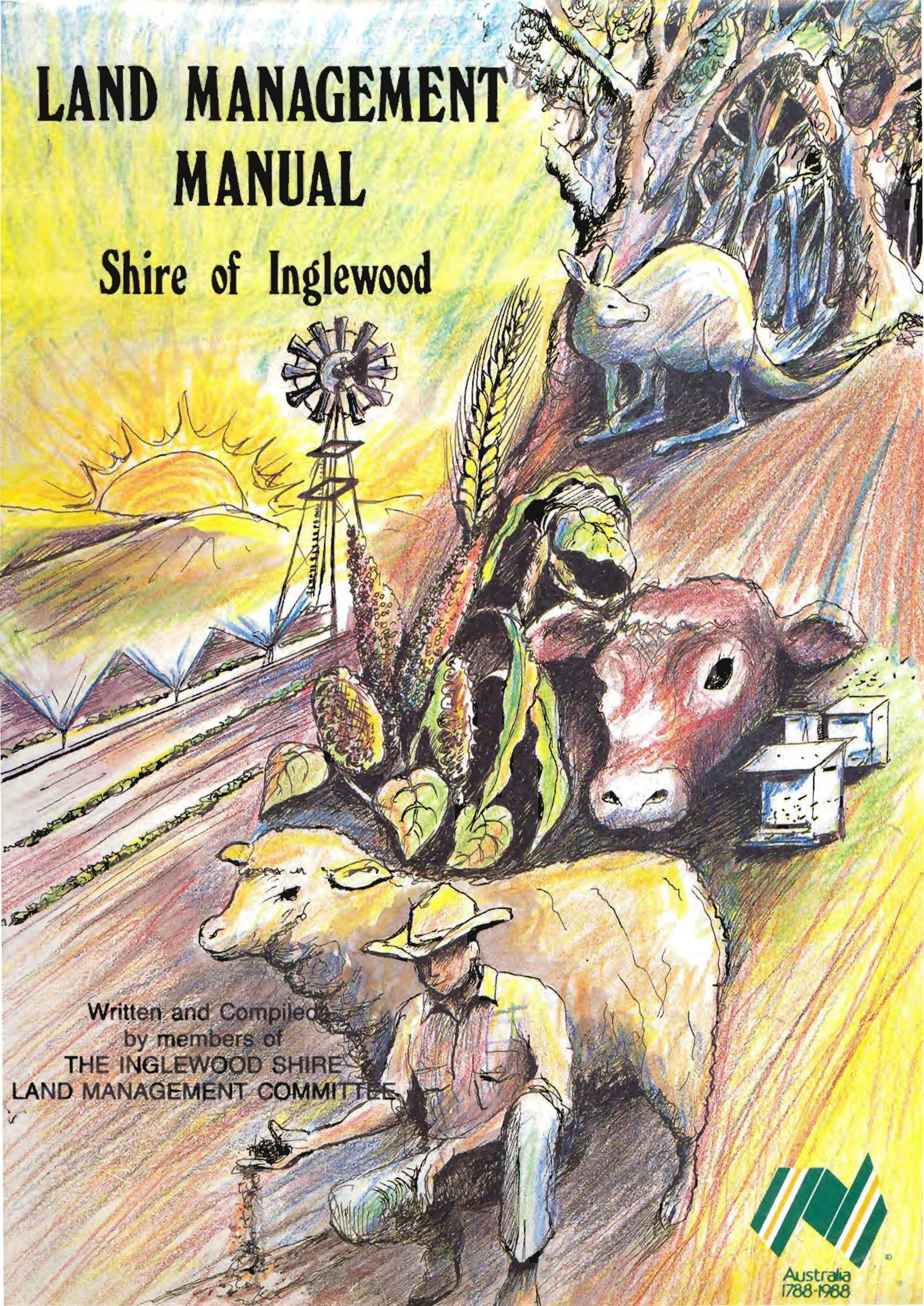
LAND MANAGEMENT MANUAL

Shire of Inglewood



Written and Compiled
by members of
THE INGLEWOOD SHIRE
LAND MANAGEMENT COMMITTEE

Australia
1788-1988

LAND MANAGEMENT MANUAL

Shire of Inglewood

Written and Compiled by Members of
THE INGLEWOOD SHIRE BICENTENNIAL
LAND MANAGEMENT COMMITTEE

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Published by the Inglewood Shire
Bicentennial Land Management Committee

National Library of Australia
Card Number and ISBN 0 7316 4633 9

This publication has been funded by grants from The National Soil Conservation Programme and the Australian Bicentennial Authority to celebrate Australia's Bicentenary in 1988

ACKNOWLEDGEMENTS

The committee acknowledges the continuing support of the Inglewood Shire Council in providing meeting venues and secretarial services.

The support of members of the Queensland Department of Primary Industries, in particular Messrs. Tom Crothers and Bruce Carey of Soil Conservation Services and Mr. Graham Harris, Agriculture Branch, has been vital to the committee's success.

Also acknowledged is the valuable assistance of:—

Mr. Malcolm Taylor, Forester at Inglewood — for his contribution and advice
Dr. Tom Kirkpatrick, Queensland National Parks and Wildlife, for assistance in preliminary editing
Dr. Colin Owen — for information on Tree Planting.

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• The committee wishes to acknowledge the assistance of the Queensland Department of Primary Industries, and that of Lionel Coxen in particular, for the provision of the photographs in this manual.

■ Maps were made available by the Queensland Department of Primary Industries.

INTRODUCTION

A request by the Inglewood Shire Council for suitable projects to marks the bicentenary of white settlement in Australia provided the incentive for the formation of the Inglewood Shire Community Bicentennial Land Management Committee. Interested members of the community felt such a project could provide benefits that would last well beyond the celebration year. It would be an appropriate way to mark the bicentenary. The aim of the Committee is: "To promote the highest level of sustainable productivity of shire lands, by identifying land degradation problems, and by promoting and instigating practical solutions." The production of this manual has been, for members, a goal which was a focus for activities undertaken during the four years of the committee's life.

In identifying and seeking solutions for land degradation problems within the shire, members retained a clear understanding of the need for these to be viable within the constraints that confront our rural community. The Committee has ensured therefore that all information was scrutinised by practical farmers and graziers. All farmer and grazier organisations in the shire have members on the Land Management Committee. Although not official representatives of their organisations, their membership is representative of the broad range of rural enterprises and districts of the Shire. Reinforcing those who are practical farmers and graziers have been the Queensland Department of Primary Industries members. They have provided a high level of technical advice and participation.

The Inglewood Shire community is almost totally dependant on primary production and associated services for its viability. The diversity of enterprises in the shire, along with a comparatively favourable climate, have provided a cushion against the severe downturns experienced by some other rural communities. Shallow, fragile soils with limited fertility are, however, one feature of the district that calls for careful management. Control of the land degradation problems identified and addressed in this manual is essential if our community is to remain viable through the third century of white settlement.

Agriculture requires us to modify the environment very significantly. In doing so, landowners must be careful to maintain a balance. There is clear evidence of drastic environmental damage in a number of areas of Australia, causing severe production losses e.g. land lost to crop production on the Eastern Darling Downs through soil erosion; large areas of land lost for grain production in Western Australia due to salinity. Generally, losses in our shire are not as dramatic, but the evidence suggests that they are widespread. Together they are very significant.

The chapters in this manual deal with the conservation of the soil and its fertility; also enhancement or maintenance of production by weed and pest control. Hand in hand with these is the conservation of native animals and plants. Indeed the health and variety of wildlife will probably be a continuing test of our ability to maintain a balance in modification of the environment. Landholders have, in most cases, an affinity with native animals, birds and plants; they acknowledge a responsibility to maintain them at a proper level.

The desire of many producers to retain an adequate habitat for wildlife, much of which is beneficial to their enterprise, is reinforced by the significant areas of state forest in the shire. As well as providing significant economic benefit to the shire through the timber industry these forests ensure continued reproductive success for many species of native wildlife.

This manual brings together the best information available to committee members, both from their own experience and from critical analysis of management practices tested by others. The commitee acknowledges that new techniques, varieties of plants, and evolving management practices will continue to enhance land management as time goes by. As a result some information will become dated. This manual will, however, provide a sound guide on which to base future decisions, and a sound base on which improved management practices can be built.

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CHAPTER 1

THE CLIMATE AND ITS EFFECT ON AGRICULTURE

The Inglewood Shire experiences a dry sub-humid climate with hot summers and cold winters. The shire includes the most southern part of Queensland, and it is thus less under tropical influences and more under the cool influences of the south than any other part of the state. However the natural variability of weather systems ensures that effects from both sources are felt in most years. In common with most of Australia, the area's weather reflects the west to east passage of alternate depressions and anticyclones. The centres of the depressions are usually too far south to have a direct effect but the associated cold fronts may extend throughout the area, especially in the cool season. However the changes in wind associated with the passage of the southern systems produce fairly predictable and characteristic changes in the weather. Other features which can affect the weather of the shire include tropical cyclones in their decaying phases, upper-air low-pressure areas and the extension of the central Queensland trough, which is a semi-permanent summertime phenomenon.

Rainfall distribution and variability

The average annual rainfall for the shire is about 625 mm with variations of only about 36 mm above and below that figure in different parts of the shire. During summer, the dominant rain influence is the north-easterly to south-easterly airflow which introduces moist unstable air from the Pacific Ocean or the Tasman Sea. This rainfall declines considerably with distance inland. Other summer influences are essentially random in their occurrence and come in the form of thunderstorms and degenerated tropical cyclones. In winter, the northward movement of the western systems produces airflows predominantly from the south-west to the south-east quadrant. The main influences in this season are the generally regular pattern of cold fronts which move across the region, resulting in instability and moderate rainfalls on the plains country to heavy falls in the upland country in the east of the shire.

Seasonal distribution is similar for all centres in the shire; sixty-five percent of all rain falls in the summer months of October-March, with the remaining thirty-five percent falling in the winter period (April-September). The pattern of summer rainfall in the shire shows a distinct westward decline while the pattern of winter rainfall is generally associated with elevation, with the exception of an isolated area around Inglewood which experiences a slightly higher winter rainfall.

Northern Australia and most of Queensland experience high rainfall variability. This is due to a high summer rainfall component, much of which is convective and highly localised. Sporadic occurrence of tropical cyclones also adds to this. By Queensland standards, the shire is subject to a moderate variability only. This can be attributed partly to the southerly location which is responsible for the higher winter rainfall component. The second major influence is its position in the lee of the Great Dividing Range, an effective barrier to the coastal, cyclonic influences which frequently bring high summer falls to other areas.

Primary producers are heavily dependent on rainfall for successful plant and animal production. Competent management decisions should be related to expected rainfall incidence. Decisions can now be based on objective data available from the Australian Bureau of Meteorology. From past climatic records, the chances of receiving certain amounts of rainfall have been assigned probabilities. The following tables present this data for individual months and "runs" of months at the centres of Inglewood, Texas and Yelarbon. Each table gives expected cumulative rainfall for a specific period from the start of every month of the year. Thus the first line in Table 1 indicates expected cumulative rainfall for a 1 month period from the start of January, February, March . . .; the 2nd line indicates expected cumulative rainfall for a 2 month period and so on. Each table shows expected rainfall for three levels of probability — 20%, 50% and 80%. A probability stated in percentage terms can also be expressed in two other possible forms. Thus if there is a 20% probability that a centre will receive a certain annual rainfall, this is equivalent to saying either that one year in five, or preferably 4 years in 20 (larger periods are required for probability information to be valid) this rainfall would occur, or that in any one year it would be a 4 to 1 "bet" that the specified rainfall would occur.

Using the information

Primary producers in Queensland know only too well that rainfall is highly variable between years. Many remember the run of better than average seasons in the mid fifties and certainly the run of drought years during the sixties and early seventies. In spite of this, some may not be fully aware of average monthly rainfall in their particular areas or of its distribution throughout the year. Even fewer primary producers would be aware of the different probabilities with which varying rainfall totals might be expected. This suggests that the main use of the figures given in Tables 1-3 is to provide objective information about rainfall so that decisions may be made in the light of the best historical data available. Some examples of important management decisions that could benefit from the use of this information are:

- the chances of growing a grain crop;
- the likely onset of new pasture growth after a dry season;
- the likely length of drought feeding period from a given time.

Men on the land have learnt to operate their enterprise in an uncertain environment which is due in part to variable rainfall. In such a situation it is impossible to suggest management rules and decision guidelines that will always produce results. Very often it is only with the benefit of hindsight that the best management strategy becomes known. Nevertheless, decisions must be made in this environment and more objective information should help to improve them.

Consider a grazier, say in the Texas area, faced with a situation at the end of April where, due to poor summer rainfall, a serious shortage of pasture exists. Suppose that he narrows down his options to a choice between selling and doing nothing, i.e. between selling or allowing stock to take their chance. There may be other possible strategies. A simple choice is posed here to better illustrate the point. There would be many other examples where the choice would not be so clear-cut but where knowledge of probabilities could still help in decision making.

An examination of the data in Table 2 indicates that for Texas there is a 50% chance of getting the following rain (mm) from the end of April to the end of the months shown.

May	June	July	Aug.
33	73	110	154
Sept.	Oct.	Nov.	Dec.
186	241	320	382

Table 1. Expected rainfall at Inglewood for different periods beginning each month of the year (in mm). Records from 102 years (1883 to 1984).

20% Probability

Starting Month	J	F	M	A	M	J	J	A	S	O	N	D
1 month	129	113	103	62	70	70	64	56	66	80	108	131
2 months	201	195	142	120	122	120	104	109	130	171	210	235
3 months	284	225	196	169	171	159	164	185	217	279	305	312
4 months	327	279	262	220	220	210	224	264	321	369	393	377
5 months	380	322	295	249	264	274	304	365	428	453	447	404
6 months	413	372	338	302	332	356	418	461	519	525	506	445
7 months	462	405	380	371	429	460	523	565	566	559	533	511
8 months	495	454	438	456	507	569	606	620	602	609	577	563
9 months	563	523	513	540	620	656	659	650	658	626	632	600
10 months	613	603	602	652	702	703	685	701	682	700	677	638
11 months	703	706	719	737	755	728	739	717	748	735	315	698
12 months	793	795	779	789	782	774	769	776	791	795	780	772

50% Probability

Starting Month	J	F	M	A	M	J	J	A	S	O	N	D
1 month	61	58	43	23	32	32	35	27	35	48	66	69
2 months	153	129	84	60	70	74	69	66	87	128	139	156
3 months	199	156	124	95	102	111	105	117	160	195	225	219
4 months	243	211	159	136	143	147	164	184	239	281	299	273
5 months	275	254	201	174	182	205	227	262	317	351	341	318
6 months	326	299	232	214	235	274	303	354	382	403	381	353
7 months	365	333	268	277	308	363	336	418	435	450	433	407
8 months	405	360	341	352	395	424	443	464	483	485	469	436
9 months	442	416	400	427	480	506	506	504	519	533	496	475
10 months	501	495	483	506	536	549	556	546	568	558	544	518
11 months	570	581	557	554	611	602	594	597	593	593	582	573
12 months	649	644	626	638	639	639	645	631	627	627	638	645

80% Probability

Starting Month	J	F	M	A	M	J	J	A	S	O	N	D
1 month	35	22	15	6	11	12	14	10	12	24	25	39
2 months	78	63	35	34	34	36	38	33	52	66	85	95
3 months	136	90	68	58	63	65	65	77	100	139	146	157
4 months	163	124	89	83	90	97	105	127	164	183	201	205
5 months	205	152	118	115	124	143	153	198	224	245	248	225
6 months	244	173	158	153	166	190	231	256	269	298	278	270
7 months	258	204	194	192	216	252	281	301	334	327	335	311
8 months	289	245	240	243	280	320	337	360	360	369	372	354
9 months	330	277	297	309	343	383	392	392	414	425	421	390
10 months	367	344	361	363	419	414	426	443	448	456	448	411
11 months	433	431	428	444	454	444	475	483	477	489	480	461
12 months	497	500	513	500	486	496	514	518	524	520	538	527

Table 2. Expected rainfall probabilities at Texas for different periods beginning each month of the year (in mm). Records from 103 years (1881 to 1984).

20% Probability

Starting Month	J	F	M	A	M	J	J	A	S	O	N	D
1 month	129	121	83	48	67	74	64	54	61	94	105	119
2 months	220	194	142	113	128	126	113	106	144	172	211	212
3 months	300	245	193	166	187	166	164	180	220	265	318	305
4 months	343	284	239	218	214	212	236	259	317	377	414	382
5 months	375	331	287	257	257	292	326	357	423	454	471	423
6 months	428	384	320	309	325	382	416	482	512	562	511	458
7 months	489	408	366	370	419	467	533	574	609	581	535	511
8 months	522	463	438	449	498	575	621	646	641	614	589	553
9 months	571	527	497	523	624	682	687	654	672	665	629	590
10 months	631	596	584	650	714	744	719	702	724	721	663	646
11 months	704	711	699	727	786	769	740	757	767	745	712	701
12 months	803	820	793	816	812	807	775	811	790	791	779	780

50% Probability

Starting Month	J	F	M	A	M	J	J	A	S	O	N	D
1 month	69	63	42	27	33	34	37	28	35	47	59	68
2 months	154	125	80	63	73	74	71	66	88	122	138	157
3 months	194	159	114	105	110	114	110	122	157	198	226	236
4 months	243	201	161	140	154	147	163	181	236	272	287	278
5 months	277	240	213	181	186	211	231	270	316	344	336	316
6 months	319	283	253	216	241	266	316	338	382	396	393	362
7 months	351	324	287	272	320	336	370	412	438	444	425	399
8 months	396	364	341	353	382	423	457	469	479	480	477	446
9 months	428	426	420	435	480	493	511	506	519	533	517	480
10 months	504	495	481	506	547	554	553	552	560	564	554	524
11 months	580	551	579	566	579	596	597	604	595	606	598	587
12 months	651	650	643	613	621	630	642	645	645	646	649	660

80% Probability

Starting Month	J	F	M	A	M	J	J	A	S	O	N	D
1 month	39	24	12	7	10	13	15	11	14	29	27	31
2 months	84	53	34	28	38	41	40	38	50	61	80	93
3 months	136	83	66	58	62	66	73	80	99	125	131	149
4 months	155	115	97	84	94	99	119	116	156	187	207	196
5 months	202	150	122	120	133	147	155	184	216	244	254	232
6 months	225	175	166	154	180	187	216	248	280	2301	274	253
7 months	247	205	188	200	223	253	278	314	318	320	305	300
8 months	293	242	227	243	281	310	345	353	349	363	350	334
9 months	338	292	303	302	340	376	386	374	379	391	390	378
10 months	382	351	362	363	410	406	407	409	424	447	424	411
11 months	420	413	421	442	470	460	447	450	476	487	453	459
12 months	484	485	496	490	500	500	475	507	509	517	508	510

Table 3. Expected rainfall probabilities at Yelarbon for different periods beginning each month of the year (in mm). Records from 60 years (1923 to 1984).

20% Probability

Starting Month	J	F	M	A	M	J	J	A	S	O	N	D
1 month	115	133	80	51	57	60	52	52	54	97	91	107
2 months	223	190	129	105	112	102	95	94	133	178	185	217
3 months	279	230	182	147	149	137	129	178	211	262	267	281
4 months	299	269	228	175	185	180	211	255	300	331	346	371
5 months	326	296	260	229	214	252	288	327	379	416	411	400
6 months	388	335	295	260	289	316	386	415	444	498	464	422
7 months	422	374	325	343	389	416	462	494	528	521	481	458
8 months	443	397	383	407	478	523	533	563	563	540	495	495
9 months	481	474	457	509	547	583	594	597	569	565	533	519
10 months	534	531	552	577	637	650	627	621	616	600	561	566
11 months	597	646	655	689	703	676	657	651	643	632	615	630
12 monthns	706	738	742	724	731	693	681	665	678	685	686	710

50% Probability

Starting Month	J	F	M	A	M	J	J	A	S	O	N	D
1 month	57	55	31	25	29	25	31	29	28	45	52	63
2 months	131	105	69	58	52	54	63	61	84	107	129	136
3 months	186	146	106	92	79	95	99	109	142	194	207	219
4 months	222	182	143	123	130	130	161	167	229	259	269	250
5 months	245	225	169	158	161	189	202	262	295	314	313	290
6 months	291	244	199	185	214	243	284	317	342	359	335	325
7 months	315	296	241	235	271	314	348	371	383	398	372	367
8 months	355	314	298	301	356	374	410	421	430	429	420	394
9 months	381	368	352	392	423	445	460	464	463	476	446	423
10 months	443	415	422	444	489	495	493	479	500	508	479	469
11 months	521	469	485	516	536	530	527	523	534	548	522	517
12 months	576	549	557	574	579	579	561	566	565	572	578	579

80% Probability

Starting Month	J	F	M	A	M	J	J	A	S	O	N	D
1 month	25	16	8	5	6	8	8	10	11	23	17	25
2 months	74	46	25	26	32	29	41	28	43	52	78	74
3 months	126	71	54	46	51	60	58	69	81	130	117	135
4 months	142	99	80	73	80	80	99	114	148	172	185	185
5 months	188	144	104	108	114	128	138	192	202	253	243	208
6 months	217	156	142	134	151	154	207	228	277	285	271	245
7 months	243	195	174	184	182	231	257	310	315	31	307	266
8 months	288	214	224	218	257	275	316	344	347	360	337	301
9 months	306	256	281	295	314	341	354	371	400	382	377	344
10 months	360	325	364	339	381	372	388	424	413	415	415	369
11 months	401	397	402	401	405	402	446	453	440	430	429	420
12 months	447	447	468	420	445	470	492	488	471	452	479	459

Consideration of these totals indicates, for example, that there is a 50% chance of 241 mm falling between May and October inclusive. However, suppose that in fact no rain is received during that period, then the amount of rain to be expected with a 50% probability in November should read from Table 2 under that expected in one month beginning in November, namely 59 mm. Looking at these tables in April, then, it would be obvious to the grazier that "substantial" falls could not be expected before September, and that significant relief to the pasture shortage would be unlikely to occur before September/October. In view of this the grazier may well conclude that if stock were not sold they would be unlikely to survive the period May to October. Then, providing it were profitable to do so, a selling program could be commenced.

To test how useful this approach might have been, actual rainfall (mm) for Texas over the period May-October for the 20 years 1964-1983 is given below.

1964 — 305	1974 — 276
1965 — 140	1975 — 287
1966 — 337	1976 — 294
1967 — 245	1977 — 151
1968 — 214	1978 — 400
1969 — 306	1979 — 256
1970 — 331	1980 — 240
1971 — 227	1981 — 320
1972 — 332	1982 — 149
1973 — 246	1983 — 525

Examination of these May to October totals reveals:

That in 11 of the 20 years rainfall in the period was significantly greater than the total of 241 mm which can be expected with 50% probability.

That in 3 of the 20 years, rainfall was greater than 241 mm but not by enough to have ensured the survival of stock.

That in 6 of the 20 years rainfall was below the 241 mm that can be expected with 50% probability. It was noted earlier that a 50% probability of receiving a specified rainfall was equivalent to saying that, for a given number of years, such rainfall (or more) would be received in half that number of years. In the above example more than the median rainfall was received in 11 of the 20 years considered. Considered over the whole 20 years, a decision to sell stock would have been correct in 9 of the 20 years (and the wrong decision in 11 of the 20 years).

The general point of the above simple example is that a probability approach is valid only if a reasonably long period is considered (say 10 years or more). Thus, for a new settler in an area, an adverse run of seasons may prejudice his financial situation. However, in the longer term, providing he can 'weather' the poor early years, a probability approach should serve to improve his overall stability.

It is emphasised that, having interpreted the probability information relating to rainfall, the next step is to estimate the financial outcome of alternative strategies. This will not always be easy. For example when a grazier decides to sell stock, an important determinant of the final outcome will be the price he will have to pay for replacement when the drought breaks. This price will, in turn, be related to such factors as the size of the drought affected area.

Another important point about budgeting the financial outcome of a strategy is that many graziers may prefer to accept lower average returns over a period if these are less variable from year to year; rather than returns that show high variability but are somewhat higher when averaged over a period. Other important factors to be considered in any budgeting exercise would be market outlets for drought affected stock and taxation concerns.

Different attitudes to risk

Individual producers vary in their attitudes to risk or uncertainty. Some factors likely to affect attitudes are financial situation, age, experience, number of dependants, and personal make-up. For whatever reasons, some will be prepared to take greater risks than others. Because of these differing preferences it is important to provide rainfall data in an appropriate form. In Tables 1-3 the rainfall expectations with probabilities of 20% and 50% would be of greater relevance to producers ready to undertake risky situations whilst the 50% to 80% probability would be more relevant to farmers and graziers with a preference for safe or relatively certain situations. For "average" primary producers whose preferences indicate a use for the 50% probability information, an important point should be noted. It is that there is a less than 50% chance of receiving the "average" rainfall for most Queensland centres. For monthly rainfall this effect is quite marked. A comparison of 50% probability totals ("median" rainfalls) with average (arithmetic means) rainfall for Inglewood for each month and for a 12 month period illustrates this point.

	Average rainfall (mm)	Median rainfall (mm)
January	85	61
February	72	58
March	61	44
April	32	23
May	42	32
June	43	32
July	41	35
August	33	27
September	41	35
October	57	48
November	68	66
December	81	69
Year	656	649

In the case of median rainfall note that all the monthly and the yearly figures are independent and cannot be combined or grouped. For example, the yearly median total is not the sum of the monthly median totals, in contrast to the yearly average which is the sum of the monthly averages.

The term "median" would be unfamiliar except to specialist economists and statisticians. Because of its importance in the use of probability information the following simple example illustrates the differences between it and the more commonly used "average" or arithmetic mean.

Rainfall records indicate the following January totals (mm) for Yelarbon for the period 1974-1984:

1974 — 66	1980 — 38
1975 — 59	1981 — 6
1976 — 53	1982 — 55
1977 — 123	1983 — 63
1978 — 120	1984 — 153
1979 — 47	

To obtain the average rainfall for January the procedure is simply to total the 11 separate January rainfalls and divide by the number of years — as follows:

$$\text{Average} = \frac{783}{11} = 71 \text{ mm}$$

The median value is the one in the "middle" of all the figures — when they are arranged in either ascending or descending order — as follows:

January Rainfall
in descending order 153 123 120 66 63 59 55 53 47 38 6
(mm)

From these figures the median January rainfall is 59 mm, for it is the one in the 'middle' in the sense that it has as many figures above it as below. If the median had to be calculated from 10 rainfall figures the "middle two" are selected and averaged. The median concept is a very useful concept in situations where unusually high or low (but also rare) values may considerably distort the average figure. In the example given it is evident that the three falls of 153, 123 and 120 mm have a strong influence in raising the average to 12 mm above the median.

Rainfall intensity

Rainfall intensity is a measure of the rate at which rain falls. It has a direct bearing on problems of soil erosion, runoff and flooding. The 24 hour rainfall intensity is a measure of this aspect of rainfall. It is derived by dividing the mean rainfall (mm) by the number of rain days. A high rainfall intensity area (greater than 12 mm/rain day (annual) and greater than 15 mm/rain day (January) lies to the east of a line through Yuraraba, Silverspur and the Glenlyon Dam. The remainder of the shire has a moderate rainfall intensity (between 8.5 mm and 12 mm/day (annual) and between 11.5 and 15 mm/rain day (January). The high rainfall intensity zone is the result of trough-associated cumulus cloud moving east reacting with rising altitude. The result is highly localised heavy showers of high intensity.

Thunderstorms may form when cold fronts pass through the area. They may also form over the border ranges to the east of the shire and migrate west as they develop, or they can form locally as a reseult of intense daily heating during humid summer conditions. There are few records of hail frequency and severity. The Bureau of Meteorology have provided approximate information on hail frequency from press reports over the period 1935 to 1953. A line drawn through Leyburn, Gore, Yuraraba, Graysholm, Greenup and Smithlea divides the area of the shire with a hail frequency of greater than once in two years (to the east of this line) from the western part of the shire where hail frequency is less than once every two years.

Historical rainfall patterns

Historical rainfall patterns for three centres — Inglewood, Texas and Yelarbon — are shown in Figures 1 to 9. The figures graph the variation from the average of seasonal (summer and winter) and annual rainfall totals for these centres. The summer rainfall variation is determined by subtracting the average from the total rainfall for the six month period October to March prior to the winter of the year recorded. The patterns of summer rainfall variation for the centres of Inglewood, Texas and Yelarbon are shown in Figures 1 to 3. The winter rainfall variation is determined by substracting the average from the total rainfall for the six month period April to September for the year recorded. The patterns of winter rainfall variation for the centres of Inglewood, Texas and Yelarbon are shown in Figures 4 to 6. The annual rainfall variation is determined by subtracting the annual average from the rainfall total for the year of record (from October of the previous year to September). The pattern of annual rainfall variation for the centres of Inglewood, Texas and Yelarbon are shown in Figures 7 to 9. It is evident there is no recurring pattern of wet or dry seasons at any one centre. It is also evident that there is no pattern between seasons; a wet summer can be followed by either a dry or a wet winter. These graphs clearly demonstrate the variable nature of rainfall in the shire over time. The average totals for the periods shown at each centre are set out in Table 4.

Table 4. Average rainfall totals (mm) for three centres.

	Summer	Winter	Annual
Centre	(October-March)	(April-September)	
Inglewood	424	232	656
Texas	421	231	652
Yelarbon	390	199	589

The information can be used in several ways. For example, at Inglewood since 1884 there have been 16 winters with rainfall more than 100 mm above average; the winter rainfall of 1886 being 507 mm above the average rainfall of 232 mm. There have been 14 winters with rainfall more than 100 mm below average. The annual rainfall figures for Inglewood (Figure 7) show that the longest period since 1884 with below average rainfall has been the eight years 1936 to 1943. The longest period since 1884 with above average annual rainfall has been the six years 1889 to 1894. The year with the highest annual rainfall was 1886 (547 mm above average) and the lowest was 1902 (406 mm below average).

Seasonal Evaporation

Evaporation from a free water surface has been recorded by the Queensland Department of Primary Industries since 1969 using a standard Class A Pan evaporimeter. This information can be used by irrigators to time irrigations more effectively so as to increase crop yields and profits. Crops and pastures use water at different rates dependent on their stage of growth, availability of soil water and climatic conditions. The evaporation rates from the Class A Pan can be converted to an estimate of crop and pasture water use by a simple method, and used to plan when irrigations are necessary, so as to increase crop yields. Information on this technique should be sought from the local extension agronomist of the Queensland Department of Primary Industries.

The average evaporation rates (Table 5) exceed the average rainfall figures in every month of the year. Despite a higher proportion of rainfall during the summer months there is a significant soil water deficit for about seven months of the year (November to May inclusive). This, combined with the low moisture holding capacity of most district soils, makes dryland summer cropping unreliable. However, summer cropping of the brigalow soils, which have the highest moisture capacity, can be reliable if reduced tillage is practiced (in order to maximise soil moisture prior to planting). Winter rainfall, while lower than that received in the summer months, is more reliable, reasonably well distributed and has greater impact on winter cereal crops than its relatively low figures would indicate. The lower evaporation rates during winter mean a greater proportion of effective rainfall. For this reason dryland cropping of winter cereals is more reliable than summer dryland cropping.

The measurement of evaporation rates using the Class A Evaporation Pan enables irrigators to estimate crop water use and time their irrigations so as to increase yields and profits.

Temperature

Air Temperature

Temperatures in the shire are recorded at Texas post office and the Department of Forestry, Inglewood. Temperature data for the former Queensland Department of Primary Industries Inglewood Field Station is available for the years 1972 to 1985. Tables 6 and 7 set out the monthly average daily minimum and daily maximum temperatures

recorded at the Texas Post Office and the Inglewood Field Station. The percentiles in Tables 6 and 7 are used to show the spread of temperature throughout the month. The 14 percentile of the maximum is that temperature which was not reached on 14 percent of days, or one day per week. The 86 percentile is that higher temperature which was not reached on 86 percent of days or six days per week, having being equalled or exceeded on the other day in the week.

In the case of minimum temperatures, the overnight temperature falls below the 14 percentile on an average of once per week and remains above the 86 percentile on an average of once per week. In Texas the daytime temperature exceeds 36.6°C on an average of once each week in December, and the night-time temperature falls below −2.1°C on an average of once each week in July. At Inglewood the daytime temperature exceeds 36.5°C on an

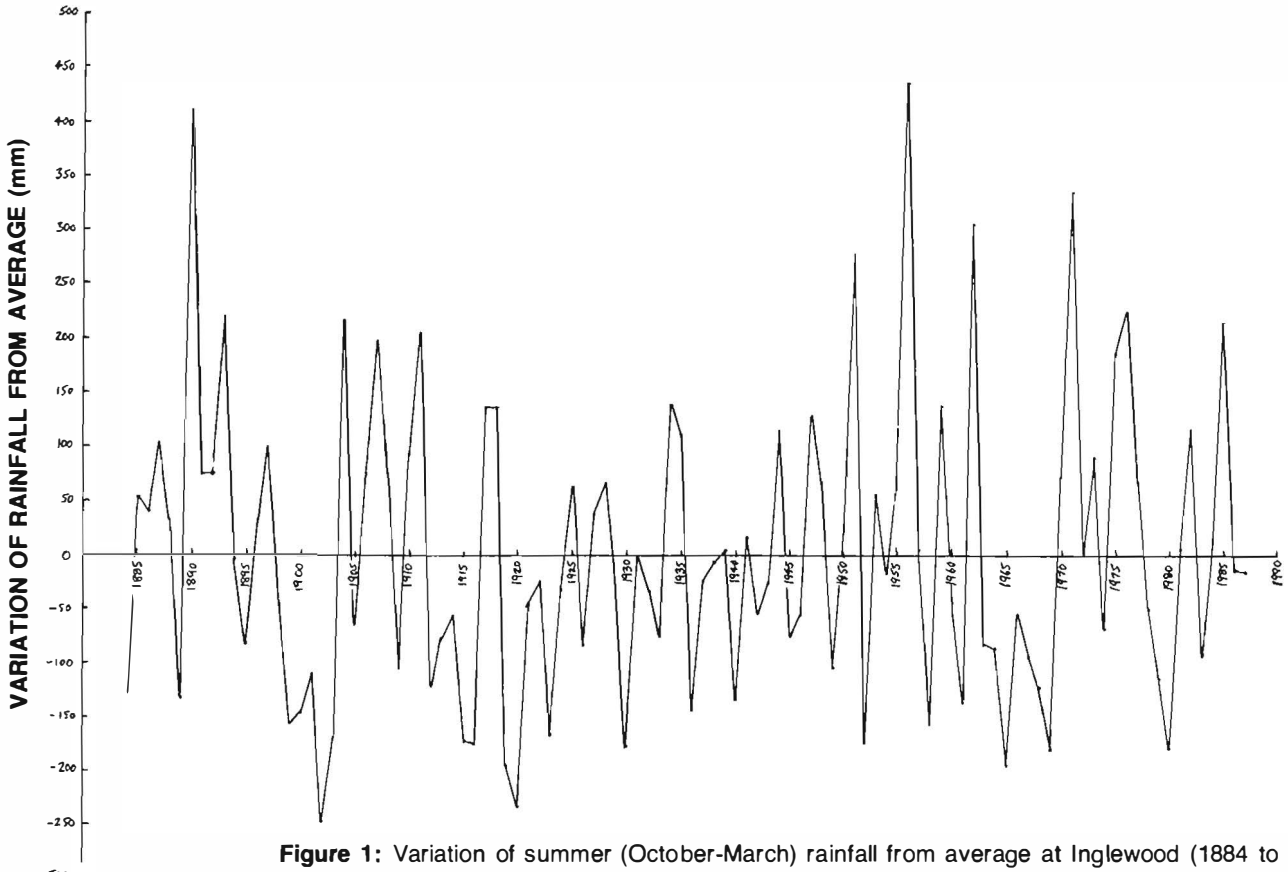

Figure 1: Variation of summer (October-March) rainfall from average at Inglewood (1884 to 1987)

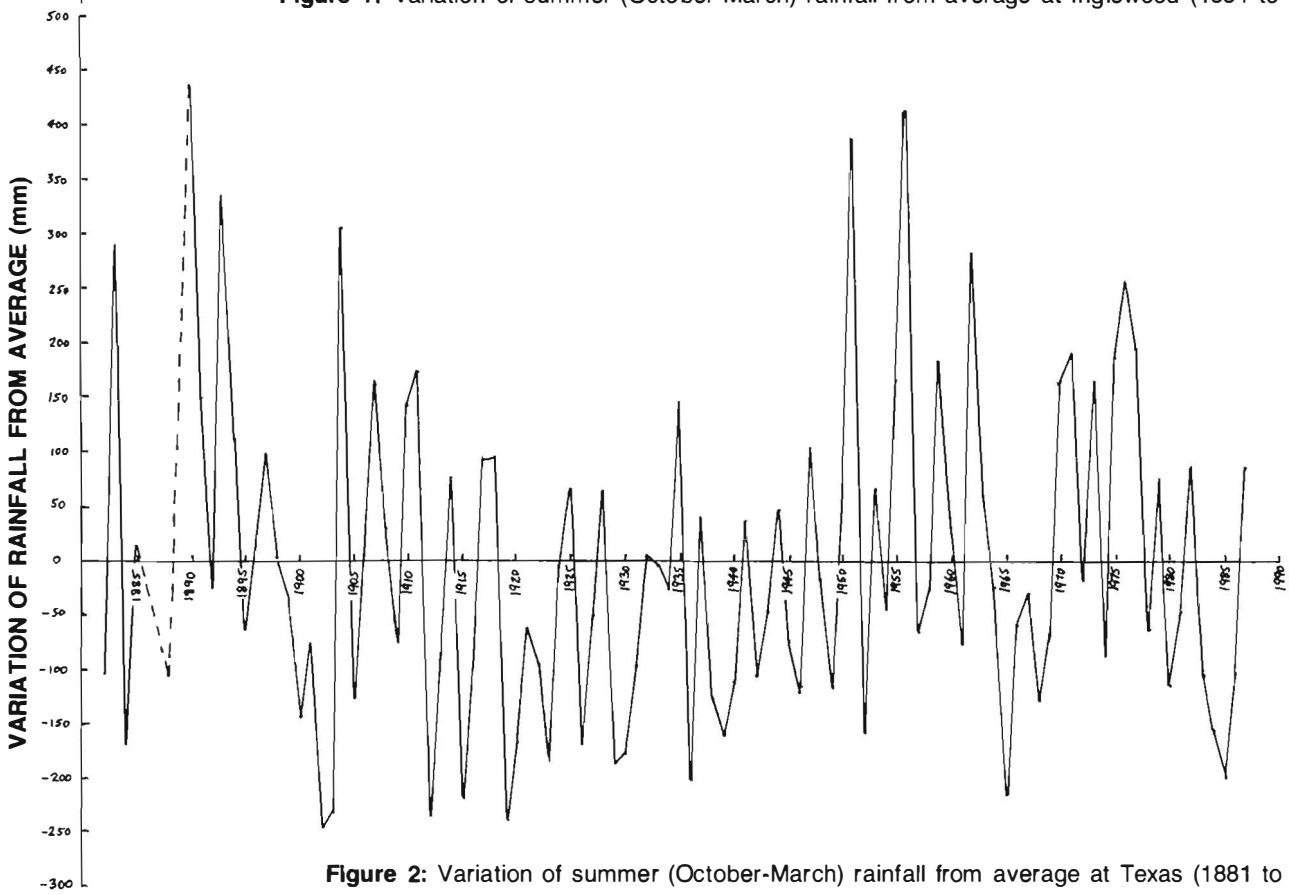

Figure 2: Variation of summer (October-March) rainfall from average at Texas (1881 to 1987)

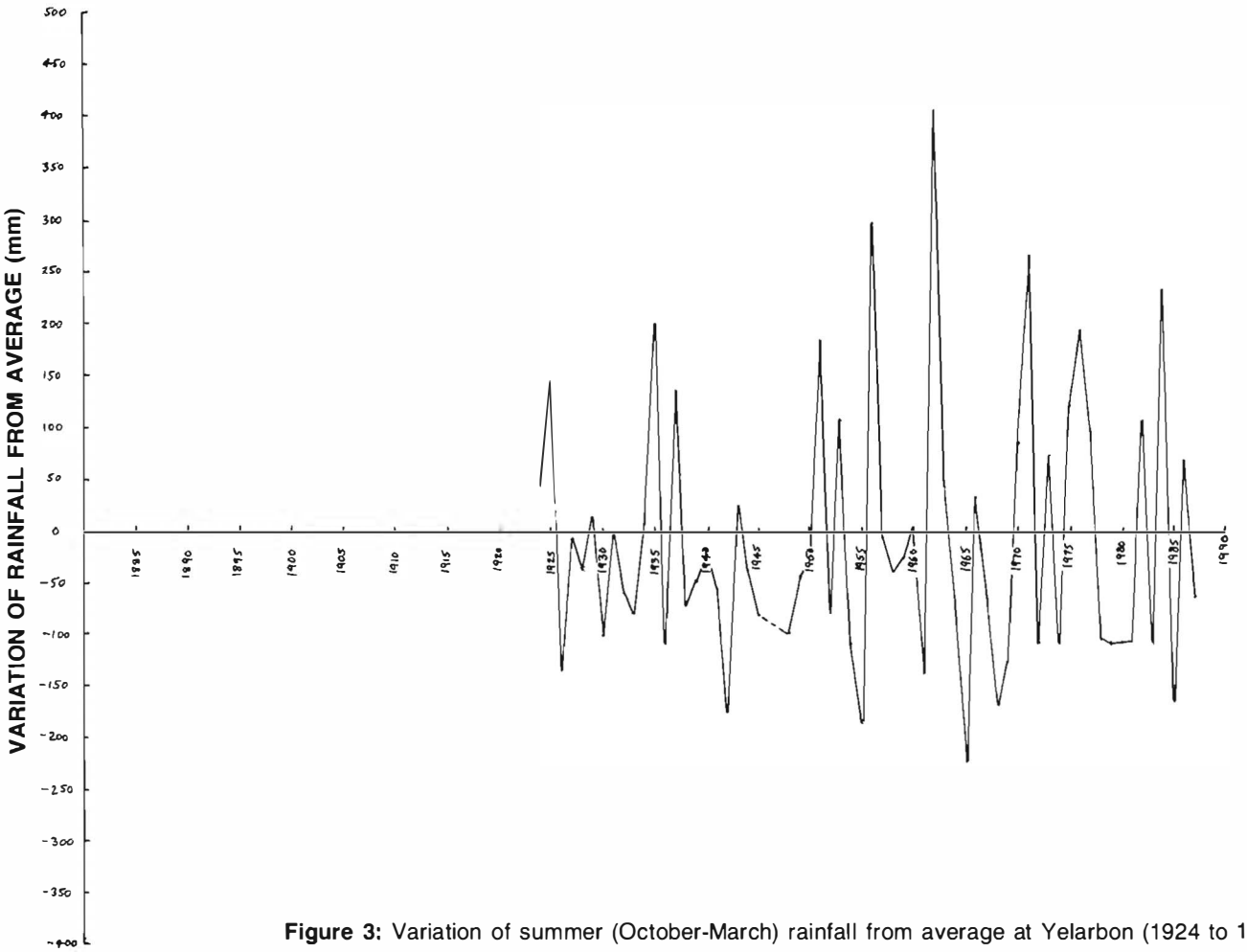

Figure 3: Variation of summer (October-March) rainfall from average at Yelarbon (1924 to 1987)

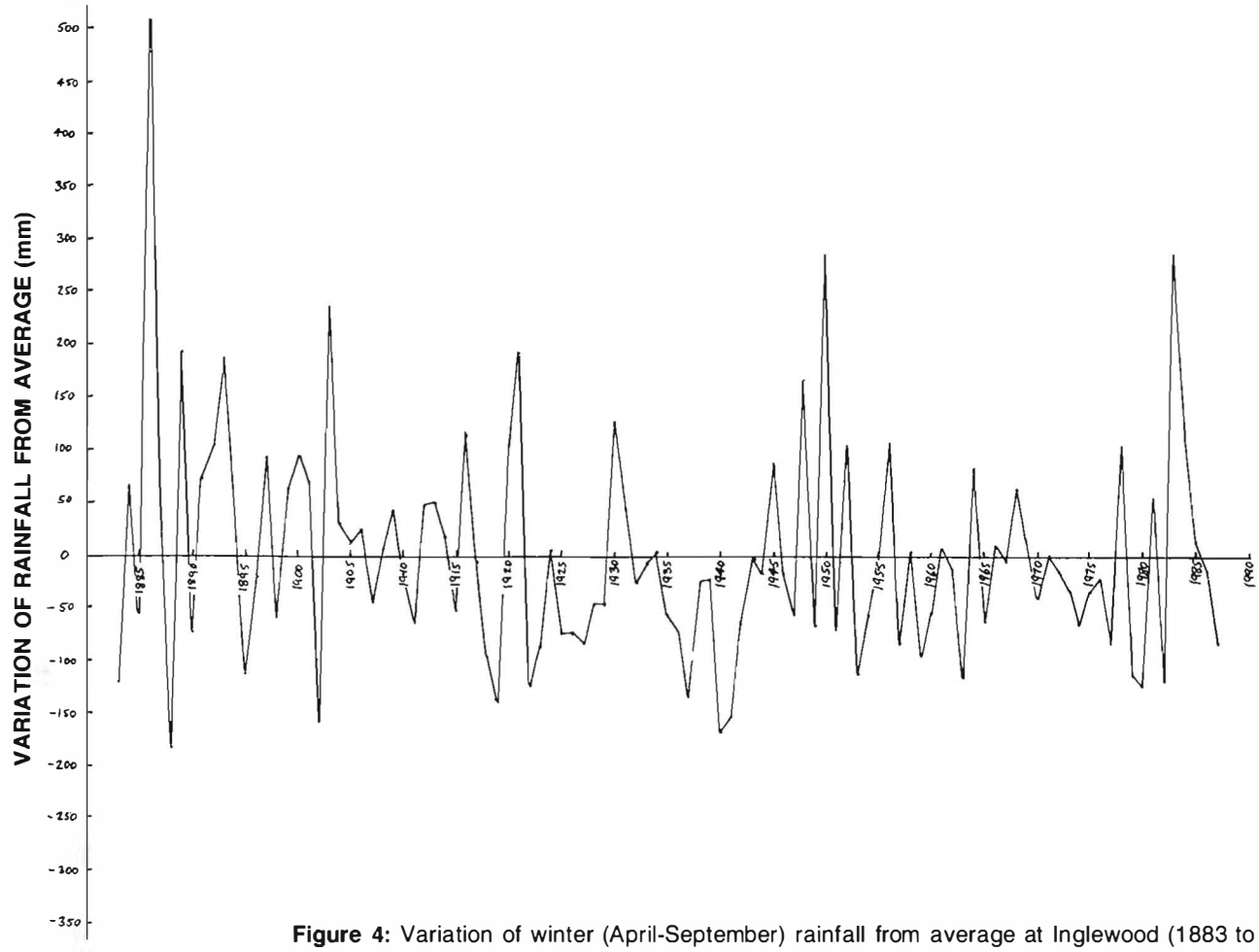

Figure 4: Variation of winter (April-September) rainfall from average at Inglewood (1883 to 1987)

