ADOPTION OF THE SHRUB LEGUME *LEUCAENA LEUCOCEPHALA* IN CENTRAL AND SOUTHEAST QUEENSLAND

L. C. LESLEIGHTER* and H. M. SHELTON**

*Queensland Country Life, G.P.O. Box 711, Brisbane, Qld. Australia 4001.
**Department of Agriculture, University of Queensland, St. Lucia, Qld. Australia 4067

ABSTRACT

A survey was conducted in November, 1984 to quantify the level of adoption of leucaena (Leucaena leucocephala *(Lam.) de Wit) in central and southeast Queensland and to determine reasons for the suspected low level of adoption. The survey was of 1208 farms from 14 shires in the statistical divisions of Fitzroy, Wide Bay-Burnett and Moreton. These comprised 30% of the beef and dairy producers in these divisions. Valid responses were received from 451 producers.*

Results showed a low level of adoption in terms of area planted and number of growers using leucaena (6% of respondents). Adoption was limited by a low level of awareness (only 60% had heard of leucaena), a lack of information and a high failure rate (65% of area originally planted). However, data indicated that by 1986 there would be a more than 10-fold increase in the area planted and a 3-fold increase in number of growers. Adoption was greatest in the Fitzroy Division and was greater for beef than for dairy producers. Other factors influencing adoption of leucaena such as property characteristics, attitudes and experiences, and information levels and sources are discussed. The high failure rate of leucaena plantings was linked to low level of use of recommended cultural practices such as scarification and inoculation, and the many small plantings (71% of areas < 4.1 ha) which were vulnerable to damage by feral animals.

INTRODUCTION

Leucaena, *Leucaena leucocephala* (Lam.) de Wit, is a versatile, tropical legume which has potential for use as firewood, timber, soil improver and stabilizer, and as a protein rich human and animal food (National Research Council 1984).

Native to Mexico, leucaena is now grown in many parts of the world, including Australia where it was naturalized in north Queensland by 1920 (White 1937). Large areas of Queensland and northern Australia are suitable for growing leucaena (Hutton and Gray 1958; Wildin 1982).

In Australia, comprehensive research over the past 30 years, has highlighted the potential of leucaena as a high quality forage. Excellent meat and milk production has been demonstrated on leucaena pasture (Jones 1979; Foster and Blight 1983). In southeast Queensland, cattle liveweight gains of 300–400 kg ha^{-1} from leucaena/grass pastures were double those obtained from pastures based on siratro *Macroptilium atropurpureum*, the most popular alternative legume (Jones and Jones 1984).

Despite leucaena's long history and proven forage potential in Australia, we suspected that few primary producers were growing the legume. This study was designed to quantify the level of leucaena adoption in central and southeast Queensland, to identify factors influencing adoption and to draw conclusions which might assist in improving the rate of adoption.

RESEARCH METHODS

Data collection

A five page questionnaire was mailed to 978 beef and 230 dairy producers in central and southeast Queensland on November 16 and 19, 1984. This sample covered *c.* 30% of all beef and dairy producers from 14 shires in the statistical divisions of Moreton, Wide Bay-Burnett and Fitzroy (Fig. 1). Each shire surveyed was close to a centre of leucaena research and/or extension and was within the area climatically suited to growing leucaena, as outlined by Hutton and Gray (1959).

