ketmia, Sesbania and Sowthistle are all weeds that can be controlled very well with Glyphosate CT when applied to young actively growing weeds. If these weeds are allowed to grow into large plants, then herbicide mixes are usually required to obtain good control.

In my area most growers on average are spraying their paddocks once per month during the summer. From the farm monitoring most farmers are spraying every 2 months with at least a 2-way mix of herbicides. Also the Glyphosate rates are 1.2-1.5 L/ha while we try to use 0.6-1.0 L/ha of Glyphosate CT.

There is never a perfect farm and weather, family commitments can cause weeds to get away. The biggest reason why weeds tend to get away is when growers are waiting for a second germination and then it does rain and stays wet for a long period allowing weeds to seed. If weeds are allowed to seed they have that weed for between 2-7 years depending on the type of weed.

> I feel most weed problems in the cotton crops monitored resulted from that weed seeding in a fallow prior to the cotton crop. In the case of Fleabane I think the weeds may have been old plants that have regrown in some places, as it is a perennial plant.

Take home message – Keep fallows clean, spray young weeds, chip surviving weeds.

The End