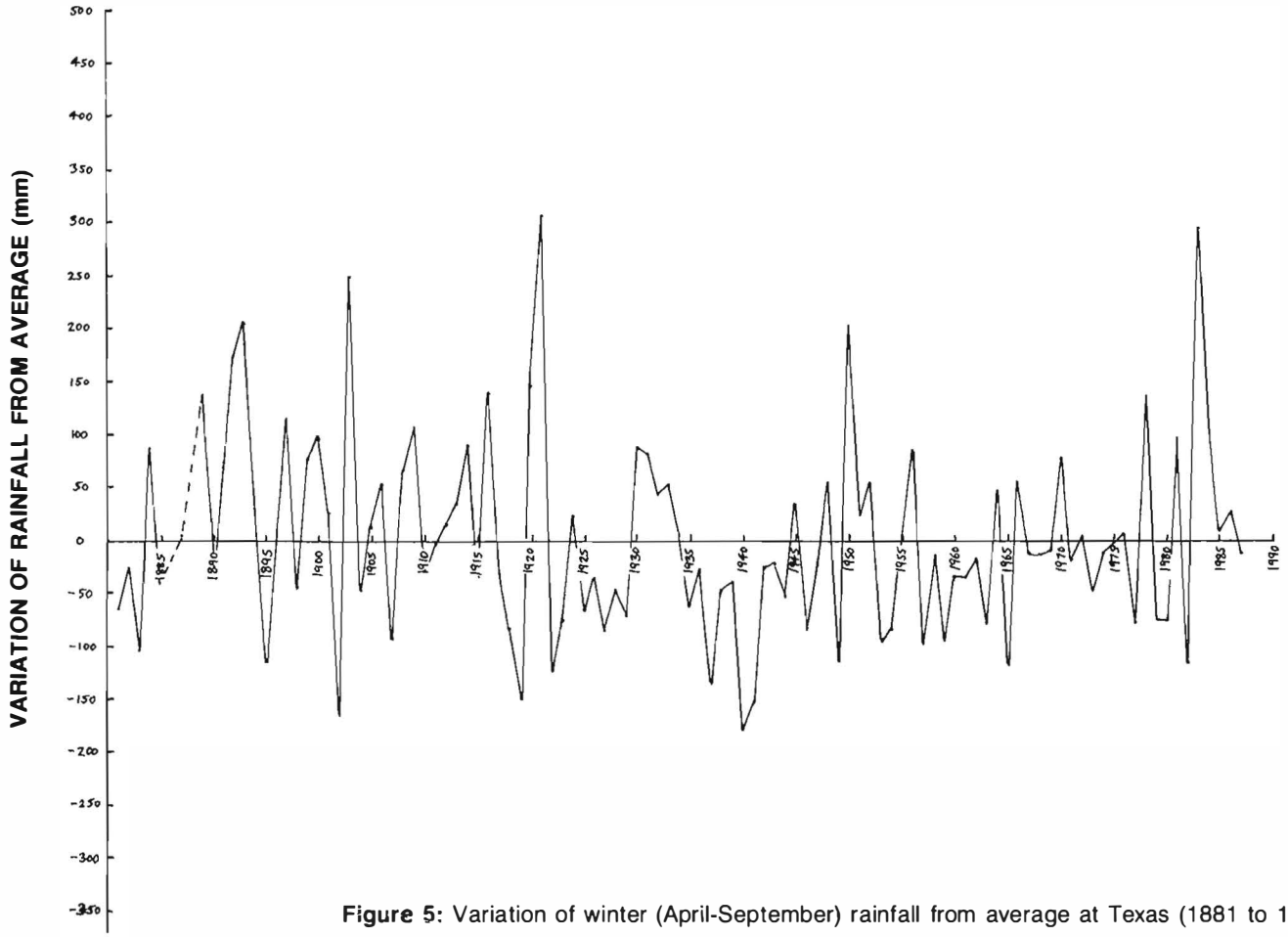

Figure 5: Variation of winter (April-September) rainfall from average at Texas (1881 to 1987)

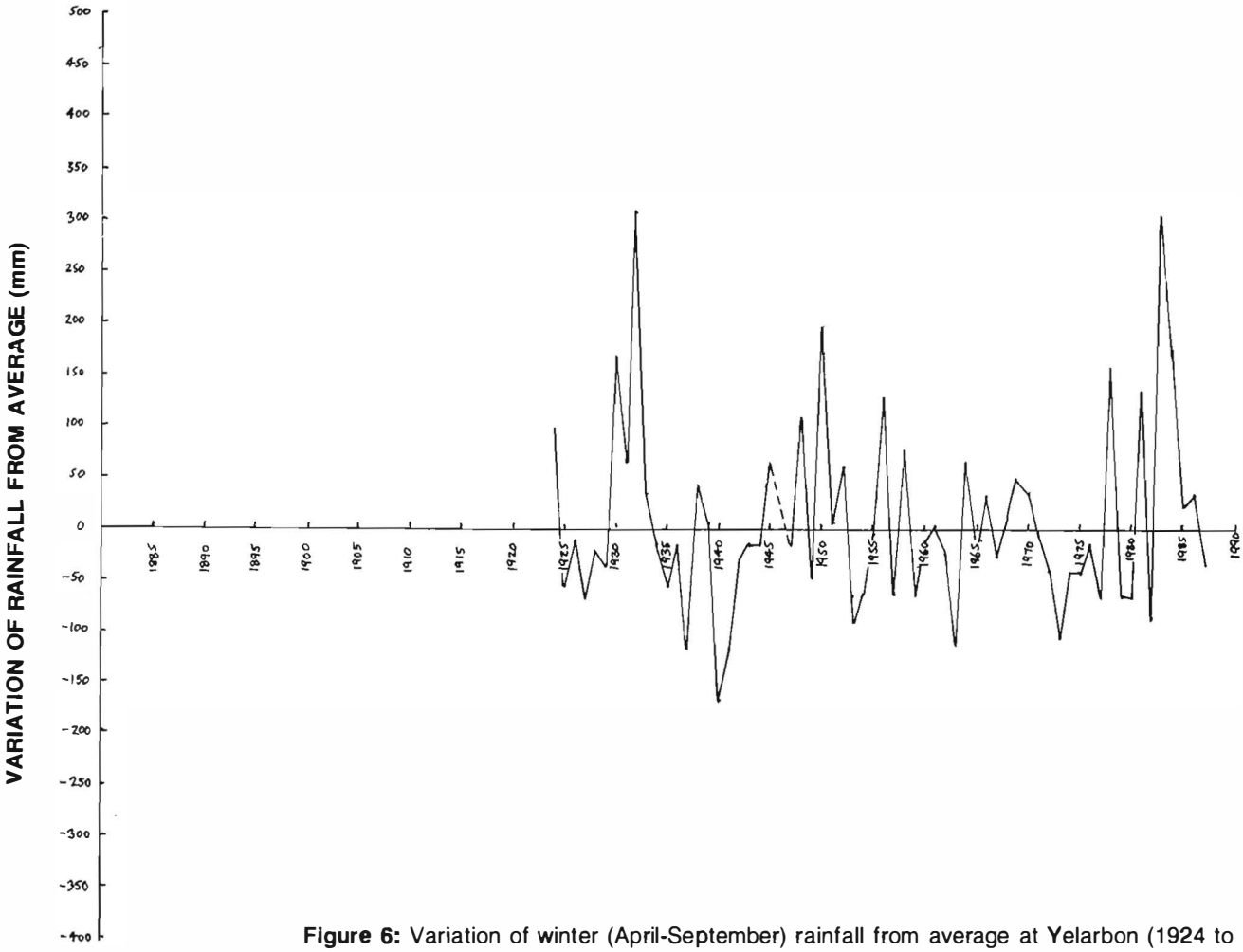

Figure 6: Variation of winter (April-September) rainfall from average at Yelarbon (1924 to 1987)

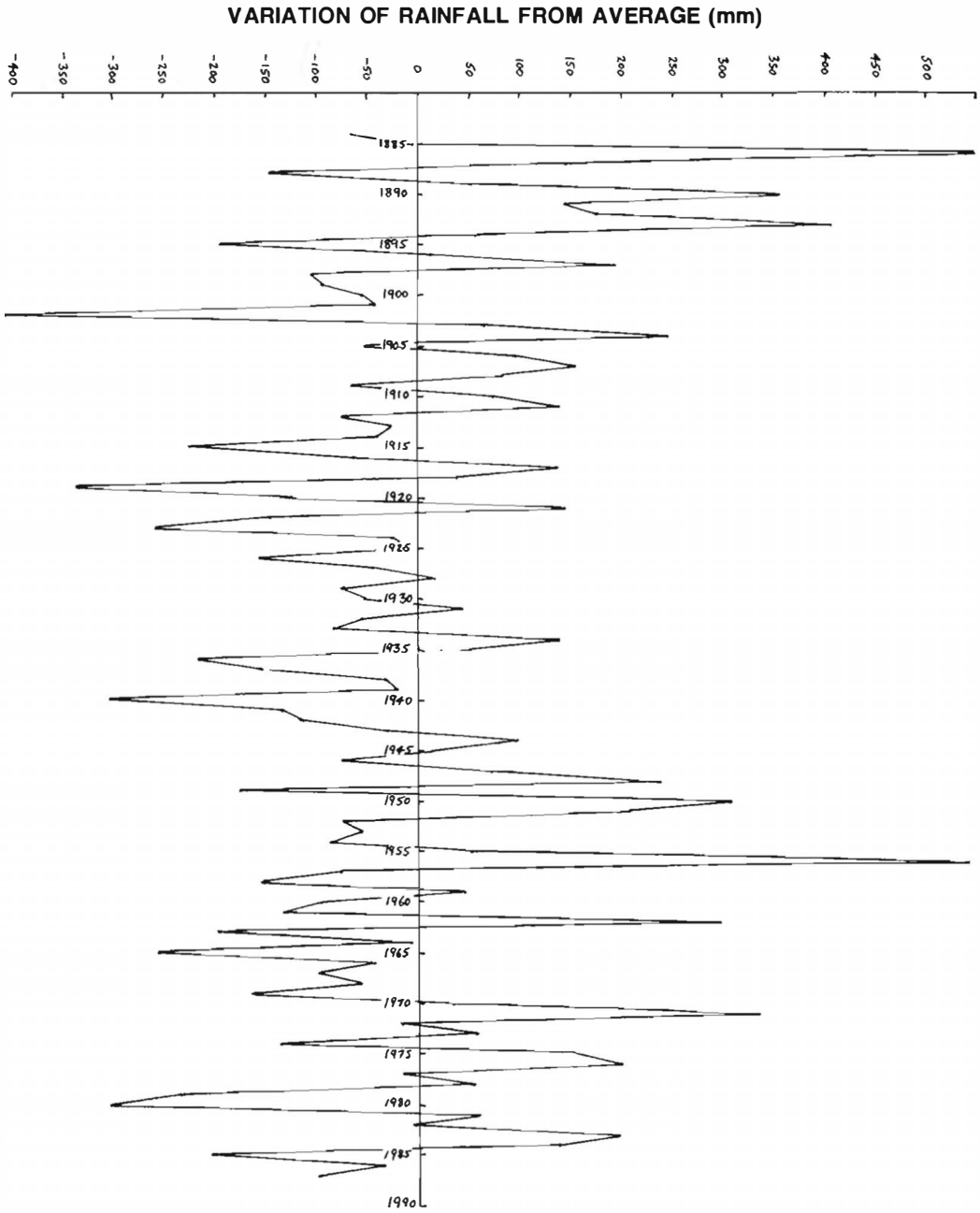

Figure 7: Variation of annual (October-September) rainfall from average at Inglewood (1884 to 1987)

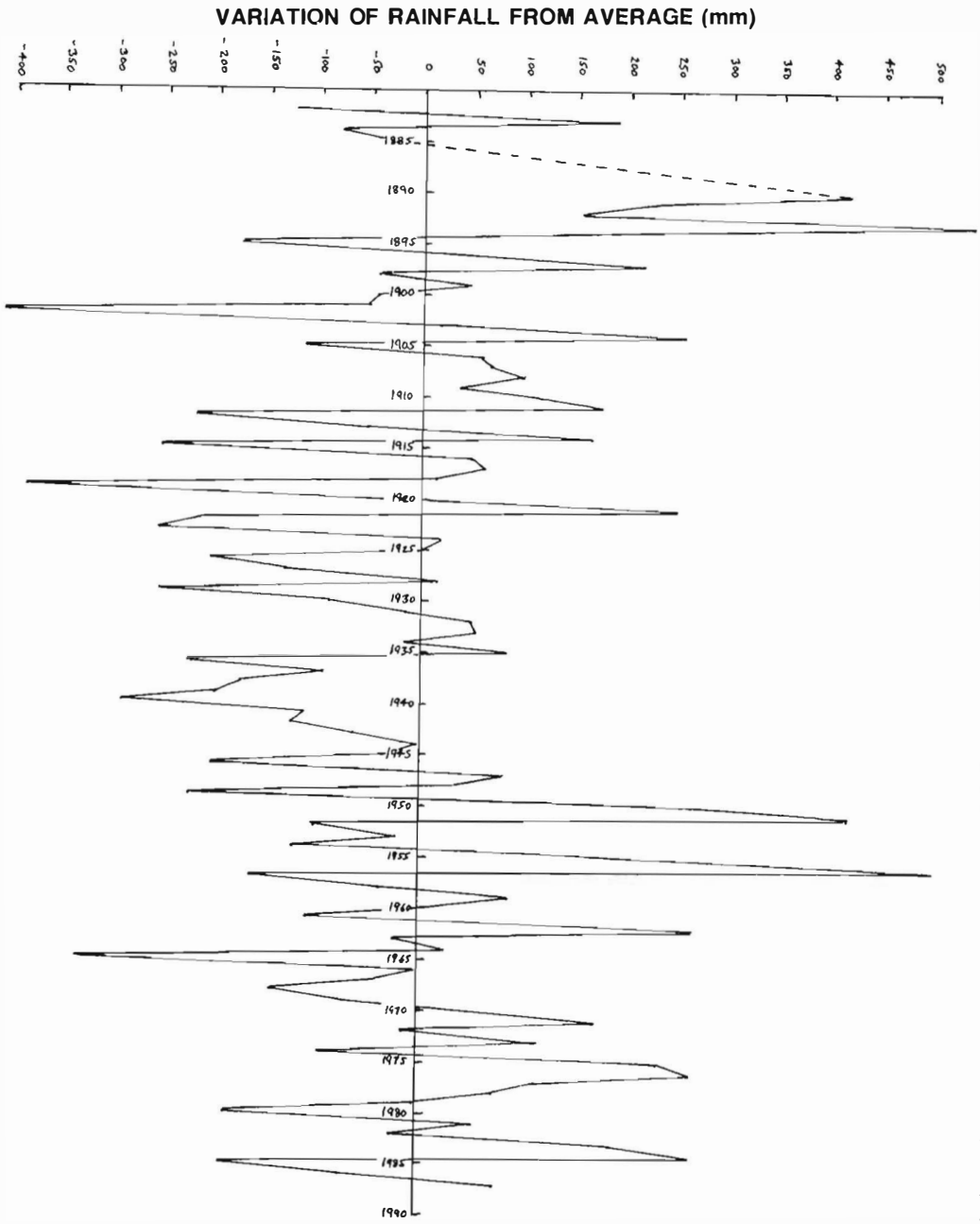

Figure 8: Variation of annual (October-September) rainfall from average at Texas (1881 to 1987)

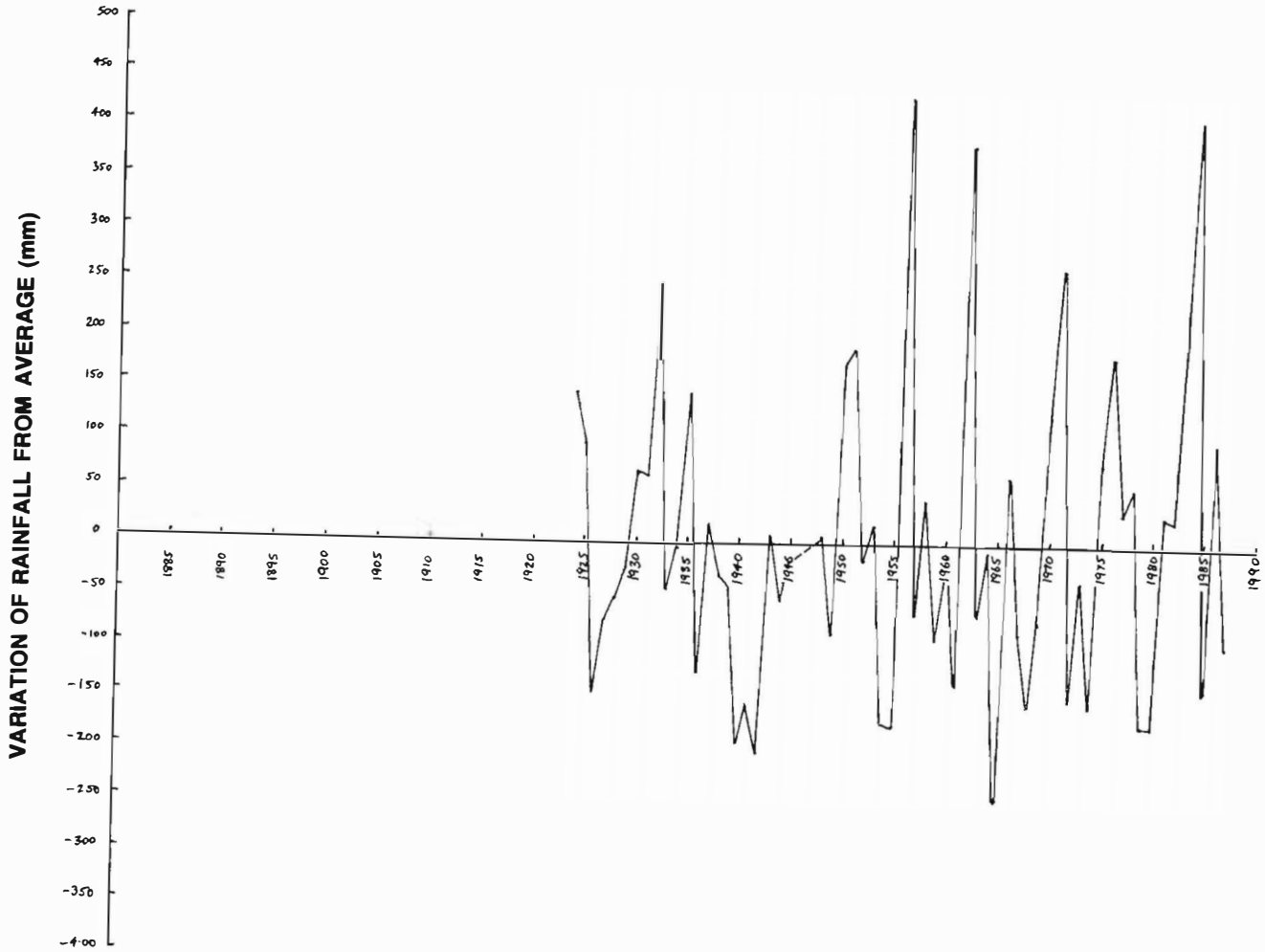

Figure 9: Variation of Annual (October-September) rainfall from average at Yelarbon (1924 to 1987)

Table 5. Average daily evaporation rates (mm) for Inglewood since 1969 (from Standard Class 'A' Pan Evaporimeter).

Month Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
1969	6.4	6.8	5.2	4.6	2.4	1.4	1.6	1.9	3.4	3.6	4.9	6.6	1,478
1970	6.0	7.0	6.1	4.4	2.4	2.0	2.1	3.4	3.4	4.7	5.8	5.8	1,610
1971	5.3	4.4	4.4	3.6	2.6	1.8	1.7	2.3	3.0	5.3	5.4	6.7	1,415
1972	5.9	5.6	5.6	3.5	2.7	1.9	2.5	2.6	4.1	4.8	5.8	7.8	1,605
1973	6.6	6.1	6.1	4.7	3.0	2.1	1.7	2.0	3.3	4.9	6.1	6.6	1,615
1974	6.4	7.2	5.3	4.1	2.5	1.5	2.2	2.8	3.2	4.4	5.8	7.0	1,588
1975	7.1	6.8	4.6	3.8	3.0	1.9	1.8	2.5	3.6	4.6	6.5	6.8	1,607
1976	6.5	5.0	4.3	4.2	2.5	1.2	1.9	2.7	3.6	4.2	5.9	8.2	1,526
1977	6.2	6.3	3.6	3.4	2.4	2.0	2.2	3.0	4.2	5.8	7.6	8.4	1,660
1978	6.5	6.4	5.0	4.0	2.3	1.2	1.6	2.1	2.9	4.3	5.9	6.6	1,480
1979	7.6	6.9	5.8	4.4	2.3	2.1	2.1	3.3	4.6	5.6	6.5	10.1	1,862
1980	9.4	8.0	7.5	5.4	2.6	1.8	1.9	3.0	5.8	5.8	7.4	7.2	1,995
1981	8.2	6.8	6.9	3.8	3.2	1.6	1.8	3.0	4.1	5.5	2.2	7.1	1,738
1982	9.3	7.9	3.8	3.4	2.6	1.9	2.4	3.1	4.3	5.8	8.5	8.0	1,849
1983	7.2	8.2	6.3	3.6	1.9	1.6	1.7	2.3	3.8	4.7	6.0	6.5	1,628
1984	5.8	5.2	5.2	3.3	2.1	1.8	1.5	2.7	3.8	4.6	6.6	7.6	1,525
1985	9.6	8.4	6.1	3.8	2.8	2.1	2.4	3.0	3.6	5.6	7.0	6.7	1,852
1986	7.4	7.1	6.9	4.9	2.6	2.3	2.1	2.6	4.5	4.8	6.2	7.8	1,796
1987	6.9	6.6	5.5	4.6	2.7	2.3	2.4	2.8	4.5	5.7	7.2	7.7	1,788
1988	7.7	5.8	5.2	2.8	2.3	2.0	2.2	2.5	3.6				
Daily Average	7.1	6.7	5.5	4.0	2.5	1.8	2.0	2.7	3.9	5.0	6.3	7.3	
Average Total	220	188	171	121	78	54	62	84	117	155	189	226	1,667

average of once each week in December, and the night-time temperature falls below −2.8°C on an average of once each week in July.

Tables 8 and 9 set out the percentage chance of receiving heavy or light frosts or warm, hot or very hot days, based on data recorded at Texas post office and Inglewood Field Station respectively. These temperature frequencies are the daily percentage chance of receiving more than or less than a specified temperature in a given month. Temperature frequencies as shown in Table 8 and 9 ignore consecutive "runs" of say, very hot days, in a single year and have no value in predicting heatwaves. At Texas there is a 23 percent chance of receiving a hot day in December. As there are 31 days in December, one can normally expect that on about seven days in December the screen temperature will register 35°C or more. Similarly 19 percent of July days would normally register a heavy frost. January is the hottest month with most frequency of warm, hot and very hot days.

Table 6. Temperatures (°C) — Texas Post Office.

Month	Daily Minimum			Daily Maximum		
	Mean	Percentile		Mean	Percentile	
		86	14		86	14
January	18.3	21.4	15.1	32.6	36.4	29.0
February	17.9	21.2	14.9	31.8	36.0	28.6
March	15.8	19.0	12.6	30.9	34.1	28.0
April	11.2	14.6	7.4	27.7	30.0	25.1
May	7.0	11.4	2.5	22.6	26.0	18.6
June	4.1	8.5	0.0	19.4	22.3	16.1
July	3.1	8.3	-2.1	18.9	22.0	15.3
August	4.8	10.1	0.4	20.4	23.8	16.8
September	7.7	12.7	2.9	23.2	28.0	18.4
October	11.6	15.7	7.0	26.8	30.4	23.2
November	14.1	17.9	10.1	29.6	33.6	25.5
December	17.1	20.5	13.4	32.6	36.6	28.6
Year	11.1			26.4		

Table 7. Temperatures (°C) — Inglewood Field Station.

Month	Daily Minimum			Daily Maximum		
	Mean	Percentile		Mean	Percentile	
		86	14		86	14
January	18.7	22.0	15.1	32.7	36.1	29.5
February	17.9	21.4	14.5	32.1	35.2	29.0
March	15.7	19.1	12.1	30.2	33.2	27.5
April	10.2	14.0	6.6	27.1	29.8	24.3
May	6.7	11.7	2.0	22.4	25.6	18.4
June	3.6	8.7	-1.0	18.5	22.0	15.0
July	2.2	8.4	-2.8	18.1	21.6	14.2
August	3.0	8.8	-2.1	19.7	23.6	15.5
September	6.1	12.0	0.5	23.0	27.6	18.5
October	10.8	15.5	6.1	26.0	30.1	21.8
November	14.3	18.2	10.00	29.7	33.6	25.7
December	17.0	20.7	12.9	32.7	36.5	28.6
Year	10.5			26.0		

Frost can assume considerable importance within the shire. Late frosts often have a serious effect on winter cereals and some early sown summer crops, whilst early frosts can have serious effects on late sown bean crops. Table 10 lists the date of first and last frosts at the Texas post office from 1969 to 1982. The incidence of frost is highly variable through-

out the shire; it varies even on the one property from paddock to paddock. Producers should monitor minimum temperatures on their properties using max-min thermometers located in their winter crops. In some situations a knowledge of frost severity can provide a guide in making prompt decisions regarding the future of a crop — i.e. whether to bale, feed, ensile or leave alone. For further advice on the use of max-min thermometers and their use in crop programs consult with the local Q.D.P.I. extension agronomist.

Table 8. Temperature frequencies — Texas Post Office (percentage chance of temperature not being attained [frosts] or being equalled or exceeded [hot days]). Based on recordings from 1969 to 1985.

Month	Daily Minimum		Warm Day	Daily Maximum	
		Light Frost		Hot Day	Very Hot Day
	< 0°C	< 2.2°C	<30°C	<35°C	<40°C
January			61	23	
February			57	18	
March			48	7	
April			10		
May	3	7			
June	10	27			
July	19	36			
August	10	26			
September			3		
October			16		
November			37	10	
December			52	23	3

Table 9. Temperature frequencies — Inglewood Field Station (percentage chance of temperature not being attained [frosts] or being equalled or exceeded [hot days]). Based on recordings from 1972 to 1985.

Month	Daily Minimum		Warm Day	Daily Maximum	
		Light Frost		Hot Day	Very Hot Day
	< 0°C	< 2.2°C	<30°C	<35°C	<40°C
January			84	26	
February			82	21	
March			58	7	
April		3	10		
May	7	16			
June	23	40			
July	39	55			
August	26	52			
September	10	20	3		
October		3	13		
November		47	10		
December			77	26	

Soil Temperature

Soil temperature is an important factor in the planting of many summer crops. Most of these have minimum soil temperature requirements for seed germination and crop emergence. Planting a crop before the minimum soil temperature required is reached will result in slow germination and crop emergence. Planting a crop before the minimum soil temperature required is reached will result in slow germination, and often poor emergence. Similarly, if there is a fall in soil temperature after planting then establishment may also be affected. The minimum soil temperature for successful establishment varies for different crops. (See Table 11.)

Producers should measure their soil temperatures in the paddocks intended for planting, using one of the commercially available soil temperature thermometers. Soil temperature should be measured at 7.00 a.m. at the intended depth of seed placement. Alternatively minimum soil temperatures can be calculated using the daily minimum and maximum air temperatures and the formula:

$$\text{Minimum soil temperature} = \frac{\text{Maximum} + (2 \times \text{minimum})}{3}$$

The maximum and minimum air temperatures can be measured with the same thermometer used to measure frost severity.

Table 12 lists the dates of critical soil temperatures measured at 10 cm depth at the former Inglewood Field Station from 1974 to 1984 inclusive. The data show that the critical temperature for early sorghum planting (15°C) occurs on about the 8th September. However, for adequate crop establishment soil temperatures must remain above the critical soil temperature. The data in Table 12 show that the first period of at least seven days above a soil temperature of 15°C occurs on about the 29th September. It is important that summer crops not be planted before soil temperatures exceed the critical temperature, and remain above this temperature following planting. If sorghum was planted on 15th September in each of the 11 years shown in Table 12 it would have meant that the crop experienced a week with soil temperatures above 15°C in only 3 of the 11 years (1975, 1981 and 1983). On the basis of soil temperature only, crop establishment by planting on the 15th September may have been successful only in 3 of the 11 years (1974 to 1984).

* **Table on next page**

Table 10. First and last frosts at Texas, 1969-1982.

	Dates of Light Frosts (<2.2.°C)		Dates of Heavy Frosts (<0°C)		Frost Period (days)
Year	First	Last	First	Last	
1969	3 June	26 Sept	8 June	16 Sept	115
1970	5 May	12 Sept	8 May	2 Sept	130
1971	11 May	2 Sept	1 June	31 Aug	114
1972	25 April	15 Sept	19 May	14 Sept	143
1973	17 May	6 Sept	17 May	16 June	112
1974	27 May	16 Sept	10 June	14 Aug	112
1975	27 May	6 Sept	6 June	16 July	102
1976	3 June	8 Sept	18 June	13 Aug	97
1977	25 May	15 Sept	2 June	16 Aug	113
1978	27 April	18 Sept	22 June	15 Sept	144
1979	14 May	3 Sept	2 July	15 Aug	112
1980	5 June	19 Sept	7 July	4 Aug	106
1981	16 June	2 Sept	25 June	31 Aug	78
1982	29 April	13 Sept	24 May	2 Aug	137
Average	19 May	12 Sept	7 June	17 Aug	115

Table 11. Minimum soil temperature requirements for the emergence of selected summer grain crops.

Crop	Minimum soil temperature for germination (0°C)	Emergence time following planting (days)
Maize	12	—
Millet	17	—
Sorghum	15	11 to 14
Sorghum	17	7 to 10

Table 12. Dates of critical soil temperature (10 cm depth), Inglewood (1974 to 1984).

	First Date of Critical Soil Temperature			Date of the first 7 days at the Critical Soil Temperature		
Year	12°C	15°C	17°C	12°C	15°C	17°C
1974	1 Aug	14 Sept	2 Oct	29 Aug	30 Sept	23 Oct
1975	1 Aug	12 Sept	19 Sept	7 Sept	12 Sept	16 Oct
1976	23 Aug	30 Aug	22 Oct	16 Sept	2 Oct	26 Oct
1977	12 Aug	24 Sept	1 Oct	29 Aug	24 Sept	9 Oct
1978	2 Aug	13 Sept	29 Sept	31 Aug	25 Sept	11 Oct
1979	7 Aug	5 Sept	11 Sept	19 Aug	17 Sept	23 Sept
1980	12 Aug	23 Aug	9 Sept	19 Aug	21 Sept	24 Sept
1981	21 Aug	12 Sept	21 Sept	8 Sept	12 Sept	8 Oct
1982	12 Aug	6 Sept	27 Sept	23 Aug	3 Oct	24 Oct
1983	17 Aug	5 Sept	8 Sept	5 Sept	14 Sept	22 Oct
1984	5 Aug	15 Sept	13 Oct	11 Sept	15 Oct	19 Oct
Average	12 Aug	8 Sept	1 Oct	2 Sept	29 Sept	10 Oct
Median	12 Aug	12 Sept	27 Sept	31 Aug	21 Sept	16 Oct

Table 13. Wind run (km/day) and relative humidity (%) for the former Inglewood Field Station (1973-81) and the Texas Post Office.

Month	Wind run (km/day)	Relative Humidity (%) 9 a.m.	3 p.m.
January	166	58	40
February	149	59	41
March	127	59	37
April	79	62	37
May	86	71	42
June	101	77	44
July	99	73	40
August	111	68	38
Septembeer	121	61	37
October	136	58	38
November	141	55	35
December	160	54	33

Wind

Wind has an important effect on crop water use, particularly when coupled with low humidity and higher temperatures (as occurs in summer). Wind also has an effect on spray irrigation of crops. Strong daytime wind during summer can result in unirrigated areas of crop. It limits the area which can be effectively watered because of time lost when high wind prevents irrigation. This problem is greatest during summer (see Table 13). Wind run (kilometres/day) is measured using a cup counter anemometer. It is the sum of the wind speed past the anemometer over a 24 hour period.

The effect of floods

Floods have an important influence on agriculture in the shire. Irrigated cropping is carried out on the alluvial floodplains of the Dumaresq River and the Macintyre Brook; it is this activity which is at greatest risk. Tables 14, 15 and 16 show the flood frequenciees recorded on the Dumaresq River at Texas and Riverton, and on the Macintyre Brook at Inglewood. At Texas there is on average a flood every 5 years which causes moderate flooding downstream (with some flooding of crops and grazing areas once every 3 years). At Riverton there is on average one flood every 10 years which causes serious flooding downstream (with moderate flooding downstream once every 4 years). At Inglewood there is on average one flood every 12 years which floods crops downstream from Inglewood (two severe floods having been recorded since 1924). The worst periods for flooding are October to March, and also the June-July period (probably resulting from a combination of abnormal rains, low evaporation rates and enhanced runoff due to sparse winter ground cover).

Small-scale flash flooding is a characteristic of much of the Inglewood Shire as a result of the narrow, minor floodplains which often have substantial catchments in

Table 14. Floods in the Dumaresq River at Texas (27.3.1880 to 24.5.1988).

Month	Peak Flood Height* Equalled or Exceeded (metres) 3.05	6.40	6.71	7.62
January	19	7	6	3
February	19	5	4	3
March	11	4	4	2
April	6	2	1	0
May	5	1	0	0
June	15	7	7	6
July	18	5	5	2
August	4	0	0	0
September	12	2	2	0
October	17	6	5	1
November	16	5	3	1
December	15	2	2	1
TOTAL	157	46	39	19

*Flood classification at Texas:—
3.05 m: Old traffic bridge height
6.40 m: First breaks at gauge — small areas flooded
6.71 m: Floods crops and grazing areas — could flood lower area of town
7.62 m: Moderate flood downstream

country of steep slopes and shallow soils with only a sparse vegetative cover. This flash flooding is a major limitation to intensive use of alluvial soils in the shire. In particular, the lower levees on the Macintyre Brook and Dumaresq River, which have the most suitable soils for irrigated cropping, can be seriously affected by these flash floods. Erosion of lower levees, if cultivated, can reduce their productivity for many years. It is advisable to leave these to grass, or to plant improved pasture and lucerne to reduce the erosion risk. There is a section in this manual which deals with the management of lower levees so as to limit flood damage. Tables 17 and 18 list the date and heights of floods at Texas and Inglewood which have exceeded the critical heights of 7.62 m and 8.53 m respectively (see Tables 14, 15 and 16).

Table 15. Floods in the Dumaresq River at Riverton (1921 to 29.1.1978)

Month	Peak Flood Height* Equalled or Exceeded (metres)			
	2.74	3.66	6.10	7.62
January	17	11	1	1
February	21	14	3	2
March	11	7	3	0
April	3	2	0	0
May	3	1	0	0
June	8	5	4	2
July	7	6	1	1
August	2	1	0	0
September	3	3	0	0
October	16	9	1	0
November	7	4	0	0
December	11	9	0	0
TOTAL	109	72	13	6

*Flood classification at Riverton:—
2.74 m: Bridge height
3.66 m: First affects river bank installations (motor/pumps)
6.10 m: Moderate flood downstream — breaks banks at gauge and small areas flooded
7.62 m: Flood crops and grazing areas and serious flooding downstream

Table 16. Floods in the Macintyre Brook at Inglewood (13.11.1924 to 24.5.1984).

Month	Peak Flood Height* Equalled or Exceeded (metres)			
	3.10	6.58	8.53	10.16
January	9	3	2	1
February	8	3	2	1
March	7	1	0	0
April	1	1	0	0
May	3	2	1	0
June	4	2	0	0
July	3	1	0	0
August	0	0	0	0
September	4	1	0	0
October	7	1	0	0
November	6	0	0	0
December	5	0	0	0
TOTAL	57	15	5	2

*Flood classification at Inglewood:—
3.10 m: Old traffic bridge at Whetstone
6.58 m: Old traffic bridge height at Inglewood
8.53 m: Floods crops downstream from Inglewood
10.16 m: Floods Inglewood town area and cuts railway line. Large areas of crop and grazing land flooded.

Coolmunda Dam and flooding in the Macintyre Brook

Inglewood has experienced at least two severe floods — in 1956 and 1976 (also the 1890 flood equivalent to the 1976 level). After the flood of 1976, there was considerable controversy as to the effect of Coolmunda Dam on flooding in Inglewood. The Queensland Water Resources Commission responded by conducting a detailed study. Outflow from Coolmunda Dam is monitored at a set gauges located downstream in the picnic area. Data collected from this gauge show the relationship between Coolmunda Dam and Inglewood gauge heights (see Table 19). Using this table as a guide, it would require a height of at least 4 m at the Coolmunda Dam gauge to cause moderate flooding at Inglewood provided Canning Creek was not in major flood.

Table 17. Peak flood heights and dates at Texas which exceeded 7.62 m (1890 to 1984).

Date	Flood Height (m)	Height above moderate flood level (m)
27 March 1890	9.68	2.06
1 June 1893	8.53	0.91
11 June 1893	8.69	1.07
13 Dec 1917	7.72	0.10
10 June 1921	8.00	0.38
23 June 1921	10.08	2.46
30 January 1927	7.62	0.00
13 January 1937	7.62	0.00
16 June 1948	8.08	0.46
25 June 1950	8.38	0.76
29 July 1950	7.77	0.15
19 October 1954	8.23	0.61
22 January 1956	10.06	2.44
10 February 1956	8.41	0.79
19 February 1956	10.11	2.49
26 June 1956	7.92	0.30
9 November 1966	7.87	0.25
30 March 1975	8.40	0.78
12 February 1976	9.03	1.41

Table 18. Peak flood heights and dates at Inglewood which exceeded 8.53 m (1924 to 1988).*

Date	Flood Height (m)	Height above downstream flooding level (m)
28 January	8.84	0.31
22 January 1956	12.50	3.97
6 February 1971	9.68	1.15
11 February 1976	11.73	3.20
3 May 1983	9.65	1.12
11 April 1988	10.45	1.92

*there are reports of a flood reaching a similar height to that of the 1976 flood occurring in 1890.

Flood warning system

The Bureau of Meteorology operates a flood forecast and warning system for Queensland, including the Macintyre Brook and Dumaresq River. Most of the data are received from volunteer observers. The Bureau telegraphs river heights and selected rainfall data to radio stations for broadcast, to selected police stations in threatened areas, and to some additional organisations on a needs basis. The Bureau also publishes a daily river height bulletin during periods of river rises. This bulletin is broadcast each day on the A.B.C. Country Hour. River height observers start reporting when levels reach a pre-determined height on the gauge. Reports are continued at regular intervals after this. There are four classes of flooding used in the Bureau warnings:

* Local flooding:— Flooding caused by heavy rain which has fallen in the immediate vicinity of the area affected. Small creeks become flooded in rural and urban areas. Drainage systems overflow in urban areas and cause temporary traffic disruption.

* Minor flooding:— This causes closing of minor roads and submergence of low level bridges. It makes the removal of river pumps necessary. The effect of minor flooding may be felt in the reach of the river in question, in the vicinity of the river gauge or at some distance upstream or downstream from the gauge.

* Moderate flooding:— This causes inundation of low lying areas — requiring the removal of livestock and the evacuation of isolated houses. Main traffic bridges may be closed.

* Major flooding:— This causes inundation of large areas, isolating towns and cities. Major disruption occurs to road and rail traffic and other communication. Evacuation of many houses and business premises may be required.

Table 19. Relationship of Coolmunda Dam gauge heights with Inglewood gauge heights.

Date	Coolmunda Dam Gauge Height (m)	Inglewood Gauge Height (m)	Difference (m)
February 1976	6.25	11.7	5.45
September 1978	2.55	6.45	3.90
March 1982	1.60	5.10	3.50

For flood warnings to have the greatest economic benefit they must be received, interpreted and acted upon so that the appropriate protective measures can be taken. Warnings are normally issued about one and a half hours after the reporting time although in the smaller catchments subject to flash flooding, efforts are made to issue warnings within one hour of each reporting time. The police act as the main distributors of information in flood threatened areas because they are largely a 24 hour organisation and have close co-ordination with local authorities and S.E.S. under the umbrella of the State Counter Disaster Organisation. River height data collected at Inglewood and Texas, together with Yetman and Bengalla are of vital importance for forecasting expected flood height at Goondiwindi. Flood forecasts will be issued for other towns such as Inglewood and Texas when sufficiently reliable techniques have been developed. However, moderate to major floods are relatively rare in Inglewood, hence little data are available since the completion of Coolmunda Dam. Flood losses on the farm can be minimised to some extent by erecting permanent markers on parts of the property likely to be subjected to flooding. By using these permanent markers, and relating them to the broadcast peak flood heights for gauging stations during floods, it should be possible to anticipate the magnitude of flooding, downstream from gauging stations, in future floods.

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Floods have an important influence on agriculture in the shire.

CHAPTER 2

SOILS AND LAND CAPABILITY OF INGLEWOOD SHIRE

Soils

The soils of Inglewood Shire have been broadly mapped at a scale of 1: 2 000 000 in sheets 3 and 4 of the Atlas of Australian Soils (Northcote, 1966 and Isbell et al., 1967). However, separate sections of the shire have been reported in more detail. Isbell (1957) mapped part of the shire west of 151°5'E longitude at the scale four miles to one inch (approximately 1:253 000. The accompanying soils map (Map 1) is a composite of these more detailed reports. This map was first published in the Inglewood Shire Handbook (Malcolmson and Lloyd 1977). Table 21 describes the soils, vegetation, land use and management for each of the main soil groups. Much of the information in this table is derived from the Inglewood Shire Handbook. Definitions of some of the terms used in the table are listed at the end of this chapter.

Land capability

The information in this section was reproduced from the Inglewood Shire Handbook.

Land capability classification is the basis for land use planning. Land is made up of areas of different production potential, that is, land capability units or land classes. When classifying land it is necessary to determine the limitations to agricultural production for each land unit. The kind and severity of these limitations determine the type of use for which a particular land unit is best suited. The form of land use that ensures long term productivity is the one which should be practiced. Knowing the limitation of each land unit and the degree of erosion hazard to overcome, a selection of conservation measures can be prescribed. Under the system of land capability classification adopted in Queensland, eight main classes are recognised. These classes are grouped into three broad classifications of use called land capability divisions. The eight classes fall into these three divisions and are shown in Table 20.

Factors affecting land capability are:—

- Available moisture holding capacity of the soil.
- Effective soil depth.
- Soil physical factors affecting crop growth.
- Soil nutrient fertility.
- Soil salinity or sodicity.
- Topography.
- Soil workability.
- Rockiness or stoniness.
- Surface microrelief (for example, gilgai and gullying).
- Wetness.
- Susceptibility to water erosion.
- Susceptibility to flooding.
- Susceptibility to wind erosion.

The combination of limiting factors, but especially the severity of the limitations, determines the class of the land.

Source: Rosser et al. (1974) — A Land Capability Classification for Agricultural Purposes.

Patterns of land capability

For a broad land capability classification of the shire, reference is made to the land capability map (Map 2). The basis of this map is the Land Capability Map of The Granite and Traprock Area of South-East Queensland by A. K. Wills (Division of the Land Utilisation, Queensland Department of Primary Industries) which has been extended to cover the western part of the Inglewood Shire. Some modifications have been made to the original to suit the author's interpretation of the peculiarities of the shire area. The intention of this section is to highlight and explain the main variations in land capability within the shire.

Class II land is found on the flood plains of Canning Creek and the Macintyre Brook. The main limitations to cultivation are occasional wetness and flooding. Soil physical problems and workability restrictions of the soils of older terraces and levee slopes of the Macintyre Brook, can be so severe that some areas would have to be downgraded to Class II and IV. Also the risk of severe flood damage could put low lying areas and narrow depressions into Class III or IV.

Class II to III areas are mainly on the Dumaresq flood plain with a few minor alluvial strips along Oakey, Nanny and Bracker Creeks. The erodible surface structure of the soils combined with some relief, make them slightly to moderately erosion prone. The risk of severe flood damage downgrades some areas into Class III and IV.

Class III land occurs north-east of Inglewood. This is brigalow-belah country where erosion risk is the main limitation arising out of moderate slopes or long slopes which allow runoff water to concentrate. The lower areas with severe gilgai are of Class V. Other Class III areas are found along a number of watercourses. Susceptibility to water erosion, often combined with shallow effective soil depth, susceptibility to flooding, and poor surface soil structure is the main limitation here. Class III to IV, and IV country is similar in its limitations to the previous class, but stoniness is also significant. The difference between Class III, III to IV, and IV is mostly in the degree of the limitations.

Class V land is very strongly gilgaied brigalow country. Wetness is the main limitation, as land levelling has, for a

Table 20. Land capability divisions and classes.

Land capability divisions	Land capability classes	
Land suitable for cultivation	Class I	No special practices needed.
	Class II	Special, but simple practices needed.
	Class III	Complex or intensive practices required.
	Class IV	Suitable for occasional or limited cultivation only.
Land not suitable for cultivation	Class V	Good land but with obstructions to cultivation not practical to remove (for example, gilgais).
	Class VI	Moderately susceptible to deterioration, therefore requiring some restrictions in use (moderate grazing).
	Class VII	Highly susceptible to deterioration therefore requiring severe restrictions in use (light grazing).
Land not suitable for cultivation or grazing	Class VIII	Suitable only for wildlife reserves and watershed protection.

number of years, an adverse affect on the productivity of the soil and is also costly. The economics do not favour cultivation.

Class IV to VI land is concentrated around Warroo and Limevale. The main hazard is erosion through poor soil structure, occasionally complicated by long slopes and location below steeper land units which discharge concentrated runoff onto these lower units. Soil depth, stoniness and poor moisture holding characteristics are also limitations in some areas. This is the last unit in which there is any chance of successful cultivation, which can only be conducted under careful controls to prevent deterioration of the land resource.

Class VI land is found mainly in the sandstone country north and south-west of Coolmunda Dam and between Limevale and Clarinda Station and Limevale and Magee Station. This is the better class of grazing land and is limited by the erosion potential of its shallow, stony, poorly structured soils.

Classes VI to VII, VII and VII to VIII are the lower grazing classes. They are successively more restricted for the same reasons as Class VI. The traprock area in general and the sandstone country in the western sector of the shire, fall in this category.

Strictly speaking, the deeper sandy soils of the sandstone country are arable. Some areas are cleared and cultivated for crops, or for improved pasture establishment. However, the overall low fertility of these soils, combined with a low waterholding capacity and a high wind erosion potential, make this unsafe and uneconomic. Timber production is really the only suitable form of land use, but care should be taken that forestry tracks do not wash out. Another problem in clearing this land is timber regrowth. To control such regrowth it is necessary to cultivate for several years, during which time couch grass invades.

Texture contrast soils have sodic subsoils which are highly susceptible to erosion. Care should be exercised in the management of these soils to prevent topsoil loss and subsequent exposure of the sodic subsoil.

Improved species do not persist because of soil deficiencies. Fertilisation of improved pastures under similar soil and climatic conditions has proved uneconomical. If the end result of timber clearing is regrowth or a solid mat of couch grass after a period of cultivation, the expenditure would certainly not be warranted. In the process, severe erosion is likely to occur. Contour banking for water erosion control would be another heavy cost.

Class VIII land has negligible productive potential because it is often rugged and inaccessible. The vegetation should be preserved to ensure stability of this land.

Table 21. Soils of Inglewood Shire.

Unit	Soil Description and Landform	Vegetation	Land Use and Management
SOILS DEVELOPED ON ALLUVIUM			
1	This unit can be found bordering the Dumaresq River and Macintyre Brook and can be divided into two subgroups.		
	(a) **Soils of the Younger Terraces and Levees**		
	Deep, slightly acid to neutral sandy loams to silty loams. Silty clays also occur.	Murray River red gum, poplar box, forest red gum and occasionally Moreton Bay Ash.	Highly productive soils because of their depth and sandy loam texture. Not as prone to surface crusting as the soils of the older levees, and with better water infiltration rates. However, they are prone to flood damage and should not be cultivated because of this. Best suited to permanent pasture. The less flood prone areas can be planted to lucerne. Care should be exercised to prevent overgrazing of these flood prone levees.
	(b) **Soils of the Older Terraces and Levees**		
	Much more extensive than group (a) soils. Generally slope away from the streams. Deep soils with 30 to 60 cm of slightly acid to neutral loam or clay loam overlying compacted red-brown alkaline clay subsoils.	Silver-leaved ironbark and poplar box. Rough barked apply may occur on sandy areas.	Nitrogen, phosphorus and sulfur deficiencies exist in irrigated crops without correct use of fertilisers. Cultivation and irrigation often lead to surface crusting and the development of hard pans. Undesirable chloride accumulation may occur with irrigation. Subject to inundation by exceptional floods. The depth to the red-brown subsoil can limit the infiltration of irrigation water. Where the subsoil occurs close to the soil surface water infiltration is reduced and crop root zone restricted.

Unit	Soil Description and Landform	Vegetation	Land Use and Management

2 This unit is found bordering the Dumaresq River upstream from Smithfield.

DOMINANT SOILS

(a) **Dark-brown structured earths**
Deep soils with a hard setting clay loam surface which gradually changes to a dark brown clay subsoil containing lime concretions.

(b) **Dark-brown texture contrast soils**
Deep soils with a usually hard setting loam to clay loam surface with an abrupt change to an alkaline clay subsoil. Lime may occur at depth.

MINOR SOILS

(a) **Dark loams**
Deep, dark-brown, sandy clay loams to clay loams of neutral pH occasionally becoming more clayey and alkaline with depth.

(b) **Dark, hard setting clays**
Deep, black to dark-brown clay becoming alkaline with depth. Lime concretions in subsoil are common. Clay colour may become browner with depth.

Cleared open forest of river red gum, forest red gum, white box and poplar box with some rough barked apple.