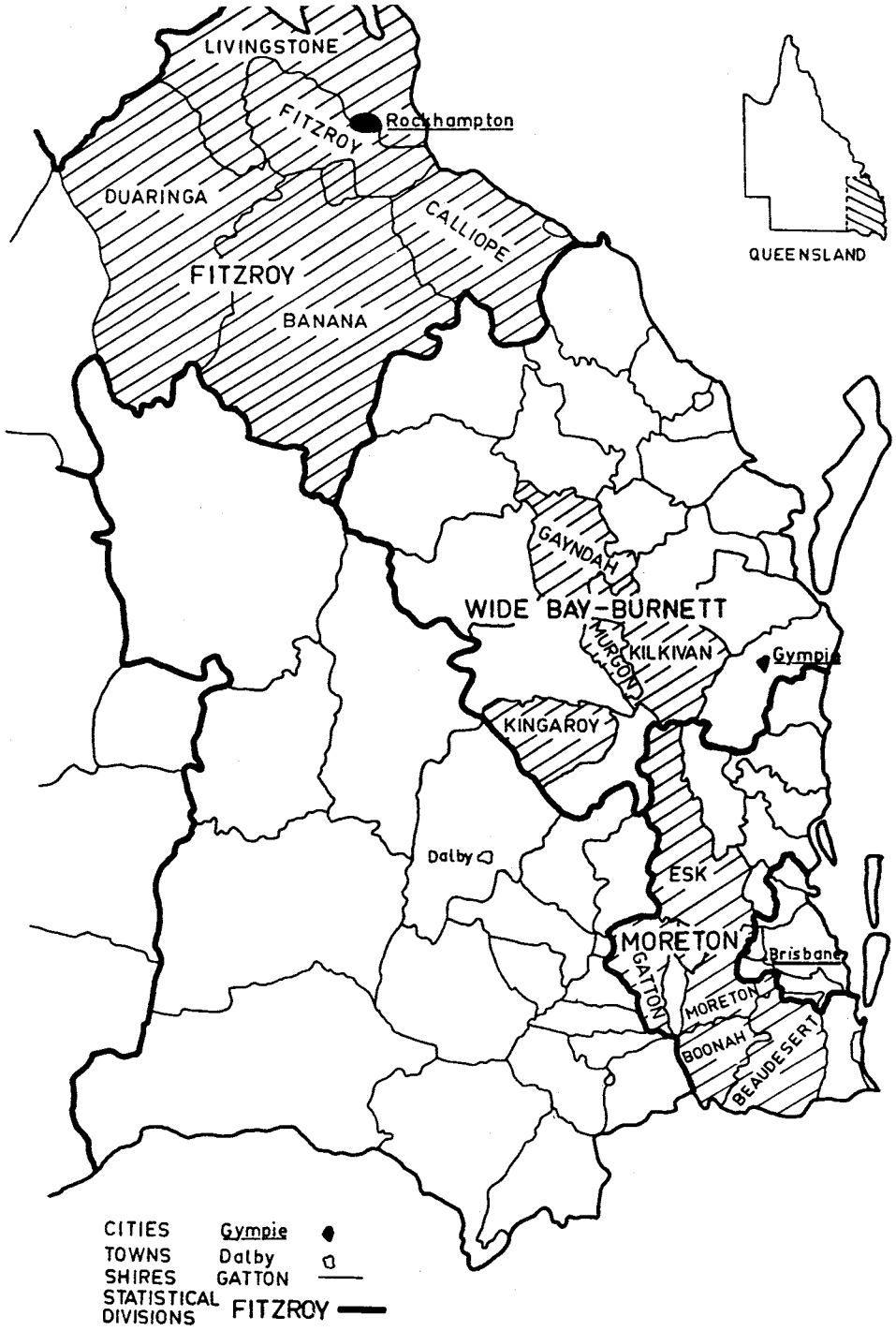

FIGURE 1
Location of shires surveyed in Queensland, Australia.

Sample selection

Sample selection was based on the 1982–1983 agricultural census data and was conducted by the Australian Bureau of Statistics (ABS). The sample was drawn at random from groups of farmers stratified into herd size categories from the census data. The number of farmers selected from each group was proportional to the size of the group. Lower herd size limits, of 70 head for beef and 20 head for dairy producers, were set in an attempt to sample only commercial producers. Full details of sampling procedures are provided by Lesleighter (1985).

Questionnaire preparation and despatch

The questionnaire was prepared in consultation with staff of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Queensland Department of Primary Industries (QDPI). To check ease of answering, 45 producers pre-tested the questionnaire. The final questionnaires were distributed by the ABS. The ABS did not disclose producers' names to maintain confidentiality. A reminder letter and questionnaire were sent on December 16 and 19, 1984 to 985 producers who had not responded.

Measurement and analysis

Hypothesis

Data collected were tested against two general hypotheses:

1. That there is a low level of leucaena adoption, in terms of both area grown and grower numbers, in central and southeast Queensland.
2. That adoption of leucaena is affected by property characteristics, personal experience and attitudes, and information received on the use and performance of leucaena.

The *property characteristics* tested were—location (statistical division), property type (source of income), property size, herd size, tenure, development priorities, alternative feed production, and systems of grazing management used. *Personal experience and attitude* data surveyed included—number of years of operating the property, attitudes toward and experience with legume-based pastures and leucaena. *Information characteristics* tested were producers' awareness of leucaena, the year they first heard of leucaena and the source of their current information on leucaena.