Soil fertility is generally good, but salt accumulation, particularly in the dark-brown texture contrast soil is a severe restriction. The hardsetting surface is a problem for cultivation and the impermeable, poorly drained, clay subsoils of the dark-brown texture contrast soils restrict the soil's cultivation and irrigation potential. Flooding can occur. Well suited to all irrigated crops. Nitrogen, phosphorus and sulphur deficiencies exist in irrigated crops without correct use of fertilisers.

3 This unit is found bordering the Macintyre Brook east of Inglewood and bordering other streams surrounded by sandstone or traprock.

DOMINANT SOILS

Yellowish-brown and brown, neutral to alkaline, texture contrast soils. Topsoil is hardsetting with a light texture and is often gravelly. Subsoils are coarse blocky or columnar structured clays.

MINOR SOILS

(a) **Soloths**
Deep soils with a brown loamy-sand to fine sandy-loam surface over a red-brown, acid, clay subsoil.

(b) **Red and brown alkaline structured earths**
Deep soils with a brown light textured surface over an alkaline clay subsoil.

(c) **Sandy-loams**
Deep soil with a brown to reddish-brown, light textured surface over a brown acid to neutral sandy-loam subsoil.

(d) **Brown, grey and dark cracking clays**
Deep soil with large hexagonal surface cracks. May have a clay loam surface. Usually has lime at depth.

Variable with pine and mixed stands of poplar box, yellow box, brown box and rough barked apple.

The hardsetting surface and poorly structured clay subsoil of the dominant soil restrict long term cultivation prospects without irrigation. Nitrogen, phosphorus and sulphur levels are low and subsoil sodicity is occasionally undesirably high. Suited to irrigated forage cropping and improved pastures. Deeper soils are suited to irrigated grain crops.

Unit	Soil Description and Landform	Vegetation	Land Use and Management

SOILS DEVELOPED ON LIMESTONE

4 This unit is found on small areas around Limevale and the Pinnacle.

DOMINANT SOILS

Red-brown structured earths
Deep soil with a hardsetting, dark reddish-brown, clay-loam surface soil grading into a red-brown blocky, medium clay subsoil containing manganiferous nodules and neutral to alkaline at depth.

MINOR SOILS

Dark red, hardsetting, calcareous clays
Moderately deep clay with a gritty, brownish-black to brown surface soil grading into a dark-brown to brownish-black, blocky subsoil with powdery lime throughout.

Dominated by an open forest of brown box, white box and silverleaf iron bark.

Suitable for cultivation, but soil surface may be hardsetting and salinity levels may be high. Soil fertility status is fair. Well suited to short-term cropping provided soil conservation practices are carried out. Improved pastures based on lucerne and temperate legumes are a suitable pasture mix in a crop/pasture rotation.

SOILS DEVELOPED ON SANDSTONE

5 (a) **Texture contrast soils**
Acid, sandy, loose surface soil over a bleached sandy subsurface overlying a tough solonised acid to alkaline, clay subsoil.

Dominated by cypress pine with bulloak narrow-leaved ironbark, tumbledown gum and rusty gum. Grass cover is sparse.

Undesirable agricultural soils because of their low fertility, often very acid surface and impermeable clay subsoil causing impeded internal drainage and waterlogging.

(b) **Deep sands**
Deep. light grey to light brown sands. Occur near Macintyre Brook and are usually at least 2 metres deep.

Cypress pine, black pine, rusty gum and silver leaf ironbark.

Some potential for agriculture and horticulture, particularly under spray or trickle irrigation. Fertiliser requirements would be high.

6 **Deep, texture contrast soils**
Loam to clay loam surface, occasionally gravelly. Subsoils are coarse blocky or columnar, grey-brown to reddish-brown, commonly mottled, neutral to alkaline, clay subsoil.

Forest dominated by bulloak with cypress pine, poplar box, narrow leaf ironbark and mallee box.

Unsuitable for agriculture. Clearing of the deeper soils (greater than 30 cm above the subsoil) can improve carrying capacity through improved native pasture growth. Short-term forage cropping is necessary to control regrowth.
Low to very low fertility. Subsoils contain undesirably high levels of magnesium and sodium.
Low stocking rates are required to minimise pasture deterioration. Stocking rates range from one beast to 12 to 20 hectares. Higher stocking rates are acceptable on the deeper soils with less regrowth.

7 Shallow stony soils with numerous rock outcrops.

Forest of silver-leaf ironbark, narrow leaf ironbark, poplar box and cypress pine.
Wattle is present in some areas.

Unsuitable for agriculture.

8 Shallow to moderately deep, texture contrast soils. Hardsetting, gravelly, light textured surface soils.
Subsoils are blocky or columnar structured acid clays.

Open forest of tall narrow leaf ironbarks among cypress pine with the occasional rusty gum.

No agricultural potential because of hardsetting surfaces, poor internal drainage, shallow soil depth and a high gravel content. Low to fair fertility. Very low in phosphorous. Subsoil has an undesirably high sodicity.

Unit	Soil Description and Landform	Vegetation	Land Use and Management

SOILS DEVELOPED ON TRAPROCK

9 These soils are shallow and are characterised by a high content of angular parent rock.

DOMINANT SOILS

(a) **Shallow gravelly loams**
Brownish-black to brown surface soil over a brown or bleached, acid subsoil.

(b) **Shallow gravelly texture contrast soils**
Surface soil is brownish-black to dark brown loam to sandy clay loam. Subsoil is clay with a coarse blocky or columnar structure and is acid to neutral.

MINOR SOILS

(a) **Shallow to deep gravelly earths**
Surface soil is a brownish sandy loam to a light sandy clay-loam. Changes gradually to a dull yellowish-brown to reddish-brown, acid, clay-loam or clay subsoil.

(b) **Shallow gravelly clays**
A red-brown clay soil with a thin (2 cm) dark brown clay-loam hardsetting surface veneer.

Varies with locality. Mixed and pure stands of cypress pine, tumbledown gum, narrow leaved ironbark, silver leaved ironbark, Caleys ironbark, white box, Mugga ironbark, brown box.

Shallow depth, rough terrain and rock outcrops make grazing or forest reserve the only possible land uses. Fertility status is extremely variable, but is more commonly low. Subsoil sodicity is commonly high in the gravelly texture contrast soils.
Low stocking rates are required to minimise pasture deterioration. On native pastures stocking rates of 1.25 dry sheep/ha can be carried. Improved pastures where practical can carry 2.5 dry sheep/ha.

10 **DOMINANT SOILS**

Shallow, gravelly loams over clays
Surface soil is a brownish-black to brown, sandy-loam to clay-loam. Abrupt change to a brownish clay subsoil.

MINOR SOILS

(a) **Shallow gravelly loams**
Brownish-black to brown surface soil over a brown or bleached acid subsoil.

(b) **Deep, gravelly, texture contrast soils**
Surface soil is a brownish-black sandy-loam to clay-loam. Subsoil is an alkaline clay, reddish-brown to dull yellowish-brown.

Same as for Map Unit No. 9.

Cultivation may be attempted in limited areas where subsoil structure and soil depth and slope are satisfactory. Improved pastures based on temperate annual legumes are possible. Fertility status is low to fair, often being low in phosphorous. Subsoil sodicity is undesirably high. Low stocking rates are required to minimise pasture deterioration. On native pastures stocking rates of 1.25 dry sheep/ha can be carried. Improved pastures where practical can carry 2.5 dry sheep/ha.

GRAVELLY SOILS OF MIXED ORIGIN

11 Gravelly texture contrast soils with a hardsetting stony surface. Surface soil is a fine sandy-loam to clay-loam. Subsoil is a columnar brown to dull yellowish-brown acid to alkaline clay.

Open forest dominated by broadleaf ironbark, poplar box, some bulloak, cypress pine and rusty gum.

Undesirable for agriculture because of their hardsetting, gravelly surface, poor internal drainings and low fertility. Subsoils contain undesirably high contents of magnesium and sodium.

Unit	Soil Description and Landform	Vegetation	Land Use and Management
BRIGALOW-BELAH SOILS			
12	(a) Deep, grey and brown clays, strongly gilgaied with a self-mulching surface. Commonly with gypsum and lime present. Subsoils can be acid or alkaline. (b) Associated soils are texture contrast with sandy-loam to clay-loam surface soils. Subsoils are commonly gravelly with coarse blocky or columnar structured alkaline clays.	Brigalow with varying degrees of belah and some false sandalwood. Belah tends to dominate on the texture contrast soils.	Many areas are suitable for cereal crops where land can be successfully prepared. Strong gilgai development may restrict cultivation. Fertility status is fair to good except where the surface soil is acid. Salt content may be fairly high. Sloping land is susceptible to water erosion. Conservation cropping practices should be combined with contour banks and grassed waterways. Long-term cultivation without a pasture phase in undesirable. Developed brigalow can carry one beast to 3 to 4 hectares.
13	This unit is closely associated with Unit 12. Deep texture contrast soils with a clay-loam surface. Subsoils are brown to grey-brown alkaline clays which may become acid at depth. Gypsum and lime commonly occur in the subsoil.	Normally belah with some brigalow and false sandalwood.	Generally suitable for cereal crops. Fertility status is fair to good. Subsoil salt may be moderate to fairly high. Sloping land is susceptible to water erosion. Conservation cropping practices should be combined with contour banks and grassed waterways. Long-term cultivation without a pasture phase is undesirable. Developed brigalow can carry one beast to 3 to 4 hectares.
SANDALWOOD — POPLAR BOX SOILS			
14	Weakly solodised solonetz soils. Occur along the outer fringes of alluvial flats and also drainage lines in Unit 12. Deep texture contrast soils. Clay-loam surface. Subsoils are grey-brown to brown alkaline clays which may become acid with depth.	Sandalwood usually accompanied by poplar box.	Agricultural use is restricted by:— (a) poor structure; (b) surface soil has low water holding capacity; and (c) subsoils are impermeable and poorly drained.
TEA TREE-SPINIFEX SOILS			
15	Yelarbon 'desert' soils. Texture contrast soils with a hard-setting, loam to clay-loam surface which has commonly been eroded away giving a clay pan appearance. Subsoils are coarse, columnar structured clays.	Stunted community of tea tree, sandalwood, bulloak and mallee box with spinifex very prominent.	Soil conditions are unsatisfactory for almost any crop growth. These are highly alkaline soils with undesirably high amounts of sodium and magnesium.

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Glossary of terms used

Gilgai:— An alternative name for melonholes.

Soil colour:— The description of soil colour tends to be rather subjective. People who study soils use the Munsell soil colour charts to give soil colours a value such as 5YR3/4, rather than a colour name. In the absence of a chart, soil colours should be named as simply as possible. Soil colour can usually be attributed to three pigments which produce black (humus), red (iron) and white (silicates and salts). Poorly drained soils have a mottled appearance. This is the presence of two or more distinct colours dispersed throughout the profile.

Soil reaction or pH:— This is the term used to describe soil acidity or alkalinity. In the field, pH kits are available to give an estimation of pH. The following table indicates the relationship between pH value and reaction for soils.

Strongly acid	pH up to 5.5
Acid	pH 5.5 to 6.5
Neutral	pH 6.5 to 7.5
Alkaline	pH 7.5 to 8.5
Strongly alkaline	pH above 8.5

Most plant nutrients are readily available between pH 6 and 8. If pH values are outside this range nutrient deficiencies may occur.

Soil structure:— This refers to the manner in which the individual particles which make up the soil are grouped together. Some soils, for example, beach sands, have no structure at all. Humus (formed when plant material decomposes) in the soil, helps give it good structure as it binds soils particles together.

Soil texture:— This is the estimation of the amount of gravel, sand, silt and clay in the soil. The texture term 'light' is applied to soils with much sand and silt relative to clay. Heavy soils are those with much clay relative to sand and silt. The texture of the soil profile may change with depth. Soil profiles may be classified as follows:

- **Uniform:—** The texture is uniform throughout the profile. For example, the grey brigalow clays have a clay texture throughout, while soils on sand hills in Western Queensland are sandy throughout.
- **Duplex:—** The texture changes abruptly at one part of the profile. These soils are often called 'Texture Contrast' soils. Solodic soils are a good example of a duplex soil. An example of solodic soil would be a soil with approximately 15 cm of loam overlying a sodic clay subsoil.
- **Gradational:—** The texture changes gradually as you go down the profile. The dark brown structured earths in Mapping Unit 2 are examples of gradational soils.

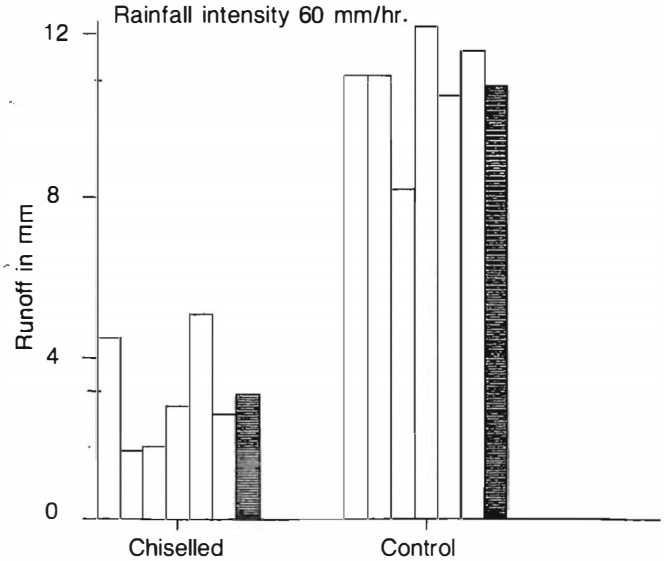
The procedure for estimating texture is to work the soil between the thumb and fingers until it is broken into individual particles, then to wet the soil to 'sticky point' (until it adheres to the fingers) and note its properties after moulding. The texture classes relate to the degree of grittiness (indicating sand), silkiness (indicating silt) and moulding ability (indicating clay). Gravel is determined separately.

The following texture classes grade from light to heavy and depend on the soil's ability to be rolled into rods about 8 cm long and 7 mm across. Another method of determining texture is to check a soil's capacity to ribbon out between the thumb and fingers.

Sand	Does not cohere. Has a gritty feel.	Will not roll into rods. Breaks easily.
Sandy loam	Coheres and is friable. Has a gritty feel.	
Loam	Friable and coherent. Sand grains cannot be felt.	
Sandy clay loam	Has a gritty feel.	Rolls into a rod, but cannot be turned into a ring without cracking.
Clay loam	Sand grain cannot be felt.	
Light clay	Easy to mould.	Rolls into rod easily. Can be turned into a ring without undue cracking.
Medium clay	Fairly stiff and plastic to mould.	
Heavy clay	Very still and plastic to mould.	

Soil Conservation Services Branch Officers measuring runoff on a traprock soil at John Greacen's, 'Brooklyn', Cement Mills using a rainfall infiltrator. 7/1/88

Figure 12. Effect of chisel furrows at Brooklyn. Runoff after 20 mm rain. Averages shaded.



Control and prevention

Minimising run-off is the obvious solution. This will not only stop the loss of existing soil but will eventually help in the regeneration of the entire site. In grazing areas run-off is reduced by greater penetration of rain into the ground. If rain drops strike vegetation (grass, shrubs, crops, weeds, trees etc.), they are shattered to a fine mist which does not pound the surface and which is quickly absorbed by unencumbered capilliary action. If the rain is intense, the presence of vegetation acts as a hindrance to any run-off, thus allowing more time for water to soak into the soil. The increased absorption promotes better growth of vegetation, which in turn aids greater retention of the next fall of rain.

Under natural conditions areas under trees are naturally stable, as the ground surface will usually be protected by grasses or forest litter. However if the surface cover is removed by grazing or camping stock, or by torrential downpour, such areas may become very susceptible to erosion. Many of the ridges in the shire with tumble down gum and pine growing on them have become rocky and wasted through erosion.

Simply stated, the answer is to prevent wind and water from interacting with the top-soil so as to shift it about. Expertise and techniques which can be used to mitigate particular problems are available. Some practical ways are outlined elsewhere in this book. Solutions to many problems plus their associated costs are available from the Soil Conservation Services branch of the Department of Primary Industries. Especially recommended reading is the January-February 1987 edition of the Queensland Agricultural Journal which contains a useful outline of the way that property planning can affect the potential for soil erosion (1). The author highlights the following points:

Sandstone derived soils with their sodic subsoil are very prone to gully erosion as illustrated in this photo.

Property roadways can be a source of extensive erosion. Thought must be given to roadway locations and protection so as to minimise problems. Here diversion channels have been constructed so as to remove runoff water from the road edges and prevent erosion.

CHAPTER 3

SOIL EROSION IN INGLEWOOD SHIRE

"We cannot do everything at once; but we can do something at once." — Calvin Coolidge

Erosion on grazing lands

Erosion is not new, nor is it necessarily man made. The mountain ranges of this country have been shaped by aeons of erosion. However at the property level the process tends to wash away the basis of a landowner's living, and take it somewhere outside his boundaries. Therefore, every grazier or farmer benefits himself by exerting some control over erosion. Progressive land degradation can be well underway on a property before the owner is fully aware of it. Signs of erosion, however, do not develop overnight. These signs are:

- the development of gullies and tunnels
- the development of "rills" in sandy topsoils
- the appearance of "fans" — deposits of transported soil or sand
- the development of "bare" areas.

Once erosion is detected, it is every landowner's concern, whether it affects his own personal investment or it degrades public land within the shire.

Causes and symptoms

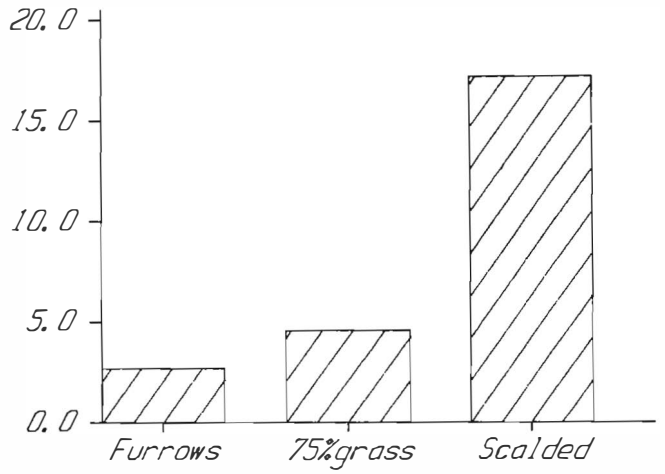
Soil erosion is the removal of soil, especially top-soil, by water or wind, leaving the area unproductive and unstable enough for further erosion. Basically, it is caused by water washing over soil faster than it can be absorbed. Inevitably it becomes fast enough and concentrated enough to carry sand, soil and gravel from their original sites. Grazing land in the Inglewood Shire is relatively unaffected by wind erosion. There are too many hills and trees. On most of our soils, water erosion is much more severe and apparent. The process of water erosion is activated by rain, or flooding, or both. When a drop of rain strikes the bare ground it is falling at approximately 30 km/hr. If the rain is intense, the capilliaries in the soil cannot carry the water down quickly enough. The battering of large raindrops creates a thin slurry of mud on the surface, which seals off this capilliary action, and the water starts to run-off if there is any slope at all. If the velocity of this run-off is sufficient it will cause the slurry to be washed away with it. As the rain continues the slurry will be constantly recreated and removed. As the volume of the flow increases, due to the continuing slope and/or the intensity of the rain, it becomes more concentrated. This concentrated energy causes rilling and gullying, which further localises the water and intensifies the erosion. The top-soil is displaced until rock, sterile sub-soil and underlying clays are laid bare.

When the soil is left unprotected and vulnerable to the elements it is at risk. There is very little naturally bare ground in the shire. It is usually made bare of vegetation through over-utilisation, both by man and by animals; and occasionally by natural disasters, e.g. bushfires. Overclearing, overstocking, ploughing, large populations of rabbits/kangaroos, quarrying, the activities of local and state governments making roads etc., and development of urban areas can all activate and continue the process.

A field study

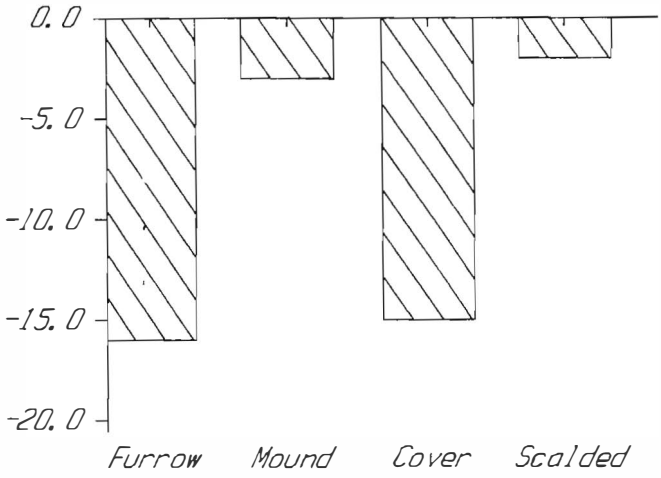
In an experiment carried out on a traprock soil, Crossley and Glanville (private communication) of the Toowoomba office of the Queensland Department of Primary Industries, used a rainfall simulator to apply rainfall at an intensity of approximately 55 mm/hr. Treatments compared were a single pass contour chisel cultivation, 75% plant cover and 12% plant cover (i.e. "scalded"). A total of 30 mm of "rainfall" was applied and the following conclusions were drawn:

Fig. 10 Runoff (mm) after 30mm of rain



Based on Rainfall Simulator data 6/1/87

Fig. 11 Depth of wetting (cm) after rain



*without adequate plant cover much of the rain that falls in storms will run-off and be of little use to the small amount of existing plant life (see figure 10);

*by maintaining plant cover through management of stocking rates, more rain will soak in resulting in plant growth over a longer period. That is depth of wetting to 2 cm may provide plant growth for one day as opposed to 10 days if depth of wetting was 15 cm (see figure 11);

*contour chisel ploughing can in the short term (12 months) be a very useful technique for improving water infiltration in overgrazed pastures, but more research is needed into its longer term benefits (figure 11);

*run-off was related to soil type. Loamy hard setting traprock had 14% run-off even with grass cover, while gravelly traprock had only 1% run-off;

*The effect of chisel ploughing was confirmed by measurements made 12 months later. These compared run-off from the chisel ploughed treatment with that from an untreated area of the same soil with similar ground cover

- Roads and tracks should be located away from areas where run-off water tends to concentrate;
- Stock laneways should also receive the same consideration;
- Shelter belts of uncleared timber can protect steep areas;
- Fence lines should not help to concentrate run-off water;
- Watering points and stock concentrations which tend to expose the soil and create bare "pads" should not be on sloping land;
- Fire breaks, where possible, should be graded across the slope and across the prevailing wind direction;
- Stockyards and buildings, ideally, should be on a flat, elevated well drained site.

Broad based contour banks for controlling erosion on a property in the north-east corner of the shire. These contour banks are part of a planned soil conservation layout.

No grazier or farmer need be ashamed of his erosion problems until he is aware both of the specific nature of the problem and the methods of prevention and cure. Public criticism has been levelled at landholders, suggesting that they are not husbanding the nation's natural resources and that they are creating an economic and aesthetic loss for all Australians. To some extent this may be true. However the pressure on primary producers, not only through operating in a harsh environment but also by governments, to push their land to the limit, has been almost impossible to withstand. De-stocking and re-stocking according to seasonal trends would be ideal conservation but commercially impossible. Some overgrazing can be caused by unrealistic expectations of carrying capacity and sometimes by the desire to prevent the contamination of wool by grass seeds. In some cases the use of cattle for rotational grazing can help reduce the problem of seed and shive in wool, while allowing native grasses to re-establish. These matters are covered in more detail in the chapter dealing with pasture production in the shire.

Erosion of cultivated soils

Prior to the clearing and cultivation of land the vegetative cover of trees and pasture protected the soil from wind and water erosion. The removal of natural cover and the cultivation of the soil makes nearly all the agricultural lands of Inglewood Shire extremely susceptible. The susceptibility of a soil to erosion depends on:

*Soil characteristics. Some soils are more easily washed away than others. Soils which have a high clay content (e.g. brigalow soils) are not broken down as easily by raindrop impact or affected by wind as much as the sandy or loamy soils (e.g. Macintyre Brook soils).

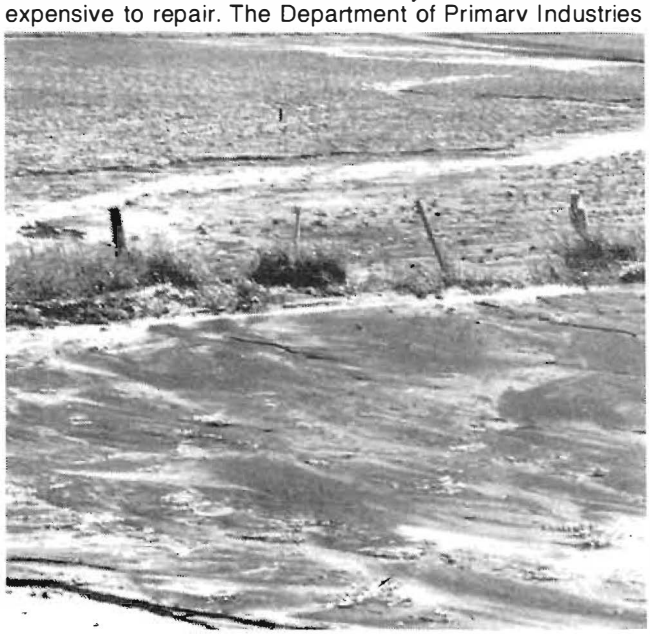
Rainfall erosivity. This is the potential ability for rain to cause erosion. While light rainfall does not have enough force to break up soil particles, the large drop size and intensity of storm rains which occur from October to March, do have the capacity to break down soil structure.

*Land slope. The steepness of slope, the length of the slope and the size of the catchment all have an effect on susceptibility of land to erosion. As the steepness increases the speed of run-off and potential for breaking up of soil particles increase. On long slopes, the quantity, depth and speed of water are increased.

All cultivated lands with a slope of more than 1% (that is, 1 metre fall in every 100 metres) are susceptible to water erosion; particularly the brigalow soils and red-brown earths

A recently constructed waterway ready for stabilizing with a suitable grass such as Rhodes grass on African star grass.

that occur in the shire. Water erosion occurs in three ways. Sheet erosion is the loss of a thin layer of surface soil. It is caused by run-off when the soil either cannot absorb the rain fast enough or is already saturated. Rill erosion results when run-off concentrates into small streams and erodes small channels to the depth of cultivation. Rills are small enough to be refilled with cultivation, but the soil loss is high. Gully erosion occurs when large quantities of running water are concentrated on an unstable area. This erosion cuts large channels which cannot be refilled by cultivation and are expensive to repair. The Department of Primary Industries



Sheet and rill erosion on unprotected brigalow-belah soils in the shire. Note the accumulated silt deposits above the fence line.

has estimated that approximately 7,400 ha of cultivation land in Inglewood Shire are susceptible to these three types of water erosion.

The main agents of soil erosion in Inglewood Shire are wind and water. The lighter textured cultivation lands (mostly sandy and clay loams) associated with the Macintyre and Dumaresq River flats are susceptible to wind erosion. The low percentage of clay and organic matter in these soils leads to rapid breakdown of structure by rain or cultivation. The Queensland Department of Primary Industries has estimated that 12,600 ha of cultivation land in Inglewood Shire are susceptible to wind erosion.

Control and prevention

Soil erosion by run-off water causes the major short-term production losses in the shire, so its control is a high priority. This can be done by controlling the speed of water running off the land and maximising the quantity of water that soaks into the soil.

Run-off control structures include contour banks and natural drainage lines or artificial waterways. Contour banks are constructed across the slope to guide excess run-off away from cultivation land and to discharge it in a safe disposal area. The grade along contour banks is kept very low so that water travels slowly along the channel and does not cause erosion. The number of banks required depends on the slope of the land and the erodibility of the soil. The steeper and more erodible a paddock, the closer together the banks need to be. For example, on a 4% slope banks should be spaced 80 metres apart, whereas, on a 3% slope, the recommended spacing can be increased to 95 metres. The type of bank used depends on paddock location, land slope and soil type. Cultivation paddocks that have steep or rocky areas situated above them often require a large bank to intercept this run-off. This bank is one of the most important structures in a soil conservation scheme. It is called a top diversion bank. The catchment area above a diversion bank determines its size.

On cultivation land with a very gentle slope and deep soils, wide contour banks can be built so that it is possible to cultivate both sides of the bank and achieve excellent weed control. As the slope increases it becomes impracticable to build this type of bank. The best alternative is a narrow based bank where the channel is still cultivated, but the bank is allowed to re-grass. On the cracking brigalow soils the aim also is to build a bank which can be cultivated at least on the top batter. This allows the cracks which occur on these soils to be filled in. Unless suitable natural drainage lines are available for the discharge of water from diversion and contour banks an artificial waterway is necessary. The width of a waterway is dictated by the catchment area, the expected storm intensity, the land slope and the type of grass used for stabilisation. The quantity and speed of water flowing in waterways is much higher than in diversion or contour banks. Waterways must therefore be planted to a grass which provides a dense soil cover. Rhodes grass (Katambora or Callide varieties) or African star grass are two species which are ideal for this purpose.

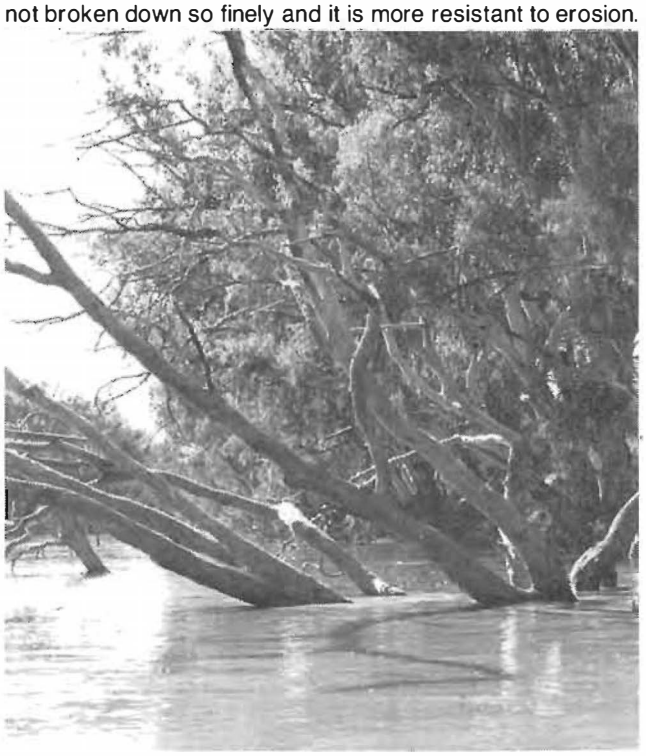
Contour bank systems are a major means of controlling erosion, but they do not give absolute control. A certain amount of erosion still occurs between banks. This silts them up progressively and reduces their useful life. Control of inter-bank erosion is achieved by the use of conservation management strategies. The first line of defence is to keep the surface of the soil protected from the impact of heavy raindrops. These shatter soil particles and seal off the surface so that moisture cannot enter the profile. In natural situations protection is provided by trees and ground cover. The same effect can be achieved with crops and crop residues. Growing crops, or crop residues left on the surface, absorb the energy of raindrops without sealing or breaking up the surface. This criterion should be built into cropping systems on farm enterprises in the shire.

Crops that give maximum ground cover during periods of high storm intensity are most desirable. Because winter cereal crops (wheat, barley and triticale) are planted in narrow rows, they give excellent protection in winter. If managed correctly, the stubble remaining after these crops are harvested can give protection against summer rainfall. Of the traditional summer crops, sorghum can give some protection, provided it is planted and established before heavy storms occur. Crops such as sunflowers and soya beans give less protection. Due to low stubble levels they leave the soil exposed to erosion after harvest, and during the growing period.

If sufficient soil moisture is available after a crop is harvested, another crop may be planted instead of fallowng the land. This is known as opportunity or double cropping. This practice can reduce the erosion risk, as more crops mean more soil cover. The increased use of soil water also means the soil profile is drier and ready to store water rather than let it run off.

After a crop has been harvested, as much stubble as possible should be retained on the soil surface. Practices such as burning, grazing or ploughing the stubble in should be avoided. New tillage implements, such as high clearance chisel ploughs and blade ploughs, allow farmers to kill weeds during a fallow while retaining large amounts of stubble on the surface. In more recent years, herbicides have been used to replace some or all tillage operations, further increasing levels of stubble retained.

Regular tillage operations break the soil down into a progressively finer condition. In the past, this was desirable, as a fine seedbed was required for planting machinery. Now, however, seed can be sown into fairly roughly ploughed or even unploughed ground through the use of special planters. This means that farmers can now plough less. The result is that more stubble is maintained on the surface, the soil is not broken down so finely and it is more resistant to erosion.



Fallen timber in watercourses can be a major cause of streambank erosion resulting from water being diverted towards the banks.

By contacting your local soil conservation officer or extension agronomist you will be able to obtain further information on these improved management techniques. DPI extension officers from both Soil Conservation Services (Warwick) and Agriculture Branch are available to landowners in the shire. They are of great assistance in planning contour layouts and conservation cropping systems.

Losses of river bank soils through flooding

Landowners along the rivers have a special problem. Floodwaters can erode streambanks and strip top-soil from cultivation on the lower terraces. This ruins, or partly ruins, good land for many years to come. Such soil losses can make the land unproductive, reduce property values, and cause problems downstream where the soil is deposited. Natural and gradual stream changes are inevitable. However the man who is farming river land can help minimise damage to both his own and his neighbour's properties if he learns to recognise and to combat signs of trouble. For example:

*a "fresh" may cause a minor bank fall or threaten cultivated soil. This could point out a potential erosion situation;

*a fallen tree may deflect the stream so that it begins to erode the opposite bank;

*trees or bush growing on silt which has built up on the inside of a curve may have the same effect;

*susceptible river banks should not be overgrazed or overcleared;

*flood prone land should not be overcultivated or cultivated at the wrong time;

*a more complicated problem may be caused through soil deposited in the main channel by smaller streams which drain steep cleared land close to the river.

Steps which can be taken to keep a stream bank stable are as follows:

*retain vigorous vegetation cover by fencing steep banks to exclude livestock. Give them access to the water at selected points;

*remove any brush, fallen trees or other obstructions that might begin to deflect the course of the stream;

*be aware that soil conservation measures taken on the whole watershed (and presented in other chapters of this manual) are important in reducing flood damage by keeping soil and silt from being washed into the main channel;

*re-establish plant cover on eroded stream banks — using grass, shrubs and trees. On steep areas it may be necessary to use mechanical aids such as stakes or mats. Willow poles, together with cuttings which have developed roots can be used in appropriate situations. (See note at the end of this chapter.)

River soils subject to flooding are nearly always good soils. It is often unrealistic to leave them completely without tillage. Some precautions are as follows:

*adopt a cropping plan which puts only part of the cultivation land in danger at any one time;

*avoid a bare soil cultivation at times of the year when flooding is most likely;

*consider perennial crops like lucerne or sown pasture, which reduce the need for cultivation;

*adopt tillage methods which retain crop residues on the surface as a mulch to help hold the soil;

*clear obstructions from the cultivated area. They tend to cause turbulence and therefore rapid erosion;

*try to cultivate across the general flow of water.

Naturally, the economic soundness of any project should be estimated at the outset. The cost of control should be weighed against possible benefits. The flow line of a stream is often the boundary between properties. Care must be taken not to divert the stream from its natural course as the ultimate result may be damage to another property. On our major rivers and streams no vegetation can be removed, or diversions implemented in the main water channel without the prior consent of the water authority concerned. In the case of a border stream the consent of water authorities from both states must first be obtained. In all aspects of land management it should be remembered that nature is a great healer and with a little help can go a long way towards rectifying damage caused by the indiscretions of man.

Willow poles for streambank protection

Drive or jet poles in a double row on the eroding bank of the stream just above the normal water line. The poles should be from one half to 1 metre apart and staggered between rows. They should be over 2 metres in length and from 70 and 100 mm in diameter. About two-thirds of the pole should be below ground level. This ensures that they will be stable and not removed by any sharp rise in the stream while the root system is developing. The poles should be supplemented by planting willow cuttings which have developed roots. It is recommended that the trailing ends of willow branches which have sprouted roots be used. It is important that treatment is commenced immediately the flood water has subsided. The poles are easy to drive and the cuttings easy to set. The available moisture ensures that the vegetation used will survive.

Willows can be planted along stream banks in order to reduce losses during floods.

References

1. Rowland, P. (1987). Property facilities need careful plannning. Queensland Agricultural Journal, Vol. 113, No. 1, 5-8.

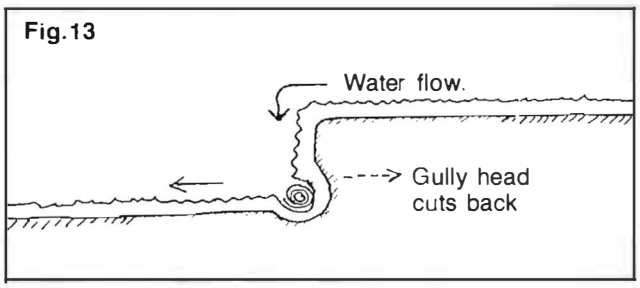
2. Truong, P. H. et al (1986). Graziers can avoid damage to grazing land. Queensland Agricultural Journal, Vol. 113, No. 1, 31-39.

CHAPTER 4

STABILISING GULLY EROSION

Reduced ground cover through grazing combines with self-sealing soils to cause heavy run-off in Inglewood Shire. After summer storms, large amounts of water are carried down the natural drainage lines. If the floors of these drainage lines are not protected, then gullies develop. The other important cause of gully erosion is the concentration of running water in stock pads, property tracks and roadside table drains. The typical form of gully erosion has a gully head or overfall eating its way back up the drainage line or slope. The depth and size of the gully head are determined by the degree of the slope, soil erodibility, soil depth and the amount of water carried. Figure 13 shows that as water flows over a gully head it washes away the soil at the bottom of the overfall.

Graham Harris, Q.D.P.I. and Dave Blomfield, 'Dungorm', Gore examining gully head on traprock at 'Dungorm'. Dave Blomfield has attempted to stabilise these gullies by use of spreader banks constructed above the gully head in order to divert water from the gully.

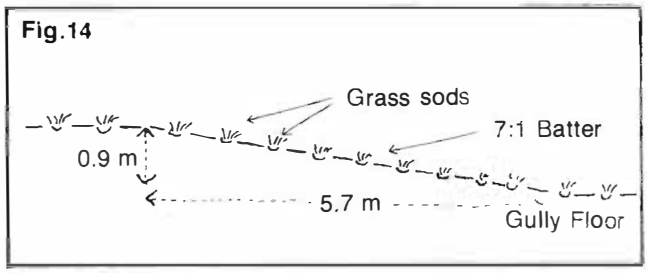


Grass is the cheapest and most effective means of stabilising soil erosion. However, it has its limitations, depending on the quantity of flow to be controlled and the depth of the overfall or gully head. Where grass cover alone is not effective in stabilising a drainage line, some other method must be used. Gully control must aim at stopping the undermining of the soil at the gully head. This can often be achieved by battering the overfall to a more gentle grade and stabilising it by diversion of the flow to another location, or by putting in a structure that controls the water energy and prevents further 'eating back' of the gully head. This chapter describes five different ways of gully control which were installed in 1986 to stop erosion in drainage lines on John Greacen's and Max Fitzgerald's properties near Cement Mills. These vary from comparatively cheap to quite expensive. Costs have been included as a basis for comparing them, using 1986 values.

Grass sod chute

This method involves battering the gully head (overfall) and stabilising the batter using grass. It is a useful low cost way of treating gully erosion where water cannot be permanently diverted to a safer area. Its limitations are that it is unsuitable where low rainfall or poor soils limit grass growth or where the soil type is highly erodible. It also has a high risk of failure if a temporary diversion of water cannot be achieved during grassing. It is limited to maximum chute grade of 1 in 6 (17 percent) and to a maximum catchment size of 80 ha.

On the properties quoted a farm tractor was used to flatten off or batter the overall to maximum grade of 7:1 (14 percent). The width of the batter was designed to carry the peak flow for the 1 in 20 year storm intensity. Wing banks were constructed on each side to direct run-off onto the stabilised area. The wing banks were pushed from behind to minimise the destruction of existing vegetation and to reduce the exposure of soil at the top of the batter to further erosion. Sods of African star grass and kikuyu were planted above and below the chute and across the face of the battered area at 1 metre intervals. (Figure 14.)



Gully stabilisation using a grassed sod chute on John Greacen's, 'Brooklyn' property.

The 1986 construction cost (excluding fencing materials) was estimated at $96.00, which covered 2 hours of tractor use plus 8 hours labour for planting grass and fencing. This method is the cheapest, most common and easiest treatment for gully erosion. Its success depends on the establishment and maintenance of a good sward of dense grass across the area which has been battered off and carries the flow of water.

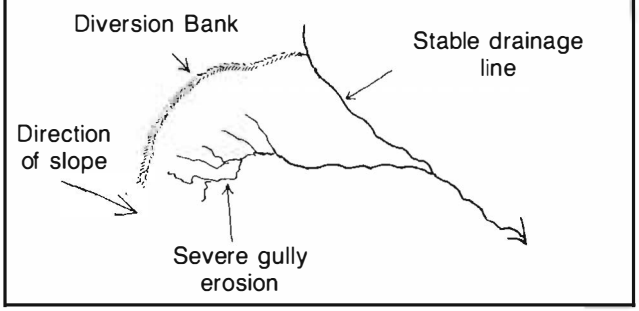
Fencing the grassed area to prevent overgrazing, and occasional fertilising to promote vigorous growth are essential. Regular inspections should be made to check that small erosion cutbacks are not occurring on the face of the chute. Any cutbacks should be refilled with soil and re-grassed.

Diversion of flow to a safer area

This method involves the diversion of water flows away from the eroded area to a stable location. It is a low cost way of treating gully erosion where water can be diverted permanently to a safe disposal area. It is unsuitable unless such a disposal area is available. Also the catchment size is limited by the capacity of the diversion bank and the drainage line receiving the water. On highly erodible soil the diversion bank would need to be pushed from below.

In the example quoted, a dozer was used to construct a diversion bank above an eroding drainage line and thus divert the water to a stable drainage line 250 metres south. The diversion bank was designed to carry the peak flow for a 1 in 20 year storm intensity. The severely eroded area was battered to help promote grass growth. Sods of African star grass were planted on the eroded area and in the channel of the diversion bank. (Figure 15.)

Fig.15

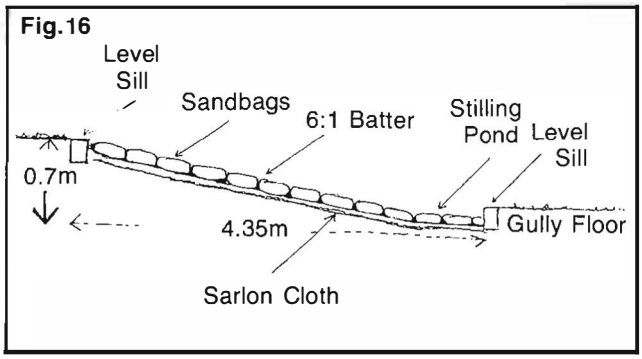


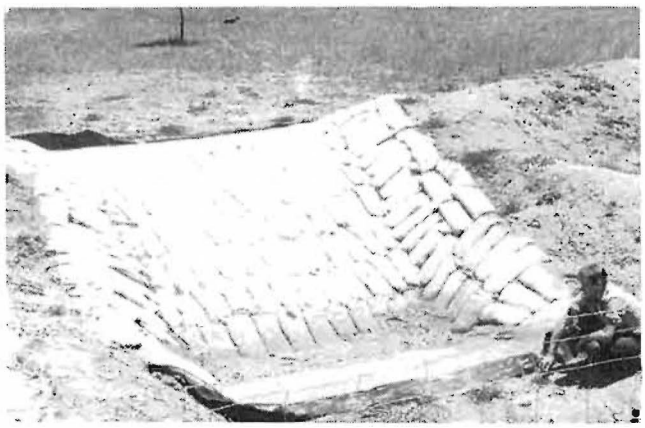
The 1986 construction cost (excluding fencing material) was estimated at $284.00. This covered 4 hours of tractor time, 2 hours supervision and 6 hours labour, fencing and planting grass. Fencing the area to prevent overgrazing, and occasional fertilising of the grass to promote vigorous growth were again essential. Regular inspections were made to check that small erosion cutbacks were not occurring at the outlet of the diversion bank. Any cutbacks were regrassed.

Sandbag chute

This method involves battering a gully head and the installation of a mechanical structure to stabilise the batter. It is a high cost way of treating gully erosion where water cannot be diverted to a safer location. The cost can only be justified when a major improvement such as a road or a dam bywash is in danger of being washed away. It is unsuitable on highly dispersible or heavy cracking soils; there is a high risk of failure where chute grade is steep. It is limited to a maximum catchment size of 40 ha.

Fig.16





A sandbag chute gully control structure on John Greacen's, 'Brooklyn' property.

In the example quoted, a farm tractor was used to batter the gully overfall to a grade of 6:1 (17 percent). The width of the batter was designed to carry the peak flow for a 1 in 20 year storm intensity. Because of the soil's erodibility a sarlon shade cloth mat was laid on the face of the chute. This mat protected the soil from wash until the sandbags had settled and stabilised. Sandbags were filled with a dry 7:1 sand cement mixture and placed end to end on top of the shade cloth. Care was taken to pack the bags tightly and to overlap the top edges of the lower bags. A shallow stilling pond was formed at the bottom end of the batter to help discharge any water energy which built up during flow down the chute. To avoid concentration of water flows on one side of the chute, the entry and exit points were controlled by level sills. These sills were constructed by concrete cut-off trenches and were also used to anchor the shade cloth and sandbags. (Figure 16.)

Sandbags were laid on their ends down each side wall of the chute to protect the side from under cutting. After all the sandbags were laid, they were watered and allowed to set in position. Wing banks were constructed on each side to divert run-off onto the stabilised area. The wing banks were pushed from behind to minimise the destruction of existing vegetation and reduce the exposure of soil at the top of the batter to further erosion. Sods of African star grass and kikuyu were planted above and below the chute to stabilise the area fully.

The construction cost in 1986 was estimated at $842.00 (excluding fencing material). It included 206 bags, 1 roll tie wire, 30 bags cement, 3 hours tractor use and 74 hours labour to lay sandbags and erect fencing. In view of its high cost, the structure was fenced to prevent damage from stock. Regular inspections were made in case sandbags were washed out, and replacements made immediately.

Galvanised iron verandah flume

This method involves the installation of a mechanical structure that prevents the water from cutting back the gully head. Again as a high cost way of treating gully erosion, where water cannot be diverted to a safer area, it can only be justified where a major improvement such as a road or a dam bywash is in danger of being washed away. It is limited to a maximum catchment size of 40 ha. Sealing of the front apron is difficult in heavy cracking soils.

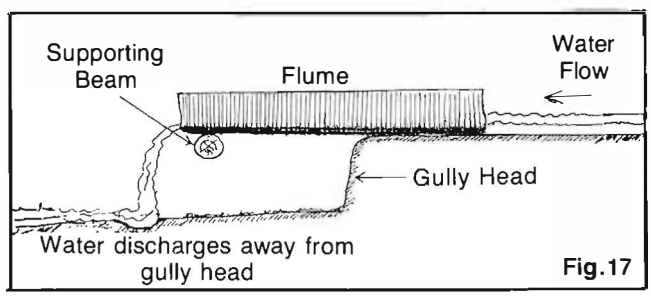


Fig.17

A galvanised iron verandah flume for controlling gully erosion in the Cement Mills district on Max Fitzgerald's property.

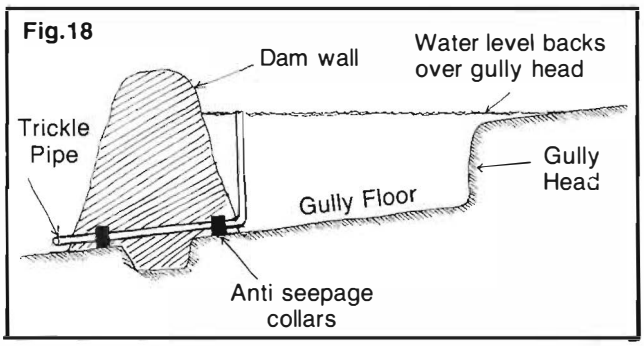
In the case quoted, the flume was constructed from 16 sheets of 2.4 m galvanised tank iron. Each sheet had a 90° bend rolled on one end to form a U section when bolted together. The width of the flume was designed to carry the peak flow for a 1 in 20 year storm intensity. Due to the weight of water on the flume during a design flow, a substantial log or beam was necessary to support the outlet end. A framework was also constructed to support the flume under design flows. Wing banks were constructed on each side to divert run-off onto the flume. A rubber apron was used to seal the edge of the flume with the wing banks and the gully floor.

Sods of African star grass and kikuyu were planted to stabilise the area above the rubber aprons. (Figure 17.)

The 1986 construction cost (excluding fencing material) was calculated at $1,082.00. This included the rubber apron, galvanised iron, 1 packet of tank bolts, timber, assorted bolts, 2 hours of tractor time and 61 hours labour. The galvanised iron cost could be reduced by using second-hand iron. Regular inspection of the rubber apron is necessary to ensure that water does not flow under the flume.

Gully dam and drop inlet pipe

This method calls for the installation of a mechanical structure that drowns out the gully head with backup water and prevents the water from building up energy. It is a way of treating gully erosion where suitable material can be found to construct a dam, and a stable bywash area is available. It is not suitable in highly erodible soils. A drop inlet pipe is essential for spillway protection from trickle flows, and bywash suitability limits the size of catchment. (Figure 18.)



After prolonged rainfall trickle flows are a common occurrence in traprock soils. These trickle flows can cause serious problems to the stability of dam bywashes. The installation of a drop inlet pipe was used to overcome trickle flow in this example. A 15 cm PVC pipe was laid on the gully floor prior to construction of the dam wall. Two cement anti-seepage collars were constructed around this pipe. The gully dam and bywash were then constructed using a D5 dozer. After completion of the dam, the riser of the drop inlet was installed. The drop inlet height was set to back up 50 mm (2 inches) of water over the top of the gully head. The bywash height was set to flow when a further 50 mm of water was held in the dam. The bywash height was designed to carry the peak flow for a 1 in 20 year storm intensity. Sods of African star grass were planted to stabilise the bywash.

The construction cost in 1986 (excluding fencing material) was calculated at $964.00. This covered 6 hours dozer time, 2 hours tractor time, 2 hours labour for grassing, 15 m × 0.15 m PVC pipe, 1 × 90° bend, 1 junction, 1 vent top, 4 bags cement, 48 hours labour. Fencing the bywash area to prevent overgrazing and occasional fertilising of the grass to promote vigorous growth were essential.

Regular inspections are needed to check that erosion is not occurring in the bywash. Any erosion scours are refilled and regrassed.

One landowner's approach

On David Blomfield's property, "Dungorm", Gore, gully erosion has been greatly reduced, and in some instances completely stopped, very simply and cheaply. The solution has been to divert water from eroded sections to safe disposal areas where velocity is reduced and it can safely re-enter the water way.

The equipment he uses is as follows:

A tractor, preferably 50 hp (Fordson Major Size) or better; mounted with front blades and rippers.

A device for taking levels. David used a spirit level on a straight edge 2.5 metres long with a leg on each end. The degree of gradient is set by adjusting a leg. A water tube level would be satisfactory also, but two people are needed to operate it.

His method is first to select the disposal area, then take the necessary levels for a bank to direct the water from the gully at the required gradient. Generally two passes with a single tine ripper and one, possibly two, passes with the blade turning the dirt out (angled) are sufficient, even on traprock if the ground is reasonably moist. The only costs are the operating cost of the tractor plus the driver's time. After several years there is a marked easing of the sides of the eroded areas. Where cover, such as netting or branches, was put out, grass cover has developed. A similar technique to this is being used to contain erosion on internal roads on an adjoining property.

CHAPTER 5

THE IRRIGATED ALLUVIAL SOILS — PROBLEMS AND SOLUTIONS

One irrigator's viewpoint

An important problem on alluvial soils of the shire is "crusting". A full understanding of the soil types in the irrigation area is needed to define the problem in detail. Soils of the river flats are classified into three broad types:

First levee (sandy loam — well drained);
Second levee (sandy clay loam);
Third levee or remote levee (clay loam or silty clay loam).

First levee soils tend to be deep and less likely to crust. However being closer to the river, they are more prone to flooding which causes damage by scouring if the land has been recently cultivated. Second levee soils are still close to the river. When in good order, they are excellent soils, but with less depth than first levee soils. Third or remote levee soils form a large part of local irrigation land. These soils can produce good crops, but require much more skill on the part of the farmer. Small areas of brigalow soils and deep sandy soils with less severe crusting problems are within reach of irrigation.

The writer has made the following observations since 1966. Early irrigation was applied on lucerne planted into second levee soil that had not been ploughed for up to 30 years. Establishment was easy and water penetration excellent, giving the impression that large volumes of water could be applied quickly. However frequent cultivation on equivalent soils resulted in soil structure deterioration. One grazing or grain crop per year was acceptable provided the soil was not over exposed by grazing or burning of stubble in dry summer months. This single cropping meant less intensive use of irrigation water, a situation which was not economically viable on most irrigation farms.

Attempts to "double crop" irrigated land tended to speed up the process of soil deterioration. Existing tillage and planting machinery dictated cultivation practice. Extra cultivations were necessary to work in masses of straw from the previous crop and to achieve the necessary seedbed conditions for applying pre-emergence herbicides.

Suitable systems of minimum tillage need to be developed for these soils. They need to incorporate straw spreading and cutting by headers, followed by slashing and mulching to leave trash in or on the ground in a way that does not impede the establishment of the next crop.

The loss of topsoil along the river valley during a major flood is serious. Land that was under lucerne during the flood of February 1976 is still out-performing, 10 years later, the adjoining land which carried emerging green beans at the time. Every farmer should use areas of permanent pasture or lucerne as buffers to soil loss.

Gambling on the weather has taken on a new meaning with these soils. Land sown to a crop and then subjected to 10 mm of rain or spray irrigation may not crust under still air conditions before the emergence of that crop. However gusty dry winds will make certain it does. If ground has been pre-irrigated or if planting rains have been received, sowing should be delayed when more rain seems likely. Conversely, if more rain does not eventuate within a couple of days, planting moisture is lost. Much luck is involved.

The use of gypsum on these soils has shown a disappointing result. No doubt pasture rotation is a way to regain some of the lost soil structure. This would mean a drastic farming system change for some people, who do not run livestock at present. Capital investment for fencing, yards and other stock handling facilities is very heavy and hard to justify. Another option is growing lucerne or pasture to be sold as hay.

Nut grass has invaded much of the best land along the river system where it limits production from summer crops. When heavy infestation occurs the ground contains a mat of nuts, putting a great strain on moisture and fertility. Many people think there is an associated toxic effect on crop growth. Some control can be obtained by frequent tining of the soil during hot dry weather, thus exposing the nut chains to the sun — but this is a way to destroy the structure of these soils. Modern chemicals will control nut grass at high cost but only if timing and application are correct in every detail. This is dealt with in the weed control section of this manual.

Characteristics of the irrigated soils

Without doubt, many of the soils used for irrigation in Inglewood Shire are difficult to manage. The aim of this section is to describe these soils and, in later sections, make recommendations on managing them for long term production.

Soils found on the Dumaresq River can be classified briefly as:

* Recent alluvial soils consisting of:
  (a) soils of young levees;
  (b) soils of older levees;
* dark brown texture contrast soils;
* dark loams;
* dark hard setting clays.

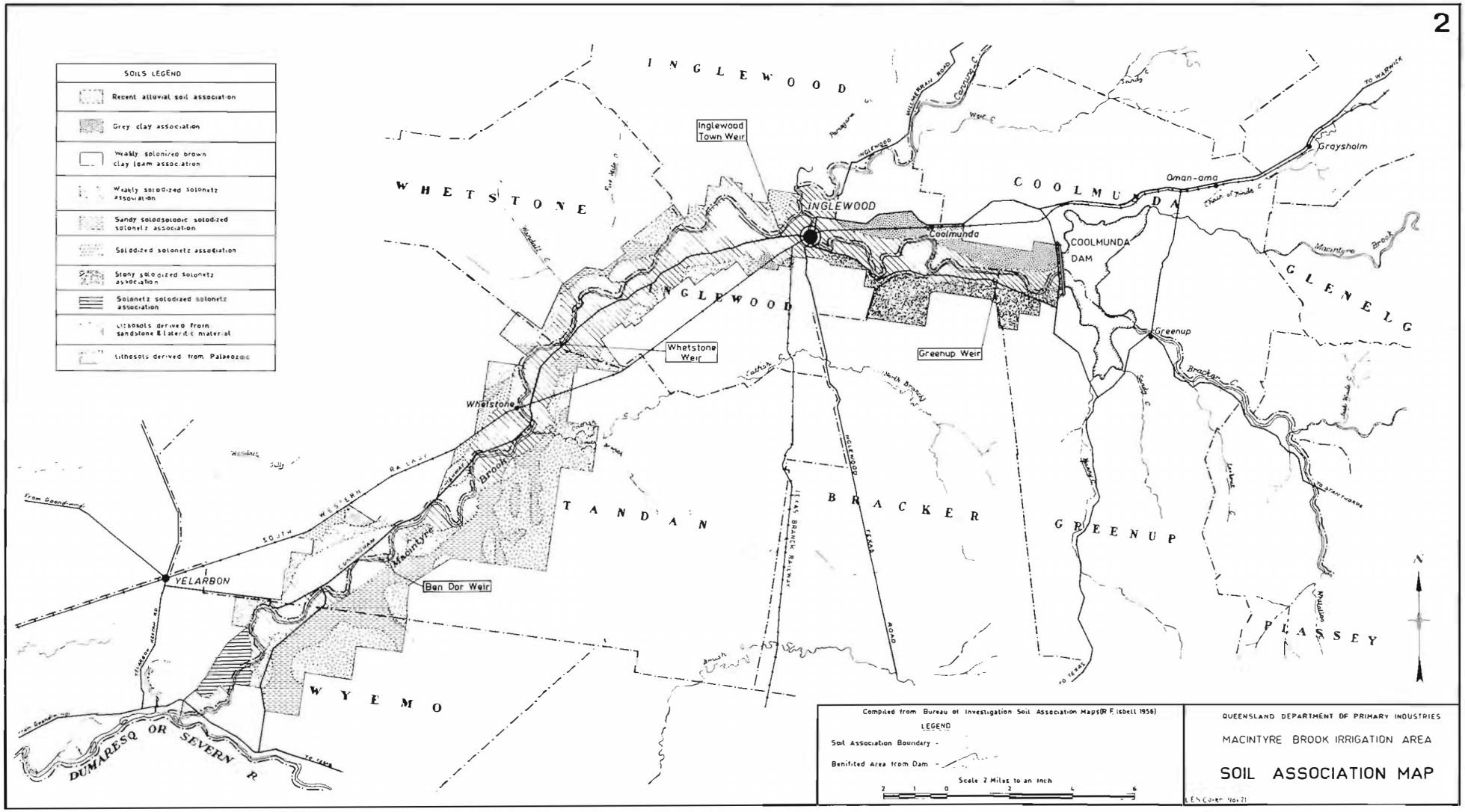
Figure 19 shows the main soil types found on the Macintyre Brook. These can be split into seven basic types.

1. Recent alluvial, first levee soils (sandy clay loam)

These soils are generally found on low terraces between a levee bank and the normal water line. They are deep soils uniform to a depth of 150 cm. The texture varies from sandy loam through to silty loam (occasionally they may be sands or silty clays). They are normally dark grey to grey brown in colour. They are slightly acid to neutral (pH 6.2 to 7.1), with medium to high levels of phosphorus and low levels of nitrogen and chloride salts. The organic matter content is usually higher (on average four percent) and the silt percentage lower than for soils of the older terraces.

2. Recent alluvial, second levee soils (silty clay loam)

These are more extensive and slope away from the present course of the Macintyre Brook for a distance of up to 2.5 km. There is a more marked profile development. The surface texture ranges from loams through silty loams to clay loams with a heavier subsoil starting at 30 to 60 cm. This heavier subsoil is due to an increase in clay content with depth. The soil is light grey-brown or light brown, with red-brown subsoil. The A horizon is lightly acid to neutral and becomes more alkaline with depth. These soils have moderate levels of most nutrients including phosphorus, but are low in nitrogen. Total soluble salts and chloride increase with depth and are at higher levels than in the sandy claim loams. The organic matter content is lower than those in the first levee soils, with an average of 2.6%. There is significantly less organic matter in the soils of the second levee than in those of the first levee, with levels as low as 0.6% having been recorded. These levels are very low. These soils have a higher silt level than those of the first levee, up to 45%.


SOILS LEGEND
Recent alluvial soil association
Grey clay association
Weakly solonized brown clay loam association
Weakly solodized solonetz association
Sandy solodsolodic solodized solonetz association
Solodized solonetz association
Stony solodized solonetz association
Solonetz solodized solonetz association
Lithosols derived from sandstone & lateritic material
Lithosols derived from Palaeozoic
INGLEWOOD
WHETSTONE
TANDAN
BRACKER
GREENUP
COOLMUNDA
GLENELG
PLASSEY
WYEMO
Inglewood Town Weir
Whetstone Weir
Ben Dor Weir
Greenup Weir
COOLMUNDA DAM
Coolmunda
Greenup
Whetstone
YELARBON
Graysholm
Oman-ama
Macintyre Brook
Macintyre
Bracker C.
DUMARESQ OR SEVERN R.
TO WARWICK
TO STANTHORPE
TO TEXAS
Compiled from Bureau of Investigation Soil Association Maps (R.F. Isbell 1956)
LEGEND
Soil Association Boundary
Benifited Area from Dam
Scale 2 Miles to an inch
2 1 0 2 4 6
QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
MACINTYRE BROOK IRRIGATION AREA
SOIL ASSOCIATION MAP

3. Recent alluvial, remote levee (sub-mature red-brown earth)

These soils occur in small areas within pumping distance of the Macintyre Brook. They have a clay loam texture and a grey-brown topsoil which changes to reddish-brown subsoil. The surface soil is structureless, but becomes columnar with depth. The surface soil is moderately acid to neutral, but increases in alkalinity with depth. They have moderate levels of phosphorus, but are low in nitrogen. Chloride increases with depth, to levels higher than that in the silty clay loams. These soils have a high silt and clay level, similar to those of the second levee soils. The amount of coarse sand is much greater in the first levee than in either the second or remote levees. There are no significant differences in the fine sand fraction between the three levees, although there is a tendency for a decrease in the quantity of fine sand with increasing distance from the Macintyre Brook. The proportion of silt increases with distance from the stream, with greater levels in the remote and second levees. There was no significant difference between the portion of clay in the soils of the levees, although there is a trend for the quantity of clay to increase, with distance from the Macintyre Brook. Where the remote levee soils have not been cropped, the organic matter levels are higher than either the first or second levee soils (they average 6%). When cropped, however, the organic matter levels drop quickly to the levels of the second levee soils.

4. Weakly solodised solonetz

These are shallow acid clay loams with a grey-brown coloured surface. This overlies a hard clay containing manganese nodules and carbonate concentrations. The profile has a neutral to slightly acid surface, but becomes more alkaline with depth. The total soluble salts is similar to that in the recent alluvial associations. The chloride levels increase with depth to those in the silty clay loams and clay loams. Mechanical analysis of these soils shows a smaller quantity of coarse and fine sands than in the soils of the recent alluvial associations, and a greater fraction of silt and clay. This is to be expected, as they are further from the present course of the Macintyre Brook.

5. Deep cypress sands

These can be classified into four distinct classes as follows:

* Pale raw sands between 60 cm and 75 cm deep. They are split by a sandstone layer above an impermeable clay. The chloride levels increase with depth, but are not as high as in the previous soil types. There are medium levels of exchangeable calcium, low levels of exchangeable magnesium and sodium and very high levels of exchangeable potassium. The silt and clay fractions are only a small proportion of the soil, which is predominantly sand (67% coarse sand and 22% fine sand in the top 30 cm).

*Light-grey sand from 15 to 45 cm deep, overlying an impermeable clay. Bull oak *(Casuarina luehmannii)* is the main vegetation.

* Deep light-grey to light-brown sands found close to the Macintyre Brook; usually at least 180 cm deep.

* Brown to reddish-brown sands found on the deep sand ridges away from the Macintyre Brook.

These soils are very low in available nutrients and have ironstone concretions in the B horizon. Soil reaction varies from acid to strongly acid or neutral to strongly alkaline. The subsoils often contain undesirable levels of magnesium and sodium.

6. Solonetz-solodised solonetz soils

These are very alkaline soils with a pH of 9 to 10.8 at 33 to 200 cm depth in profile. They have a columnar to massive structured clay subsoil. There is free sodium carbonate in the profile. They are brownish-grey in colour at the surface. They have high levels of exchangeable calcium and sodium, medium levels of exchangeable magnesium and very high levels of exchangeable potassium in the topsoil. In the subsoil, at about 50 cm depth, the levels of exchangeable calcium, magnesium and potassium have increased still further, with a drop in the level of exchangeable sodium. There is an accumulation of chloride at about 50 cm. They have a high fine sand fraction (up to 52%), with clay levels of up to 24%. These soils are found around Yelarbon and are locally known as the "Yelarbon desert".

7. Grey clay-brigalow soil

The dominant vegetation on these soils is brigalow *(Acacia harpophylla)*. They may be heavily gilgaied (melon-holed). The surface soil is moderately alkaline and becomes increasingly acid with depth. Concretions of calcium carbonate and calcium sulphate can be found in the subsoil. The chloride levels are very high. There tends to be high sodium levels in these soils also. They have a high clay level, up to 59%, with a small fine sand content averaging 27%.

Land use and the irrigated soils

Past land use has altered the physical and chemical characteristics of the irrigated soils in the Inglewood Shire. The changes have been most obvious on the Macintyre Brook, but there have been similar effects on the soils of the Dumaresq River.

Recent alluvial, first levee (sand clay loam)

Where these soils have been cultivated, irrigation has been used. They are the most suitable for irrigation, due to their higher initial fertility, lower crusting potential and higher water infiltration rate. They have been used to grow lucerne, maize, potatoes, onions, and cucurbits, with a few tobacco crops.

Recent alluvial, second levee (silty clay loam)

These soils have been used for either dryland or irrigated farming. Where they have been used for dryland farming, wheat, oats and barley have been the main crops. Yields have fallen, as fertilisers have not been used. They have been cultivated with disc implements, often under low soil moisture conditions. As a result, organic matter levels are low and there has been a loss of structure, with hard cultivation pans forming at 13 to 20 cm. The surface tends to crust after rain. There has been some erosion, particularly on the headlands. Tobacco, lucerne and fodder crops have been the main irrigated crops grown. However, pasture, maize, navy beans, soybeans, vegetables, stone fruit and grapes have also been grown. The irrigated soils of this association can be divided into three sub-groups based on previous land use. These groups are:

* old tobacco lands which have been heavily fertilised. Phosphate and potash reserves are high. The nitrogen levels are low. The organic matter is low and cultivation pans have formed at 15 to 18 cm. The surface crusts after rain. Structural deterioration is greatest where high salt levels have occurred in irrigation water below the Ben Dor Weir;

* those soils where other annual row crops, such as navy beans, soybeans and maize have been grown. Structural degradation is much slower, but does occur. Poor infiltration and surface crusting is present;

* the soils used to grow lucerne, pastures and fodder crops which improve in structure once stands establish and cultivation ceases.

Recent alluvial, remote levee (sub-mature red-brown earth)

Similar history and problems to that of the silty clay loams characterise this soil association.

Weakly solodised solonetz

The shallow topsoil of this association limits its potential for irrigation. These soils have been used for dryland cropping in the past, or left under native pasture for grazing. The effect on them of dryland farming has been the same as that on the silty clay loams of the second levee. Pastures may be the only practical irrigation crop for these soils.

Deep cypress sands

Where these soils have been cropped, irrigation has been used. Organic matter is low and poor fertility necessitates continued application of fertilisers. The pale, raw sands and the deep light-grey to brown sands are the most suitable soils for growing tobacco on the Macintyre Brook. Erosion and the leaching of applied nutrients have been problems on these soils.

Solonetz-solodised solonetz

The strongly alkaline nature of these soils prohibits their use for irrigation. They have been used for dryland cropping and structural deterioration is apparent.

Grey clay-brigalow association

These soils have been largely used for dryland cropping. Structural problems have now arisen due to the prolonged use of disc ploughs and cultivation outside the optimal soil condition range. Irrigation has been limited, due to the gilgai micro-relief and their distance from the Macintyre Brook.

Soil limitations to irrigated cropping

Many of the soils used form a surface crust after rain or irrigation. If rain falls after planting, but prior to emergence, the crust which forms causes a reduction in seedling emergence. The surface crusting problem is most acute on the silty clay loams of the second levee. The low organic matter content and high proportion of fine-silt and sand fractions causes the soil particles to slake when wetted. The result is a structureless layer which forms a strong crust as it dries. The degree of crust development is associated with both the intensity and the amount of rain. Severe crusting can result from high intensity falls of less than 12.5 mm. Dense crusts can also form from low intensity falls of fairly long duration. The crust which forms in this situation is usually thicker than that formed by heavier falls. Lillistons and harrows have been used to break the crusts in order to assist seedling emergence. These crusts formed by extended rainfall are more difficult to overcome because the soil remains too wet to cultivate during the critical pre-emergence period. The emergence of broad-leaf type plants is more seriously affected by crusting than grass type plants. Wet crusts have also been found to reduce crop emergence.

The other major limitation to irrigation of these soils is a low rate of water infiltration. Research by Jim McAllister and Jim Gunton of the Queensland Department of Primary Industries into infiltration rates at 50 sites along the Macintyre Brook showed the relative differences between the soil types. They chose half of their sites from cultivated areas while the others were from uncultivated areas of the same soil type. The purpose was to examine the three main soil types of the recent alluvials. They ponded water inside a 30 cm diameter, 20 cm high ring placed on the soil surface. This method overestimates infiltration rates by as much as four times the real situation under sprinkler irrigation. Nevertheless, the method indicates the relative rates for the soil types of the Macintyre Brook. Jim McAllister determined the infiltration rate for the other soil associations (see Table 22).

On the recent alluvials, the infiltration rate decreases with increasing distance from the Macintyre Brook. As the amount of clay and silt increases in the soil, the amount of sand decreases and the infiltration rate falls accordingly. In reality, when spray irrigating the soils of the second and remote levees, the rate of application achievable is usually between 6 and 9 mm/hour. The maximum single application for annual crops before surface ponding of water and run-off occurs is 32 to 38 mm. Rates of up to 100 mm per irrigation are quite possible when irrigating lucerne and pasture.

The soils of the first levee are well suited to cropping. However, due to the irregular shape of the areas on which they occur, they are difficulties in setting up irrigation systems and in growing some crops. They are also susceptible to flooding. The grey-brown clays can be irrigated only in those situations where gilgai micro-relief allows it. The solodised solonetz associations are very alkaline. The weakly solodised solonetz subsoil, together with the shallow topsoil, restricts the potential of this association for irrigation. Surface irregularities which cause localised waterlogging or droughting, plus random areas of salt affected soil, have been implicated in the degeneration of lucerne stands after only three years of production. Other crops could be affected the same way. Hardpans have formed in these soils in a relatively short time. They are the result of cropping intensity and of cultivation outside the optimal soil moisture range. These hardpans, close to the soil surface, affect crop growth adversely.

Overcoming soil limitations

Alleviating soil crusting

McAllister and Gunton found that crust strength decreased with increasing pH, organic carbon, sand and coarse sand percentages. They concluded that increasing carbon content, through organic matter build-up, is the most feasible way to overcome the crusting problem. They also found that infiltration, emergence and crust strength are all related to one another. The present problems are due to the soil particle size distribution. Increased organic matter content is likely to reduce crust strength, increase plant emergence and to provide improvement in infiltration.

Lillistons have been used successfully to break the surface crust resulting from heavy rain after planting. The last cultivation or harrowing on a crusting soil should be across the slope, to reduce the rate and severity of crusting, should rain between planting and emergence. Heavy grading should be avoided. Crop planting should be spread over several days. This reduces the risk of complete failure, but does increase the risk of failure for any one planting. The use of spring steel weeders, harrows, rollers or spray irrigation where crusting is likely to occur before emergence, is recommended. All these practices have been used by farmers. Presswheels should not be used because they increase the strength of the surface crust.

In 1972 Jim Gunton and John Kerr, Queensland Department of Primary Industries, investigated several ways of overcoming the effects of surface crusting. These included:

* using two sets of V-shaped rollers in tandem. The front set compressed the soil below the seed position. The seed was placed in the furrow and the following set of rollers was used to cover the seed. A find seedbed was necessary for success:

Table 22. Minimum infiltration rate (mm/hr) for soil types of the Macintyre Brook.

Soil type	Minimum infiltration rate (mm/hr)	
	Pondage method	Adjusted for spray irrigation
1. Recent alluvial, 1st levee	79	20
2. Recent alluvial, 2nd levee	44	11
3. Recent alluvial, remote levee	46	12
4. Weakly solodised solonetz	7	2
5. Deep cypress sand	432	108
6. Solonetz-solodised solonetz	43	11
7. Grey clay-brigalow	124	31

* using heavier seeding rates to reduce the energy per plant required to break the crust;

* using shallow planting. There are dangers to this practice. Seeds must be planted in suitable moisture conditions;

* using trash cover to reduce the damage from raindrop splash on the soil surface. There was little benefit when enough rain fell to saturate the top 5 to 7.5 cm of soil;

* harrowing the ground to break the surface crust following rain. It is difficult to time this operation because the soil is often too wet to carry machinery during the critical emergence period. Rotary cultivators proved more effective than diamond harrows;

* maintaining a wet crust by applying small quantities of water until the seedlings emerge. However, trials have shown that a wet crust reduced further germination of some crops;

Lower levee soils prone to flood damage should be left under permanent pasture, or if cropped, planted to lucerne which offers some protection from damage. In this photo a lucerne stand is growing on a lower level soil adjacent to the Dumaresq River.

Reduced-till and no-till cropping can be used on the alluvials to help improve soil structure. Here Vic and Phillip Donges, 'Glenarbon Estates' discuss no-till soybeans planted into barley stubble with David Venz, formerly with the Q.D.P.I.

Soil loss due to flood is well illustrated in this photo. Here soil in the cultivation layer has been removed by flooding of the Macintyre Brook, exposing the uncultivated soil where tine marks are very evident.

* using high rates of ameliorants such as gypsum and lime. The results were poor and the cost makes this practice uneconomical.

No one method gave an outstanding improvement in emergence. They concluded that the best way to reduce surface crusting was to improve the structural stability and aggregation by increasing organic matter.

Soil variability is a feature of alluvials used for cropping in the shire. Here soybeans are stressed in patches where water penetration is very poor.

Increasing Infiltration Rates

Where soils have been overworked and infiltration rates are low (such as on the older levees), the use of tined implements rather than disc ploughs should be considered. Disc ploughs quickly destroy the structure of finely-textured soils and result in the formation of ploughpans. Pans can be broken with chisel ploughs — which assist with water penetration. Discs should be used only to chop up crop residues or to avoid spreading nutgrass. Operating speeds should be moderate to prevent the fine soil particles being left as a layer of dust on the surface. Cultivation should also be kept to a minimum in order to maintain organic matter levels and soil structure. John Kerr (1971) recommended the maintenance of a large amount of trash on the soil surface. Such a practice requires suitable planting machinery to handle the stubble left. Present technology can overcome this problem. Using herbicides to control weeds, rather than cultivation, is a necessity. There are several irrigators in the shire who successfully use a reduced tillage approach to irrigated double-cropping on these soils.

It has been a common practice to cultivate between rows to control weeds and to improve infiltration. However, the effect of inter-row cultivation on the growing crop must be considered. It will not normally damage tap rooted crops, but the growth of fibrous rooted crops can be affected. It may also displace fertiliser so that it cannot be utilised. There is a narrow moisture range within which these soils can be cultivated successfully. When the soil is too wet, it results in compaction; and when too dry, in surface powdering and subsequent sealing. Frequent inter-row cultivations hasten structural deterioration.

In 1977 Jim Gunton investigated the effect of different furrow shapes on infiltration. He attempted to increase the rate of infiltration by slowing the rate of water flow down the furrow (Table 23).

The research was carried out on a low slope (0.12%) and used low inflow rates (10 L/min). Three furrow shapes were tested for their effect on the rate of infiltration. The furrow shapes were:

* normal V-shaped furrow;

* broad based furrow (a disc with a 38 cm flat section is dragged behind in the same way as a row opener); and

* W-shaped furrow (where two share points are paired 2.5 to 5 cm apart at the closest point).

The dry crust, which was moderately cracked, registered higher infiltration rates than the wet crust in each of the furrow shapes. Subsequent irrigations tended to have a slow, steady infiltration rate. The W-shape produced better infiltration rates than the other furrow shapes. However there are limitations to its practical application. This trial was conducted on a low slope with low inflow rates. It is unlikely that similar results would occur with steeper slopes and/or higher inflow rates. Also, the W-shaped furrow was not as deep as a normal V-shaped furrow, so that deformities tended to cause sideways redistribution of water. This could leave some patches of the field unwatered. However it should be possible to use the W-shaped furrow to improve infiltration rates in a well designed and well graded layout.

Table 23.

Date	Surface condition before irrigation	Furrow shape	Total infiltration (mm) 1 hr	2 hr	3 hr
Feb. 1975	Wet	V-shaped	4.1	6.4	—
		Broad based	4.5	6.7	—
		W-shaped	6.0	11.5	15.5
18.02.77	Dry	V-shaped	9.0	10.9	12.8
		Broad based	10.5	13.9	17.0
		W-shaped	15.2	18.0	23.7
17.03.77	Damp	V-shaped	2.6	3.7	—
		Broad based	4.2	5.3	—
		W-shaped	6.4	9.6	12.9
01.04.77	Damp/Dry	V-shaped	4.3	5.8	11.7
		Broad based	2.7	3.8	5.2
		W-shaped	7.7	10.4	12.3

The use of chemical amendments to improve infiltration rates has been suggested. Chemical amendments considered were synthetic additives such as vapam which maintain structural stability (but their price prevents their use commercially) and ameliorants such as gypsum, sulphur and lime to overcome the effects of high sodium levels in some soils. There has been some research into the use of gypsum and lime to improve the structure of the silty clay loams. In 1972 Jim Gunton and John Kerr recorded a slight improvement in emergence with high rates of these ameliorants. However, final emergence was still poor. The cost cannot justify their commercial use.

Two projects were undertaken to study the effect of gypsum on water infiltration in established lucerne. Gypsum was broadcast and incorporated at rates of 1.25 t/ha, 5 t/ha and 10 t/ha on a fine silty loam. These treatments increased the initial penetration of water. However, there was no associated improvement in lucerne growth. In the second project, dissolved gypsum was applied at 125 kg/ha, 250 kg/ha and 500 kg/ha with each irrigation on established lucerne. There was no apparent effect on water penetration. McAllister and Gunton tested the effects of gypsum, lime and sulphur on soil structure in a three year trial. The trial was conducted on the Inglewood Field Station with double cropping of wheat and navy beans. Only one crop of navy beans was grown. This was the result of a replant, producing a late crop with a very low average yield. Due to the difficulty of dissolving gypsum and the lack of crop response, the dissolved gypsum treatments 6 and 7 were changed to heavier rates of broadcast gypsum for the last two years.

The results show an initial increase in wheat yields with broadcast gypsum, lime and sulphur. There was no yield improvement with dissolved gypsum. In the second and third year after the application of the treatments the yield advantage disappeared (Table 24). Following the addition of

gypsum at 15 t/ha, there was a marked response in the navy bean yields. However, the improved yield was only just comparable with commercial crops. The results cannot be taken as those of a normal irrigated navy bean situation. The brief effect on crop yield is probably due to the gypsum providing sufficient salt concentration in the soil solution to reduce swelling and consequent breakdown of soil aggregates. This effect is temporary and lasts only while free gypsum is present. There does not appear to be any residual effect due to the replacement of sodium in the soil with calcium. The low cation exchange capacity (CEC) of these soils is a possible explanation for the low residual effect of gypsum even at excessive rates. Chemical amendments are not likely to be used commercially to improve soil structure on the Macintyre Brook.

The addition of organic matter to improve soil structure and infiltration rates has been recommended on these soils for many years. This includes ploughing in green manure crops and crop residues which therefore should not be burnt or heavily grazed. Using pasture rotations and/or reduce tillage with double cropping is the only way to improve soil structure and prevent breakdown in the long term.

One other option which has been suggested is the addition of sawdust to increase organic matter. There may be two problems with this. Sawdust can immobilise soil nitrogen. Some sawdusts also produce toxins which inhibit plant growth. Two farm investigations were established to examine the effect of local cypress pine sawdust. At one site in 1979 sawdust to a depth of 1.25 cm and a depth of 2.5 cm was applied. It was then incorporated into the soil. Three barley and three navy bean crops were then grown. There was an initial improvement in the soil tilth. The amount of stored soil moisture also increased. There was a high incidence of damping-off in the first and second navy bean crops. The third crop failed. Navy beans growing in untreated soil were not affected. The first barley crop yielded well, but subsequent crops did poorly. In the second investigation, sunflowers were grown as a test species. Soil tilth was improved with the addition of sawdust. However, the sunflowers in the treated area grew to only half the size of those in the untreated area. The problems associated with sawdust as an organic amendment are nitrogen immobilisation, presence of toxins and availability of adequate sawdust supplies.

The method used to irrigate can minimise soil crusting. Furrow irrigation is used for row crops such as navy beans, soybeans, maize and grain sorghum but the uneven topography of many paddocks means erratic watering. Sideways water penetration in the silty clay loams is poor. The V-shaped furrow is unsuitable for effective water distribution. A flat bottomed furrow is needed to allow water to spread close to the row. Surface sealing reduces the rate of penetration so that long flow periods are required for effective watering. Inter-row cultivation is possible, but is restricted by the clearance height of the cultivating equipment. Once cultivation ceases, infiltration rates fall. This usually coincides with flowering when water requirements are at their peak.

It is hard to maximise yields with furrow irrigation on these soils. The rate of fall and length of furrow are important considerations. In furrows up to 200 m long, the fall must not exceed 0.12% (12 cm in 100 m) with 0.06% being ideal. However, a fall of 0.2 to 0.25% is acceptable in furrows up to 400 m long. There is an erosion risk during heavy storm rains in these longer furrows with steeper slopes. If these rates of fall are exceeded, there will be unsatisfactory water infiltration, so careful grading is essential.

The first spray irrigation plant was installed on the Macintyre Brook in 1958. Spray irrigation enables low application rates so that run-off can, in principle, be prevented.

Table 24. The effect of soil amelioration on wheat and navy bean yields in irrigable soils of the Macintyre Brook.

Treatment	Wheat Yield kg/ha (12% mc)			Navy Bean Yield kg/ha (14% mc)
Year	1968	1969	1970	1969
1. Control	2,541	3,398	2,354	643
2. Gypsum broadcast 2.5 t/ha	3,471	3,529	2,802	681
3. Gypsum broadcast 5 t/ha	3,199	3,281	2,811	644
4. Gypsum broadcast 10 t/ha	3,149	3,747	2,598	859
5. Gypsum dissolved 125 kg/ha	2,839	3,344	3,077	518
6. Gypsum dissolved 250 kg/ha	2,787	—	—	—
Gypsum broadcast 15 t/ha	—	3,409	2,969	1,584
7. Gypsum dissolved 500 kg/ha	2,484	—	—	—
Gypsum broadcast 20 t/ha	—	3,169	2,899	1,035
8. Lime broadcast 1.6 t/ha	3,023	3,322	3,016	732
9. Lime broadcast 3.3 t/ha	3,166	3,322	2,826	462
10. Lime broadcast 6.5 t/ha	3,099	3,209	2,806	452
11. Flowers of sulphur broadcast 462 kg/ha	3,253	3,398	2,836	866

It has been necessary to design systems with low rates of application to obtain good moisture penetration and to prevent excessive run-off and crusting on the silty clay loams. Medium pressure sprays which operate at 172 to 344 kPa are satisfactory. High pressure sprays should not be used because the droplet size is too big. It causes compaction and surface puddling. Application rates in the order of 7.5 to 8.75 mm an hour are recommended. The three main problems with spray irrigation are:

* high capital cost and high operating cost, particularly when low value crops and pastures are to be irrigated;

* only small areas can be covered, due to the slow rate of application and the relatively small area covered per spray line;

* "Tow lines" cannot normally be used at flowering in grain crops because of crop height. This is the most critical stage of growth. Navy beans are an exception in that they are not so tall.

Lucerne pastures, grain sorghum and fodder crops have all been successfully irrigated using a border check system. The fall needs to be a little more than that needed with furrow irrigation, because dense crop cover impedes the movement of water down the bay. Length of the borders should not exceed 240 m. Up to 160 m long, the fall should be 0.2 to 0.25%, increasing up to 0.3% with bays over 160 m long. Bay widths of 6.7 to 9 m are satisfactory and can be made to suit implement widths. The main problem with this system is the need for levelling to achieve the prescribed even grades with negligible side fall. Such land levelling can be very expensive. Heavy grading should be avoided. Exposure of the subsoil causes patchy crop growth. This is due to uneven water penetration, as well as the greater tendency of this exposed subsoil to crust.

Trickle irrigation appears well suited to the soils of the Macintyre Brook but the capital cost of the system restricts its use to high value horticultural crops.

In 1968, the then Irrigation and Water Supply Commission established a trial area of flood irrigation on a property adjacent to the Macintyre Brook. The aim was to see if good stands of pasture could be established using flood irrigation and to observe its impact on soil structure. Assessment in 1972 compared infiltration at that time with the initial rates — prior to pasure establishment (Table 25). Even when the soil set hard on top, some water still penetrated. There was a marked response to the high gypsum rate (Bay E). This was due to the solute concentration effect, previously mentioned. The lower rates of gypsum had no noticeable effect. The area under lucerne for four years (Bay J) had a quite suitable infiltration rate. There appears to be no effect from deep ripping.

It is apparent that infiltration rates have improved where good irrigated pasture has been established. The IWSC recommended the use of small inflows through siphon tubes for initial flood irrigating on these soils. This should minimise surface sealing which results from the clay particles floating to the surface when first irrigated. Once pasture is established and the soil has improved in structure, then higher application rates through bay outlets may be used.

In 1970, an irrigated farming systems demonstration was set up at the Inglewood Field Station by George Malcolmson and Gerry Gibson of the Queensland Department of Primary Industries. The aim was to determine the economic return from a system of winter grain cropping and summer beef fattening, with emphasis on improving soil structure. The project ran for three years. It involved the rotation of Rhodes grass pasture with oat crops grown for grain. Fourteen month old steers were used in the grazing phase. The Rhodes grass phase improved soil structure. However, it failed to provide satisfactory liveweight gains. This was due largely to severe attacks of ephemeral fever in the cattle. The oat crop phase, interrupted by seasonal conditions and disease, was uneconomic as well. Apart from improvement of the soil this farming system was not applicable to the area. Another option using winter pasture species and a summer cropping phase may prove more economic, and still improve soil structure. Another research project, "Organic amelioration of silty loams at Inglewood", examined the effect of different farming systems in reducing surface crusting and increasing infiltration. This project was conducted by Gerry Gibson at the former Inglewood Field Station. Its results are discussed in a separate section.

Table 25. Infiltration rates under different treatments on a silty loam of the Macintyre Brook.

Bay	Treatment	Infiltration amount (mm)		
		60 min	120 min	400 min
A	Freshly prepared ground	31	55	—
B	Freshly prepared ground	13	23	—
C	White clover/ryegrass pasture since April 1970	17	22	31
D	As for C + 2.5 t/ha gypsum	15	18	20
E	As for C + 25 t/ha gypsum	56	86	114
G	Recently sown to pasture 1.25 t/ha gypsum	5	8	20
H	White clover/ryegrass/paspalum pasture since September 1970	23	48	142
I	As for G + deep ripped	24	48	142
J	Lucerne since August 1969	32	51	83
K	As for I + 2.5 t/ha gypsum	18	33	57

Other problems

The selection of soils suitable for irrigation is critical. This is difficult on some farms, because of small size and soil variability. In such situations, farmers may consider growing high value horticultural crops. Little can be done about the irregular shape of first levee areas. Once again, horticultural crops may be the answer.

Small irregularities can be removed by land levelling. The correct grades for particular irrigation practice must be used. Levelling may create hardpans. There are four methods to overcome this problem — cultivating deep with chisel ploughs or rippers; avoiding the use of disc implements; using pasture rotations and retaining crop residues; adopting practices which reduce the need for tillage when soils are wet, such as utilising herbicides in place of some cultivations.

Irrigated pastures are a very suitable rotation for improving soil structure on irrigated alluvials in the shire. Prime lambs are produced on these pastures but cattle fattening is also practiced.

Table 26. Treatment phases of cropping management trial.

Treatment Number	Treatment phase 3 years	Crop	Subsequent tillage	Assessment phase 4 years
■	Summer legume	Lucerne	N	Double crop (Soybeans/oats)
2	Summer grass	Rhodes Grass	N	Double crop (Soybeans/oats)
3	Summer crop/ winter pasture	Sorghum/ryegrass, medic	M	Double crop (Soybeans/oats)
4*	Summer crop/ winter crop	Sorghum/oats	D	Double crop (Soybeans/oats)

* Control treatment: N = no tillage; M = minimum tillage (1 cultivation each year), D = double crop with tillage.

Crop and pasture rotations for improved soil structure

This section draws on the research of Gerry Gibson, Queensland Department of Primary Industries. He examined the effect of some crop and pasture rotations on the structure of silty clay loams of the Macintyre Brook. A long term rotation trial was commenced in 1971. It consisted of a three year treatment phase, followed by a four year assessment phase under a double crop system of soybeans and oats (Table 26).

During the assessment phase, measurements of organic matter, aggregate stability, crust strength, soybean populations and yield were taken. The pre-trial organic matter (OM) level was 1.08%. Figure 20 shows the levels of OM in each year of the assessment phase. The greatest OM build-up was in the non-cultivated treatments. The three year Rhodes grass phase had the highest OM improvement (a 103% increase over the pre-trial level). Following a year of double-cropping, the OM levels fell in the lucerne and increased for sorghum/oats. By the fourth year of the assessment phase, the OM levels of the lucerne and Rhodes grass phases had risen again. The OM levels of the other two treatments had also risen. This suggests than an increase in OM is possible through pasture rotation, and through the retention of crop residues in a continual double-cropping system. It is not always possible to double-crop successfully each year, so a pasture in the system may be necessary to increase OM levels.

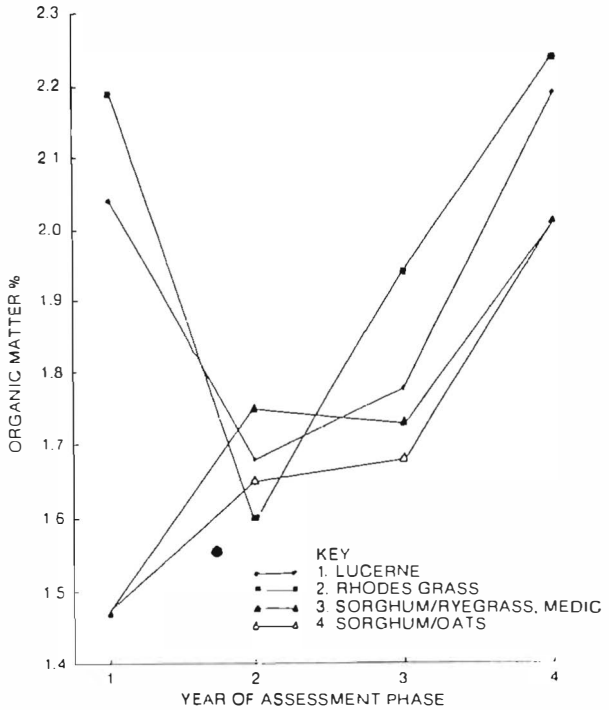


Figure 20. Organic matter levels in each year of the assessment phase.

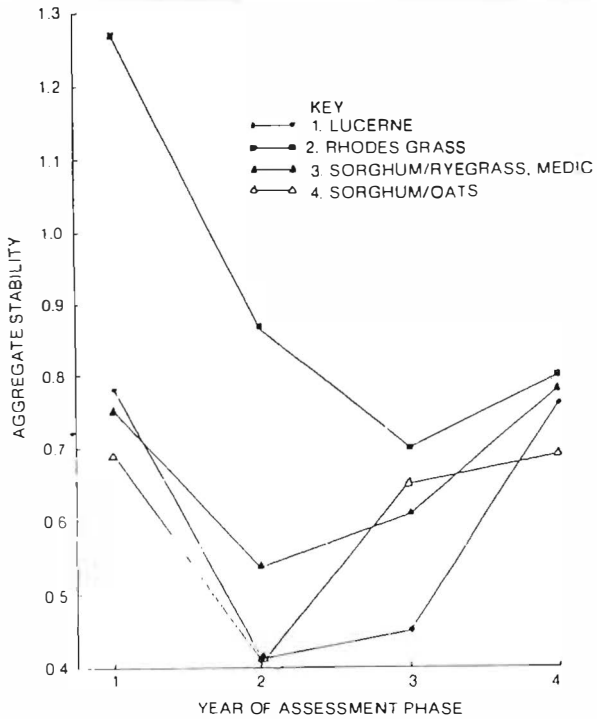


Figure 21. Aggregate stability in each year of the assessment phase.

Table 27. Average soybean populations over the four year assessment phase.

	Treatment Phase 3 years	Average soybean population number/ha
1.	Lucerne	136,300
2.	Rhodes grass	156,100
3.	Sorghum/ryegrass, medic	144,800
4.	Sorghum/oats	118,400

The Rhodes grass phase improved the stability of the soil aggregates, an effect which declined by the third year of the assessment phase. By then, the soil aggregate stability had fallen to the same level as the other treatments (Figure 21). The measurements of crust strength showed similar trends to those above (the crust following the Rhodes grass phase was only half that following the sorghum/oats phase).

The yields of soybeans following the sorghum/oats phase were the lowest in all years, although they increased each year of the assessment phase (Figure 22). There was a reduction in the first year after lucerne. The yields tended to be greatest where three years of pasture had been grown. The effect of the pasture appears to have lasted for three to four years. The yield trends were, in part, related to crop

establishment. Table 27 shows the average soybean population over the four years of the assessment phase. The better establishment of the crop in the Rhodes grass treatment is due to better surface soil structure, demonstrated by greater aggregate stability and a lower tendency to crust (both the result of increased OM levels). Rotation with pasture and a reduction in the number of cultivations in a double-cropping system can improve structural stability of these soils and, hence, crop yields.

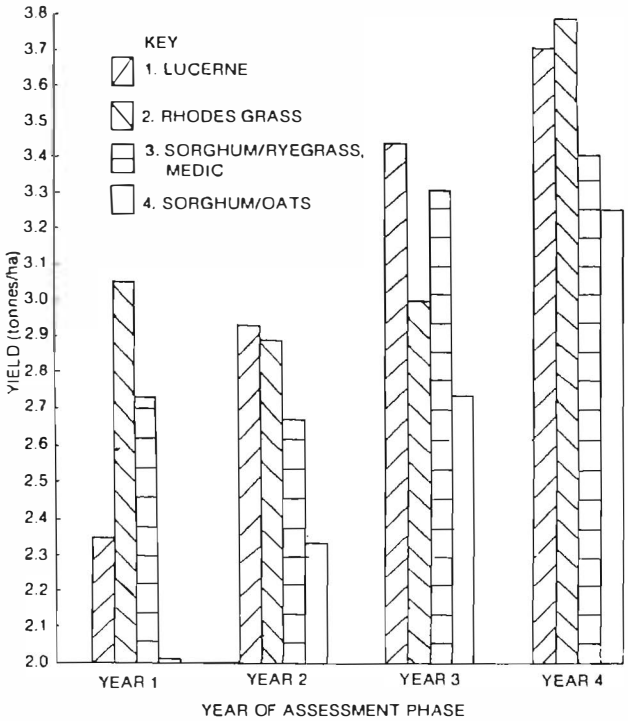


Figure 22. Yield of soybeans in each year of the assessment phase.

Recommendations for long-term management of irrigated soils

It is apparent the past agricultural practices have altered the physical characteristics of soils on the Macintyre Brook and Dumaresq River. This has been detrimental to present farming activities. Research plus observations by farmers provide evidence for recommendations on how to tackle the problems of surface crusting and low infiltration rates. Organic amelioration is the only answer. The options available to farmers involve the adoption of a different farming system which should include a pasture phase and/or a double cropping phase in which crop stubbles are retained.