Measure of adoption

Two measures of leucaena adoption were used: the area of leucaena planted and the grower-status of producers in relation to leucaena usage. The five grower-status levels were:

1. Never heard of leucaena.
2. Heard of, but had never grown leucaena.
3. Had grown, but no longer grew leucaena.
4. Had never grown, but intended to plant leucaena in the 1984/85 and/or 1985/86 seasons.
5. Currently grew leucaena.

Property characteristic measures

A locality score, 1 to 3, was assigned on the basis of statistical divisions. Property types were ranked in order of increasing dependence on beef cattle. The 4 categories used were: dairy, beef and other income, beef and crop, and beef only. Development priorities from 1(low) to 6(high) were assigned to the following tasks: tree clearing, pasture improvement, stockyard construction, water point development, fencing, and breed improvement. An aggregate score for development tasks was developed by multiplying scores by frequencies. Tasks were ranked on the basis of their aggregate score.

Grazing management systems were categorized in order of increasing complexity as follows: continuous only, strategic only, rotational only, combinations of systems.

The areas of alternative forage and legume-based pastures both initially planted and still persisting were obtained. The percentage of planted improved legume-based pastures still persisting was calculated. Producers were asked to indicate their property tenure status.

Attitude measures

Attitude indices were prepared from responses to statements by the growers on their attitude to pastures and leucaena. Statements included in the index were chosen on the basis of Pearson's correlation values and Cronbach's test of reliability (Specht 1981). Scores for selected statements were combined, and categorized into negative, reserved and positive attitude categories. Details are given elsewhere (Lesleighter 1985).

Information measures

An awareness measure indicated whether or not producers had heard of leucaena. The year of first information on leucaena was scored using the last 2 digits of the year. Those who first heard of leucaena through the survey were listed as hearing in 1985. Sources of information were scored 1 to 4 and ranked in a manner similar to development priorities.

Statistical analysis

Measures of adoption were cross tabulated with the factors being tested. Chi square (X^2) and Pearson's correlation (R) values were computed. Analyses were conducted on a Vax digital computer using the Statistical Package for Social Sciences (SPSS) (Nie *et al.* 1975; Hull and Nie 1981).

RESULTS AND DISCUSSION

Response

By April 2, 1985, 530 returns (44% of sample) had been received. These included 451 questionnaires (37% of sample) with sufficient answers to warrant coding and analysis. Other responses included blank questionnaires and letters. Allowing for non-deliverable despatches, responses from non-producers or producers who had ceased production and 16 late responses not analysed, valid responses represented 39% of the sample. The response appeared to be representative on the basis of herd size distribution and the proportion of responses from each statistical division.

Level of adoption

The level of leucaena adoption in the survey area was low, both in the number of producers growing leucaena (Table 1) and the area of leucaena planted (Table 2). Assuming non-respondents were not growing leucaena then only 2% of producers surveyed were currently growing leucaena.

TABLE 1

Grower-status in terms of awareness and use of leucaena by statistical division within Queensland
(Columns show % of producers in each category)

Grower-status	Moreton	Wide Bay Burnett	Fitzroy	All Divisions
Never heard	46	47	18	35
Never planted	35	28	45	38
Past grower	2	2	6	4
Current grower	7	5	6	6
Intending grower*	5	13	18	12
Not indicated	5	4	7	6
	(n=179)	(n=95)	(n=177)	(n=451)

$X^2 = 48.5$ 8 d.f. $P = 0.000$

* Excluding past or current growers who planned to plant more leucaena.

TABLE 2

Number of growers and area of lucerne by statistical division within Queensland

Grower-status	Moreton		Wide Bay Burnett		Fitzroy		Total	
	ha	(n)	ha	(n)	ha	(n)	ha	(n)
Planted	32	(17)	8	(7)	129	(21)	169	(45)*
Persisting	29	(13)	8	(5)	22	(11)	59	(29)†
Planned by mid '86	34	(13)	16	(14)	728	(42)	778	(69)**

* Includes 10 who planted small, unstated areas, and 7 who did not give any indication of area.
† Includes 9 with small, unstated areas.
** Includes 43 not decided on area to plant and 53 who had not previously grown leucaena.

The largest area of leucaena planted was 81 ha, while the largest persisting area was 12 ha. The first, and oldest remaining stand was planted in 1968, but most areas (76%) were planted since 1980.

There was a high failure rate of plantings which involved 65% of the planted area and 36% of the leucaena growers (Table 2).

Data predicted that new plantings would increase the existing area of leucaena by more than 10 fold and the number of growers by about threefold by mid 1986 (Tables 1 and 2). This proposed rapid expansion suggests that leucaena adoption is commencing exponential growth (Rogers 1983) and is thus likely to increase for many years. This trend has been confirmed for Fitzroy where Wildin (1986) indicated that 8000 ha of leucaena had been planted by the end of 1985. The increase in adoption of leucaena was associated with a rapid increase in awareness of this plant (see later section).

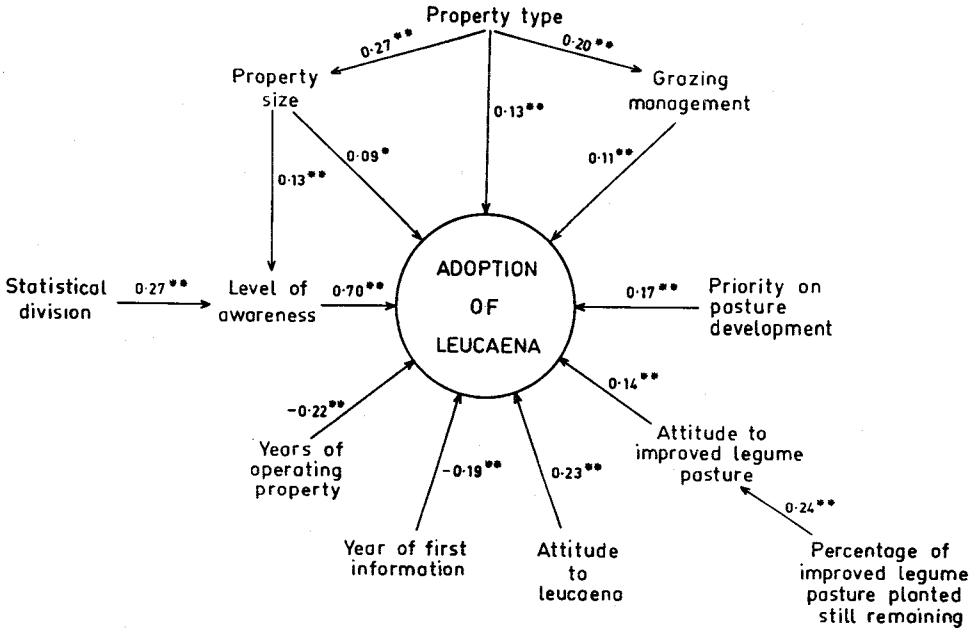

FIGURE 2

Factors affecting adoption of leucaena (Pearson R values are shown with significance levels of: *$P < 0.05$; **$P < 0.01$).

Property characteristics affecting adoption

The network of factors affecting the adoption of leucaena is given in Fig. 2.

Property characteristics which had a significant effect on adoption of leucaena were locality, property type and size, priority placed on pasture development, presence of legume-based pastures, and grazing management systems used. Property characteristics which had no apparent effect were herd size, area of other legume-based pasture or other fodder crops planted. Tenure was also unimportant as 98% of respondents owned their own property under freehold tenure.

Locality

Most of the total area of leucaena, both planned (94%) and current (76%), occurred in Fitzroy (Table 2). The proportion of future leucaena growers was greatest in Fitzroy, although the proportion of current growers varied little across divisions (Table 1).

TABLE 3

Total area of leucaena by property type

Grower-status	Beef only		Beef & crop		Beef & other		Dairy	
	ha	(n)	ha	(n)	ha	(n)	ha	(n)
Planted	121	(15)	11	(11)	27	(4)	11	(8)
Persisting	40	(12)	8	(9)	2	(1)	8	(6)
Planned*	252	(30)	66	(18)	424	(13)	19	(5)

* 3 intending planters did not indicate property type.