The pasture phase should be of three to four years duration, followed by two to three years cropping. Pasture species adapted to the district and to the planned livestock enterprises should be used. White clover cv. Haifa, lucerne, ryegrass, fescue, Rhodes grass and phalaris are species which have performed well in different combinations under irrigation in the shire.

The cropping phase should include the following elements:

* double crop;

* adequate fertiliser to improve yields (therefore returns) and to provide sufficient crop residues for organic matter improvement;

* retention of all crop residues on the soil surface as long as possible;

* in conventional systems, the use of tined implements for cultivation (no discs, except where cutting up of stubble is required, or to avoid the spread of nutgrass);

* in conventional systems, the use of chisel ploughs following harvest, to allow water penetration and the mini-minising of further working prior to the next planting;

* weed control with herbicides, rather than cultivation. Strict farm hygiene measures should be taken to minimise the weed problem;

* cultivation at the correct soil moisture level. Inter-row cultivation should be kept to a minimum;

* sowing into moist soil with as little disturbance as possible. Disc planters are preferable. If tined planting equipment is used, a narrow sowing point is recommended. Excellent crop emergence has been achieved with both types of planters within reduced tillage systems in the shire;

* even spreading of the stubble at harvest to prevent blockage of tillage equipment. Harvesters fitted with chopper-spreaders give the best result. Slashing after havest can also improve stubble spread. Conventional four-row combines can be coverted to six-row machines for better stubble handling.

For effective irrigation the soil should be levelled accurately, particularly where surface methods are used. Low flow rates should be imposed to avoid exacerbating the crusting problem. Spray irrigation is the most suitable method for the Macintyre Brook alluvials, generally. Small droplet sizes should be used through low to medium pressure sprinklers, preferably at night . Irrigation scheduling practices, based on estimates of crop water use, should be used.

CHAPTER 6

IMPROVING AND MAINTAINING THE PASTURES OF INGLEWOOD SHIRE

Perennial native grasses provide the basis for livestock enterprises which earn 60% of the gross value of agricultural production in Inglewood Shire. They occupy about 76% of the land surface — mixed with varying levels of original forest and areas of regrowth. The statistics show a total of only about 8,700 ha of sown pastures (1.5% of the shire area). The management of native pastures in particular is therefore of great importance to the economic well being of the shire.

Native pastures and their management

The composition and the quality of native pastures are linked to the main soil type on which they grow. These soil types can be classified very broadly as follows.

Traprock

This country occupies most of the eastern half of the shire. It varies from flat to hilly terrain. The soil cover is shallow, stony and basically infertile. Rainfall run-off is high and pasture productivity is low. The area is thus very susceptible to drought conditions. Pasture growth is confined to a five month period from November through to March. Even during this period the pasture is of never more than fair quality and will only enable cattle to improve condition, rarely to the stage of finishing. After March the feed quality deteriorates rapidly, with a protein shortage from April through to November. Energy supply also becomes critical in mid to late winter. The country is considered more suited to wool production with cattle grazing confined to store production except for a few favoured localities. The average carrying capacity of cleared traprock is about 1.5 dry sheep equivalent per hectare. The main grasses encountered on traprock country are Queensland blue grass *(Dichanthium sericeum),* pitted blue grass *(Bothriochloa decipiens),* slender bamboo grass *(Stipa verticillata),* love grass *(Eragrostis* spp.*),* slender rat tail grass *(Sporobolus elongatus),* spear grass *(Stipa* spp.*)* and *Chloris* spp.

Sandstone — Solodics

These areas of very fragile light soil are scattered throughout the shire but mainly occur in the north and west. Most lie within state forest reserves and are available for cattle grazing only under special forestry leases. Pastures generally are of very poor quantity and quality, being virtually useless during winter. Average stocking rates are about one beast to 10 hectares. Grass species encountered are wire grasses *(Aristida* spp.*),* some ridge grass *(Enneapogon avenaceus),* and some love grasses *(Eragrostis* spp.*).*

Grey grown clays

These areas occur to the north and west of Inglewood, and include the brigalow-belah scrub areas. They are fairly small and usually carry heavy regrowth. Cleared areas are devoted almost entirely to winter grain and fodder production. Native grasses are brigalow grass *(Paspalidium caespitosum)* and some *Chloris* spp.

Alluvials

Alluvial country is scattered throughout the shire. Many properties have some alluvial frontage country which is mainly devoted to annual cropping, but broken country unsuitable for cultivation is quite highly productive and suitable for cattle breeding at one beast to about 4 hectares. Grasss are mainly pitted blue grass, slender bamboo grasses, love grasses and spear grass.

Yelarbon "desert"

This classifies a small area of spinifex-tea tree country which occurs just north of Yelarbon. It provides some light grazing but carrying capacity is extremely low.

A pitted bluegrass native pasture on traprock. This pasture shows good groundcover and is setting seed which is essential to maintain the more suitable native species in pastures.

Early development of the pasture

This involves elimination of tree and shrub cover so that useful pasture will grow, then taking steps to promote and maintain the desired balance between grass and trees. The process is not as easy as it sounds. It involves complex management decisions and a careful manipulation of the field environment, all aimed at preventing the regeneration and rapid encroachment of unwanted trees and shrubs. Techniques and criteria for the clearing of trees and shrubs, as well as control of regrowth, are outlined in Chapter 8 of this manual. Successful programs undertaken on the country in question are also described in some detail in the "Queensland Agricultural Journal" (1, 2). In any clearing program the basic considerations are as follows:

* Clear only the most productive soils, leaving ridges and shallow gravelly soils.

* Leave 10-20% of trees in shelter belts. Do not leave single trees in the paddock. They will succumb to "die-back" in the long term and also will be sources of seedling regrowth.

* Clear only an area which can be handled using available stock numbers to control regrowth of eucalypts and shrubs (wattles and wild rosemary). Wethers are more effective than ewes in controlling regrowth. Goats are the most effective of all.

* If stock numbers are insufficient for the development of an entire paddock, subdivision should be undertaken before clearing.

* Burning, coupled with grazing, has been used successfully to control timber regrowth. It must, however, be used with knowledge and purpose (1). Its excessive use can be detrimental to the desired pasture.

* Management to avoid invasion by some shrub species (particularly wild rosemary) is not yet fully understood. Situations where a heavy understoty of this plant exists would be more wisely avoided for clearing until more information becomes available. Consult the local D.P.I. extension agronomist before tackling doubtful propositions.

Wiregrass (*Aristida* spp.), which dominates significant areas of traprock country, provides only low quality summer feed. The spear-like seeds cause carcass damage, wool fault and ill-thrift, especially with young sheep. This grass is not a vigorous competitor. Its dominance is due to the fact that sheep will not eat it readily. If it can be subjected to heavy grazing pressure at high stocking rates in the young stages

the stands are "opened up" and better species tend to move in. Such stocking rates may have to be 3 or 4 times normal. Also, after 3 weeks or so, the grazing sheep reach the brink of starvation and need to be changed. One summer of this strategy may be enough to reduce the wiregrass to an acceptable level, allowing better grasses to dominate the pasture. Control is also possible, where soils are good enough, through cultivation and sowing improved species. Burning or slashing prior to grazing will also reduce populations.

A control strategy, using grazing management, has been evolved on the N.W. slopes of N.S.W. (3). However it depends on the encouragement of certain winter growing grasses which are only minor components of pastures in this shire; and on stocking rates which may not be achievable under the local system of more extensive grazing. Officers of the Queensland D.P.I. are conducting trials aimed at grazing management recommendations for the control of wiregrass.

The proper management of native pastures in Inglewood Shire, as well as in all others, is up against human nature. It means foregoing some of today's easily achievable returns in order to preserve the future basis of production. In many cases, of course, social necessity intervenes. Production economics are making some properties too small, so that maximising turn-off today becomes a matter of livelihood rather than extra income. However, the fact is that over-utilisation causes progressive degradation of the productive capacity of nature pasture. Conservation management is largely a matter of applying a few universal principles which have emerged in recent years (4). They are as follows.

Average annual stocking rate must be maintained within the ability of the pasture to carry animals without deterioration. This allows for periods of strategic heavy grazing (e.g. to control wiregrass or tree seedlings) which need to be offset by periods of spelling. Consistent overgrazing prevents seeding and subsequent establishment of the palatable species. It results in pastures dominated by weeds and relatively useless grasses. Producers' experience and research (5) carried out in the shire indicate a maximum safe stocking rate of 1.5 sheep per hectare. Native pastures benefit from periodic resting. It may be desirable, for instance, to rest the pasture for 3 months during the growing season, every 4 years. This rejuvenates the vigour of both top and root growth in tufted grasses. Overall forage yield is increased and a larger and better seed crop is produced.

About 90% of pasture growth occurs in the summer. The amount of forage standing in the paddock in April will vary according to the season. This reserve is expected to carry stock at least until the first rains of the following summer. As far as practicable, therefore, stock numbers should be adjusted each year according to the grazier's assessment of the amount of this reserve. In this shire it could be said that winter rainfall influences the quality rather than the quantity of pasture available and has little effect on carrying capacity.

It is emphasised that the above measures are put forward as principles, flexible enough to include a range of other management considerations which include fluctuating annual numbers as well as control of grazing by subdivision, provision of water and licks, and strategic burning. They could also encompass a system of heavy grazing and pasture spelling to control wiregrass, get more use out of the less palatable species, and encourage the better forage plants. Studies carried out in recent years (6) indicate that fire is a useful, indeed a recommended, management tool in maintaining native pasture productivity. Traditionally, landholders in the shire use controlled burning to remove old grass, to stimulate green grass, to control woody weeds and to reduce the accidental fire hazard. All these are valid reasons. However the most rewarding way to use fire is in conjunction with careful grazing management. In eucalypt communities, for instance, fire is used to keep tree regrowth within reach of the grazing animal. It should be remembered, however, that burning removes feed; so the more country that is burnt in the spring, the greater the risk of subsequent feed shortages. Burning for an early green pick has a measured beneficial effect on animal performance (6) but this advantage disappears later in the season when animals on unburnt country perform just as well. Pasture deterioration (e.g. wiregrass dominance) may be alleviated by burning and grazing. Sections of a paddock may be burnt annually on a rotational basis. Stock graze these areas preferentially, thus spelling the remainder of the paddock. This must be balanced against the possibility of increased surface run-off and erosion on many sites. Too frequent burning should be avoided.

Guidelines to burning, published by the Queensland D.P.I., are as follows:

* before lighting up be sure that a fire is needed, and burn only enough to achieve your aims;

* burning after sufficient rain ensures good moisture for grass growth;

* the best time to burn is at the beginning of the wet season, after the first storms;

* burning too early (e.g. autumn) can expose the soil surface to many months of storm erosion;

* the minimum time between burns should be 3 years;

* controlled burning is a major aid in fire prevention/ hazard reduction in years when standing dry matter is great. Before lighting up ensure the fire can be controlled. Fires are more easily controlled if lit in late afternoon. On sloping land, burning downhill into the breeze helps in control. Fires should never be lit in windy conditions;

* in areas susceptible to erosion, patch burn with low intensity fires;

* before lighting a fire advise your neighbours and get a permit from the local fire warden.

Wiregrass is a major weed problem in native pastures in the shire. It has little feed value and the seed heads contaminate wool and sheep carcasses. Dense wiregrass limits the productivity of native pastures in the shire.

Wild rosemary is a significant weed problem on some areas of traprock. Here Graham Harris of the Q.D.P.I. inspects a stand of dense wild rosemary which resulted when timber was cleared in 1982. The wet 1983 and 1984 seasons favoured wild rosemary establishment.

Improved sown pasture

Pastoral soils within the shire are not very suitable for sown pastures which, in effect, are a perennial crop. The pastures must, therefore, be high yielding to justify the cost of cultivation, seed, fertiliser, and fencing. This is confirmed by the small areas existing so far. A break-up of the 8,700 ha mentioned above is as follows:

	Area (ha)
Lucerne (mostly irrigated for hay)	1,195
Other pasture legumes	1,166
Sown grasses only	907
Grass/legume mixtures	5,441
TOTAL	8,709

Reasons for this situation are not hard to find. The general paucity of the pastoral soils (traprock and sandstone/solodic) in terms of fertility, depth and water holding capacity preclude extensive sown pasture development with the current technology.

The grey-brown soils, used mostly for grain cropping, will eventually need a pasture rotation to restore their structure and maintain productivity. Some people are already taking advantage of improved livestock returns to turn these soils over to a perennial pasture phase. A similar situation exists on the alluvial soils where irrigated cropping is beginning to make room for irrigated pasture because of the same narrowing ratio between cropping and livestock enterprises — namely prime lamb production and the finishing of store cattle. More detailed economic studies are needed to assist producers with sown pasture decisions.

Dryland grown pastures in the shire have been, for all practical purposes, confined to the traprock country. Significant success is associated with favoured locations, such as valley floors, where the soil is deeper. The main component sown is lucerne, which, unless grown for hay, is better used as an oversown component into native pasture; with only moderate surface cultivation (i.e. not enough to eliminate the grass). Thorough cultivation for a pure lucerne stand tends to extract a price in terms of weedy unproductive ground as the lucerne dies out (usually a maximum of 3 years). Lucerne can be established this way on shallow hillside soils but quickly withers and drops its leaves in hot dry weather.

A small suite of other pasture legumes, used by some graziers in the shire, and recommended by the Queensland D.P.I. (2, 7) are capable of making a significant contribution in seasons when good spring rains occur. It includes barrel medic, cluster clover, subterranean clover and rose clover. If a sown grass is needed, useful species are Rhodes grass varieties and creeping blue grass (2, 7). Except for pastures on former cultivation, or other grassless areas, little emphasis should be placed at this stage on improved grasses. They do have great potential for high forage production over a longer growing season; but only under a higher plane of nutrition than that which exists at present (i.e. a really vigorous associated legume or regular fertilising with nitrogen). Sown grass performance will only express the productivity of the soil on which it grows. There is, therefore, no case at present for replacing the native grass with something better. Meanwhile, regional pasture research by the Queensland D.P.I. continues to be a priority (7). The constant search for productive and persistent pasture species (especially legumes) is pursued with determination. Sown pasture technology, especially the establishment of legumes, is somewhat complex. It is strongly recommended that anyone contemplating such an enterprise makes sure of access to the latest information through their Queensland D.P.I. extension agronomist.

Cattle grazing a dryland lucerne and Halfa white clover pasture on Bob Dowding's, 'Palomar', Inglewood.

Local experience

Bruce Finlay, "Emu Plains", Texas has developed 800 ha of traprock country consisting of red-brown earths overlying limestone. He has surveyed and contoured this

Cattle being fattened on irrigated pasture growing on traprock country at John Crombie's, 'Weynnga', Gore, With suitable dam sites and irrigation management it is possible to grow irrigated pastures on traprock, enabling diversification into fattening enterprises.

country so that cultivation can be used to control wiregrass without the risk of erosion. He has developed 200 ha annually for four years by planting a winter forage crop under which a lucerne based pasture is sown. Other species also included are Jemalong barrel medic, Namoi woolly pod vetch and Wimmera ryegrass. As the lucerne component declines, the native grasses which take over are proving to be better quality ones. Bruce aims to re-cultivate and grow forage crops for a few years before replanting to lucerne again. Other species which have proved successful are the summer growing legume siratro and the grasses Molopo buffel, Hatch creeping blue grass, and the Rhodes grass varieties Katambora and Callide.

Ross Hockley of "Mascotte", Texas has developed 150 ha of a sandy surfaced granite soil and a red earth ironstone soil with improved pastures since the 1986 winter. He has used a range of species; the most successful being Haifa white clover, lucerne, Namoi woolly pod vetch, sub clover and Wimmera ryegrass. This pasture development has enabled a three-fold increase in stocking numbers. Prior to pasture development there were 65 head running on 280 ha. Following the 150 ha pasture development that same 280 ha carries 220 head. He has also planted dryland improved pastures on some alluvial soils. The following species have proved successful — green panic, Katambora Rhodes grass, Sirosa phalaris, Wimmera ryegrass, and Namoi woolly pod vetch.

Bob Dowding of "Palomar", Inglewood has planted 400 ha of improved pasture since 1985. A range of soils has been developed, including gray clay box soils, hard setting ironstone clays, pine-bullock soils and alluvial soils. Again, successful species have been lucerne, snail medic, cluster clover, Haifa white clover, Jemalong and Cyprus barrel medics, Wimmera ryegrass and prairie grass.

Irrigated sown pasture

The use of highly productive, intensively grazed irrigated pastures in Inglewood Shire increased during the mid 1980s. They can be established on the alluvial soils of the Macintyre Brook and the Dumaresq River. In some cases stored surface water has enabled their use on traprock grazing properties. This trend is due to the narrowing gap between returns from cropping and from quality meat production. From a land use point of view this is an important trend. The effect of pastures in restoring structural stability of these soils, by increasing organic matter content, has been outlined in Chapter 5. Irrigated pastures also constitute a much safer land use option than regular cultivation for the flood prone lower levee soils. These pastures are mixtures of suitable lucerne and white clover varieties, with annual and perennial ryegrasses, as well as some temperate perennial grass options. They are usually of such high quality and productivity they must be rationed to grazing stock. This means fairly intensive subdivision and rotational grazing. Information on planting mixtures, fertiliser, irrigation and grazing management should be sought from the local Queensland D.P.I. extension agronomist.

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CHAPTER 7

TREE MANAGEMENT ON SHIRE LANDS

Land within the Inglewood Shire was virtually all timbered originally. Clearing has occurred in conjunction with the development of grazing and farming. Significant areas of the shire remain uncleared. About 99,200 ha or 16.9% of the shire is state forest, while portions of the grazing land are still heavily timbered.

The balance between trees and forage production

The highest level of sustainable production will be maintained in a grazing environment only when all the contributing factors are understood. A balance must be struck between what is taken from the pasture and what is put back. Grazing converts herbage to livestock products. Rainfall washes soil and nutrients from the land by erosion and by leaching nutrients deeper into the soil below the root zone of the herbage. Those losses must be replaced to maintain productive pasture, either by top dressing with fertiliser or by natural process. Plants take up nutrients from their root zone and by the breakdown of surplus plant material nature recycles nutrients in the surface soil for the benefit of the pasture. The thinking grazier aims to create a balance between these factors to achieve the highest level of sustainable production. Additions of fertiliser are not widely used on native pastures in this shire because of uneconomic returns although increases in commodity prices could change this situation.

Compatible trees and the grazing enterprise

The benefits of trees can be listed as follows. They

- cycle nutrients to the pasture
- help bind the soil to control erosion
- moderate extreme climatic effects on pasture, stock and cultivation
- help to control soil salinity
- provide habitat for insectivorous birds, insects and reptiles
- provide a browse component of livestock diet, especially during droughts
- provide timber for farm and commercial use
- provide a major source of honey
- have aesthetic value.

There are also disadvantages, in that too many trees provide excessive competition for soil moisture, light and nutrients, thus reducing pasture production; regrowth from seedlings and lignotubers is a major problem in the shire; and trees can cause mustering difficulties.

The shire has a range of tree species, many of which have some of the above benefits. It is up to the individual landowner to determine which are compatible with his enterprise. Such will be called "grazing compatible" trees in the rest of this chapter. The Kurrajong *(Brachychiton populneum)* is rated very highly and has none of the disadvantages, so it would be the best example of a grazing compatible tree in the Inglewood Shire. However, it is so palatable that regeneration has been very restricted. Populations are therefore too low to have a significant impact. More common species with a useful rating in certain situations include narrow leafed ironbark *(Eucalyptus crebra)*, rough barked apple *(Angophora floribunda)* and brown box (also called gray box) *(E. microcarpa)*.

Nutrient cycling

Deep rooted trees and shrubs continually bring plant nutrients from soil horizons below that reached by grasses. Some of these nutrients are transferred to the topsoil through leaf and twig fall. This process maintains organic matter levels and promotes soil aggregation. Leguminous shrubs (i.e. *Acacia* spp.) also have the advantage of being able to fix atmospheric nitrogen.

View of native pastures on cleared traprock.

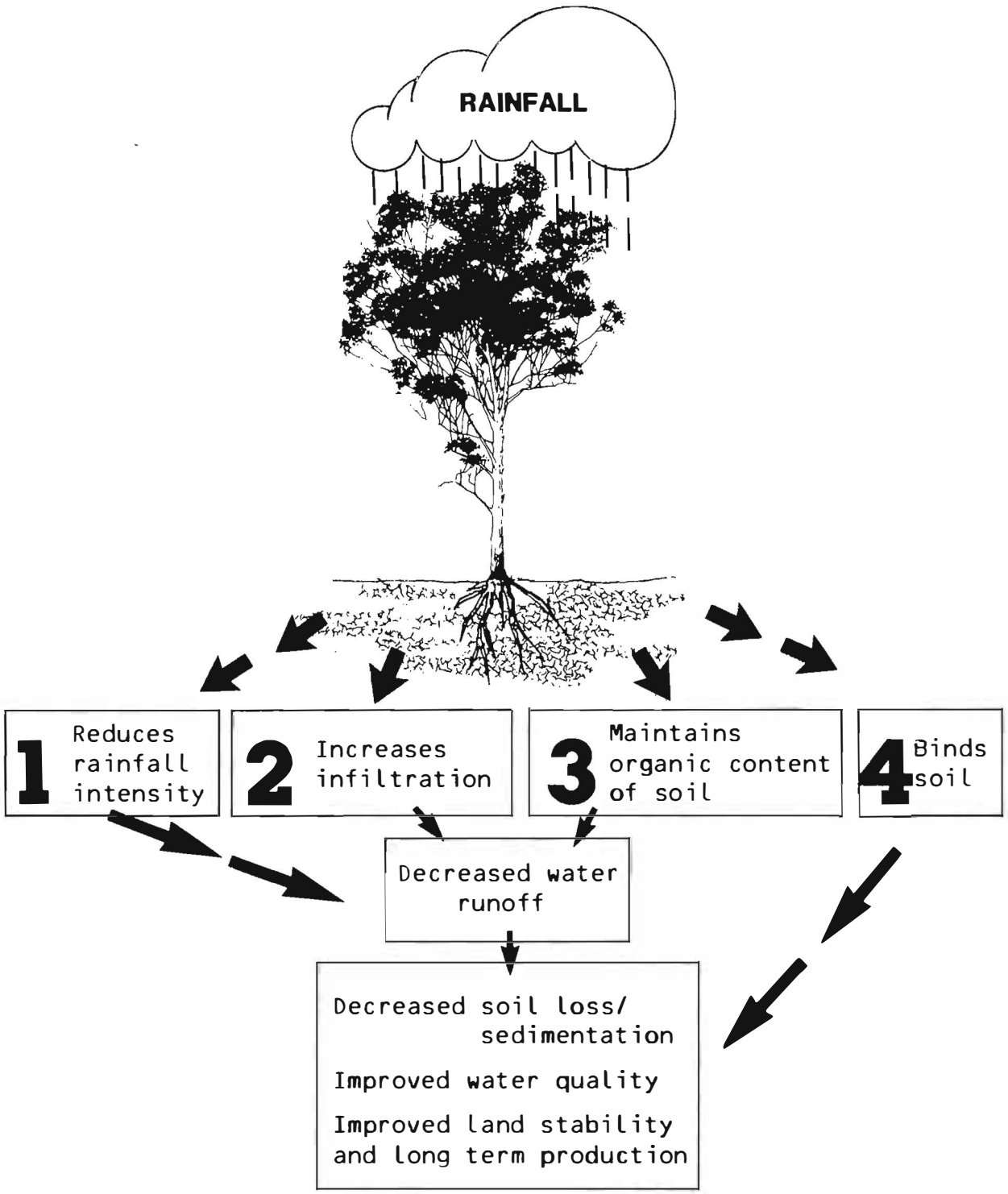


Figure 23. The effect of trees on erosion. Courtesy — Qld. Dept. of Primary Industries.

Erosion Control

Some natural erosion is inevitable in our environment, largely because the environment is unable to support an adequate permanent cover of vegetation. Any use of the land which reduces the cover tends to cause accelerated soil erosion, that is, erosion greater than that which is natural to be environment. This accelerated erosion can be minimised by using trees and shrubs as agents in conserving soil resources. Grazing animals reduce the protective plant cover and compact the soil surface. The resultant exposure to storm rainfall gives rise to soil removal and pasture degradation. Changes in vegetation include infestation by weeds, wire grasses, galvanised burr, cotton bush and the complete denudation of "scalded" patches. An adequate permanent cover of grass is required to keep erosion to the minimum. This is not always possible in a grazing situation. Trees and shrubs are practical means of combating erosion caused by a reduction of grass cover. Trees can help to reduce erosion of the surface soil in several ways:

* The impact of storm rain and therefore its ability to move soil is dissipated when the raindrops collide with foliage.

* Water infiltration into the topsoil is increased by additional pore space left by old root channels and by the reduction of surface crusting through the addition of organic matter.

* Leaf and twig fall increase the overall organic content of the soil.

* In the absence of enough grass cover, trees and shrubs will help bind the soil.

Some tree species are more efficient than others in combating soil loss. The canopy type, density, branching pattern, root structure and growth pattern of a tree influence its effectiveness as an erosion control agent. Some tree types and trees in the wrong location can actually aggravate a problem. For instance erosion can occur in certain timbered areas, particularly where soils are shallow and infertile and stocking is heavy. The damage is greater if the tree species have a shallow root system which restricts the growth of protective grass. Erosion may be greater if such trees are on the lower portion of a slope and the area above is cleared. Run-off from above flows through, creating exposed areas of the soil. Cattle camps need to be carefully located for this reason. Deeper rooted trees allow more ground cover. Narrow leafed ironbark *(E. crebra)* and brown box *(E. microcarpa)* are better than tumble-down gum *(E. dealbata)* or yellow box *(E. melliodora)*. The ground cover naturally becomes very sparse during a drought under set stocking rates. Trees are most important in binding the soil when the rains eventually arrive.

The protection offered by their soil binding ability is also vital in the prevention of streambank and drainage line erosion. Trees are essential on the steep banks and the outside arc of stream. River red gums, most *Casuarina* spp. willow and *Callistemon* spp. are well adapted for streambank planting. The land on either side of main drainage lines often carries large volumes of run-off water from the catchment to the stream. These areas should be protected by well spaced trees that will bind the soil and slow the run-off. Rough barked apple is well suited here. Yellow box could also be grown, preferably in clumps, to minimise the cost of regrowth control. The steeper the slope the higher the density of trees required to bind the soil. Slopes over 25% should not be cleared as soil types are usually infertile, shallow and stony. Clearing the hills may also cause salinity on the more productive pasture below.

Moderation of the climate

Trees are an important source of shade and shelter for livestock. A leaf canopy that does not block sunlight or is sufficiently high, such as a narrow leafed ironbark, will allow grass to grow beneath it. They also provide frost protection. This is one of several reasons why stock do better through winter in a timbered paddock.

Shelter belts grown as in Figure 24 with trees or shrubs of different heights can prevent crops or pasture dessicating in hot winds. They can thus provide a kinder environment for plants, animals or even man. The shelter belt should be in the south or west of the paddock for shelter from the cold winds while a north or west location would provide some protection from the hot drying winds. The best shade and shelter is provided by large compact clumps of 8 to 10 hectares. While these are best left on ridges they may also be used to attract stock to a section of a paddock that is not fully utilised. Shade clumps are needed at watering points and stock yards. They should not be left in places where droppings and disturbed soil could be washed into dams, nor should they be in drainage lines or hollows where concentrations of stock may lead to erosion.

The above information has been obtained from 'Guidelines for Land Clearing' by Officers of the Soil Conservation Services Branch compiled by R. M. Stephens in the "Queensland Agricultural Journal".

Trees and soil salinity

When trees are cleared from the upper part of a slope the ground water table tends to rise at the bottom of the slope because less water is being used by the vegetation. If the ground water is saline, and the water table reaches the soil surface, then salt can accumulate at the surface. Enough salt can accumulate to kill plants after successive wetting and drying cycles. This accumulation causes the random "scalded" patches which can be observed around the shire. For this reason trees on the crests and upper slopes of hills should be retained wherever possible.

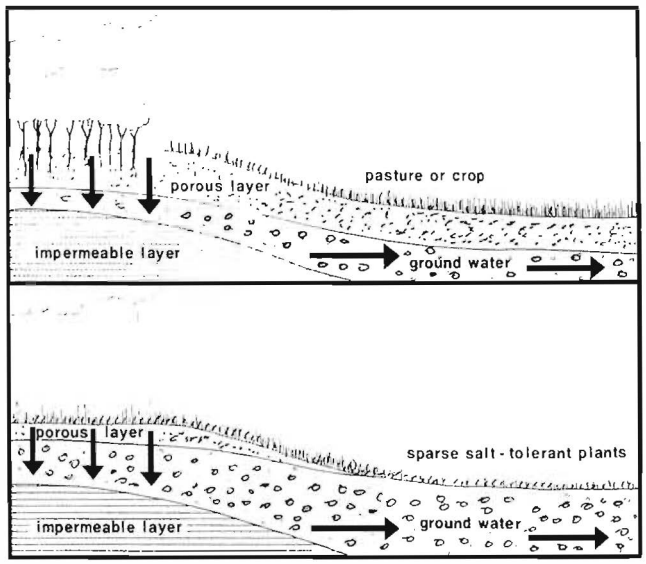
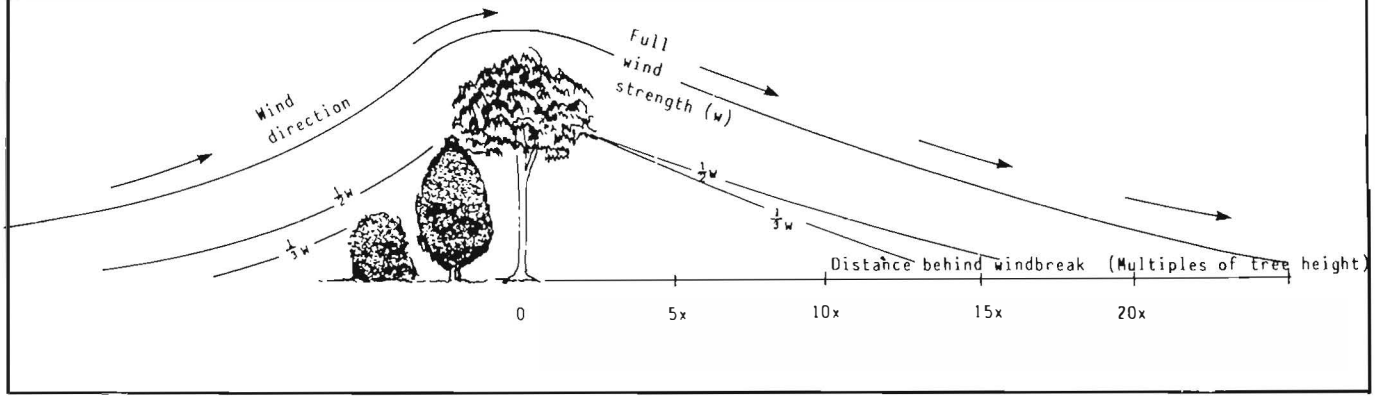


Fig. 25

A review of 772 soil tests carried out on samples within the shire over a period of 15 years (1970-1985) representing a wide range of soil types reveals that three of the samples tested had salinity levels high enough to kill all but tolerant plants. It is however a matter of history that in 1960-61 salinity levels in the Macintyre Brook became high enough to affect seriously the leaf quality of irrigated tobacco. As a result the leaf became unsaleable, the industry was decimated and the economy of the shire affected significantly. A subsequent survey (McNee, 1963) revealed the principle source of saline

Fig. 24



water to be Treverton Creek and its associated gullies (see Figure 26), the water entering Macintyre Brook via Bracker Creek. Chloride levels exceeding 120 mg/litre were found. One gully (Connor's gully) registered a peak level of 646 mg/litre. Tobacco leaf quality is seriously affected at a level of 40 mg/litre.

Graham Harris and Bruce Carey of the Q.D.P.I. discussing the extent of salting in the salt pan area below Coolmunda Dam. Note the absence of groundcover and the surface salt in the severely affected area.

The source of the chloride in the Treverton Creek catchment was attributed to overclearing of trees, resulting in a raised water table and springs containing poor quality water. Chloride levels in shire streams become higher in times of reduced flow (i.e. drought). However it has been reported that, in general, stream water is suitable for the irrigation of all crops except tobacco. Oakey Creek which enters the Dumaresq west of Texas has chloride levels higher than is found in the Dumaresq at Texas. There has been a noticeable increase in dieback of river red gum *(Eucalyptus camaldulensis)* along the banks of the Macintyre Brook during the last seven years. Tree deaths have occurred particularly below Coolmunda Dam. Streamwater salinity has contributed to this situation. It seems that the problem of salinity has not so far become generalised in the shire in spite of extensive clearing of trees. On much of the improved country, timber regrowth has been a problem so there is still a level of tree cover. However it must be pointed out that the relationship between overclearing and the problem of soil salinity is now well established. It should be taken into consideration by landholders.

River red gum suffering 'dieback'—the result of insect attack which increases in severity with increasing stream salinity.

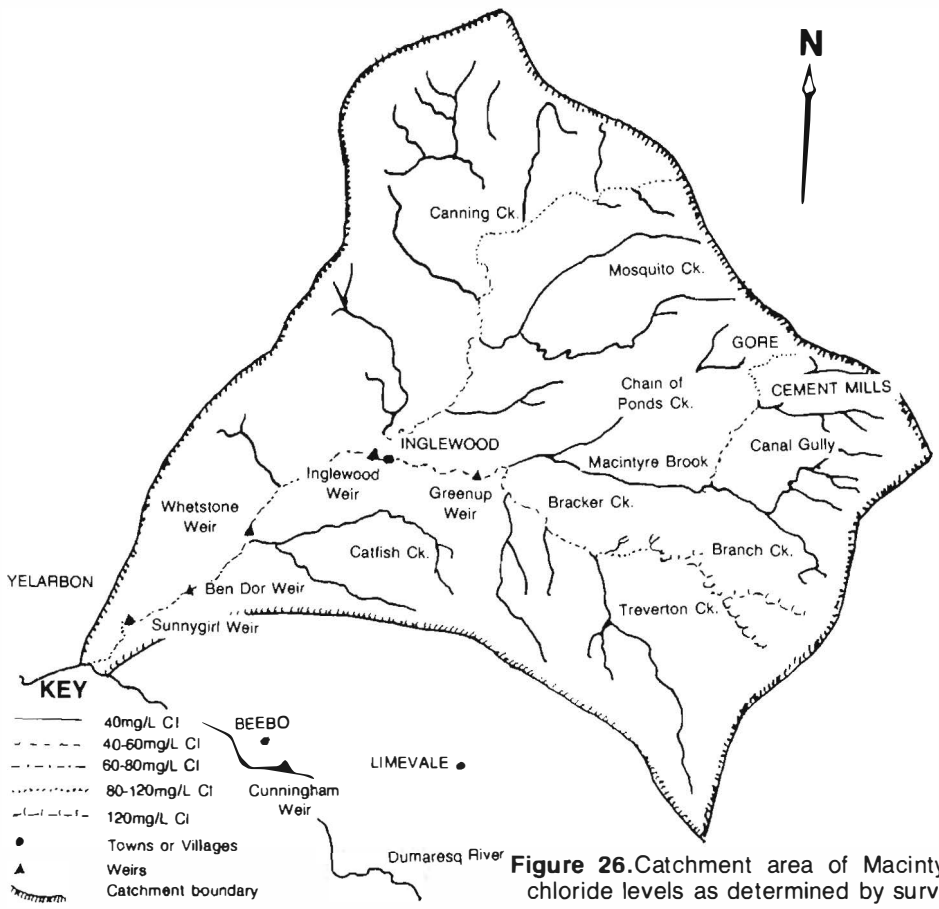


Figure 26. Catchment area of Macintyre Brook showing chloride levels as determined by survey (McNee, 1963)

Habitats for beneficial fauna

Many studies in recent years have revealed that nature can be a valuable ally in keeping pest populations of crops and pastures down so that control with insecticides does not become necessary. Insectivorous birds, lizards and even other insects, are important agents in this regard. Most require a suitable habitat of trees and shrubs within operating range of their source of feed. The Australian magpie, for example, has adapted particularly well to the pastoral environment of open pasture with scattered clumps of trees. Territorial magpies maintain a permanent territory which may be as small as 0.8 ha and feed mainly in short grazed pasture. Scattered clumps of trees adjoining pasture areas provide a greater number of territories than a windbreak of many trees close together, which may be defended by one group. Ibis are another beneficial predator and each ibis can consume about 250 g each day of crickets, grasshoppers, grubs and moths. Beneficial insectivorous native creatures in Inglewood Shire include 53 species of birds, 50 species of reptiles, and two mammals (Queensland National Parks and Wildlife Service).

Optimum levels of tree retention

Removal of trees is necessary for pasture production and in the short term there is an increase in fertility due to decaying vegetation from dead trees. In the long term, the level of sustainable productivity will depend on management. The aim should be for balance; retaining the maximum possible benefit. Work done by Walker, Moore and Robertson (CSIRO 1972) on poplar box country near Talwood and in the Cecil Plains area showed that leaving up to six trees and 360 shrubs per hectare had no limiting effect on the production of herbage. If six trees/ha or more are scattered singly in a park-like setting they would tend to provide maximum benefit to the pasture by the recycling nutrients and providing protection. However regrowth would be uncontrollable. Individual trees also tend to be short lived and more prone to mistletoe infestation.

Retention of trees in clumps and belts can provide some of the benefits while greatly reducing the problem of seedling regrowth. Eucalypts form the most common species of trees in the shire. Eucalypt seeds are not normally dispersed for a distance more than twice the height of the tree. The long term regrowth problem would be restricted to along the borders of uncleared belts or clumps of trees. A suggested level of tree retention is 10% of the total area. Where strips are desired a 50 metre strip on the contour every 500 metres could be a rule of thumb. If clumps are the preferred option these should be 8 to 10 hectares in size and about every 100 hectares.

The topography of the property and location of yards and watering points would have a very large bearing on where belts or clumps of timber should be left. Steep or stony areas and strips along water courses would be suitable in many parts of the shire. Species that have a strong tendency for regrowth and which require more expensive control measures may best be left as shelter belts. A point of note in selecting shelter areas is their relationship to dams, as dung from stock camps can pollute water. The species of trees or shrubs are critical in determining the level of retention. Trees with fodder or browse potential must be considered differently to invasive types that have no benefits for the grazing environment. These latter species should be left in larger clumps only if they are uneconomical to treat or if they are all that is available. This will make them easier to contain.

Sources of fodder

Recognised fodder trees actually growing in the shire include kurrajong *(Brachychiton populneum), whitewood (Atalava hemiglauca)*, bumble *(Capparis mitchellii),* green wattle *(Acacia deanei)* and wilga *(Geijera parviflora).* Naturally everything should be done to encourage the regeneration of these species.

Other species have been utilised in drought. These varied in acceptance from property to property. Brown box, narrow leafed ironbark, and rough barked apple were all eaten in drought periods. A solution of 12% molasses and 5% sulphate of ammonia in water sprayed onto the lopped or fallen foliage of such trees made a useful drought ration. It would seem feasible to combine the chemical control (by treating the stumps) of such species as brown box with the provision of browse fodder in drought time. Establishment of access tracks and clearing of fencelines could further help justify this form of drought feeding.

Table 28 compares the feed value of some edible trees with that of lucerne hay.

From results of trials there is little difference in levels of crude protein and metabolisable energy through the full range of seasons.

Table 29 gives the approximate chemical composition of leaves. It provides no indication of the digestibility and palatability of these plants. Experiments to determine digestibility are expensive and time consuming. They have only been carried out on a limited number of native plants to the author's knowledge.

Stock may lose their appetite for scrub after a couple of months and an alternative source of feed will then have to be found. Impaction can occur, especially with more fibrous species such as Casuarinas. Spraying the leaves with 1:8 mix of molasses and water plus 5% sulphate of ammonia makes a useful supplement. Lop generously so stock are not forced to eat twigs. Some native plants can be toxic. The seeds of kurrajong trees have been known to poison stock. For some reason stock will eat some trees, e.g. wilga, but will leave others of the same species. Scrub can be fed every

Table 28. Feed values of some of the species occurring in the shire that have been tested compared with lucerne hay.

	CP			DDM			ME		
	Low	Ave.	High	Low	Ave.	High	Low	Ave.	High
Belah	7.6	8.8	13.9	50.0	53.0	65.0	7.5	8.0	9.8
Wild Orange	11.3	12.6	13.6	60.0	61.0	62.3	9.0	9.2	9.3
Wilga	8.7	13.6	15.9	55.0	65.0	70.0	8.3	9.8	10.5
Lucerne Hay	5.8	17.6	31.8	41.8	61.7	77.5	6.3	9.0	11.6

CP — CRUDE PROTEIN (The total amount of protein available from the feed expressed as a percentage of the feed.)

DDM — DIGESTABLE DRY MATTER (The percentage of material that the animal is able to digest compared to the total amount eaten.)

ME — METABOLISABLE ENERGY (The amount of "fattening ability" in the feed.)

Courtesy N.S.W. Department of Agriculture.

second or third day, but, if feeding it daily, cut in the late afternoon so that stock will camp after feeding and graze out early the next morning. Always allow fodder tree regeneration.

Several methods could be used to introduce fodder trees or shrubs to the grazing environment. Individual trees can be planted out each with a stock and vermin guard, or group plantings can be surrounded by a fence. If group plantings are placed in a paddock corner, or along an existing fence, materials can be saved. A suggestion for utilising fodder shrubs is an intensive planting of about 3,000 compact shrubs per hectare in a single block. This could be used for supplementary or drought feed on a controlled access basis. A stock and vermin proof fence would be essential. Trickle irrigation would be desirable for establishment. If placed below an existing large stock dam (which would have to be sacrificed for that period) the water could be gravity fed. The laterals feeding water to the shrubs could be of "TAPE" or more substantial low density poly tubing. The system could be moved to a second plot when the first is established. In a reasonable season irrigation may not be necessary.

Commercial value of native forests

Within Inglewood Shire, cypress pine for milling timber, and ironbark for milling, sleeper supplies and landscape timbers are currently the most marketable timber products. There is also some potential (undeveloped at present) to supply pole size timbers. Prices paid for these products when harvested from private land will usually be determined by negotiation between buyer and seller. No firm guide on likely prices can be given. However if planning to sell trees for timber, landowners should make sure they are aware of the tree quality and size preferred by potential buyers. Advice about this can be obtained from the Forestry Department or from timber purchasers. Apart from timber, other products can provide some return. Supply of firewood is an area which might be exploited. Ironbark bark is saleable. Some seeds (mainly particular eucalypt and wattle seeds) can be sold at various times. Spot prices for these specialist products can be quite high. The timber resource on a property also provides materials which might otherwise have to be purchased, e.g. fencing or sawn timbers.

Table 29. Chemical composition analyses, moisture free % of some edible trees and shrubs in the shire.

Common Name	Botanical Name	CP	Crude Fat	Crude Fibre	NFE	Ash	Calcium	Phosphorous
Belah	*Casuarina cristata*	9.6	2.6	29.8	49.8	5.9	1.28	0.05
Berrigan	*Eremophila longifolia*	14.7	1.3	16.0	61.5	6.4	0.85	0.09
Scrub boonaree	*Heterodendrum diversifolium*	11.8	2.3	25.2	51.4	9.4		
Brigalow	*Acacia harpophylla*							
Mature		13.6	2.2	25.8	53.0	5.3	1.29	0.11
Suckers above 30 cm		16.2	2.1	33.9	41.6	6.2	0.94	0.19
Suckers 15-30 cm		18.6	1.9	34.2	38.6	6.7	1.06	0.23
Suckers less than 15 cm		26.7	1.1	19.3	45.7	7.2	0.49	0.49
Budda or								
Bastard sandalwood	*Eremophila mitchellii*	10.7	2.6	13.6	66.5	6.6	1.0	0.09
Bull oak	*Casuarina luehmannii*	8.4	1.8	39.6	50.3	4.8	1.07	0.07
Bumble tree	*Capparis mitchellii*	14.0	2.0	25.0	45.7	13.3	1.5	0.09
Carbeen or								
Moreton Bay ash	*Eucalyptus tessellaris*	8.5	2.4	18.1	63.3	7.7	1.79	0.12
Currawong	*Acacia sparsiflora*	17.8	3.3	25.4	47.7	5.8	1.19	0.11
Ellangowan poison bush	*Myoporum deserti*	11.2	2.0	18.3	57.5	11.0		
Galvanised burr	*Sclerolaena birchii*	7.2	0.7	40.1	38.6	11.4	1.14	0.11
Hammermilled 2 mm		11.3	2.3	32.3	38.4	15.7	0.36	0.59
Green wattle	*Acacia deanei*	14.3	4.8	12.2	65.2	7.9	1.6	0.12
Ironwood wattle	*Acacia excelsa*	11.8	3.6	21.4	56.7	6.5	1.79	0.06
Kurrajong	*Brachychiton populneum*	12.8	3.8	25.9	50.3	7.3	1.71	0.15
Limebush	*Eremocitrus glauca*	13.4	3.0	28.1	48.2	6.32	1.93	0.13
Myrtle	*Canthium oleifolium*	21.6	1.4	8.6	41.1	28.0	1.14	0.19
Native olive	*Notelaea microcarpa*	8.6	3.6	20.6	63.2	4.0	1.10	0.08
Old man saltbush	*Atriplex nummularia*	21.6	1.4	8.6	41.1	28.0	1.14	0.19
Poplar box	*Eucalyptus populnea*	10.0	2.6	13.6	68.0	5.7	1.0	0.08
Prickly pine	*Bursaria spinosa*	5.7	2.0	20.8	64.5	7.0	1.35	0.09
Pilliga box	*Eucalyptus pilligaensis*	9.0	3.3	12.7	70.3	4.7	0.79	0.07
Red ash	*Alphitonia excelsa*	13.1	1.8	18.9	62.0	4.3	0.71	0.09
Wilga	*Geijera parviflora*	13.7	4.3	13.8	59.0	9.6	2.07	0.14

NFE — Nitrogen Free Extract

Courtesy Queensland Department of Primary Industries

Trees as sources of honey

The eucalypts are the most significant group of native trees in the shire. Most of these are valuable sources of honey. Inglewood, Stanthorpe and Rosenthal Shires together make up the most important honey producing area in Queensland. The continuance of this situation depends largely on landholders' tree management. The retention of the more useful honey species for shade and shelter will ensure a continuing source of honey. Most hives in the shire are owned by migratory beekeepers, many of whom reside elsewhere. In other areas landholders have successfully diversified into beekeeping. However major nutritional problems occur in this shire. These have made fixed site beekeeping unsatisfactory, and may explain the very small number of resident beekeepers.

Pollen, the honeybees' source of protein, essential for the continuous reproduction necessary to maintain colonies, is often in short supply. Nowadays it is possible to use trapped pollen for supplementary feeding of bee colonies. This could reduce the need for beekeepers to move out of the shire to rebuild colony strength. Some shire landholders may then diversify into beekeeping, given satisfactory industry returns. Improved pasture species used in other parts of Australia are of great importance to beekeeping, and require bees to pollinate the flowers for a satisfactory seed set. Lucerne and Haifa white clover are two plants in this category. Both are largely restricted to irrigated areas of the shire and are not of economic significance to beekeeping at this stage. The Acacias and a number of other shrubs provide the major pollen resource in the shire. While pollen may be plentiful seasonally, these plants are not in flower for much of the year. This plus the erratic flowering habit of the eucalypts (the major honey source) has dictated the migratory nature of beekeeping to date.

The following species are of major importance to honey production in the shire.

Yellow box	*Eucalyptus melliodora*
Brown box (or grey box)	*Eucalyptus microcarpa*
Blue topped ironbark (or Dusky leaved ironbark)	*Eucalyptus fibrosa* ssp. nubila
Silver leaved ironbark	*Eucalyptus melanophloia*
Tumbledown gum (hill gum, sand gum)	*Eucalyptus dealbata*
Caley's ironbark	*Eucalyptus caleyi*
Narrow leaved ironbark	*Eucalyptus crebra*

Native forest is the basis of the honey industry in Inglewood Shire. These beehives are located on Bybera Road.

Species of medium importance are as follows.

White box	*Eucalyptus albens*
Mallee box (Narrow leaved box)	*Eucalyptus pilligaensis*
Forest red gum (Blue gum)	*Eucalyptus tereticornis*
Mugga ironbark	*Eucalyptus sideroxylon*
River red gum	*Eucalyptus camaldulensis*
Brown bloodwood	*Eucalyptus trachyphloia*

Tree establishment

Three methods of establishment could have application in this shire.