TABLE 4

Grower-status in terms of awareness and use of leucaena by property type
(Columns show % of producers in each category)

Grower-status	Beef only	Beef & crop	Beef & other	Dairy
Never heard	32	30	42	51
Never planted	42	44	36	33
Past grower	3	3	9	3
Current grower	9	8	1	8
Intending grower	14	15	12	4
	(n = 143)	(n = 112)	(n = 81)	(n = 72)

$X^2 = 24.2$ 12 d.f. $P < 0.20$

Property type and size

Beef producers grew more leucaena than dairy producers (Table 3) but the proportion of current leucaena growers varied little across property types (Table 4). However, future adoption in terms of number of producers and area to be planted will be greatest among beef producers. There was a significant but small association between property size and leucaena grower-status (Fig. 2).

Pasture development priority

Overall, pasture improvement was ranked second only to breed improvement as a property development priority. The other priorities in decreasing order of importance were tree clearing, construction of water points, fencing, and construction of stockyards. Producers with top priority on pasture development had a greater tendency to grow leucaena but this effect was not as pronounced as expected (Fig. 2).

Legume-based pastures

Nearly half (49%) of all respondents had planted legume-based pastures (a total area of 31447 ha), but only 43% of the planted area still contained a productive legume

component. Most of this persisting legume-based pasture was in Fitzroy (67%) with some in Moreton (17%) and Wide Bay Burnett (16%). However, 50% of producers in Moreton grew legume-based pastures compared to 44% in Wide Bay Burnett and 33% in Fitzroy. There was a positive relationship between adoption of leucaena and percentage of improved legume pasture planted and still persisting (Fig. 2) indicating that successful managers of legume-based pastures were more likely to grow leucaena. The main legume species planted were siratro (61% of plantings), lucerne (29% of plantings), clover (19% of plantings) and stylos (12% of plantings).

Grazing management

Grazing systems used were related to property types. Continuous grazing was most common on beef properties while strategic and rotational grazing were more common on dairy farms. Producers using rotational grazing exclusively were most likely to adopt leucaena (Lesleighter 1985). As mentioned earlier, this did not extend to dairy properties where rotational grazing was commonly practised. This was probably associated with the recommendation for rotational grazing of leucaena hedgerows advocated by researchers (Wildin 1982).

Attitudes and experiences affecting adoption

Years of operation

Years of operation ranged from 1 to over 100, and included years of family as well as individual operation. Only periods up to 70 years were analysed. Over half the respondents (54%) had operated for 20 years or less. Younger or newer operators (< 20 years experience) were more likely to be adopters of leucaena (Fig. 2). This may be associated with a reluctance to change in older operators. However, other studies on adoption of innovations showed inconclusive evidence for the association between age or years of operation and adoption behaviour (Jones 1967; Rogers 1983).

Attitudes to improved pastures and leucaena

Attitudes to improved pastures were more likely to be positive in the Fitzroy Division (Lesleighter 1985). There was a significant association between attitude and adoption of leucaena (Fig. 2). Those who had planted legume pastures which had subsequently failed were most likely to have a negative attitude to further legume plantings.

Attitudes to leucaena were more likely to be positive in Fitzroy and Moreton Divisions and among dairy producers (Lesleighter 1985). Current leucaena growers

TABLE 5

Perceived advantages and disadvantages of leucaena
(Columns show % of producers in each category)

Advantage	%	Disadvantage	%
Good dry season feed	17	Slow growth	21
High quality feed	13	Lack of information	11
Persistence	10	Toxicity to cattle	9
No comment—insufficient information	9	Frost susceptible	7
		Needs to be locked up for too long	6
Increase soil nitrogen	8	Establishment problems	5
Drought resistant	5	Difficult management	4
Increases liveweight gains	4	High seed cost	3
Late season or standover feed	3	Cost of establishment	3
Palatable	3	Toxicity to horses	3
Easy to manage	2	May become a weed	2
Other	26	Mustering problems	2
		Other	20
	(n = 135)*		(n = 284)†

*n = number of advantages given by 154 producers who gave up to 3 advantages each.
†n = number of disadvantages given by 141 producers who gave up to 3 disadvantages each.

were most likely to have a positive attitude to leucaena. However, a considerable proportion of intending and current growers did show negative or reserved attitudes (Lesleighter 1985). This may be a reflection of the high failure rate of leucaena plantings and poor awareness of leucaena agronomy, and may indicate a "try and see" attitude to leucaena growing.

The main perceived advantages of leucaena were its value as a dry season feed, its general high nutritional quality, and its persistence (Table 5). The main perceived disadvantages of leucaena were its slow growth at establishment, toxicity and susceptibility to frost.