* Individual planting. Useful for the house paddock, around stock yards, special trees in the paddocks, and when testing possible introductions.

* Extensive planting. For introducing groups of "grazing compatible" trees or shrubs into over-cleared areas; establishing fodder trees; stabilising eroded or saline areas. This method allows for soil preparation with a tractor and fencing to protect the plants from stock and other animals.

* Intensive planting. For establishing an intensive fodder plantation (as described earlier) or a forestry plot. The latter enterprise is not considered economically feasible for this shire.

For individual planting, tree guards can be as varied as imagination allows. The A.B.C. booklet "Caring for Young Trees" gives numerous examples. The simplest consists of a fertiliser bag, opened top and bottom and supported by three sapling pine stakes. When horses or cattle have access the guard would have to be far more substantial.

Planting suggestions

If a posthole digger is used the resultant glazing on bottom and sides of the hole must be removed. Soil at bottom and side of the hole should be loose. Deep ripping is recommended and will make holes easier to dig. In heavy, poorly drained soils the planting hole should be within a built-up mound. In lighter, well drained soils the saucer technique should be employed. Soak thoroughly at planting for good root to soil contact. Water once a week for the first month then once a month for the first year. Extended dry conditions in the second year would warrant additional water. Trickle water systems are excellent. Drench drums with the tap just cracked open are very useful. Even natives respond to fertiliser. At planting, slow release fertilisers are best mixed with soil at the bottom of the hole. While comparatively expensive, a slow release fertiliser such as Nutricote black label with nutrient levels of 16N, 4.4P, 8.3K will last up to nine months and is much safer. A commercial N.P.K. fertiliser such as Q5 or blood and bone may be used at planting but periodic later dressings will be necessary. A little on a regular basis is necessary to avoid root burn. Where inorganic fertilisers are used, the fertiliser is best placed in two or three shallow holes within the drip-line of the tree. Hand spreading around the tree also works but encourages vigorous weed growth. Plants should not be fertilised approaching winter since new growth is particularly frost sensitive. Stock can be planted in autumn into moist soil, or in spring if watering is possible. Spring plantings are best for frost sensitive trees and shrubs.

A variety of insects (scales, grubs and beetles) attack young trees and shrubs however many cause little damage. If serious damage is occurring, identificationn can be made by sending a sample of the damage and the insect to the Forestry Department. Unfortunately identification takes time. Most leaf-eating and sap-sucking insects an be killed using Maldison at 3 ml/litre of water. Scale insects may be killed using Demeton-S-Methyl (Metasystox) at 4 ml/litre of water.

Any stress or setback during the first year should be avoided. Weed control is most important. Before planting eliminate any weeds. Post-planting weeds are more difficult to control. Chip or spray with a weedicide using a shield. A dessicating spray such as 'Gramoxone' or 'Spray-seed' is safer for young shrubs but not as effective on mature perennials as is glyphosate. Many young shrubs and trees are very susceptible to glyphosate spray drift even on the bark, but the dessicant sprays are more toxic to people. Mulching with whatever material is available is strongly advised. Finally, plant hardened stock into moist soil in autumn.

Suitable species can be obtained from private nurseries or from the Department of Forestry, Inglewood. Bulk trees can be purchased at reduced rates from the Forestry Department. Another option is to propogate one's own trees and shrubs. Seed obtained from trees in the region has the advantage of being well adapted. Some desirable trees such as kurrajong and wilga are easy to germinate but slow to grow. Seeds can be collected when the fruit matures, generally two to four months after flowering. Place the fruit in paper bags and allow to dry in a warm place. The seed then shakes readily from the fruit. Collect seed from selected trees with desirable characteristics.

A general recommendation to someone embarking on a large seedling propragation program is to germinate the seeds in small pots or 60 cell seedling trays, using a potting mix of one part peat moss to one part vermicullite. These small containers allow for many more than is required so that culling can be heavy. The best plants are transplanted into 5.5 litre bags using a commercial liquid fertiliser in this first stage. Transplant into the bags when a robust root system is established. A useful potting mix is made up of 0.5 cubic metre aged sawdust (pine or hardwood), 0.5 cubic metre river sand, 7 kg of 9 month slow release fertiliser, 6 kg dolomite, 1 kg commercial trace element mix, and 1 kg D.A.P. This will provide for 160 seedlings in bags. The bags result in a far superior root system to the traditional pot. They can produce a robust seedling for planting out in the autumn from seed germinated in the spring. About 50% shade is necessary except for the hardening off period. It may be that a professional nursery could contract to supply a large number of advanced seedlings or cuttings at a very competitive price. The establshment of nursery facilities on the property could make the first batch of trees expensive.

Trees and shrubs of the Inglewood Shire

Table 31 includes as far as could be ascertained all the species of native trees and shrubs that have been identified in the shire. The list endeavours to provide known information about the plants. Some are highly valued for timber, fodder and honey production. Many are ornamental and are, or have been, utilised by nurserymen; others are regarded as weeds. A few are known to grow only in the Inglewood Shire. All have been included in an endeavour to record a comprehensive list of the shrub and tree flora of the shire. The assistance of the Queensland Herbarium, Department of Primary Industries, is acknowledged. Mr. David Terry, a teacher at Inglewood State Primary School, provided valuable advice from his knowledge of native plants.

Trees on public land

Most reserves of any size within Inglewood Shire are leased for grazing and partial clearing may be allowed to increase grass growth, improve winds around windmills or protect improvements such as fences and buildings. Trees along main roads are the sole responsibility of the Main Roads Department, while those on shire roads are the joint responsibility of the Shire Council and the Forestry Department. Permission to clear is required from both. Trees on other public reserves are the joint responsibility of the Forestry Department and the trustees of the reserve (usually the Shire Council).

On state forests and leasehold lands, a permit to destroy trees must be obtained from the Lands Department. Delays can be avoided by having the Forestry Department supply a letter stating their conditions, if any, for the proposal.

Table 30. Native trees recommended for planting.*

Common Name	Botanical Name	Soil				Fodder										Flowering
		Traprock	Alluvial	Brigalow	Sandy	Good Fodder	Stock Browse	Drought Fodder	Mill Timber	Yards & Fencing	Windbreak	Shade	Ornamental	Honey	Pollen	
(A) UPPER STORY — 6 METRES +																
Green wattle	*Acacia decurrens*	x		x	x						x	x	x		x	September
Blackwood	" *melanoxylon*	x		x	x				x		x	x	x		x	Nov-March
Smooth barked apple	*Angophora costata*	x			x						x	x	x	x	x	Dec-Jan
Kurrajong	*Brachychiton populneum*	x	x	x	x	x	x	x				x	x	x	x	Nov-Dec
Cypress pine	*Callitris glauca*	x	x		x				x	x	x	x	x			
River oak	*Casuarina cunninghamii*	x	x	x	x	x	x	x		x	x	x	x		x	March-May
Swamp oak	" *glauca*		x		x						x	x	x			
Chinchilla white gum	*Eucalyptus argophloia*		x	x	x				x	x	x	x	x			March-May
Western white gum or River red gum	" *camaldulensis*		x		x				x	x	x	x	x	x	x	Nov-Dec
Lemon scented gum	" *citriodora*	x	x	x	x				x	x	x	x	x	x	x	
Tasmanian blue gum	" *globulus*		x		x				x	x	x	x	x			
Victorian eurabbie or Spotted gum	" *maculata*	x	x	x	x				x	x	x	x	x	x	x	

Table 30 continued

Common Name	Botanical Name	Soil				Fodder											Flowering
		Traprock	Alluvial	Brigalow	Sandy	Good Fodder	Stock Browse	Drought Fodder	Mill Timber	Yards & Fencing	Windbreak	Shade	Ornamental	Honey	Pollen		
Yellow box	*Eucalyptus melliodora*	x	x	x	x				x	x	x	x	x	x	x		Sept-Dec
Mugga	" *sideroxylon (rosea)*	x	x	x	x				x	x	x	x	x	x			April-Oct
Carbeen	" *tessellaris*	x	x	x	x				x		x	x	x				Dec-Jan
Cadaghi	" *torelliana*	x	x	x	x						x	x	x				
Silky oak	*Grevillea robusta*	x	x	x	x				x		x	x	x				Oct-Nov
(B) MIDDLE STORY — 3-5 METRES																	
Wallangarra wattle	*Acacia adunca*	x	x		x						x		x				
Golden wreath wattle	" *saligna*	x			x						x		x		x		
Glory wattle	" *spectablis*	x			x								x		x		July-Sept
Heath banksia	*Banksia ericofolia*				x								x	x	x		
Fiery bottlebrush	*Callistemon phoeniceus*	x	x	x	x						x		x				
Willow bottlebrush	" *salignus*	x	x	x	x						x		x	x	x		
Shiress' bottlebrush	" *shiressii*	x	x	x	x						x		x				
Plunkett mallee	*Eucalyptus curtisii*	x	x	x	x						x		x	x	x		
Grey mallee	" *morrisii*	x	x	x	x						x		x				
Pincushion hakea	*Hakea laurina*	x	x	x	x								x				
Willow leaved hakea	" *saligna*	x	x	x	x						x		x	x	x		
	Kunzea flavescens	x	x	x	x								x				
Paper bark	*Melaleuca alternifolia*	x	x	x	x						x	x	x	x	x		
Paper bark	" *decora*		x		x						x	x	x	x	x		
South Australian paper bark	" *halmaturorum*		x		x						x		x	x	x		
Prickly paper bark	" *styphelioides*	x	x	x	x						x	x	x				
Cattle bush	*Pittosporum phylliraeoides*	x	x		x		x	x			x		x				
Cumby cumby																	
(C) LOWER STORY — 1-2 METRES																	
	Astartea fascicularis	x	x	x	x								x				
Twiggy baeckea	*Baeckea virgata*	x	x	x	x								x				
Golden candlesticks	*Banksia collina*	x			x								x				
	Callistemon Mimosa Creek	x	x	x	x								x				
Net bush	*Calothamnus villosus*	x	x	x	x								x				
Butter bush	*Cassia nemophila*	x	x	x	x								x				
Desert cassia	*Cassia nemophila*	x	x	x	x								x				
Long leaved waxflower	*Eriostemon myoporoides*	x			x								x				
Grevillea Ned Kelly	*Grevillea Ned Kelly*		x	x	x								x				
Grevillea Robyn Gordon	" *Robyn Gordon*		x	x	x								x				
Hakea	*Hakea purpurea*	x	x	x	x								x				
Heath leaved melaleuca	*Melaleuca ericifolia*	x	x	x	x								x				
Thyme honey myrtle	" *thymifolia*	x	x	x	x								x				
Wilson's honey myrtle	" *wilsonii*	x	x	x	x								x				
Payne's thryptomene	*Thryptomene paynei*	x	x	x	x								x				
Rosemary	*Westringia fruiticosa*	x	x	x	x						x		x				
Rosemary	*wynyabbie gem*	x	x	x	x						x		x				

* Recommended = climatically adapted to the shire.

Table 31. Trees and shrubs of Inglewood Shire.

Common Name	Botanical Name	Soil				Fodder			Mill Timber	Yards & Fencing	Windbreak	Shade	Ornamental	Honey	Pollen	Flowering	Notes
		Traprock	Alluvial	Brigalow	Sandy	Good Fodder	Stock Browse	Drought Fodder									
Flannel weed	*Abutilon oxycarpum*				x											Sept-May	The Acacias are the largest group of species in this shire. Most have no commercial value but all are ornamental to varying degrees and produce a brilliant golden display in many parts of the shire in August. Currawong *(Acacia sparsiflora)* has been used successfully as drought fodder, and Green wattle *(Acacia deanei)* is eaten readily. Wattles have an ability to survive on degraded areas such as old gravel pits, and may find an increasing place in revegetation of degraded lands, particularly those that have a stock feed value. Some of these wattles are available from nurseries and are very attractive garden plants. From observation, almost all wattle fruit matures in November, irrespective of flowering time.
Hook wattle	*Acacia amblygona*	x											x		x	Aug-Sept	
	Acacia blakei				x								x		x	July-Sept	
Currawong	*Acacia burrowii*		x		x		x	x					x		x	July-Sept	
Box leaf wattle	*Acacia buxifolia*				x								x		x	July-Sept	
	Acacia caroleae				x		x	x					x		x	July-Sept	
Flat stemmed wattle	*Acacia complanata*				x								x		x	Sept-Oct	
	Acacia conferta				x								x		x	March-July	
Yarran	*Acacia crassa*	x											x		x	July-Sept	
Knife leaf wattle	*Acacia cultriformis*	x											x		x	July-Sept	
Green wattle	*Acacia deanei*	x	x	x	x	x	x	x					x		x	Jan-Dec	
Pretty wattle	*Acacia decora*		x		x								x		x	July-Sept	
	Acacia falcata	x											x			April-July	
Prickly moses	*Acacia farnesiana*		x	x			x									Aug-Oct	
	Acacia flexifolia				x		x	x					x		x	July-Sept	
	Acacia hakeoides		x										x		x	July-Sept	
Brigalow	*Acacia harpophylla*			x			x			x	x	x	x		x	July-Sept	
	Acacia ixoiphylla				x								x		x	July-Sept	
	Acacia ixodes				x								x		x	July-Sept	
	Acacia jucunda				x								x		x	July-Sept	
	Acacia juncifolia				x								x		x	July-Sept	
Early flowering black wattle	*Acacia leiocalyx*	x			x								x		x	June-Aug	
	Acacia lineata	x											x		x	July-Sept	
	Acacia melvillei		x										x		x	July-Sept	
	Acacia montana												x		x	July-Sept	
	Acacia neriifolia				x								x		x	July-Sept	
Nelia	*Acacia oswaldii*						x	x					x		x	Aug-Sept	
Mountain hickory	*Acacia penninervis*				x								x		x	September	
Queensland silver wattle	*Acacia podalyriifolia*																
	Acacia polybotrya				x								x		x	July-Sept	
	Acacia pravifolia				x								x		x		
	Acacia resinicostata				x								x		x	July-Sept	

Table 31 continued.

Common Name	Botanical Name	Soil				Fodder											Notes
		Traprock	Alluvial	Brigalow	Sandy	Good Fodder	Stock Browse	Drought Fodder	Mill Timber	Yards & Fencing	Windbreak	Shade	Ornamental	Honey	Pollen	Flowering	
Queensland silver wattle	*Acacia rigens*				x								x		x	July-Sept	
Doolin	*Acacia salicina*				x						x	x	x			April-June	
	Acacia semilunata				x								x		x	July-Sept	
	Acacia semirigida				x								x		x	Feb-June	
Currawong	*Acacia sparsiflora*				x	x	x	x					x		x	May-Sept	
Glory wattle	*Acacia spectablis*	x			x		x	x					x		x	July-Sept	A very attractive wattle, available for planting.
Pilliga wattle																	
Kogan wattle																	
	Acacia stricta				x								x		x	July-Sept	
Prickly moses	*Acacia ulicifolia*		x		x										x	June-Sept	
	Adriana glabrata																
Red ash	*Alphitonia excelsa*	x			x	x	x	x				x	x	x	x	Jan-April	
Smooth barked apple	*Angophora costata*	x			x		x	x				x	x	x	x	Dec-Jan	
Rusty gum; Cabbage gum; Rough barked apple	*Angophora floribunda*	x	x		x		x	x				x		x	x	Dec-Jan	Timber used for truck floors; often lopped for drought feed.
	Aotus subglauca var. *filiformis*				x								x			Sept-Oct	
Broom bush	*Apophyllum anomalum*			x			x	x					x			Sept-Dec	
White wood	*Atalaya hemiglauca*	x	x	x	x	x	x	x				x				Oct-Nov	
Saltbushes	*Atriplex* species		x	x		x	x	x							x	February	
	Baeckea densifolia				x												
Honeysuckle oak	*Banksia integrifolia*				x								x			Jan-June	
	Beyeria viscosa																
Narrow leaved boronia	*Boronia anethifolia*				x								x		x	July-Sept	
Rock boronia	*Boronia bipinnata*				x								x		x	May-Oct	
Boronia	*Boronia glabra*				x								x		x	July-Oct	
Forest boronia	*Boronia rosmarinifolia*				x								x		x	July-Oct	
	Bossiaea rhombifolia				x											July-Sept	
	Bossiaea scortechinii				x											July-Sept	
Kurrajong	*Brachychiton populneus*	x	x		x	x	x	x				x	x			Nov-Dec	Attactive shade tree; useful for fodder.
Daphne heath	*Brachyloma daphnoides*				x								x			Aug-Oct	
Prickly pine	*Bursaria spinosa*	x			x								x	x		February	
Blackthorn																	

Table 31. Trees and shrubs of Inglewood Shire.

Common Name	Botanical Name	Soil				Fodder											Notes
		Traprock	Alluvial	Brigalow	Sandy	Good Fodder	Stock Browse	Drought Fodder	Mill Timber	Yards & Fencing	Windbreak	Shade	Ornamental	Honey	Pollen	Flowering	
	Burtonia foliolosa				x											Nov-Dec	
Ooline	*Cadellia pentastylis*															Jan-Mar	Found along water courses.
Stiff bottlebrush	*Callistemon rigidus*										x	x	x			Sept-Nov	Suitable for windbreak and garden plantings.
White bottlebrush	*Callistemon salignus*		x								x	x	x			Sept-Nov	
Weeping bottlebrush	*Callistemon viminalis*		x	x	x						x	x	x			Sept-Nov	Many varieties not native to the Shire are available from nurseries and are suitable for planting. Very attractive to nectar eating birds.
White cypress	*Callitris columellaris*	x			x				x		x	x	x			Sept-Oct	The most important milling timber in the Shire.
Black cypress	*Callitris endlicheri*	x			x						x	x				Oct-Nov	
Fringe myrtle	*Calytrix longiflora*				x								x		x	Sept-Oct	
Fringe myrtle	*Calytrix tetragona*				x								x		x	Sept-Oct	
Myrtle tree	*Canthium oleifolium*	x	x	x	x	x	x	x								Oct-Dec	
Wild orange	*Capparis canescens*	x				x	x	x				x	x			Oct-Jan	Valuable stockfeed species
Nipan; Split jack	*Capparis lasiantha*			x		x	x	x								Oct-Nov	Valuable stockfeed species
Bumble	*Capparis mitchellii*	x	x	x	x	x	x	x				x				Oct-Jan	Valuable stockfeed species
Currant bush	*Carissa ovata*		x	x	x		x	x								January	
	Cassia coronilloides			x													
Butter bush	*Cassia nemophila*		x	x												Sept-Oct	
Wild rosemary	*Cassinia laevis*	x	x	x	x		x								x	Dec-Jan	
River oak	*Casuarina cunninghamii*	x	x		x		x	x		x	x	x	x		x	March-May	Good windbreak trees with some drought feed value
Belah	*Casuarina cristata*			x			x	x		x	x	x	x		x		
Thready bark; Woolly oak	*Casuarina inophloia*				x							x	x		x	April-May	
Bull oak	*Casuarina luehmannii*				x		x	x		x		x				Dec-Feb	
	Cheiranthera cyanea				x		x									Oct-Nov	
	Chloanthes parviflora																
	Choretrum candollei																
Devil's rice	*Conospermum taxifolium*				x								x			Sept-Nov	
Yellow rattlepod	*Crotalaria mitchellii*		x		x												
	Cryptandra armata				x											July-Sept	
	Daviesia filipes				x								x		x	Aug-Sept	
Native gorse	*Daviesia ulicifolia*				x		x	x					x		x	Aug-Sept	

Common Name	Botanical Name	Soil				Fodder											Notes
		Traprock	Alluvial	Brigalow	Sandy	Good Fodder	Stock Browse	Drought Fodder	Mill Timber	Yards & Fencing	Windbreak	Shade	Ornamental	Honey	Pollen	Flowering	
Native gorse	*Daviesia genistifolia*				x								x		x	Aug-Sept	
	Daviesia mimosoides				x								x		x	Aug-Sept	
	Daviesia squarrasa				x								x			Aug-Sept	
Prickly parrot pea	*Dillwynia juniperina*				x								x		x	Aug-Sept	
	Dillwynia sericea				x								x		x	Aug-Sept	
Hop bush	*Dodonaea heteromorpha*												x		x		Flower mainly late summer with attractive hop-like seed pods maturing in November.
Hop bush	*Dodonaea macrossanii*												x		x		
Hop bush	*Dodonaea peduncularis*												x		x		
Hop bush	*Dodonaea triangularis*						x	x					x		x		
Sticky hop bush	*Dodonaea viscosa*						x	x					x		x		
Hop bush	*Dodonaea truncatiales*												x		x		
Limebush	*Eremocitrus glauca*			x			x										
Berrigan	*Eremophila longifolia*			x	x		x						x			November	
Fuschia bush	*Eremophila maculata*		x										x			September	
Budda; Sandal box	*Eremophila mitchellii*	x	x	x			x						x			October	
Bastard sandalwood																	
White mahogany	*Eucalyptus acmenoides*				x				x	x	x	x				December	The eucalypts are the second largest group of species in the shire. Narrow leaved ironbark *(E. crebra)* is the most important local hardwood for timber, but a number of others are logged for railway sleepers, fencing materials and landscaping. Whilst not considered good stock feed species, some have proven valuable as readily available drought feed, in particular the ironbarks and Brown box *(E. microcarpa).* Almost all the eucalypts are highly valued by the beekeeping industry as a source of choice honey. Most popular trees for plantings are Mugga ironbark *(E.sideroxylon),*
White box	*Eucalyptus albens*	x								x	x	x		x	x	April-Sept	
Baker's mallee	*Eucalyptus bakeri*	x			x					x	x	x	x			Nov-Jan	
Blakely's red gum	*Eucalyptus blakelyi*				x						x	x		x		Nov-Dec	
Caley's ironbark	*Eucalyptus caleyi*	x					x	x			x	x		x		Feb-Aug	
River red gum	*Eucalyptus camaldulensis*		x						x	x	x	x		x	x	Nov-Dec	
Fuzzy box	*Eucalyptus conica*		x								x	x		x		Aug-Oct	
Narrow leaved ironbark	*Eucalyptus crebra*	x			x		x	x	x	x	x	x		x	x	July-Dec	
Tumbledown gum	*Eucalyptus dealbata*	x			x						x	x		x	x	Oct-Dec	
Mountain gum																	
Gum topped ironbark	*Eucalyptus decorticans*				x					x	x	x		x		January	
Queensland peppermint	*Eucalyptus exserta*				x											Dec-Jan	
Broad leaved ironbark	*Eucalyptus fibrosa* ssp. *fibrosa*				x		x		x	x	x	x				Nov-Dec	
Dusky leaved ironbark	*Eucalyptus fibrosa* ssp. *nubila*	x			x					x	x	x	x	x	x	Mar-Sept	

Common Name	Botanical Name	Soil				Fodder											Flowering	Notes
		Traprock	Alluvial	Brigalow	Sandy	Good Fodder	Stock Browse	Drought Fodder	Mill Timber	Yards & Fencing	Windbreak	Shade	Ornamental	Honey	Pollen			
Pink bloodwood	*Eucalyptus intermedia*	x			x				x	x	x	x					Feb-Mar	Yellow box *(E. elliodora)*, River red gum *(E. camaldulensis)*, Forest red gum *(E. tereticornis)* and Narrow leaved ironbark *(E. crebra)*, all of which are suitable for shade and windbreaks.
Spotted gum	*Eucalyptus maculata*				x				x		x	x		x	x		Dec-Jan	
Silver leaved ironbark	*Eucalyptus melanophloia*	x	x		x		x			x	x	x		x	x		Dec-Jan	
Yellow box	*Eucalyptus melliodora*	x	x								x	x	x	x			Sept-Dec	
Yellow jacket																		
Brown box	*Eucalyptus microcarpa*	x	x				x	x			x	x		x			Jan-Mar	
Tumbledown ironbark	*Eucalyptus panda*				x						x	x		x	x		Sept-Oct	
Pilliga box	*Eucalyptus pilligaensis*	x	x	x	x		x				x	x		x			Feb-Apr	
Long fruited bloodwood	*Eucalyptus polycarpa*				x				x	x	x	x					Jan-Mar	
Poplar box	*Eucalyptus populnea*		x				x			x		x					Nov-Dec	
Mugga ironbark	*Eucalyptus sideroxylon*	x			x						x	x	x	x			Apr-Nov	
Forest red gum	*Eucalyptus tereticornis*	x	x		x					x	x	x		x	x		June-Nov	
Moreton bay ash	*Eucalyptus tesellaris*		x		x					x	x	x	x				Dec-Jan	
Carbeen																		
Thozet's box	*Eucalyptus thozetiana*				x					x	x	x					July-Oct	
Brown bloodwood	*Eucalyptus trachyphloia*				x						x	x		x	x		Jan-Mar	
Green mallee	*Eucalyptus viridis*				x						x	x						
	Exocarpus aphyllus																	
Native cherry	*Exocarpus cupressiformis*																	
Sandpaper fig	*Ficus coronata*																	
Wilga	*Geijera parviflora*	x	x	x		x	x	x			x	x	x				Seot-Nov	Valued shade and fodder tree but slow growing.
	Grevillea floribunda				x								x				Sept-Oct	
Beefwood	*Grevillea striata*				x	x	x	x					x				November	
Finger hakea	*Hakea dactyloides*				x								x					
Corkwood oak	*Hakea fraseri*				x								x				Aug-Dec	
	Hakea gibbosa				x								x					
	Hakea purpurea				x								x					
Sago flower	*Helichrysum diosmifolium*				x								x		x		Oct-Nov	
Scrub boonaree	*Heterodendrum diversifolium*			x		x	x	x										
Holly bush																		
Boonaree	*Heterodendrum oleifolium*		x		x	x	x	x										
	Hibbertia linearis				x								x				July-Nov	

Table 31 continued

Common Name	Botanical Name	Soil				Fodder			Mill Timber	Yards & Fencing	Windbreak	Shade	Ornamental	Honey	Pollen	Flowering	Notes
		Traprock	Alluvial	Brigalow	Sandy	Good Fodder	Stock Browse	Drought Fodder									
Boonaree	*Hibbertia stricta*				x								x				
	Hibbertia vestita				x								x				
	Hovea linearis				x								x			Aug-Sept	
Purple bush pea	*Hovea longifolia*				x								x			Aug-Sept	
Australian indigo	*Indigofera australis*	x	x		x								x			Aug-Apr	
Hairy indigo	*Indigofera hirsuta*	x	x		x											Aug-Apr	
Dogwood	*Jacksonia scoparia*	x			x		x	x					x		x	October	
	Keraudrenia collina				x											Sept-Oct	
Heath myrtle	*Kunzea opposita*				x								x			Sept-Oct	
	Leucopogon biflorus				x								x			Aug-Sept	
	Leucopogon confertus				x								x			July-Aug	
	Leucopogon muticus				x								x			Aug-Sept	
Wild may	*Leptospermum flavescens*				x								x			October	
	Leptospermum minutifolium				x								x			October	
	Leptospermum parvifolium				x								x			October	
Budgeroo	*Lysicarpus augustifolius*				x					x		x	x			Nov-Dec	
Tom Russell's mahogany																	
Black cotton bush	*Maireana decalvans*		x				x										
Cotton bush	*Maireana enchylaenoides*		x				x										
	Maytenus cunninghamii		x														
	Melaleuca adnata																
River tea tree	*Melaleuca bracteata*	x	x								x	x	x	x	x	October	
	Melaleuca decora		x		x						x	x	x			November	
	Melaleuca densispicata															November	
Western tea tree	*Melaleuca lanceolata*		x	x							x	x	x	x	x	Dec-Jan	
Black tea tree																	A popular tree for planting. Melaleucas (Tea trees) like Callistemons (Bottle brush) have been developed by nurserymen for garden planting and a number are readily available. Thyme honey myrtle *(M. thymifolia)* is very attractive used as a garden plant.
Snow in summer	*Melaleuca linariifolia*				x						x	x	x			December	
Flax leaved paper bark																	
Prickly leaved paper bark	*Melaleuca nodosa*				x								x			Oct-Nov	
	Melaleuca pallescens																
Thyme honey myrtle	*Melaleuca thymifolia*				x								x				
	Melaleuca uncinata				x								x			Oct-Nov	

Common Name	Botanical Name	Soil				Fodder											Notes
		Traprock	Alluvial	Brigalow	Sandy	Good Fodder	Stock Browse	Drought Fodder	Mill Timber	Yards & Fencing	Windbreak	Shade	Ornamental	Honey	Pollen	Flowering	
Honey heath bush	*Melichrus adpressus*				x								x			June-Sept	
	Melichrus urceolatus																
	Micrantheum ericoides																
Hang down	*Micromyrtus sessilis*				x								x	x		September	
	Mirbelia pungens				x											September	
Boobialla	*Myoporum acuminatum*		x		x		x						x		x	Aug-Sept	
Ellangowan poison bush	*Myoporum deserti*		x	x			x						x			Aug-Sept	
Native myrtle	*Myoporum montanum*			x			x						x				
Sugarwood	*Myoporum platycarpum*																Rare
Native olive	*Notelaea microcarpa*	x	x		x		x						x			Sept-Oct	
Peach bush	*Olearia elliptica*	x											x	x	x	Jan-April	
Sticky daisy bush																	
	Olearia pimeleoides				x		x						x			August	
	Olearia ramulosa																
Emu apple	*Owenia acidula*		x										x				
Broad leaved geebung	*Persoonia cornifolia*				x												
	Persoonia oxycoccoides															Oct-Dec	
Quinine berry	*Petalostigma pubescens*				x								x			October	
	Phebalium squamulosum				x								x			September	
	Philotheca salsolifolia																
Flaxleaf rice flower	*Pimelia linifolia*				x								x			October	
	Pimelea neo-angelica			x	x								x				
Meemeei	*Pittosporum phylliraeoides*		x				x						x			Sept-Nov	
Cumby cumby																	
Cattle bush																	
	Platysace ericoides				x								x			October	
	Prostanthera parvifolia				x											Sept-Oct	
	Pultenaea foliolosa				x								x		x	September	
	Pultenaea microphylla				x								x		x	September	
Berry saltbush	*Rhagodia spinescens*			x			x										
Wedding bush	*Ricinocarpus bowmanii*				x								x			September	
Plumwood	*Santalum lanceolatum*				x												

Table 31 continued

Common Name	Botanical Name	Soil				Fodder											Notes
		Traprock	Alluvial	Brigalow	Sandy	Good Fodder	Stock Browse	Drought Fodder	Mill Timber	Yards & Fencing	Windbreak	Shade	Ornamental	Honey	Pollen	Flowering	
Galvanised burr	*Sclerolaena birchii*	x	x														
Grey bopper burr	*Sclerolaena diacantha*																
Prickly roly poly	*Sclerolaena muricata*		x	x													
Brigalow burr	*Sclerolaena tetracuspis*			x													
Sesbania pea	*Sesbania cannabina*		x			x	x									Dec-Feb	
Narrawa burr	*Solanum cinereum*				x											Nov-Dec	
	Solanum nemophilum															Oct-Mar	
Glossy nightshade	*Solanum nodiflorum*															Apr-Oct	
Devil's needles	*Solanum stelligerum*															Oct-Mar	
	Solanum tetrathecum			x												Oct-Mar	
Five corners	*Styphelia viridis*			x									x			Mar-May	
Smooth Darling pea	*Swainsona galegifolia*	x			x											October	
	Swainsona microphylla	x														Sept-Oct	
Variable swainsona	*Swainsona oroboides*															October	
	Templetonia stenophylla															Aug-Sept	
	Westringia cheelii				x											Aug-Sept	
Woody pear	*Xylomelum pyriforme*				x								x			Oct-Nov	
	Zieria aspalathoides				x											Aug-Sept	
	Zieria smithii				x											Sept-Oct	

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CHAPTER 8

THE CONTROL OF UNWANTED TIMBER

The Land Management Committee identified timber regrowth as a major factor limiting grazing production in the shire. A long term strategy is necessary to convert forest land to useful grazing country. Much of the present heavily timbered country is the result of earlier improper treatment. Appropriate stocking management and "follow-up" treatment need to be applied for several years if systems of extensive timber control are to work. Selective treatment of colonising species may be required to return country to a balanced grazing environment. Chemical thinning is the most commonly used technique in this shire. Mechanical clearing must be considered if unwanted timber is too thick or extensive. A good principle is to clear an area which is not too big for alternative development should the first treatment fail.

It can be difficult to calculate the cost of development in the planning stage. The cost of timber control does not end with the initial treatment. "Follow-up" operations against regrowth will determine the final return on capital invested. In the past much money has been wasted through inadequate "follow-up"; with treatment of mature regrowth ultimately promoting even denser regrowth — including shrubs like wild rosemary and wire grass. The most common follow-up treatment is the imposition of increased wether stocking rates. The level of stocking required can be determined only by the grazier. It will vary greatly with the palatability of the regrowth and the season.

The cost components of control by grazing will be loss of wool production, loss of sheep body weight, and the cost of any increase in overall stock numbers. The spelling of other paddocks could offset some of this cost. Extra operational costs and interest on borrowed money may be other expenses. Tax relief is available for expenditure on regrowth control (not for virgin country). It is treated as an operational expense required to earn income. Often the cost of treatment cannot be justified when compared to the sale price of the land or the returns from grazing. However, other factors must be considered. Nearby land may not be available for purchase; livestock management (particularly mustering) is enhanced. Capital for timber control can be outlaid as the need arises. The fact is that every year nothing is done to control regrowth, further productivity is lost.

Methods of chemical control

Stem injection

This is a widely used control method, as most of the shire's timber problems arise from mature eucalypt regrowth. The equipment required is a small axe with the blade ground down to 5 cm, and a tree vaccinator or "velpar" injection kit. A spear is used for low injection. Stem injection involves significant costs for chemical and labour with high stocking rates as follow-up for larger areas. The type of timber and its density will dictate the economics of this technique. It is the method to use for thinning, clearing small patches, or selecting against undesirable species.

Two chemicals are widely used for stem injection — Tordon Timber Control Herbicide and Velpar. The former is cheaper for all registered treatments by stem injection on mature eucalypt species found in this shire. However Velpar is popular because it will kill a wider range of trees and shrubs. It can also be used for soil application so that odd small shrubs are treated at the same time. Trees should be treated only at times of good sap flow; not when they are under stress from drought or cold.

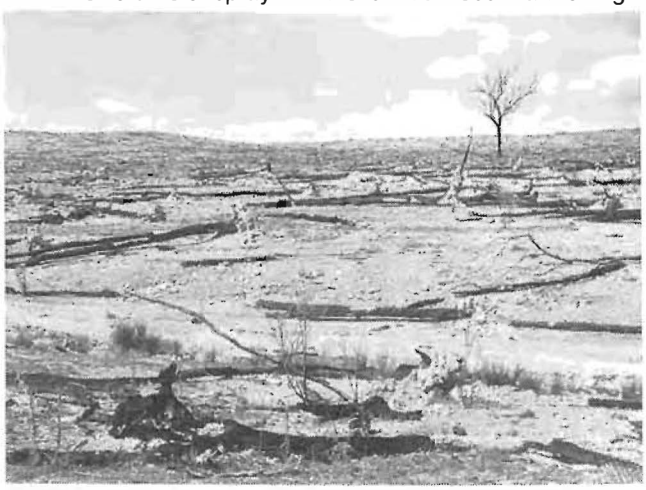
The chemical should be applied into 5 cm cuts made through the bark at an oblique angle into the sapwood. Injection should be made before the axe is removed. The cuts should be at the recommended spacing around the tree circumference. Branches below cuts must be removed or treated. Rates and spacings are recommended by the manufacturer and will depend on the size of the tree, species and type of treatment. "Tordon T.C.H." is registered for close or wide spacing at waist height or ground level (spear).

CSIRO trials in the shire with the former Tordon 105 (245T formulation) addressed the problem that acceptable kill rates were more difficult to achieve in this region than in other parts of the state. Species and climate were seen as contributing factors. The results of these trials indicated that low treatment was significantly more effective than waist high treatment. Treatments applied in winter or early spring (July, August or September) gave higher percentage kills than similar treatments in the summer and autumn. Experience has shown that close spacing of cuts has given better results, indicating that the chemicals are not effective at translocation around the tree. Indeed, where dose rates are marginal with wide spaced cuts, it is not uncommon to see a dominant lateral branch survive if a cut is not injected directly below that branch. Trials carried out in 1984 by the Eastern Graziers' Regional Development Committee endorsed these findings.

Glyphosate ("Roundup") is an alternative for stem injection. It is not considered economical at the manufacturer's recommended application rates, which call for both high chemical and high labour costs. However glyphosate has the advantage of non-persistence in the soil; so it may be considered where cropping is intended.

Foliar Sprays

Generally, overall spraying should be carried out when plants are actively growing and the soil is wet. These conditions are most common in the late summer-early autumn period. Complete coverage of all foliage is necessary as unsprayed branches and leaves may keep the rest of the plant alive. Frosting may "harden" foliage and make absorption more difficult. High volume spraying is used for covering small areas of dense shrubs. All leaves should be thoroughly wetted to the point of run-off. Large shrubs require up to 4,500 litres per hectare. Knapsacks or engine driven pumps are used. Effectiveness of this system on eucalypts is limited and cost is high. Low volume spraying also requires complete coverage but depends on droplets rather than a continuous film. The volume of spray mixture is much less than for high



Traprock pasture cleared by pulling and the use of a hot January fire. This area has been stocked at 2.5 wethers/ha to control wattle and eucalypt regrowth. The photo was taken 33 months after pulling (In September 1986). Note extensive clearing of upper slopes, the absence of a grass cover and erosion in the foreground.

volume spraying, commonly in the range of 20-60 litres per hectare. Tractor misters or knapsack misting machines are used. Chemicals used in overall spray include Grazon, Garlon 480 and glyphosate.

Foliar application using "Roundup" (glyphosate) through a spotter gun is effective for suckers up to 1.5 metres high. Dilute one part Roundup to five parts water and apply 5 ml per 0.5 metre of tree height. Use a sweeping action to ensure a fine spray contacts most of the foliage. A commercially available spotter gun or a modified common drench gun may be used. The drench gun is adapted by using a Rega No. 6 adjustable nozzle with a ¾ BSP-¼ BSP reduction fitted. Foliar spraying is useful in follow-up work for major control systems or for natural regrowth. Treat when the plants are small for maximum cost effectiveness.

Basal spray

Saplings can absorb herbicides through their bark when it is applied in a distillate solution. The species for which this method is most successful have smooth or relatively thin bark. This method is used on trees up to 5 cm in basal diameter. The oil solution is applied under relatively low pressure to wet the base of each stem thoroughly to a height of 30 cm. Recommended chemicals are Garlon 480 or Tordon 1040 dissolved in distillate.

Cut stump

This method of application is generally used on saplings that are too small to be stem injected, but have a bark tissue too thick to allow penetration of the chemical as a basal spray. It is also useful for treating timber along fence lines and tracks, or when felling unwanted trees for drought feeding. The tree growth is cut close to the ground and the stump surface treated immediately and thoroughly with herbicide solution. It is necessary to have a "cutter" and an "applicator". A knapsack spray, spotter gun, swab or brush is used to apply this solution. Brush cutters or chainsaws are mostly used. When using a chainsaw and a water based herbicide a wetting agent or household detergent should be added to prevent the chain oil sealing the cut. Chemicals used in cut stump application include Tordon TCH or Roundup in water and Garlon 480 or Tordon 1040 in diesel.

Soil application

Two treatments exist that may have application in the shire. Velpar spot soil application and Graslan soil treatment. For individual bush control with Velpar a modified drench gun (spot gun) is used to apply the undiluted chemical onto the soil between the base and the dripline of the bush. Litter should be removed (with the boot) as the chemical can be "locked" up in humus. Absorption will be fast on moist soil. This method is a labour effective follow-up system for isolated regrowth or seedlings. It should not be applied within twice the height of a desirable tree.

Velpar can be used in a grid pattern for small dense shrubs, but chemical costs are high. This herbicide will remain active in the soil for about two growing seasons and will create a 1 metre diameter patch of soil bare of grass for about one season.

Soil treatment with Graslan

Aerial application of Graslan pellets is new to the Inglewood Shire so no recommendations can be made. The Lands Department and the Eastern Graziers' Regional Development Committee have trials in their early stages. Further commercial trials are planned. The earliest trial using Graslan in the region was at Karara. It was not successful at the recommended rate of 7.5 kg/ha. The hard setting soil of the trial site may have prevented the herbicide from being carried into the soil by rainfall. The range of susceptible species has not been established. Graslan consists of clay pellets containing the active ingredient tetuthiuron. The pellets are broadcast from the air, dissolved by rainfall, and the herbicide taken with moisture into the root zone of the plants. The manufacturer claims a soil residual effect of about 3 years and that the herbicide has not been found below 60 cm depth in the soil. However, should it be effective, follow-up treatments are expected to be minimal. A hand applicator is available.

The effect of a single cultivation is seen here in wattle regrowth where stock have been excluded for a 12 month period (June 1986 to June 1987) following initial pulling in December 1983. The area to the left of the wattle regrowth in the foreground has had a single cultivation to assist in the establishment of an improved pasture. The cultivation has significantly reduced the wattle regrowth but stock may have to be introduced once more in order to keep it under control. This could be detrimental to pasture species trying to establish. There still remain many unanswered questions in relation to the best methods for developing timbered traprock pastures.

Mechanical clearing

Pulling with bulldozers is a common means of clearing timber in this shire. Success has been variable. The experience of neighbours, especially those who have been successful, should be sought. The time span from pulling till all regrowth shrubs and undesirable grasses are removed to produce the final healthy pasture may be three years. Management during that period is critical. Pulling to develop native pasture is used only for dense forest on intermediate soil types. It is not suited to semi-open forests where chemical treatment is cheaper and more effective. Much of the area suited to pulling was ringbarked or poisoned in the past and the treatment failed. In such country two 134 kw crawlers and chain can pull 3 to 5 ha per hour under most conditions. A "Caterpillar" D8 or its equivalent is generally considered to be the most economical machine for local conditions. Difficult conditions for pulling include hard, dry soil; dense forests of larger timber; stumps of previously milled timber and rough topography.

The moisture content of the soil is critical and dictates the follow-up system to be used. It is important to obtain the maximum amount of dry fuel where a burn is intended. If the soil is too wet and some trees fall more easily but have some active roots in the ground and those trees will remain green. In a "burn" system the fire will control the growth from any broken lignotubers. In a "graze only" system it is more difficult for the stock to control vigorous growth from lignotubers left in the ground, so moisture levels need to be such that the lignotubers are removed cleanly with the tree.

The capacity of eucalypts for resprouting from lignotubers (swollen stems just below the ground containing dormant buds) is well known. The development of these organs has enabled many species to adapt to fire, drought and infertile soils. Such species in Inglewood Shire are tumbledown gum, brown box, white box, narrow leaved ironbark, silver leaved ironbark, yellow box and rusty gum.

Wattle and eucalypt regrowth to the right of the fenceline is the result of wethers being excluded from grazing pulled and burnt traprock country for a period of 12 months (June 1986 to June 1987). This area was initially pulled in December 1983. Wethers have been run at 2.5/ha to the left of the fenceline since burning — timber control has been good as a result but at the expense of grass cover. The dilemma facing graziers is to run the risk of soil erosion through heavy stocking, or the loss of pasture productivity through timber regrowth if stock are not used. There is no easy solution.

Mechanical clearing disturbs the soil and encourages a secondary succession of pioneer growth. Frequently native trees and shrubs regenerate at a higher density than the original community. There are three systems of strongly disciplined management which can be imposed over about three years to control such regrowth. They are described in turn.

Pull-burn heavy graze

An effective system has been evolved by Mr. Rod Chandler at Limevale. Pulling is done in October or November. At this time the boundary of the treated area is windrowed for a future firebreak at about 8% of the cost of pulling. The area is destocked to provide fuel for a "hot" fire in January or February. Burning must be authorised by the local fire warden and requires a force of about four men.

Heavy stocking rates are required after burning as the prime aim is to keep the regrowth checked. Sheep will eat almost everything at a very young stage. However unpalatable species such as tumbledown gum and yellow box become more difficult to control after they reach 15 cm. Stocking rates are actually determined by the proportion of open grass patches or untreated area within the paddock. General figures could be 4 wethers per ha through summer with 1.5 wethers per ha through winter. Regular monitoring and adjustment of stocking rates is essential.

Pull — heavy graze

This system does not use a burn. The heavy stocking rate must be applied immediately after pulling so that the early flush of feed does not build up and form an alternative to the expected regrowth. Higher stocking rates than the previous system are required because the fire is not used to set back strong initial regrowth or remove the grass and logs.

Pull — stick rake — heavy graze

This system has the advantage of the fire, but the high cost of stick raking into windrows, which are burnt, means it can be used only on good country. The raking can be done immediately after pulling to give the stock access; or it can be left till when it will destroy any regrowth which has occurred after pulling.

Grazing animals

Merino wethers control regrowth because they are forced to eat it. They suffer weight loss and wool production loss but these needn't be significant if management is good. Provision of alternative pasture, changing of mobs, and supplementation can all be utilised. Failures usually result from not having enough wethers for the area pulled. While feral goats have a better capacity to browse, their use should be restricted to those graziers prepared to erect proper fencing and who are experienced in their handling. Several examples of feral goats out of control exist in the region. Perhaps there is a case for a permit system for feral goats as is the case for deer. Mr. Gordon Leahy has successfully utilised goats at "Clearview".

Enough experience has accumulated in the shire to indicate that pulling timber with an appropriate follow-up system is an effective method for producing useful native pasture from dense forest on secondary soil types. The entire paddock must be treated as a unit for development; therefore the proportion of pulled country to untreated country is critical. In line with the concept of a balanced grazing environment, a plan of the paddock should be produced. Aerial photographs are extremely useful. Areas to be pulled or chemically treated and areas of trees retained can then be defined. Upgrading of fencing and stock water supply need to be considered at the same time.

CHAPTER 9

SHIRE WEEDS AND THEIR CONTROL

Weeds are a major constraint on agricultural productivity in the Inglewood Shire. The term 'weed' means any plant which is growing where it is not wanted. Thus, weeds can be grasses (e.g. wild or black oats, wimmera ryegrass in cereal crops), broadleaf plants (e.g. wild radish, wireweed, saffron thistle), timber species (e.g. tumbledown or mountain gum in native pastures), aquatic plants (e.g. cumbungi or bulrush, water hyacinth) and sedges (e.g. nutgrass). There is much information on weeds and their management. The aim of this chapter is to outline basic information, and to indicate where more detailed advice can be obtained.

Planning weed control

This section is summarised from "The Australian Weed Control Handbook" by J. T. Swarbrick, who advocates a logical approach to weed problems. The steps to consider are — identification of the weed problems and ranking in importance; whether control is just for one season or for the longer term; the cost of control relative to the expected benefit. Four main methods of weed control are recognised. NO ONE METHOD BY ITSELF IS SUFFICIENT FOR AN EFFECTIVE WEED CONTROL PROGRAM. These are:—

Management

This covers such things as good crop and/or pasture vigour (by using the right varieties, soil preparation, planting rates and times, fertilisers, irrigation, insect and disease control and grazing management). It also includes good hygiene which limits the spread of weeds by preventing the seeding of those around buildings, along fence lines, under trees, along creeks and ditches or on fallow land. Any machinery travelling from weedy to clean paddocks should be cleaned. Contaminated crop and pasture seed should be avoided. It also means having a crop rotation program, minimising tillage operations, and managing pastures to keep weeds down.

Mechanical control

This includes cultivation, mowing or slashing, heat and mulches.

Chemical control

This is the use of herbicides. These can be selective for certain weeds or completely non-selective. They can be "knockdown" (killing the plants they contact); or they can be residual (having some persistence in the soil). Application methods, the timing of applications and the degree of risk, to the operator and to the environment, are all very important considerations.

Biological control

This method is not available to the individual farmer or grazier. Government organisations continue to seek out biological agents (insects and disease) for the control of major weed problems.

A producer must plan ahead for economic and effective weed control so that a problem does not get out of hand. Three essentials are — anticipating the troublesome species; knowing how the crop interacts with the weeds; and knowing the control measures. Once this information is assembled, a control strategy can be developed. It should aim at maximum protection for minimum cost. It should also aim at keeping the full yield potential of the crop. Piecemeal attempts to control weed infestations after they have occurred fall into the "too little too late" category.

All plant species have a two-part scientific name which identifies them specifically. For example, wild radish is *Raphanus raphanistrum* L. and wild turnip is *Rapistrum rugosum* L. (All.). This scientific name is important for proper identification so that the right advice on control can be given. For example, wild turnip is controlled in winter cereals by 700 ml/ha 2,4-D 50% amine, whereas wild radish requires 1,100 ml/ha of the same chemical for control. The common name used for a weed often differs between individuals and between districts. This can cause confusion. For example, *Datura stramonium* and *Datura ferox* are referred to locally as datura, thornapple, castor oil or stramonium weed. People could become confused if recommendations were based only on common names. Any producer in doubt about the identity of a weed should contact his local extension agronomist. He can identify the weed problem and offer recommendations for control. Specimens can also be sent directly to: The Director, Botany Branch, Department of Primary Industries, Meiers Road, Indooroopilly, Q. 4068. The manner in which plant specimens need to be collected and packaged for sending to Botany Branch is outlined in the D.P.I.'s farmnote "Botany specimens for identification". This is available from D.P.I. offices.

Weeds of Inglewood Shire

Tables 32 to 35 list the major weeds encountered in the Inglewood Shire, and the crops in which they are a problem. It is not an exhaustive or complete list.

Poisonous plants

Factors affecting the toxicity of poisonous plants are stage of plant growth, animal species, condition of the animal, grazing routine, previous history of the animal, seasonal conditions, weather conditions and soil type. Often the first noticeable symptom of plant poisoning will be the presence of a dead beast in the paddock. It is, therefore, important that when plant poisoning is suspected, a post-mortem on the animal is carried out as soon as possible. The dead animal should, where possible, be covered with a shelter to prevent 'cooking'. Do not move the carcass as signs of the manner in which the animal died will be obliterated. Contact your stock inspector or veterinary surgeon who can obtain samples for laboratory investigation. The actual plant may still be present and identifiable in the rumen, or the toxin may still be present in the tissues of the animal. Table 35 provides information on weeds of the Inglewood Shire regarded as being poisonous to stock.

Declared plants

Table 36 lists the declared plants of Queensland and how they relate to the Inglewood Shire. A declared plant (formerly termed 'noxious plant' or 'noxious weed') is a plant considered a serous enough pest to warrant its control being enforced under legislation. This legislation is the Rural Lands Protection Act (1985) which came into force on 1st July, 1986. Under this Act an occupier of private land is required to control declared plants on that land. The local authority for the area may issue a notice on the occupier or owner requiring that certain declared plants be controlled by a specified date. Should the owner or occupier not comply with the direction contained in such notice, the local authority may authorise any person to enter the said land to carry out the requirements of the direction. The expenses incurred in carrying out this action are then charged to the owner or occupier. Local Authorities and Government Departments are also required to control declared plants on land under their control. For further information on declared plants, contact the Queensland Department of Lands.

Table 32. Major weeds of field crops in the Inglewood Shire.

Weeds		Crops			
Broad-Leafed Weeds Common Name	Botanical Name	Winter Cereals	Maize, Millets, Sorghum	Cowpeas, Mung Beans, Navy Beans, Soy Beans	
Amaranths	*Amaranthus* spp.	—	x	x	—
Bathurst burr	*Xanthium spinosum*	—	x	x	—
Blackberry nightshade	*Solanum nigrum*	—	—	x	—
Black pigweed	*Trianthema portulacastrum*	—	x	x	—
Bladder ketmia	*Hibiscus triunum*	—	x	—	—
Blue heliotrope	*Heliotropim amplexicaule*	x	x	x	x
Caltrop	*Tribulus terrestris*	—	x	x	x
Climbing buckwheat	*Polygonum convolvulus*	x	—	—	x
Deadnettle	*Lamium amplexicaule*	x	—	—	x
Fat hen	*Chenopodium album*	x	x	x	x
Hexham-scent	*Melilotus indica*	x	—	—	—
Mexican poppy	*Argemone ochroleuca*	x	—	—	x
Milk thistle	*Sonchus oleraceus*	x	—	—	—
Mintweed	*Salvia reflexa*	x	x	—	—
Mustards	*Sisymbrium* spp.	x	—	—	—
New Zealand spinach	*Tetragonia tetragonioides*	x	—	—	—
Noogoora burr	*Xanthium pungens*	—	x	x	—
Pigweed	*Portulaca oleracea*	—	x	x	—
Saffron thistle	*Carthamus lanatus*	x	—	—	—
Spiny emex	*Emex australis*	x	—	—	—
Stinking roger	*Tagetes minuta*	—	—	x	—
Thornapples	*Datura* spp.	—	x	x	x
Turnip weed	*Rapistrum rugosum*	x	—	—	—
Variegated thistle	*Silybum marianum*	x	—	—	—
Wild radish	*Raphanus raphanistrum*	x	—	x	x
Wireweed	*Polygonum aviculare*	x	—	—	x
Grasses					
Annual ryegrass	*Lolium rigidum*	x	—	—	—
Barley grass	*Hordeum leporinum*	x	—	—	x
Barnyard grass	*Echinochloa crus-galli*	—	x	x	—
Couch grass	*Cynodon dactylon*	—	x	x	x
Crowsfoot grass	*Eleusine indica*	—	x	x	x
Feather top Rhodes	*Chloris virgata*	—	—	—	x
Johnson grass	*Sorghum helepense*	—	x	x	—
Sandburr	*Cenchrus incertus*	—	x	x	x
Stinkgrass	*Eragrostis cilianensis*	—	x	x	x
Summer grass	*Digitaris ciliaris*	—	x	x	x
Urochloa grass	*Urochloa panicoides*	—	x	x	x
Wild canary	*Phalaris paradoxa*	x	—	—	—
Wild oats	*Avena fatua*	x	—	—	—
Other weeds					
Dodder	*Cuscuta* spp.	—	—	—	x
Nutgrass	*Cyperus rotundus*	—	x	x	x

x = encountered in these crops in the shire.

Common Name	Botanical Name
Cumbungi or Bulrush	*Typha* spp.
Red Azolla or Red Waterfern	*Azolla* spp.
Water Hyacinth	*Eichhornia crassipes*
Water Poppy	*Ottelia ovalifolia*
Water Primrose	*Ludwigia poploides*

Table 34. Weed problems of waterways and storages in the Inglewood Shire.

Table 33. Major weeds of pastures in the Inglewood Shire.

Weeds		Irrigated Pastures	Dryland Improved Pastures	Dryland Native Pastures
Common Name	Botanical Name			
Broad-leaf Weeds				
Blue heliotrope	*Heliotropium amplexicaule*	x	x	x
Deadnettle	*Lamium amplexicaule*	x	—	—
Galvanised burr	*Sclerolaena birchii*	—	—	x
Maynes pest	*Verbena tenuisecta*	—	—	x
Mexican poppy	*Argemone ochroleuca*	x	—	—
Saffron thistle	*Carthamus lanatus*	x	x	x
Spear thistle	*Cirsium vulgare*	—	x	x
Spiny emex	*Emex australis*	x	—	—
Variegated thistle	*Silybum marianum*	x	x	—
Wild radish	*Raphanus raphanistrum*	x	—	—
Wireweed	*Polygonum aviculare*	x	—	—
Grasses				
Barley grass	*Hordeum leporinum*	x	x	—
Slender bamboo grass	*Stripa verticillata*	—	—	x
Wiregrass	*Aristida ramosa*	—	—	x
Other weeds				
Nutgrass	*Cyperus rotundus*	x	—	—
Tree pear	*Opuntia* spp.	—	—	x
Woody weeds				
African boxthorn	*Lycium ferocissimum*	—	—	x
Brigalow	*Acacia harpophylla*	—	—	x
Cotton bush	*Kochia* spp.	—	—	x
Currant bush	*Carissa ovata*	—	—	x
Cypress pine	*Callitris columellaris*	—	—	x
Limebush	*Eremocitrus glauca*	—	—	x
Tumbledown gum	*Eucalyptus dealbata*	—	—	x
Wattles	*Acacia* spp.	—	—	x
Wild rosemary	*Cassinia laevis*	—	—	x

Table 35. Weeds poisonous to stock found in the Inglewood Shire.

Common Name	Botanical Name	Habitat	Signs of Poisoning	Notes
Bathurst burr	*Xanthium spinosum*	Disturbed ground	Little field evidence of poisoning	Almost all year
Blue heliotrope	*Heliotropium amplexicaule*	Loam soils in fallow roadsides, unused allotments or degraded pasture, esp. red loams	Chronic liver damage. May extend over to second season of grazing when losses occur. Progressive wasting jaundice leading to death. Some may recover, but are poor doers. Copper poisoning may occur when grazed on sub-clovers.	Not eaten readily. Few cases reported.
Mexican poppy	*Argemore ochroleuca*	Disturbed ground. Road shoulders. Dry stream beds. Alluvial silts and sands.	Poisoning rare. Mainly in fowls eating seeds. Depressed growth rate. Blueing of the comb, bloody scours to death.	Contaminant of wheat can be a problem.
Mintweed	*Salvia reflexa*	Fertile clays, black earths and grey to brown heavy soils, that is, bluegrass and brigalow.	Animals stand apart, breathe rapidly, muscle twitch and go down. Touching the animal induces violent twitch and the animal cannot rise. Tongue and membranes blue.	Cases in hungry animals on stock routes early summer. Sheep and cattle.
Noogoora burr	*Xanthium pungens*	Summer fallow weed and in row crops, flood plains and creek banks.	Frequently die overnight with no signs seen. Have weak rapid pulse, acute gastro-intestinal pain and die in convulsions	Spring and early summer. Mainly pigs and cattle ingesting seedlings.

Common Name	Botanical Name	Habitat	Signs of Poisoning	Notes
Crown beard	*Verbesina encelioides*	Sandy soils, cleared brigalow. Belah or softwood scrub country on clay to loam soils.	Losses occur a few days after drought rain. Mainly sudden. Some with bloating, frothy mouth and/or tongue protrusion and cyanosis, that is, blueing of membranes.	Mainly sheep, some cattle. Mature plants. Mostly drought periods. In travelling stock, introduced stock and with heavy stocking.
Climbing buckwheat	*Polygonum convolvulus*		Possibly dermatitis or photosensitisation around muzzle.	Little evidence of poisoning.
Curled dock	*Rumex* spp.	Disturbed ground.	Dullness, twitching, trembling, froth, collapse onto brisket, coma to death 10 hours after ingestion. Die in sleeping position.	Suspected of causing deaths in hungry stock.
Thornapple	*Datura* spp.	Summer crop weed, disturbed land and waste places.	Thirst, pupil dilation, exciteability, delarium, increase temperature, weak rapid pulse, excessive water consumption and bladder distention. Leading to convulsions, coma and death.	Mostly contamination of crushed grain *Datura* seed. Especially pigs and poultry. Rarely cattle, sheep and horses, except in drought, feed shortage.
Variegated thistle	*Silybum marianum*	Disturbed ground. Especially black earths and rich alluvials.	Sudden death if large quantities eaten on empty stomach. Less acute cases, rapid breathing, muscle twitch and collapse. Touch induces violent muscle twitch and animal cannot rise. Cyanosis before death.	Mainly cattle. Rarely eaten except under stress. 2,4-D and MCPA increases plant palatability, therefore, risk of poisoning.
Variable groundsel	*Senecio lautus*	Unthrifty pastures. Hillsides.	Progressive liver disorder. Death may occur months after initial plant ingestion. Weight loss, chronic scours, wandering, partial blindness, eversion of the rectum following straining (prolapse).	Readily eaten by sheep and goats. Causes 'walking' disease especially horses. Cases occur in animals with no history of stress. Symptoms may be delayed until second grazing season of the plant.
Darling pea	*Swainsona* spp.	Open grasslands and cleared brigalow. Heavy clays to light loams.	'Peastruck', decrease in condition, stary eyes, head carriage high in sheep, low in cattle and horses, stiff gait, staggers, head and limb tremble, clumsiness leads to falling over, eventually cannot regain stance and remain prone until death. Cattle and horses may be excitable. Driving animals elicits symptom exhibition.	Occurs in poor summer rainfall years with winter rain promoting its growth in the spring. Young animals, cattle severely affected. Sheep have mass outbreaks. Occasionally in horses.
Deadnettle	*Lamium amplexicaule*	Disturbed ground, that is, cultivation headlands, fallows, roadsides. Occasionally in winter cereals.	Lag behind mob when driven. Stiff hindquarters gait, head forward and back hunched. Frequently stop and breathe rapidly developing shivers and trembles. If forced to continue will fall over and die. If allowed to rest usually recover.	Mostly sheep, some horses and cattle. A danger if grazing cereal stubble containing the mature plant.
Marshmallow	*Malva parviflora*	Around houses, roadsides and especially infrequently used stock yards. Over-grazed and/or droughted pastures.	Mainly staggers in sheep, horses and cattle when driven. If continued will cause deaths. Horses perspire freely, breathe rapidly, dis-coordination, stagger and have muscle quiver.	Must be large part of diet. Toxin of the plant can be passed to the lamb via milk without the ewe affected.

Table 35 continued

Common Name	Botanical Name	Habitat	Signs of Poisoning	Notes
Pigweed (black)	*Trianthema portulacastrum*	Clay soils.	Trembling, weakness, uncoordination followed by recumbrancy, leading to coma and death.	Eaten under stress. Plant unpalatable. Suspected of poisoning cattle.
Rockfern	*Cheilanthes sieberi*	In crevices of rocky areas. Thin soil overlaying rock. Sandy loam run-off from hard country.	Sheep—'Staggers' induced by driving. May have diarrhoea and/or rapid breathing. If driving persists, death occurs rapidly. Cattle—possible sudden deaths. Some may have bloody urine and scours. Increase temperature before death. Post-mortem shows bleeding of tissue, organs and large bowel.	2 syndromes:- Sheep—travelling sheep. Feed shortages spring to early summer. Cattle—suspected of causing deaths. Seem to be more susceptible.
Spiny emex	*Emex australis*	Disturbed lands, roadsides and cultivation	(As for Curled dock)	Suspected of poisoning.

Recommendations for control

There is a vast amount of information available on the control of weeds in crops and pastures as well as in water storages and channels, fence lines and other situations. Instead of detailing control measures, this section lists some of the publications that deal with weeds and their control, and where these publications can be found. Useful books are:

"The Australian Weed Control Handbook" (8th edition) by J. T. Swarbrick. This book outlines the methods and lists the herbicides registered for weed control. Details of the label registration for each herbicide are listed alphabetically under the herbicide name. The herbicides registered are also indexed under the common and botanical names for weeds. This book is available from Inkata Press Pty. Ltd., 4 Longbourne Avenue, North Clayton, Victoria, 3168. Phone (03) 560 0272.

"A field guide to weeds in Australia" by C. Lamp and F. Collet. This book lists 283 weeds found in Australia. They are arranged in alphabetical order by botanical names, with at least one illustration for each and an index of common names for easy access. It contains 350 full colour photos of weeds listed. It is available from Inkata Press Pty. Ltd., 4 Longbourne Avenue, North Clayton, Victoria, 3168. Phone (03) 560 0272.

"Queensland Weed Seeds" by T. E. Friend. This book contains photographs of 344 commonly found weed seeds in Queensland. This book would help farmers, seed growers, cleaning machine operators and merchants to recognise weed seeds which are reported in seed analysis reports. It is available from the Information Centre, Queensland Department of Primary Industries, G.P.O. Box 46, Brisbane, Q. 4001.

"Suburban Weeds" by H. E. Kleinschmidt. This book provides descriptions and line illustrations of 120 species of weeds found in Queensland home gardens. Each description includes a suggested method of control and eradication. It also lists registered herbicides and the branded products containing them. It is also available from the Information

Table 36. Declared plants under the Queensland Rural Lands Protection Act, 1985 and how they relate to the Inglewood Shire.

Category P1 plants — The introduction of these plants into Queensland is to be prohibited:

Alligator weed	*Alternanthera philoxeroides*
Giant sensitive tree	*Mimosa pigra*
Mesquite	*Prosopis* spp. (other than P.flexuosa, P.glandulosa, P.limensis)
Largarosiphon	*Lagarosiphon major*

Category P2 plants — These plants are to be destroyed:

Alligator weed	*Alternanthera philoxeroides*
Annual ragweed	*Ambrosia artemisiifolia*
Badhara bush	*Gmelina asiatica*
Bitou bush	*Chrysathemoides monilifera*
Giant sensitive plant	*Mimosa invisa*
Giant sensitive tree	*Mimosa pigra*
Hemlock	*Conium muculatum*
Lagarosiphon	*Lagarosiphon major*
Mesquite	*Prosopis flexuosa and species other than P.glandulosa and P.limensis*
Parthenium weed	*Parthenium hysterophorus*
Perennial ragweed	*Ambrosia psilostachya*
Salvinia	*Salvinia molesta*
Sicklepod	*Cassia obtusifolia*
* Water hyacinth	*Eichhornia crassipes*

Category P3 plants — Distribution of these plants in the area of infesttation is to be reduced

* African Boxthorn	*Lycium ferocissimum*
* Bathurst Burr	*Xanthium spinosum*
Chinee Apple	*Ziziphus mauritiana*
Cottontails	*Froelichia floridana*
Crofton weed	*Eupatorim adenophorum*
Groundsel bush	*Baccharis halimifolia*
Harrisia cacti	*Eriocereus* spp.
Mesquite	*Prosopis glandulosa*
	Prosopis limensis
Mistflower	*Eupatorium riparium*
Navua sedge	*Cyperus aromaticus*
* Noogoora burr	*Xanthium pungens*
Prickly acacia	*Acacia nilotica*
* Prickly pears	*Opuntia* spp.
Rubber vine	*Cryptogestegia grandiflora*
* Saffron thistle	*Carthamus lanatus*
* Thornapple	*Datura ferox*
	Datura meteloides
	Datura tatula
	Datura stramonium
Water lettuce	*Pistia stratiotes*

* These weeds commonly occur, or have been found, at some time in the Inglewood Shire.

Centre, Queensland Department of Primary Industries, G.P.O. Box 46, Brisbane, Q. 4001.

"Weeds' An illustrated botany of the weeds of Australia" by B. A. Auld and R. W. Meed. This book contains notes on the geographic origin, description and importance of over 900 weeds in Australia. Over 550 major weeds are illustrated with colour and line drawings. It is available from Inkata Press Pty. Ltd., 4 Longbourne Avenue, North Clayton, Victoria, 3168. Phone (03) 560 0272.

"Major woody weeds of western Queensland and their control" by J. C. Scanlan and A. J. Pressland. This book identifies weed control measures that are both workable and affordable in the dry pastoral areas. They include fire and heavy grazing as well as biological, mechanical and chemical controls. The herbicides registered for controlling woody weeds in Queensland are listed, and the cost of herbicide options outlined. This book is available from the Information Centre, Queensland Department of Primary Industries, G.P.O. Box 46, Brisbane, Q. 4001.

"Weeds of Queensland" by H. E. Kleinschmidt and S. W. Johnson. This book covers more than 350 weeds, each one briefly described, with its common and scientific names, and illustrated by black and white photographs and line drawings. Notes on each weed's origin, distribution and control are included. It is available from the Information Centre, Queensland Department of Primary Industries, G.P.O. Box 46, Brisbane, Q. 4001.

In addition to the above, printed information on the whole spectrum of weed control technology is available in handout leaflet form from the Queensland D.P.I. A wide range of "farmnotes", "agnotes" and other publications present detailed recommendations that cover most weed problems. A further range of publications on weed control are available from the Alan Fletcher Research Station, Department of Lands, P.O. Box 36, Sherwood, Qld. 4075.

The control of some specific weeds

This section deals with 14 weeds which have been identified by members of the Inglewood Shire Land Management Committee as major problems.

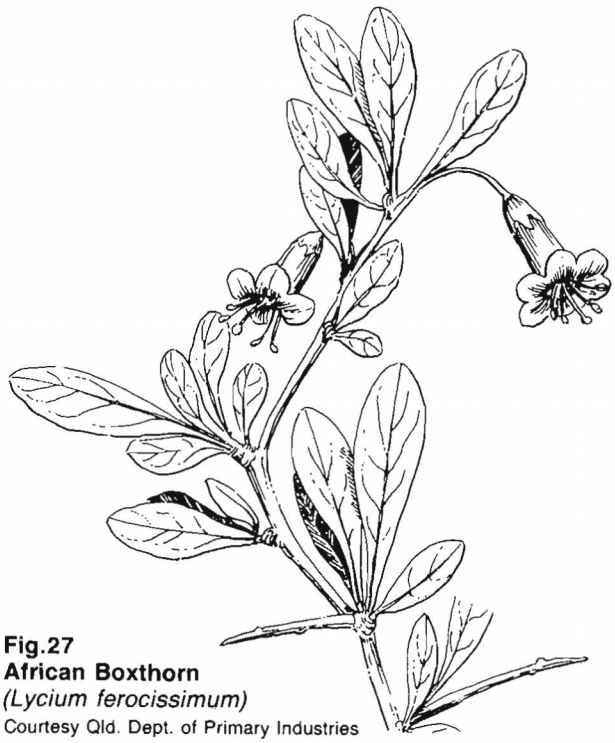


Fig.27
African Boxthorn
(Lycium ferocissimum)
Courtesy Qld. Dept. of Primary Industries

African boxthorn *(Lycium ferocissimum)* . Boxthorn is a native of South Africa brought to Australia in 1869 as a hedge plant. It is a shrub up to 2.5 metres high with stout spiny branchlets; leaves bright green, rather succulent, 1 to 2 cm long, rounded at the top, tapered at the base; flowers in the fork of the leaves, petals white with purple markings; berries bright red when ripe, smooth 6 to 8 mm long.

Problem status. Boxthorn has the potential to reduce severely the productivity of pasture lands. It can form impenetrable thickets. The current low level of economic loss due to this plant should not encourage complacency towards it. In Inglewood Shire it occurs as isolated or scattered plants in grazing land on a number of soil types, but with a preference for the more fertile soils. Boxthorn is often found under trees or poles, or along fence lines because the seed is commonly distributed by birds after eating the fruit.

Control. Several deep ploughings are necessary for mechanical eradication. Pushing with a bulldozer is recognised as a useful clearing method. However, regrowth does appear. This must be treated chemically.

Recommendations for overall foliar spraying are as follows:—

(a) Roundup (a.i. 360 g/L glyphosate) — with handgun apply at 700 ml to 1.0 L/100 L water. For a 15 L knapsack apply 100 to 150 ml. Use the lower rate for young bushes; increase to the higher rate for large mature bushes. Spray to the point of wetness. Complete plant foliage cover is essential. Do not spray during hot dry summer periods.

(b) Grazon Foliar Spray Herbicide (a.i. 480 g/L triclopry) — with a handgun apply at 1 L/100 L water. For a 15 L knapsack apply 150 ml. Spray to the point of run-off. Avoid spraying under dry conditions when plants are stressed. Only spray when there is a good growth and no leaf fall.

Cut stump treatment options where appropriate are:—

(a) T800 (a.i. 800 g/L 2,4-5-T ester) — mix 1 part to 40 parts diesel distillate (2.5 L/100 L diesel distillate or 25 ml/1 L diesel distillate). Apply liberally to freshly cut stump surface before the sap dries.

(b) T400 (a.i. 400 g/L, 2,4,5-T ester) — mix 1 part to 20 parts diesel distillate (5 L/100 L diesel diesel distillate or 50 ml/1 L diesel distillate). Apply liberally to freshly cut stump surface before the sap dries.

(c) Garlon 480 Herbicide (a.i. 480 g/L tricopyr) — apply as 1 part to 24 parts diesel distillate (4.2 L/100 L diesel distillate or 42 ml/1 L diesel distillate). Apply liberally to freshly cut stump surface before the sap dries.

Basal bark sprays are also effective. They are:—

(a) 800 g/L 2,4,5-T ester — apply as 2.5 L/100 L diesel distillate as a basal spray to bottom 30 to 60 cm of stem. There are several commercial products registered including Farmco TLV-800 Low Volatile Brushkiller, Nufarm Five T Brush Killer, T800.

(b) 400 g/L 2,4,5-T ester — apply as 5 L/100 L diesel distillate as a basal spray to bottom 30 to 60 cm of stem. There are several commercial products registered including Farmco TLV-400 Special Low Volatile Brush Killer, Nufarm Five T40 Brush Killer, T400.

Spot application is also recommended where appropriate. Use Velpar (a.i. 250 g/L hexazinone) — apply as one 4 ml spot for bushes up to 1 metre high. Apply to the soil between the base of the plant and drip line. Do not use within a distance of twice the height of desirable trees.

Further information — Lee, A. N. (1978), Is African boxthorn a problem? Queensland Agricultural Journal, Vol. 104(6).

Fig.28
Blue Heliotrope
(Heliotropum amblexicaule)
Courtesy Qld. Dept. of Primary Industries

Blue heliotrope *(Heliotropium amplexicaule)*, also known as wild verbena, originated from Brazil and Argentina. It was introduced to Brisbane as a garden plant which escaped and appeared on the Downs in the early 1920s. It is a perennial summer growing herb forming loose mats. A tap root with numerous laterals gives rise to new shoots.

Stems are prostrate or ascending; round hairy and hard. Leaves are hairy with wavy margins. Flowers are in branched terminal one sided cymes unrolling from the tip, tubular or bell shaped, 30 mm, blue to purple with a small yellow eye. Cymes elongating in fruit, with persistent hairy sepals; fruit of two smooth oval nutlets each 30 mm long and containing one or two seeds.

Problem status. Blue heliotrope competes severely with both crops and pastures. It contains poisonous alkaloids and nitrates, but is rarely eaten by stock. However, it has been found to cause a long lasting liver damage in affected stock. The clinical signs of poisoning are depression, a staggering gait, circling, photo sensitisation, scouring, straining, abdominal swelling and a depraved appetite. It is a very common weed in the shire and is particularly prevalent in deep sandy loams. It is also common in old cultivations on traprock country.

Control. Its ability to shoot from root pieces makes it almost impossible to control by mechanical means. It is deep rooted and very drought resistant. Despite these difficulties, cultivation, when combined with the establishment of a vigorous pasture (including a summer grass), can result in control. It is essential not to overgraze the pasture as blue heliotrope can again take over. Only Tordon 50-D is registered for control of blue heliotrope in a pasture situation, as a spot spray at 1.5 L/100 L water. Research in other states indicates that both seedling and adult plants are susceptible to glyphosate (Roundup). However, this is as yet an unregistered use. For further information consult with the local extension agronomist.

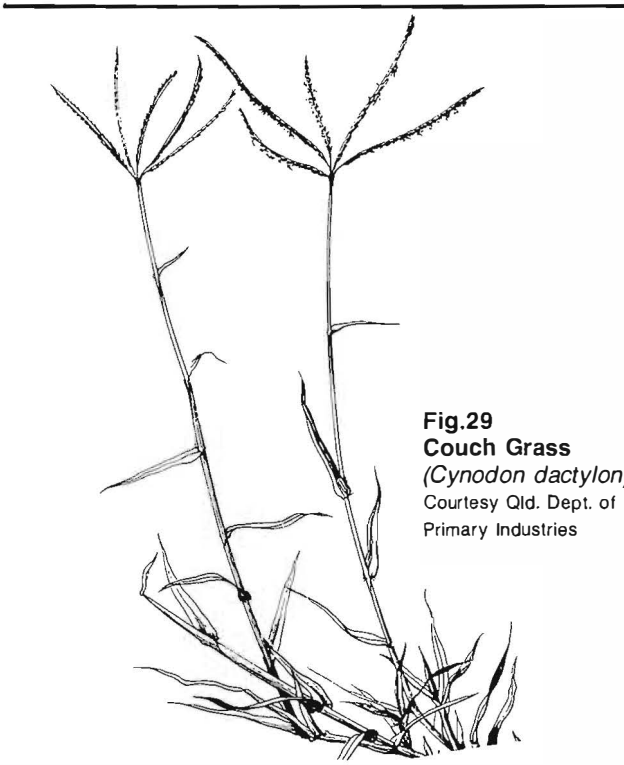


Fig.29
Couch Grass
(Cynodon dactylon)
Courtesy Qld. Dept. of Primary Industries

Couch grass *(Cynodon dactylon)*. This grass is a native of tropical Africa and the Indo-Malaysian area. It is a long-lived prostrate, fine leafed perennial grass that spreads by strong, flat stolons and scaly rhizomes to form a dense turf. Stolons root readily at the nodes. The plant on average grows to a height of 50 cm. It is a warm season grass that makes little growth in cold weather and is quickly damaged by frost. It is a sparse seed producer. The seeds are very small, numbering 4.4 million per kilogram. When eaten by cattle the seeds remain viable and may even show increased germination. The rhizomes and stolons are the main means of the weed spreading. They catch on the feet of animals and get entangled in the tines of farm machinery.

Problem status. Couch grass competes with summer crops for nutrients and water. Its turf forming ability makes it difficult to prepare ground for crop planting. Plant fragments choke cultivation and planting equipment if the stand becomes too thick. It is adapted to a wide range of soils from sand to heavy clay, but it thrives best on a medium textured soil which is moist and well drained. It will grow on both acid and alkaline soils. It survives floods and drought. In Inglewood Shire it is widespread on cultivation land, and in particular on the alluvial soils where irrigated cropping is practised.

Control. Mechanical control can be achieved in cultivation by chisel ploughing and harrowing when the ground is very dry, but this procedure may have to be repeated several times before any worthwhile control is obtained. It can also be an advantage to chisel during winter when the added effect of frost occurs. The following range of herbicides is registered in Queensland for the control of couch grass:

* 2,2-DPA a.i. 740 g/kg
* Bromacil & Diuron a.i. 400 g/kg + 400 g/kg
* Diuron a.i. 800 g/kg, 500 g/L, 800 g/kg
* EPTC a.i. 720 g/L
* Fluzifop a.i. 212 g/L
* Glyphosate a.i. 250 g/L
* Hexazinone a.i. 250 g/L

These herbicides are registered for a range of crops and non-crop situations. For specific registration and recommendations, refer to the publications list and consult the local extension agronomist.

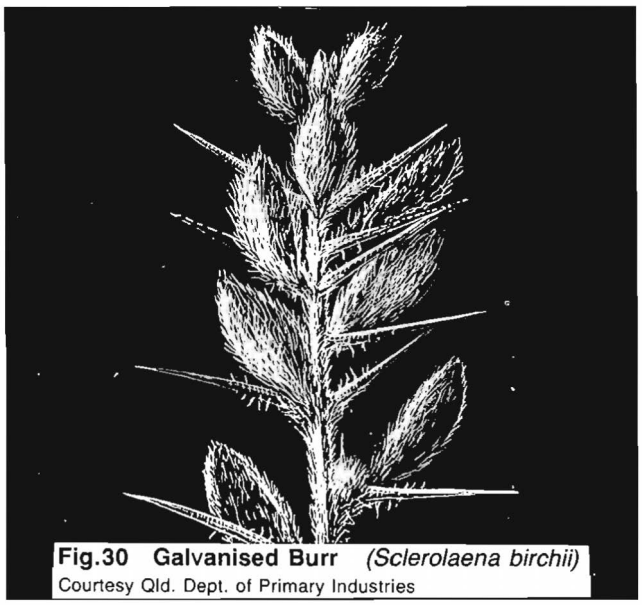


Fig.30 Galvanised Burr *(Sclerolaena birchii)*
Courtesy Qld. Dept. of Primary Industries

Galvanised Burr *(Sclerolaena birchii* formerly *Bassia birchii)*. This plant is a native of Australia. It is a densely branched shrub up to a metre high, with stems and leaves covered in white woolly hairs giving the plant a blue-green, galvanised appearance. Leaves are 4 to 7 mm wide and 12 to 18 mm long. Burrs along the stems have two short (1 to 3 mm) with three long (8 to 15 mm) spines. There is a single seed in each burr, with burrs along the entire length of stems. It is spread by broken stem pieces catching in wool of sheep and to some extent by vehicle and motorbike tyres.

Problem Status. The plant causes a minor contamination of wool and discomfort to shearers and fleece handlers. It is a nuisance around yards and dams. It can infest dryland lucerne stands, and contour banks, and headlands in paddocks. Galvanised burr is a symptom of degradation in semi-arid areas caused by over-grazing and droughts over a long period. Generally it is confined to central western areas of N.S.W. and Queensland, between latitudes 21°S and 36°S and between the 300 and 700 mm rainfall isohyets, and spreading into Victoria and South Australia. It occurs throughout the Inglewood Shire, but principally on grazing country or older cultivations which have been left to revert to native pasture.

Control. For isolated patches where plants are less than 7.5 cm high, control by hoeing to a depth of about 2.5 cm below the soil surface is effective. For larger plants, hoeing to a depth of 10 cm below the soil surface and then burning the dried out bushes is effective (if only cut at ground level plants will reshoot from the crown). In larger infestation, plants should be pushed with a blade, stacked and burnt. Following this, any remaining seed should be buried by ploughing to a depth greater than 4 cm. Following good seedbed preparation a perennial pasture or annual crop should be sown to provide competition against new seedlings.

Sheep will graze the tips of mature plants, while goats will eat the more woody stems. Very high stocking rates are needed for much effect on the density of adult plants. Seedlings are somewhat more palatable and high in protein. High intensity rotational grazing can be effective in controlling infestations.

Recommendations for chemical control are:—

(a) 2,4-D (a.i. 500 g/L amine) — Apply as an overall spray of 5.6 to 7.0 L/ha in pastures only (and not those containing legumes). Thorough coverage of plants is essential.

(b) 2,4-D (a.i. 800 g/L ester) — Apply as an overall spray at 4.0 L/ha. As a spot spray at 425 ml/100 L water. Do not use as an overall spray in pastures containing legumes. 2,4-D breaks down in soil in approximately four weeks.

(c) Dicamba (a.i. 200 g/L) — For use in non-crop situations. Apply as an overall spray of 22 L/ha. As spot sprays apply in 1.5 L/100 L water as a high volume application, or as 300 ml/15 L knapsacks. Add a 50% wetting agent. Spray plants with good coverage when weeds are young and actively growing.

Once dead, burn the bushes as herbicides do not affect mature seeds on sprayed plants. These seeds can germinate to continue the problem.

Further information is available in the following:—

Auld, B. A. (1975), Solving the problem of galvanised burr. N.S.W. Agricultural Gazette, Vol. 86(1).

Auld, B. A. (1985), Galvanised burr. N.S.W. Department of Agriculture Information Sheet. Agdex 642.

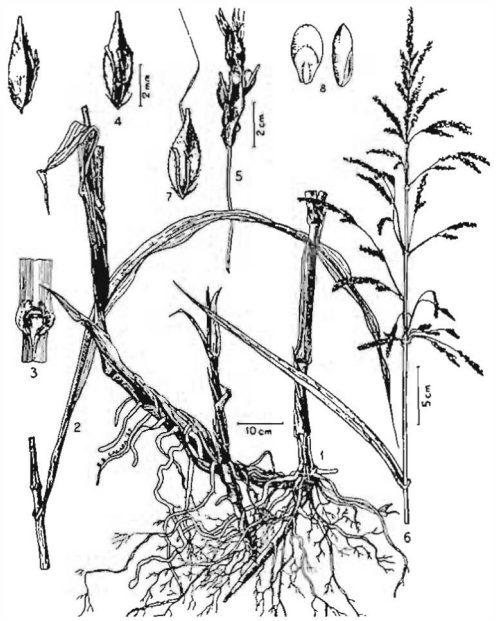


Fig.31 Johnson Grass *(Sorghum halepense)*

Johnson grass *(Sorghum halepense).* This plant is a native of the Mediterranean area. It is a perennial sorghum up to 200 cm tall, with stems arising from extensively creeping and rooting scaly rhizomes. These rhizomes distinguish Johnson grass from other sorghums (except for *Sorghum almum*). The buds on rhizomes can sprout to form new plants. Some buds remain inactive throughout the growing season, enabling the plant to re-establish after temporarily adverse conditions, such as drought or ineffective control. Few rhizomes are formed until flowering, after which rhizome production increases rapidly, resulting in up to 8 kg (fresh weight) of rhizomes from a single plant in a season. Rhizomes that develop during one summer remain dormant over winter and produce new plants in the following season. They are unable to function after that season. Seed-heads are mostly 10 to 35 cm long. Johnson grass can also produce large numbers of viable seeds — as many as 28,000 on one plant. New Johnson grass seed is dormant for about four to five months and, unlike rhizomes, can survive in the soil for at least two years. This means that areas sprayed with a non-residual herbicide must be checked for seedling regrowth for several seasons. The seeds are usually dark brown or black when mature.

Continued next page

Problem Status. Ranked as the third most serious weed in Australia and many other countries. It competes with summer crops for light, soil moisture and nutrients. It is an important host of insect pests (primarily sorghum midge), and disease of grain sorghum (the major one is sugarcane mosaic virus which affects maize and sorghum crops). It can cross-pollinate with sorghum — restricting the potential of whole regions in growing sorghum for seed. Young growth contains prussic acid which can poison stock. It restricts vision along roadsides. It is difficult to eradicate due to infestation along roadsides, railway lines, fencelines, channel banks and waste areas. It occurs in cultivation and along roadside in the eastern Darling Downs region of S.E. Queensland. In cultivation, the weed establishes as isolated patches following introduction of seed with sown crops, or irrigation channels. In the Inglewood Shire it occurs in all the situations described.

Control. Johnson grass, whether it occurs as isolated plants or as a large-scale infestation, should never be cultivated or dug up. Grading infested areas should also be avoided. Cultivation and grading are probably the major causes of increasing the severity of an infestation — by breaking up rhizomes and spreading them to new areas. Slashing or burning do not cause rhizome movement to clean areas and may reduce viable seed production. However, these methods are not generally effective.

The following range of herbicides is registered in Queensland for the control of Johnson grass.

* 2,2-DPA a.i. 740 g/kg
* benfluralin a.i. 200 g/L
* bromacil & diuron a.i. 400 g/kg + 400 g/kg
* fluzifop a.i. 212 g/L
* glyphosate a.i. 360 g/L
* TCA a.i. 835 g/kg
* tetrapion a.i. 863 g/L
* trifluralin a.i. 400 g/L

These cover a range of crop and non-crop situations. For specific registrations and recommendations, refer the publications list and consult the local extension agronomist.

Further information is available in the following:—

1. Marley, J. M. T. and Robinson, G. R. (1983), Control of Johnson Grass Patches in Cultivation Using Glyphosate. Qld. J. Agric. and Anim. Sci. 40 (z) 95-99.

2. Monaghan, N. and Dellow, J. (1982), Johnson Grass. N.S.W. Dept. of Agriculture Agfact P. 769.

Fig.32 Mayne's Pest *(Verbena tenuisecta)*
from 'Australian Weeds' Inkata Press

Mayne's pest *(Verbena tenuisecta).* This weed originated from Tropical America. It is a prostrate, branched perennial with finely dissected leaves and some erect stems. Leaves are smooth to touch and finely divided into narrow lobes. The flowers are at the end of the branches, light purple or white in clusters 3 cm across. Individual flowers with a narrow tube about 1 cm long and spreading petals about 5 mm across.

Problem Status. Mayne's pest is generally found along roadsides or in pasture land where competing species no longer exist; for example, old cultivations, overgrazed pasture areas. The plant is spreading rapidly in the Inglewood Shire via the dispersal of 'seed' in soil and on vehicles and livestock.

Control. It can be controlled by repeated cultivations where this is practical. In degraded pasture areas, improved pastures should be planted following cultivation to control the weed. For further information, consult with the local Extension Agronomist of the Queensland Department of Primary Industries.

Chemical control recommendations are as follows:

1. Tordon 50-D (a.i. 50 g/L picloram) — apply as a spot spray at 875 ml/100 L water to actively growing plants. Ensure thorough coverage. Picloram remains active in the soil for extended periods depending on rate of application, soil type, rainfall, temperature, humidity, soil moisture and soil organic matter. Do not apply where treated soil may be washed to other areas or where surface water from heavy rain can be expected to run off to other areas.

2. Ethidimuron — sold as several products for use where bare ground is required in non-crop, non-forage areas such as around buildings, yards and storage areas. The products available and rates used for control of Mayne's pest are:

* Ustilan Herbicide Spray (a.i. 700 g/kg ethidimuron) at 8 to 10 kg/ha (80 to 100 g/100 m²);

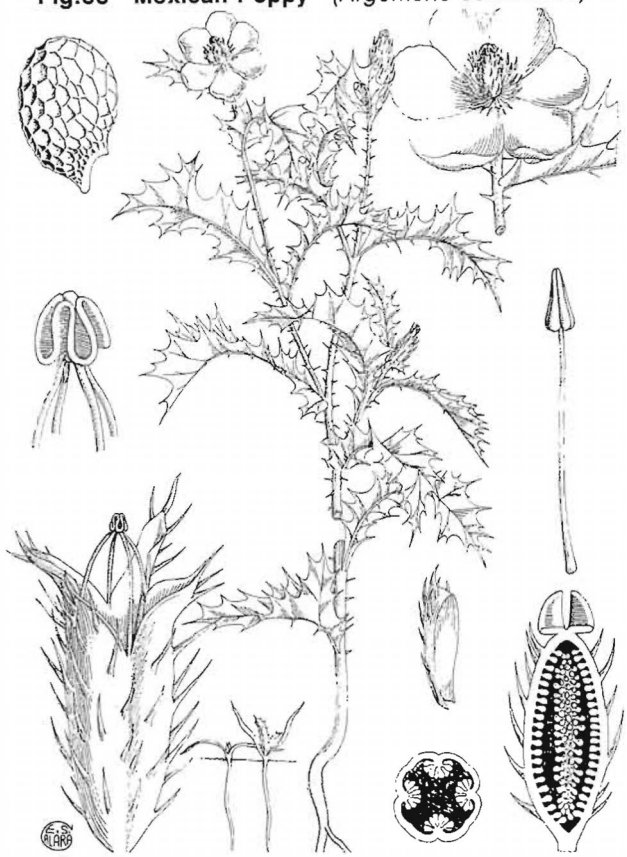
* Ustilan D Herbicide Spray (a.i. 400 g/kg ethidimuron and 400 g/kg diuron) at 10 to 15 kg/ha;

* Ustilan 50 (a.i. 50 g/kg ethidimuron) at 140 kg/ha;

* Ustilan 150 (a.i. 150 g/kg ethidimuron) at 46 kg/ha.

These products kill the existing weed and act in a residual fashion, killing weeds germinating from seed, either in the soil or introduced onto the treated surface.

Fig.33 Mexican Poppy *(Argemone ochroleuca)*



Mexican poppy *(Argemone ochroleuca).* This plant is also a native of tropical America and is now found as a weed of 15 different crops in 30 countries, principally in the tropics and sub-tropics. It grows to 1 metre in height, prior to flowering it has the appearance of a thistle. The spiny rod-shaped stems are whitish in colour. The leaves which grow up to 20 cm long are silvery-green with white veining and deep regular lobes. The poppy flowers from October to November. Flowers are light yellow or cream and about 6 cm across. The flowers develop into a prickly fruit about 2.5 cm long. These fruit contain numerous seeds.

Problem status. Mexican poppy is poisonous to stock. Some have died after eating contaminated hay or chaff. Also grain with poppy seed contamination is unsuitable for milling or stock feed. The weed is troublesome in most parts of Australia. In the Inglewood Shire, creek flats and sandy soils are most suitable for Mexican poppy.

Control. For isolated infestations, hoeing has proved a useful form of control. However, because of the great number of seeds which can be produced by a single plant (300 to 400 per seed capsule), and the dormancy of the seed, eradication on a farm is a near impossibility. High seeding rates of cereals such as barley and wheat (for example, 60 to 80 kg/ha) can reduce the establishment of Mexican poppy in a crop, particularly under irrigation. Under dryland conditions, however, high seeding rates can result in yield loss.

The following range of herbicides is registered in Queensland for the conrol of Mexican poppy:

* 2,4-D amine a.i. 500 g/L;
* 2,4-DB a.i. 400 g/L;
* 2,4-D + picloram a.i. 200 g/L + 50 g/L;
* Atrazine a.i. 500 g/L;
* Bromoxynil + MCPA a.i. 200 g/L + 200 g/L;
* EPTC a.i. 720 g/L.

These cover a range of crops. For specific registrations and recommendations, the reader is referred to the publications list and advised to consult the local extension agronomist.

Noogoora burr *(Xanthium pungens)*
Courtesy Ciba Geigy Australia.

Noogoora burr *(Xanthium pungens).* This plant possibly originated in the Mediterranean region. It is an annual weed, erect in habit up to 2 metres or higher. The leaves are similar to that of a grape with three main veins, reddish in colour and mostly 10 to 15 cm in diameter. The leaf has irregular serrated edges. The plant bears both male and female flowers; male flowers soon dropping off and female flowers in clusters on the lower part of slender, terminal, flower-bearing branchlets and in clusters in the forks of leaves-persistent, developing into hard, woody, spiny burrs. When ripe, the burrs are brown, about 2.5 cm long and densely covered with hooked spines. Each burr contains two seeds in separate compartments; one seed will germinate when conditions are right, the other remaining dormant until a subsequent favourable season.

Problem status. It is a major weed of summer annual crops, particularly those under irrigation. It competes with these crops for water and nutrients. It is a serious weed along river and creek flats, on roadsides, in old cultivation paddocks and in some pasture lands. It can make these areas inaccessible. Burr contamination of wool causes severe economic loss to graziers. In the two leaf stage, it is particularly toxic to stock. In Inglewood Shire, Noogoora burr favours watercourses and cultivation. It will survive anywhere that soil is deep and moist, like the uphill side of logs on sloping ground. Hot, dry spells in summer limit the spread on harder soils due to moisture stress in seedlings. The burrs are mainly spread by flowing water and on the hair and wool of animals.

Control. This should take place before seed set occurs. Pulling or cutting below ground level and cultivation are the main forms of control. The following range of herbicides is registered in Queensland for the control of Noogoora burr. Herbicides registered include:

* 2,4-D amine (a.i. 500 g/L);
* 2,4-D ethyl ester (a.i. 800 g/L);
* 2,4-DB (a.i. 400 g/L);

Continued next page

* 2,4-D + picloram (a.i. 200 g/L + 50 g/L);
* atrazine (a.i. 500 g/L);
* bentazone (a.i. 480 g/L);
* dicamba (a.i. 200 g/L);
* MCPA amine (a.i. 500 g/L);
* metolachlor (a.i. 720 g/L);
* pendimethalin (a.i. 330 g/L).

These cover a range of crops. For specific registrations and recommendations, the reader is referred to the publications list and advised to consult the local extension agronomist. For chemical control in non-crop areas such as roadsides, fence lines and creek banks, the following recommendations are given. If boomspraying, apply 2,4-D amine (a.i. 500 g/L) at 2.1 to 2.8 L/ha. Apply to seedlings pre-flowering. Mature weeds require higher rate. If spot-spraying, apply 2,4-D amine (a.i. 500 g/L) at 30 ml/15 L knapsack. Spray to point of run-off. Apply to seedlings pre-flowering for best results.

The stem-galling moth *Epiblema strenuana* has been released in Queensland to help in the control of Noogoora burr. The adult is a night flying moth, that spends the day resting on leaves. After feeding briefly on the leaves, the small larvae crawl down to enter the stem at tips or side shoots, where they bore into the stems. At this stage, a minute trace of black dust is the only evidence of infestation. The larva will continue to grow inside the stem and form a spindle-shaped gall about 1 cm across and 1 to 2 cm long. When full grown, about 1 cm long, the larva pupates in the gall. A few days later, the adult moth emerges. The whole life cycle takes six to seven weeks in summer with a 10 to 100-fold increase in each generation. Moths can fly up to 1 km to find isolated plants. Each female lays 150 to 200 eggs. Landholders can assist the spread of the stem-galling moth by distributing field collected galls through infestations of Noogoora burr on their properties. For further information, contact the Alan Fletcher Research Station.

Further information is available as follows:

Diatloff, G. (1984), Noogoora burr and its control. Technical Bulletin, Queensland Department of Lands.

Kalinowski, N. (1985), Plant poisoning — Noogoora burr. Q.D.P.I. Farm Note F37/May 1985.

McFayden, R. E. (1984), Biological control of Parthenium weed and Noogoora burr. Technical Bulletin, Queensland Department of Lands.

Fig.35 Nutgrass *(Cyperus rotundus)*
Courtesy Qld. Dept. of Primary Industries

Nutgrass *(Cyperus rotundus* L.*)*. Regarded as the world's worst weed, it is a sedge native to India. The below ground parts consist of roots, "nuts" (called tubers) and basal bulbs (corms) connected by rhizomes (underground stems). The above ground parts consist of a rosette of leaves and the seed head. Nuts range from 5 to 25 mm in length and may be up to 1 cm in diameter. They are white and succulent when young but turn reddish-brown to black with age. The nuts consist of nodes and internodes with buds and enclosing scale leaves at each node. A nut may contain up to 10 buds. The buds give rise to rhizomes which are, at first, white and succulent but with age become black and wiry. Most nuts are located in the top 15 cm of soil and very few are found below 30 cm. Nugrass roots may extend to 130 cm.

The basal bulb is the tuberous enlargement which occurs just below the soil surface at the junction of the rosette of leaves and the rhizome. It resembles a nut. The leaves which form a rosette at ground level are bright green 8 to 18 cm long, narrow and taper to a fine point. Each rosette bears up to 10 leaves. Seed heads develop on a single three-cornered stalk, bearing at the top two to four green "leaves" (bracts) within which are four to five slender branches, each with a cluster of brown seeds (spikelets) at the end. Although capable of producing viable seed, germination is of a low order and is not regarded as an important means of reproduction. Vegetative propagation is the main method of multiplication by nutgrass and, combined with nut dormancy, is the reason for it being such a troublesome and persistent weed.

Tracing the development from a single nut shows that the apical bud (bud on the apex of the nut) gives rise to a vertically growing rhizome which in about a week under good growing conditions develops into leaves above ground and a basal bulb beneath the soil. The newly formed basal bulb then produces several rhizomes which develop into barely discernible basal bulbs 2 weeks after emergence of the first foliar parts. From 2 to 6 weeks after the emergence of the parent plant, foliage emerges from the new basal bulbs and the cycle repeats itself. It is not until after the sixth week that dormant nuts are first formed. The production of dormant nuts coincides with the flowering of the parent from which they arise. One of the most troublesome characteristics of nutgrass from the standpoint of control is the dormancy of the nuts. Apical dominance exists both in the individual nut and the nut chain. This means that only the end nut in a chain and the topmost bud on the nut sprout, while the remaining buds and nuts lie dormant.

Problem status. Nugrass is characteristically a weed of cultivation, and its control is both difficult and expensive. It causes severe crop production losses in tropical and sub-tropical regions. It has been suggested that the detrimental effect may be due to nutrient depletion of the soil, or to biological substances released by the underground parts of the weed to inhibit or retard the growth of competing crops.

The weed is widely distributed in cultivations throughout Inglewood Shire, being most prevalent on the irrigated alluvials. The initial spread of nutgrass in the river valleys was probably due to flood water. However man and his plough has proved its greatest ally. Tined implements increased the spread of nutgrass, but they can be used to advantage in a program of eradication.

Control. Judicious cultivation is an effective method of reducing large scale infestations. It should be carried out under hot, dry conditions, and to a depth at which nuts are found. Cultivations must be repeated within 6 weeks of new shoots appearing in order to stop the development of dormant nuts. Repeated cultivations have the effect of severing and realigning the nut/rhizome system; so breaking the apical dominance in the nut system and leading to the general sprouting of previously dormant nuts. This results in the depletion of underground reserves. The process also severs nuts from their root system thus cutting off their supply of moisture and nutrients. In addition it brings others closer to the surface to be subjected to the killing effects of desiccation and high temperatures. Tined implements are particularly effective as they tend to better break the rhizomes and bring nuts to the surface. A deep tining 30 cm or more if possible followed by successive passes at about 15 cm have been found effective. Shallower cultivation with sweeps is particularly effective in bringing tubers progressively to the surface. However intermittent cultivation with a tine instrument will increase the infestation.

Temperature is also effective in eradicating the tubers (see Table 37). Such temperatures occur in the soils of this area during summer. Exposure to the sun of freshly excavated tubers can therefore cause death in 2 to 14 days depending on conditions.

Table 37. Effect of Soil temperature in killing nut grass tubers.

Depth of Tubers (cm)	Time for 100/ Kill	Average Maximum Soil Temperature (°C)
Surface	1 hour	60
2.5	12 days	49
5.0	15 days	41
7.5	21 days	38

Many herbicides have been reported as active against nutgrass. The degree of control exerted varies with the products and the conditions under which they are applied. Some are restricted in their application because of lack of selectivity while others have limited use because of high costs, difficulty of application and long residual life in the soil. The characteristics of the available nutgrass herbicides must be understood and the most appropriate herbicide selected for the particular infestation. Herbicides registered include:

* 2,4-D amine (a.i. 500 g/l);
* Amitrole (a.i. 250 g/L);
* Bromacil (a.i. 800 g/kg);
* EPTC (a.i. 720 g/L);
* Glyphosate (a.i. 360 g/L);
* Methyl bromide (a.i. 980 g/kg, 1,000 g/kg, 567 g/L, 880 g/L, 1,133 g/L);
* Pebulate (a.i. 720 g/L);
* Terbacil (a.i. 800 g/kg);
* Vernolate (a.i. 796 g/L).

These cover a range of crop and non-crop situations. For specific registrations and recommendations, refer to the publications list and consult the local extension agronomist.

Methods of controlling nutgrass biologically have been attempted, but with little success. The plant is very sensitive to shade and temporary relief can be obtained by the growing of vigorous pastures for three to four years following which it is possible to grow row crops for one or two seasons before the nutgrass again becomes dominant. Crops capable of growing vigorously enough to suppress its growth include lucerne, cowpea, velvet bean, lablab, and a number of grass/legume pastures.

Further information can be obtained by reading:

Hazard, W. H. L. and Palu, L. M. (1986). Nutgrass and its treatment. Q.D.P.I. Queensland Agricultural Journal Reprint.

Fig.36 Saffron Thistle *(Carthamus lanatus)*
Courtesy Qld. Dept. of Primary Industries

Saffron thistle *(Carthamus lanatus)*. This plant is a native of the Mediterranean region. It grows to 1.5 m high, but is commonly 60 to 90 cm, reproducing by seeds. Stems are rigid, ribbed, white or very pale green. Rosette leaves deeply divided. Flowers are solitary, bright yellow and surrounded by spiny bracts produced late spring to summer. Seeds are large, about 6 mm long, prominently ribbed, smooth grey-brown, a pappus of stiff bristles varying in length from insignificant scabs to more than 6 mm is attached to one end of the seed.

Problem status. Saffron thistle, like most thistles, is a big problem for grain crops and for stock. It has very little fodder value and can damage the eyes and mouths of animals. Dense patches of saffron will restrict most other plants from growing. It occurs in all States of Australia, and grows well in Inglewood Shire. It will grow in most soils and thrives best under a 400 to 600 mm annual rainfall.

Control. Cultivation is the most effective method. Slashing is also effective if carried out just before flowering. However, if carried out too early the plants can regrow from the base and produce new flower stems, particularly if there is good rain shortly after cutting. Infestation is encouraged by heavy grazing. A reduction in grazing pressure coupled with pasture improvement wherever possible will reduce the incidence of saffron thistle. Because most seeds germinate within the first two years, it is necessary to prevent seeding for two or three years before any worthwhile reduction in density is seen.

The following range of herbicides is registered for control in Queensland:

* 2,4-D amine (a.i. 500 g/L);
* 2,4-D ester (a.i. 800 g/L);

Continued next page

* 2,4-DB (a.i. 400 g/L);
* bromoxynil (a.i. 200 g/L);
* bromoxynil + MCPA (a.i. 200 g/L + 200 g/L);
* dicamba (a.i. 200 g/L);
* glyphosate (a.i. 360 g/L);
* MCPA (a.i. 500 g/L);
* MCPA + picloram (a.i. 420 g/L + 26.25 g/L).

These cover a range of crops. For specific registrations and recommendations, refer to the publications list and consult the local extension agronomist.

For chemical control along roadside and on headlands, the following recommendations are given. If boom spraying, apply 2,4-D amine (a.i. 500 g/L) at 1.4 to 2.1 L/ha. Spray at the rosette stage. Increase the rate as the plant matures. Spraying at a late stage of growth gives variable results and is not recommended. If spot spraying, apply 2,4-D amine (a.i. 500 g/L) at 1.0 L to 250 L water. As for boom spraying, try to restrict spraying to plants in the rosette stage.

Further information

Diatloff, G. (1984). Saffron thistle and its control. Technical Bulletin, Queensland Department of Lands.

Fig.37 Spiny Burr Grass *(Cenchrus incertus)*
Courtesy Qld. Dept. of Primary Industries

Sandburr *(Cenchrus incertus).* This weed is a native of central and eastern U.S.A. It is sometimes referred to as spiny burrgrass or innocent weed. It is a grass species than can reach 60 cm in height, though plants are usually much shorter and can form large clumps. Depending on its environment, it can have up to 30 burrs per tiller and yield 1,000 seeds per plant. One to four seeds form in each burr with an average of three being produced. The first seed formed (primary seed) is the largest and can germinate within a few months. The other seeds (secondary seeds) can remain dormant for a period exceeding three years. The majority of seed germinates in spring, but germination can occur at any time of the year except in mid-winter. Both primary and secondary seeds have the ability to establish from depths of 20 cm in sandy soils and readily establish from depths of 10 to 12 cm in most soils.

Problem status. Sandburr is a weed because of its burr and its ability to spread rapidly and develop into dense widespread infestations in favourable situations. The early growth can provide some grazing, but mature burrs can be a problem for livestock, dogs, wool and man. It is difficult to control in a number of situations, due to the lack of suitable chemicals and the cost of control. The major spread of this weed is by seed. The burrs have barbed spikes that are easily detached from plants when mature. They adhere to wool, fur, clothing, tyres and similar materials. Wind plays little part in the spread, but water in irrigation channels, creeks and rivers can spread seed rapidly. Sandburr is a summer growing, mainly annual, grass, found on light soils throughout the drier areas of Australia and on disturbed areas in Inglewood Shire. It prefers light, sandy, well drained soils and is common along roadsides, creeks and river banks.

Control. Cultivation can be used to remove seedlings and prevent seed formation. However, cultivations have to be routine and carried out for at least three years. Intermittent cultivations create conditions ideal for the germination, growth and reproduction of sandburr. Repeated cultivations, necessary to control the staggered germinations of this weed, can lead to soil erosion and soil structural problems such as compaction or surface crusting. Heavy grazing with sheep will prevent seeding but it is not always practical, especially where small patches occur in large paddocks.

A number of herbicides are registered for control of sandburr. They include pre-emergent herbicides in specialty crops such as cotton, lucerne, sunflowers, soybeans and vegetables and non-selective herbicides for such situations as fencelines and roadways. Several pre-emergent herbicides with residual properties have proved fairly successful. However, because this weed can germinate from depths of 20 cm, these are not always completely effective. The herbicides registered for a range of crops and situations are as follows:

* 2,2-DPA + amitrole + TCA (a.i. 300 g/kg + 120 g/kg + 400 g/kg);
* bromacil + diuron (a.i. 400 g/kg + 400 g/kg);
* chlorthal + linuron (a.i. 550 g/kg + 75 g/kg);
* diuron (a.i. 500 g/L);
* glyphosate (a.i. 360 g/L);
* MSMA (a.i. 800 g/L);
* oryzalin (a.i. 500 g/L).

For specific registrations and recommendations, refer to the publications list in this chapter and consult the local extension agronomist.

Taking into consideration the current methods of controlling sandburr plus the physical and climatic limitations that occur in many situations, the best approach is to combine a number of the techniques outlined. Because of the seed dormancy factor, a control program should be planned for a two to three year period. In arable situations, a program could involve cultivations during spring and summer combined with heavy grazing by sheep, followed by the planting of a winter cereal crop using a pre-emergent herbicide. By employing these practices for two to three years, the seed burden will be minimal. Non-selective herbicides could be used for fencelines and timbered areas to prevent re-infestation which can occur rapidly from non-crop areas.

Further information

Kelso, H.G. (1983). Spiny burrgrass. N.S.W. Department of Agriculture Agfact P7.6.21.

Fig.38 Thornapple *(Datura stramonium)*
Courtesy Ciba Geigy Australia Ltd.

Thornapple *(Datura* spp.*)*. There are several species of this plant, each originating in different parts of the world.

Datura ferox comes from China and *Datura stramonium* from Europe and Asia. The weed is also referred to as thornapple, datura, stramonium or castor oil. They are all robust annual herbs growing to 1 metre with erect stems, repeatedly forked; leaves mostly borne towards the ends of the branches, dark green, mostly large, with edges shallowly scalloped, emitting an unpleasant smell when crushed. The flowers are long, tubular and white in *D. ferox* and purple in *D. stramonium*. The fruit are covered with prickles, fewer in number on *D. ferox* and varying in size depending on growing conditions.

Problem status. It is a summer growing annual weed which competes strongly with annual crops for water and nutrients. Summer grown crops can be highly contaminated by the small black seeds which are of a similar size to grain sorghum and difficult to grade out of this crop. The plant and seed are poisonous to stock. Thornapples grow better on deep soils, but will grow on a large part of Inglewood Shire in favourable seasons.

Control. Mechanical control is achieved by chipping, hand pulling or cultivation. A wide range of herbicides is registered in Queensland for control of thornapples. It includes:

* acifluorfen (a.i. 224 g/L);
* atrazine (a.i. 500 g/L);
* bentazone (a.i. 480 g/L);
* dicamba (a.i. 200 g/L);
* glyphosate (a.i. 360 g/L);
* pendimethalin (a.i. 330 g/L);
* 2,4-D + picloram (a.i. 200 g/L + 50 g/L).

These cover a range of crops. For specific registrations and recommendations, refer to the publications list in this chapter and consult the local extension agronomist.

For chemical control in non-crop situations, the following recommendations are given:

(a) Tordon 50-D: for spot spraying apply at 40 to 75 ml/15 L knapsack. Use the higher rate on older plants. This herbicide provides some residual control of further germinations.

(b) Roundup: for spot spraying, apply at 75 to 100 ml/15 L knapsack. Use the lower rate on weeds up to 15 cm tall; increase to the higher rate where weeds are over 15 cm tall. This is a non-residual herbicide.

Further information

Diatloff, G. (1977). Thornapples and their control. Technical Bulletin, Queensland Department of Lands.

Fig.39 Wild Radish *(Raphanus raphanistrum)*
Courtesy Ciba Geigy Australia Ltd.

Wild radish *(Raphanus raphanistrum)*. The plant is European in origin. It was probably introduced accidentally into Australia, then spread as a contaminant in agricultural produce in the early 1800s. It is often mistaken for related weeds such as wild turnip and mustard weed. Correct identification is important as wild radish is more competitive and difficult to control. Mature plants have flowers with white or cream petals arranged in a cross shape, with distinct purple veins running through the petals. The pods are 5 to 6 cm long, and as they mature they become constricted between the seeds. Mustards are easily distinguished from wild radish as mustard plant leaves are oval in shape whilst those of wild radish and wild turnip are heart-shaped. The latter two are more difficult to distinguish from each other. The leaves of wild turnip have prominent leaf hairs and surface warts and are a lighter green than those of wild radish.

Problem status. Wild radish is the major weed of winter crops on alluvials of the Macintyre Brook and Dumaresq River. Wild radish can compete with all summer and winter crops grown in the lighter soils of the shire and causes major contamination problems in some. Control is difficult because of its high level of tolerance to herbicides, widespread germination period, long-term viability of seeds and lack of palatability to stock. It is capable of causing very serious crop losses. The weed occurs throughout Inglewood Shire in cultivation areas. However, it is rare on brigalow-belah soils where mustards and wild turnip are more commonly found.

Control. This needs integrating with crop management. It includes hand weeding of isolated palnts; spot spraying with herbicides such as 2,4-D for isolated patches; slashing of flowering plants along roads and headlands prior to seed maturity; cultivation of fallow land before seed set; avoiding the deep burial of seed, as this lengthens the period of viability; successive cropping with minimum tillage to reduce the quantity of viable seed in the soil. Pasture periods in a rotation are not of themselves a control measure, but wild radish can be effectively controlled in Haifa white clover, the major irrigated pasture plant in the shire.

When using chemical control, early spraying is essential because of high levels of crop competition. Early spraying is warranted if 10% or more of the paddock is infested with thick patches of wild radish. Spraying of winter cereals must be done within six to eight weeks of sowing. The most effective herbicide for early post-emergent control is a bromoxynil + MCPA product at early tillering of the crop and at the two to six leaf stage of the wild radish. Late spraying of a crop gives a poor yield response, but can prevent contamination. Most effective control can be obtained with early and late sprayings. Advanced wild radish can be controlled using 2,4-D amine or MCPA, provided the growth stage of the crop is correct. It is emphasised that wild radish control and eradication is quite complex. Detailed information should be obtained from the local extension agronomist.

Herbicides registered in Queensland for the control of wild radish in a range of crops include:

* 2,4-D amine (a.i. 500 g/L);
* 2,4-D ester (a.i.);
* 2,4-D + picloram (a.i. 200 g/L + 50 g/L);
* bromoxynil (a.i. 200 g/L);
* bromoxynil + MCPA (a.i. 200 g/L + 200 g/L);
* chlorsulfuron (a.i. 750 g/kg);
* dicamba (a.i. 200 g/L);
* dicamba + MCPA (a.i. 80 g/L + 340 g/L);
* MCPA (a.i. 500 g/L);
* MCPA + picloram (a.i. 420 g/L + 26.25 g/L).

For more specific registrations and recommendations refer to the publications list in this chapter.

Further information

Harris, G. A. (1986). Wild radish. Macintyre-Dumaresq Irrigation Notes Issue 40, pp 16-23.

Dellow, J. J. and Milne, B. R. (1987). Wild radish. N.S.W. Department of Agriculture Agfact P 7.6.6.

Fig.40 Wireweed *(Polygonum aviculare)*
Courtesy Ciba Geigy Australia Ltd.

Wireweed *(Polygonum aviculare).* This plant is a native of Europe and Asia. It is widespread throughout Australia, growing on moist soils from heavy black to granite loams. On emergence, wireweed is often mistaken for a fine grass seedling. Seedlings are usually less than 2 cm high and have red stems. The first two leaves are 1 to 1.5 cm long, very narrow (1 to 2 mm wide) and are supported by very short leaf stalks. These first leaves appear in a 'V' shape formation. Later, leaves grow to twice the size of the first leaves. The leaves, arranged alternately along the length of the stem, are blue-green in colour and taper at both ends. Each leaf can grow up to 4 cm long, with prominent veins running from the side of the stem to the underside of the leaf. Unlike many other broadleaf weeds, wireweed does not form a rosette and is hairless. One to five very small, pink or white flowers form in the junction between the leaf and stem. The three-sided seed is 2.5 mm wide and reddish-black in colour. The mature plant has long, stiff, wiry, but prostrate, stems that can reach 1 m in length. However, if left to mature with other tall plants, wireweed will climb them.

Problem status. Wireweed can behave as an annual or biennial. Biennial plants over winter and regrow in spring-summer. Annual plants are the major problem in crops. Winter germinations will flower in spring and early summer, while spring germination flowers from mid to late summer. The mature plants also cause physical problems by blocking tined cultivating machinery. Mature plants that have climbed crop plants, can cause header blockages and raise the moisture content of harvested grain. Wireweed does not generally present a problem to stock and, in fact, is often referred to as 'poor man's lucerne'. Wireweed can cause failure of crop or pasture establishment because of its strong competition for water and nutrients. It also contains a chemical that can inhibit the growth of plants that germinate in areas of established wireweed. This occurs particularly with annual medics or lucerne. Deformities occur in the medic/lucerne seedlings and this, coupled with the other competitive effects of wireweed, results in establishment failure. The weed occurs on all soil types in the Inglewood Shire and is particularly troublesome on the irrigated alluvial soils.

Control. Bad infestations of wireweed can be controlled by cultivation, particularly in long fallows. Cultivation also destroys the toxic inhibitor in the green plants. Grazing cattle and sheep will eat young growth, but tend to avoid mature plants. Slashing is not effective because of the prostrate habit. A wide range of herbicides is registered in Queensland for the control of wireweed. It includes:

* 2,4-D amine (a.i. 500 g/L);
* 2,4-D + picloram (a.i. 200 g/L + 50 g/L);
* 2,4-DB (a.i. 400 g/L);
* atrazine (a.i. 500 g/L);
* benfluralin (a.i. 200 g/L);
* bromoxynil (a.i. 200 g/L);
* bromoxynil + MCPA (a.i. 200 g/L + 200 g/L);
* chlorsulfuron (a.i. 200 g/L + 200 g/L);
* dicamba (a.i. 200 g/L);
* MCPA + picloram (a.i. 420 g/L + 26.25 g/L);
* pendimethalin (a.i. 330 g/L);
* trifluralin (a.i. 400 g/L).

These herbicides cover a range of crops. For more specific registrations and recommendations, refer to the publications list and consult the local extension agronomist.

Further information

Hennessy, G. F. (1983). Wireweed. N.S.W. Department of Agriculture Agfact, P7.6.20.

Contacts for weed control information

Queensland Department Primary Industries

1. Extension Agronomist,
   Department of Primary Industries,
   P.O. Box 300,
   GOONDIWINDI, Q. 4390
   Telephone: (076) 71 1388

2. J. M. T. Marley,
   Senior Agronomist (Weeds),
   Department of Primary Industries
   Hermitage Research Station,
   via WARWICK, Q. 4370
   Telephone: (076) 612 944

3. W. H. L. Hazard,
   Principal Agronomist (Weeds),
   Department of Primary Industries,
   G.P.O. Box 46,
   BRISBANE, Q. 4001
   Telephone: (07) 224 0414

4. For identification enquiries:
   The Botanist,
   Department of Primary Industries,
   Botany Branch,
   Meiers Road,
   INDOOROOPILLY, Q. 4068
   Telephone: (07) 377 9326

Lands Department Queensland

1. The Extension Officer,
   Alan Fletcher Research Station,
   Department of Lands,
   P.O. Box 36,
   SHERWOOD, Q. 4075
   Telephone: (07) 379 6611

2. Lands Department Weedicide Store,
   104 Lavarack Avenue,
   EAGLE FARM, Q. 4007
   Telephone: (07) 268 7632

Chemical companies

1. Amalgamated Chemicals Ltd.,
   Tingira Street,
   PINKENBA, Q. 4008
   Telephone: (07) 260 1091

2. BASF Australia Ltd.,
   17 Jaybel Street,
   SALISBURY, Q. 4107
   Telephone: (07) 275 3077

3. BP Australia Ltd.,
   193 North Quay,
   BRISBANE, Q. 4000
   Telephone: (07) 225 9333

4. Bayer Australia Ltd.,
   P.O. Box 161,
   TOOWONG, Q. 4066
   Telephone: (07) 369 3044

5. Biocontrol,
   P.O. Box 515,
   WARWICK, Q. 4370
   Telephone: (076) 614 488

6. Consolidated Fertilizers Limited,
   P.O. Box 140,
   MORNINGSIDE, Q. 4170
   Telephone: (07) 390 5011

7. Ciba-Geigy Australia Ltd.,
   P.O. Box 145,
   WESTEND, Q. 4101
   Telephone: (07) 844 7531

8. Dow Chemical (Australia) Ltd.,
   301 Coronation Drive,
   MILTON, Q. 4064
   Telephone: (07) 369 8288

9. Du Pont (Australia) Ltd.,
   20-26 Balaclava Street,
   WOOLOONGABBA, Q. 4102
   Telephone: (07) 391 8522

10. Elanco Products Company,
    Wharf Road,
    WEST RYDE, N.S.W. 2114
    Telephone: (02) 858 8022

11. Farmco Australia Pty. Ltd.,
    P.O. Box 73,
    HAMILTON, Q. 4007
    Telephone: (07) 268 5911

12. Hoechst Australia Ltd.,
    100 Victoria Street,
    WEST END, Q. 4101
    Telephone: (07) 844 3661

13. ICI Australia Operations Pty. Ltd.,
    P.O. Box 337,
    WEST END, Q. 4101
    Telephone: (07) 240 9444

14. Monsanto Australia Ltd.,
    P.O. Box 63,
    HAMILTON CENTRAL, Q. 4007
    Telephone: (07) 268 5888

15. Nufarm Chemicals Pty. Ltd.,
    P.O. Box 223,
    BRENDALE, Q. 4500
    Telephone: (07) 205 5088

16. Rohm and Haas Australia Pty. Ltd.,
    22 Thurlow Street,
    NEWMARKET, Q. 4051
    Telephone: (07) 356 9022

17. Retec Ltd.,
    P.O. Box 140,
    MORNINGSIDE, Q. 4170
    Telephone: (07) 390 9393

18. Schering Pty. Ltd.,
    54 Annie Street,
    ROCKLEA, Q. 4106
    Telephone: (07) 394 2382

19. Shell Chemical (Australia) Pty. Ltd.,
    301 Ann Street,
    BRISBANE, Q. 4000
    Telephone: (07) 226 5301

20. Stauffer Australia Ltd.,
    P.O. Box 105,
    HAMILTON CENTRAL, Q. 4007
    Telephone: (07) 268 7022

21. Velsicol Australia Ltd.,
    P.O. Box 405,
    PYMBLE, N.S.W. 2073
    Telephone: (02) 498 1799

The above list covers the major agricultural chemical companies in Australia. It is not an exhaustive list of all companies which produce and/or market agricultural chemicals. A specific enquiry about a herbicide should be directed to the relevant company as well as the Q.D.P.I.

extension agronomist. Some of the major companies have field officers who service producers in this district. They can provide information on the use of their herbicides. These field officers change on a regular basis. Therefore the Head Offices of the relevant companies should be contacted as they will be able to give you the name and telephone numbers of their relevant people.

Private agronomists and consultants

A growing number of private agronomists and consultants service this region. They can provide information on all aspects of property management, including weed control. They are listed in the yellow pages of the telephone book under "Farm and Agricultural Advisory Services".

Commercial agronomists

Several of the commercial companies also employ qualified agronomists to advise their clients. The following companies have such staff:

Boggabilla Seed and Grain Sales;
Dalgety-Winchcombe FGC:
Elders Pastoral.

Other contacts

Other contacts for information on weed control are:

1. Plant Protection Department,
   Queensland Agricultural College,
   LAWES, Q. 4345
   Telephone: (075) 620 211

2. The Weed Society of Queensland (WSQ)
   Membership of this organisation includes research and extension agronomists, consultants, and private landholders with an interest in weed control. They produce a regular newsletter with items of interest on weed control. They also conduct field days and seminars. For information on the WSQ, you should contact the current President (1988):

   Mr. Greg Fraser,
   I.C.I.,
   G.P.O. Box 337,
   BRISBANE, Q. 4001
   Telephone: (07) 391 8522
   or your local extension agronomist.

Some registered trade names for herbicide chemicals

An increasing number of herbicides are available to primary producers. Recommendations for control often list the active ingredient to be used, but no mention of an actual proprietary product is made. This can be confusing for farmers and suppliers. The table below lists the herbicides most commonly used in this region, together with several commercial products available. The list of commercial products is not complete because of space limitations. The inclusion of a commercial product does not imply that it has D.P.I. or Inglewood Shire Land Management Committee endorsement over other products. Not all products listed may be readily available due to commercial decisions made by manufacturers or suppliers.

Note: These are Queensland registrations only. Different registrations may apply in N.S.W.

Active ingredient	Product
aciflourfen	Blazer selective herbicide
amitrole	Farmco amitrole-T herbicide; Nufarm Amitrole-T herbicide
atrazine	Farmco Atrazine Flowable; Flowable Atrazine 500 SC; Flowable Gesaprim 500 FW; Nufarm Flowable Nutrazine
atrazine mixtures	Primextra (with metolachlor)
barban	Barban 250 EC
benfluralin	Balan Selective Herbicide
bentazone	Basagran
bromacil	Du Pont Hyvar X
bromacil mixtures	Krovan 1 Weedkiller (with diuron)
bromoxynil	Brominil; Buctril 20
bromoxynil mixtures	Brominil M (with MCPA); Buctril MA (with MCPA); Farmco Bromoxynil - MA (with MCPA); Farmco Sure-Shot (with MCPA and dicamba); Nufarm Bromicide MA (with MCPA)
chlorthal mixtures	Shamrox WP Pre-emergence Herbicide (with linorun)
5-[2-chloro-4-(trifluoro-methyl)-phenoxyl]-2-nitrobenzoic acid	Blazer 2L
chlorsulfuron	Glean
2,4-D	Farmco D-500; Nufarm Amicide 50;
2,4-D ester	Lane 2,4-D ester 80 herbicide; Farmco D-800 selected weedkiller
2,4-D mixtures	Tordon 50-D (with picloram)
2,4-DB	Nufarm Buticide; Selectone
2,2-DPA	Dowpon M; Nufarm Nu-Pon M
2,2-DPA mixtures	Weedazol Industrial Total Herbicide (with amitrole and TCA)
dicamba	Banvel 200
dicamba mixtures	Banvel M (with MCPA); Farmco Sure-Shot (with bromoxynil and MCPA)
diclofop-methyl	Hoegrass
diphenamid	Enide 50
diquat	Reglone
diquat mixtures	Spray-Seed (with paraquat); Tryquat (with paraquat)
diuron	Farmco Diuron Herbicide; Elderado Diuron Herbicide
EPTC	Eptam
ethidimuron	Ustilan Herbicide Spray; Ustilan D Herbicide Spray
flamprop-methyl	Mataven 100
fluazifop	Fusilade 212
glyphosate	Roundup; Roundup CT
hexazinone	Velpar L; Velpar 20G
MCPA	Nufarm MCPA Amine 500; Farmco MCPA 500
MCPA mixtures	Banvel M (with dicamba); Brominil M (with bromoxynil); Buctril MA (with bromoxynil); Farmco Bromoxynil MA (with bromoxynil and dicamba); Nufarm Bromocide MA (with bromoxynil); Tordon 242 (with picloram)
methyl bromide	Bromafume Soil Fumigant; Brom-o-gas
metolachlor	Dual
metolachlor mixtures	Primextra (with atrazine)
MSMA	Daconate 8 Post-emergence Herbicide
oryzalin	Surflan 500 Flowable Herbicide
oxyfluorfen	Goal
paraquat	Gramoxone; Shirquat
paraquat mixtures	Spray-Seed (with diquat); Tryquat (with diquat)
pebulate	Tillam
pendimethalin	Stomp 330E
picloram	Tordon Granules
picloram mixtures	Tordon 50-D (with 2,4-D); Tordon 242 (with MCPA); Tordon 1040 (with 2,4,5-T); Tordon Tree Control (with triclopyr)
propachlor	Ramrod 65

sethoxydim	Sertin 186 EC
2,4,5-T	Farmco TLV-400; Farmco TLV-800; Nufarm Five T40; Nufarm Five T Brush Killer
2,4,5-T mixtures	Tordon 1040 (with picloram)
TCA	Crop King TCA; Hoechst TCA Grass Killer
terbacil	Du Pont Sinbar Herbicide
tetrapion	ICI Frenock
triallate	Avadex BW
triclopyr mixtures	Tordon Tree Control (with picloram)
trifluralin	Farmco Trifluralin; Nufarm Trifluralin
vernolate	Stauffer Vernam Pre-emergent Herbicide

CHAPTER 10

NATIVE AND INTRODUCED FAUNA — ALLIES AND PESTS

Preservation of native fauna

This work would not be complete without reference to the preservation of our native wildlife. Most rural dwellers are conscious of, and enjoy, native animals and birds. They are aware that reptiles and insects all play roles in balancing nature. All recognise that, with the landing of the first fleet, the balance was inevitably disturbed. Endeavours must be maintained to keep a working relationship between nature and the land based industries.

Landowners must also be conscious of the fact that dedicated conservation groups and animal protection bodies exert considerable political influence. It, therefore, seems to be in the interests of farmers and graziers that, when planning property development, they make provision for areas in which native fauna can co-exist with man. If they ignore this, then government could eventually pass legislation which restricts the right of the occupier to develop his country without seeking prior approval.

Native animals control many pests. Hawks and owls, as well as some snakes and lizards, live on rabbits, rats and mice. Smaller birds, reptiles, and some marsupials live on insect pests which lower the productivity of pastures and crops. There are many creatures which keep the insect pests in check. Consider, for example, the number of grass eating insects which would be consumed by a flock of ibis.

The easy way to preserve fauna of all types is to set aside areas of native vegetation. This can be done in several ways according to individual requirements:

* by leaving patches of lighter, or stony, less productive country in strategic locations;
* by leaving shelter belts along fences, roads and in gullies.

A combination of these could be even better, with shelter belts connecting patches of native forest. An added benefit from shelter belts is their value as wind breaks; particularly if they are wide enough to ensure their own regeneration, and they contain an understorey of shrubs.

Much has been said about kangaroos. It is their mobility which allows them to cause so much damage to crops and pastures. Smaller herbivores do not have the kangaroo's ability to cover open ground. Their existence is therefore endangered unless they can gain mobility through corridors of timber. In one timbered roadside verge in the Victorian Wimmera, which is 2.5 km long and 70 metres wide, a count revealed 90 species of birds present, with up to 1,500 birds per square kilometre. This is considered to be almost the same population as for continuous woodland. It indicates that large areas are not required to provide a natural environment for a wide range of species. It has been found that sugar glider possums can survive very well in areas as small as 1.5 ha.

Some native animals, birds and reptiles which are not normally a problem to man's agricultural activities, can become so if the population becomes endemic. However this is not, nor is it likely to become, a problem with most species in Inglewood Shire. Wildlife found in small areas of vegetation can be of direct benefit to landowners as predators of agricultural pests. Preservation of the habitat on a property, so that it is self-sustaining, is well within the scope of good property management. Indeed, if birds and insects are to continue their unpaid contribution to man's well being it becomes a necessary part of management. This is not to suggest that land should not be developed, but that when property improvement and land clearing are planned, serious thought should be given to conserving a natural environment where native flora and fauna are able to flourish.

Mammal and bird pests

Producers in Inglewood Shire are subject to the depredations arising from the activities of animal and bird populations, both feral and native. Such activities are frequently the source of economic loss. The minimising of such losses, within reasonable conservation criteria, is an integral part of wresting a living from the land within the shire. Those pests that fall into this category are discussed in turn.

Kangaroos

These include the eastern grey kangaroo, the several wallabies (rednecks, swamp and black stripe), and wallaroo. Of all the mammal pests, kangaroos and their relatives cause the greatest financial losses, as a result of the vast amounts of pastures and crops they eat. They prefer the best of the food available. The netting fences needed to keep roos out, if at all weak, are often extensively damaged. As well as allowing stock to roam, damaged fences allow dingoes (for which netting fences are also needed) to enter sheep country. Because most of the dog-netting fences have been standing for a long time, rust at ground level makes them susceptible to kangaroo damage. Fabricated, plain, and barb wire fences, even though they allow kangaroos through them, are prone to some damage. Contrary to the view of many conservationists, landholders recognise the symbolic appeal of the kangaroo and are quite prepared to have reasonable numbers on their properties. However, they cannot afford to allow kangaroos to over-run pastures and crops. Following good seasons, with tight controls on the number allowed to be killed for skins and carcasses, they have increased steadily in recent years. In fact, kangaroo numbers have increased during the years of white settlement because of the feed and water provided in the process of pastoral and agricultural development.

Figure 41. Design for electrified kangaroo fence.
Courtesy Queensland Department of Primary Industries.

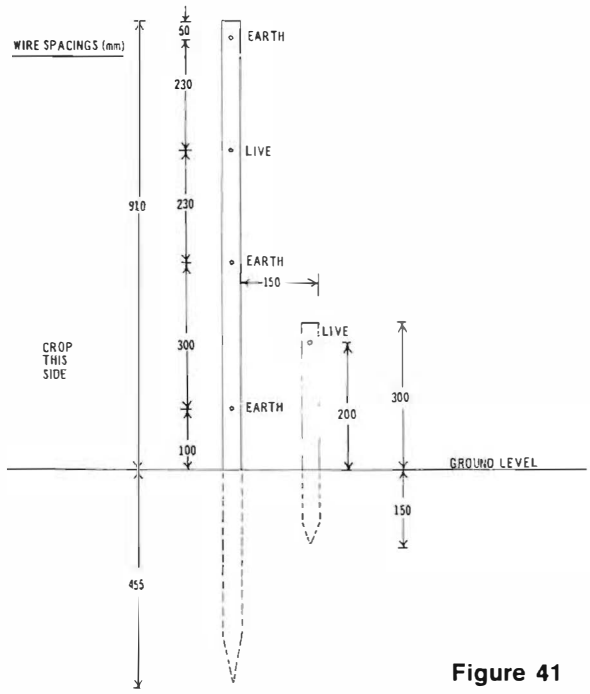


Figure 41

Control measures. As the shire has extensive timber and scrub cover, controlling the roo population is virtually impossible. The best approach from all points of view is to have the population reduced by commercial shooters who

sell hides and, sometimes, the meat. Where possible, pest animals should be taken for the kangaroo industry, as their skins and carcasses are saleable. Unfortunately, the smaller wallabies are of no commercial value. Although not a financial proposition on grazing land, exclusion fencing is a means of reducing damage to crops. However, as profit margins become slimmer, conventional fencing is getting too expensive. Electric fencing has a considerable cost advantage over conventional fences, being generally 25% to 33% of the cost of other methods. Designs to exclude roos are being developed. However, if electric fencing is to be effective, it needs to be well constructed to cut down on faults (see Figure 41).

When roos reach such numbers that destruction is necessary, the landholder is required to obtain a "Section 25" permit which will specify the number to be killed. These permits are available from the Queensland Parks and Wildlife Service. They are a legal requirement before pest destruction may be undertaken.

Rabbits

Unfortunately, Inglewood Shire is not protected by the "rabbit fence" which forms part of the boundary, as the shire is on the wrong side of the fence. Rabbits are prevalent throughout. Stocking rates have been seriously affected in the past by the large amount of pasture they consume. Feed and grain crops are also readily attacked.

Myxomatosis was introduced into the shire in the mid 1950s. This has effectively controlled their numbers. In more recent years, a government funded campaign of baiting with 1080 has further reduced populations. As summer rains are not reliable for breeding the mosquitoes which carried myxomatosis virus, a stick-fast flea is now being used to transmit the disease. As the demand for furs and carcasses has decreased, shooting and trapping are now practised only by weekend shooters for sport. Fumigating the warrens, followed by ripping, is probably the most effective way of dealing with rabbits. It generally requires doing at least twice. Burning of logs destroys another of the rabbits' habitats. Combined with myxomatosis and poisoning, this habitat control can be highly effective.

Dingoes and domestic dogs

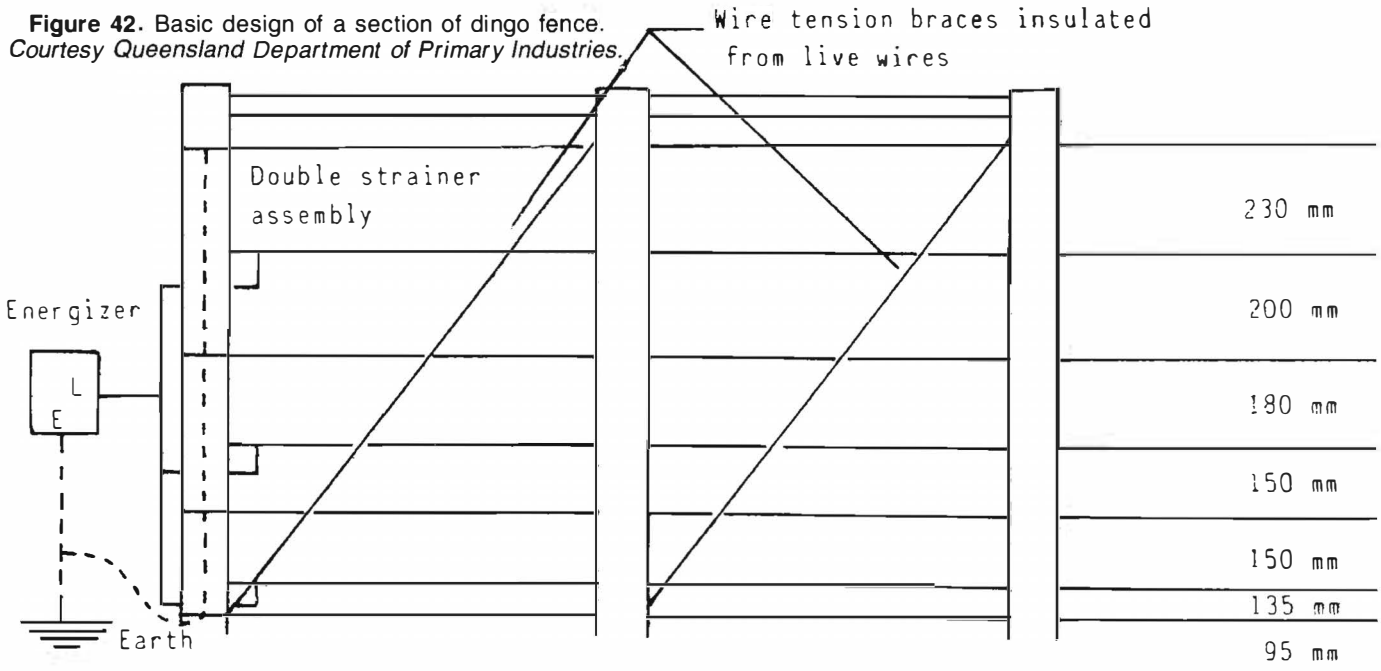
The dingo seems to have been increasing in numbers of the past 10 to 15 years. The sheep country has the protection of the dingo barrier fence and the rabbit fence, which help keep them on the other side. Around the Inglewood and Texas townships, domestic dogs not chained up at night often roam in small packs. They cause havoc amongst sheep flocks

Trapped.
Photo courtesy Peter Pavlov, Queensland Lands Department.

in close proximity. Hobby farm areas can be the source of a similar problem, as yet, this kind of development is fairly small in the shire. Apart from killing to eat, dingoes, when in numbers, cause severe stock losses because they seem to kill for pure enjoyment. When dingoes are killing in a certain area, the sheep become disturbed and do not follow their normal feeding patterns. Sheep maimed by dingoes generally die either from injuries or from fly-strike.

Control measures. The most effective type of dingo control is well-maintained netting or electric fencing, or a combination of both (see Figure 42). Cost considerations favour electric fencing. Once dingoes are found on a sheep property, then it is usual to attempt trapping by means of suitable dog traps, advise the council who employ an experienced dogger, call a dog-drive amongst the neighbours, and/or shoot on sight. All methods are time-consuming and not always fruitful. A helicopter with a marksman on board is currently being used in the Toowoomba area with reasonable success. However, Inglewood Shire supports too much timber cover for this method to be reliable and '1080' baits are largely ineffective, as dingoes have ample small game besides sheep to provide a fresh meat diet. The shire council needs to be informed with a view to co-ordinating efforts to eradicate dingoes. If a landholder is having a problem the dogger is available to investigate. Domestic/town dogs are much less wary of man and easier to eliminate. Stricter legislation and enforcement by council regarding numbers, breed, and supervision of town dogs would reduce the menace to stock. The Robert Wicks Research Station of the Department of Lands, on the Millmerran Road, is currently studying the dingo. Hopefully, research will uncover more effective methods of control.

Figure 42. Basic design of a section of dingo fence.
Courtesy Queensland Department of Primary Industries.



Foxes

These, although plentiful, do not cause farmers a great deal of harm. In recent years (but not since 1985) the furs have been in some demand and thus sought after by shooters. Fortunately, foxes are susceptible to mange which causes death in due course. They can be quite useful in controlling rabbit and mice populations. Losses are caused when they raid the household chicken yard or kill new-born lambs and goats, often eating only the tongue or kidneys.

Pig traps are one means used by district graziers to control wild pigs.

Feral pigs

Numbers of this pest are on the increase; even in trap-rock areas once thought to be an unsuitable habitat. Their preference is for grain crops on brigalow soils and along river and creek flats. Various small crops are also frequently damaged. Occasionally pigs kill young lambs and drought-affected sheep. There is also danger of disease (e.g. Brucellosis) and parasites being introduced to open-range piggeries. Wild boars may also breed with domestic sows. Fencing is frequently damaged. Not many fences are a barrier to a determined pig. It is debatable whether electric fencing is fully effective but at least it does deter the pig somewhat.

Control measures. These include baiting with '1080' and S.A.P., shooting and catching with dogs, trapping in grain or carcass-baited mesh silos, and shooting from helicopters. Carcasses are readily saleable at freezer boxes located in Inglewood, Texas and Goondiwindi — provided they can be delivered quickly for game meat, which is popular in some overseas countries. A side effect which is highly unacceptable to the farming community is that pig hunters kill only the large pigs; leaving the smaller ones to grow and breed.

Feral cats

These are increasing in numbers and, while they do not affect normal farm livestock, they prey on birdlife and small nocturnal animals which normally help control many insect and other pests. On the positive side, they also prey on mice and rabbits.

Feral goats and deer

Measures must be taken to keep feral pests down because of the threat of exotic diseases running rampant if an outbreak occurs, e.g. foot and mouth, rabies, blue-tongue.

Mice and rats

These are found in the shire, but are not likely to cause serious damage due to the mixed nature of grazing and farming. They can damage electrical wiring in houses and vehicles, thus creating a fire danger. Stored grain, unless totally rodent-proofed, is highly susceptible to damage. Normally if farm buildings and outside areas are kept free of long grass and piles of rubbish, rodents do not present a great problem; particularly if an odd cat or two is encouraged to include them in its diet. Baiting is useful but care is necessary to prevent children, dogs and domestic cats coming into contact with the baits.

Flying fox

Large numbers of these mammals raid orchards and vineyards in the shire, causing considerable damage. There is greater damage in those years when eucalypt blossoms, their natural food, are in short supply. Quite often flying foxes "short out" the lightning gaps on power poles, thus blacking out many consumers. When the foxes camp, usually along a watercourse, the weight of the large numbers breaks off tree branches. Also they excrete in the streams. This fouls the water for stock and domestic purposes. Shooting the camps with guns can destroy large numbers but vast quantities of cartridges are needed. Usually shooting will only shift their camp a few hundred metres at a time. The only practical approach to control flying foxes is to shoot the intruders that raid orchards. These intruders usually constitute a very small percentage of the total camp.

Emu

The largest of our native birds, the emu is found in some timbered areas. Emus do some damage to fencing and disturb grazing stock, especially if the stock are uneasy as is the case when dingoes are active. Like all other native fauna, emus are protected and the only control that is permitted is under a Section 25 permit, if sufficient damage can be demonstrated.

Wedge-tail eagle

These birds can be seen in our skies. They prey on young, mis-mothered lambs and weak sheep. Fortunately they also prey on other pests such as rabbits and mice. Since the 1970s, the eagle has been protected. Before then a bounty was placed on their heads, but it was removed after extensive research, mostly in southern states, showed that eagle-caused losses were small.

Wood ducks

Since the construction of Coolmunda Dam, a fauna reserve, wood ducks have increased rapidly in numbers. Lucerne and grain crops are severely affected by these grazing birds. Although there is a duck season for shooters, their numbers are not reduced enough. They are still protected out of season and may only be shot as a pest on a Section 25 licence.

Galahs, cockatoos and parrots

These birds swarm onto grain crops. Besides eating the grain, they break the heads off, making much more of it impossible to harvest. Shooting with shotguns using both live and bird-scaring cartridges is only partially effective. Kites in the shape of hawks can be flown over crops but are not practical for large areas because of the numbers necessary. These kites do not work when the wind stops blowing. However a balloon shaped like a hawk and filled with helium gas to keep it afloat on still days has been manufactured. It is debatable whether these balloons are an effective method of control. Some success has been claimed by growing strips of taller crops such as forage sorghum around and through the grain crop to create "tunnels". Apparently the birds do not like to feed if the grain crop is below the height of the tall sorghum because they cannot see approaching danger. Care must be taken to ensure that there are no gaps in the "screen" crop or the exercise will be a waste of time and money.

Small birds

Among the small birds, leather heads (noisy friar birds) can destroy 5% of a fruit or grape crop. The black-faced cuckoo shrike (blue jay) is also a grape eater. Sonic bird-scaring devices, whether of the carbide scaregun or the amplified "scary noise" type, have never proved to be particularly effective.

Crows and ravens

Everyone is familiar with common crows and ravens. As scavengers they feed on dead carcasses. However, they also eat grain, vegetables and fruit (also pests such as mice, rats and insects). A pernicious habit of these birds is to remove the eye of a weak sheep or beast if it happens to "go down" for any reason, such as a difficult birth or poor condition during drought. If the animal is found still alive with an eye removed, it invariably dies from shock and/or infection. These birds are virtually impossible to shoot because of their great wariness. However, they can be poisoned with carcasses baited with S.A.P., a procedure that is not approved by wildlife authorities, but desperate situations require desperate means, especially in droughts.

If any producer experiences a pest problem which has not been dealt with this chapter, he should contact the Lands Department, who have information on the latest developments available. The Robert Wicks Research Station close to Inglewood is carrying out research into pest problems. Hopefully, more knowledge will lead to new and more effective ways of controlling vermin. Drawing on the experience of neighbours may also provide some answers to a particular pest problem.