Reasons for not planting leucaena

The main reasons for not growing leucaena listed by producers aware of the legume, were lack of information and the belief that it was unsuitable for their situation (Table 6). This highlights the need for an improved transfer of both general and technical information to producers.

TABLE 6

Reasons for not planting leucaena
(Column shows % of producers in each category)

Reason	%
Lack of information	28
Not applicable or suitable	14
No money	6
Insufficient space or farming land	6
No time	5
Prefer other legumes	5
Frost problems	4
Satisfied with other forage crops or pasture	4
Other establishment problems	3
Native weeds would grow rampant under leucaena	2
Slow establishment	2
Difficult to manage	1
Other	20
	(n = 154)*

*n = the number of reasons given by 132 producers giving up to 3 reasons each.

A similar, positive relationship between adoption and knowledge was reported in 75% of cases reviewed by Rogers (1983). However, in the case of leucaena adoption, a lack of information has not been previously documented as a factor restricting adoption. The discussion of barriers to leucaena adoption by Wildin (1982) was based on only those who knew something about leucaena.

Cultural practices

The cultivar Peru was the most used variety of leucaena (27%) followed by Cunningham (16%). Other producers did not indicate or did not know the cultivar used. The largest area planted was 81 ha while the largest area still persisting was 12 ha. Most plantings were small (71% < 4.1 ha) which accounted for the relatively small area planted. Small plantings were more vulnerable to destruction by wildlife such as marsupials, rabbits, hares, and wild ducks (Wildin 1980).

Only 16% of producers used both the recommended seed treatments of hot water scarification and inoculation. Some (20%) used inoculation only and a few (9%) used hot water scarification only. Over half (53%) of intending growers were undecided on seed treatment. These results reinforced the view that growers and intending growers were not fully aware of the importance of seed treatment.

Only 22% of growers used fertilizers, and only 2% used lime. As infertile, acid soils constitute a large proportion of the survey area, the low use of appropriate fertilizers may be a cause of slow growth and establishment failure.

Weed competition was indicated as a cause of failure, but only 13% of growers used post-planting weed control.

Row spacings ranged from 0.9 to 9 m, with 11% using broadcast sowing, a practice not normally recommended. Seedlings were transplanted by 11% of growers.

The age of leucaena at first grazing ranged from 6 to 20 months, with many (27%) grazing leucaena after 1 year. Only 31% of growers had commenced grazing their leucaena. No leucaena was over 1.6 m high at first grazing and 40% of producers grazed leucaena at 1.2 m or less. These data reinforce the problem of slow growth during establishment in these localities. As many as 53% of the producers planning to grow leucaena were undecided on the height at which to graze leucaena. More producers (29%) planned to graze leucaena as a hedgerow (0.9–2.4 m high) than as a tree over 2.4 m in height (10%).

The major system of leucaena grazing management currently used was continuous (60%). Most new growers planned to use either continuous (28%) or rotational (28%) grazing systems.

All classes of stock, except cattle to be fattened, were grazed or were to be grazed on leucaena. This was surprising because leucaena has great potential as a forage for fattening cattle (Rosenberger 1986).

The poor adoption of recommended cultural practices and the high level of indecision among intending growers on the use of leucaena points to a need for improved dissemination of technical information.

Information levels and sources affecting adoption

Awareness

As observed earlier in this paper, the low level of awareness of leucaena (60%) appears to be the major factor restricting its adoption in central and southeast Queensland. Awareness was high in Fitzroy (82%), and low in Moreton (54%) and Wide Bay-Burnett (53%), and was significantly linked with level of adoption in these Divisions (Fig. 2).

Awareness of leucaena was greater among beef than dairy producers (Table 4) an effect confounded with locality as there were fewer dairy producers in the Fitzroy Division. Awareness tended to increase with property size which suggests that large property holders have more contact with information sources.

Awareness of leucaena is rapidly increasing. Over half (52%) of respondents had first heard of leucaena after 1980. This increase coincided with the commencement of a leucaena extension program in central Queensland in December 1979 (Wildin 1982) and has corresponded with an increase in adoption. Those who had most recently become aware of leucaena were most likely to use the legume (Fig. 2).

TABLE 7

Most important sources of information on leucaena

Source	(n)	Score
Queensland Country Life	112	277
QDPI Extension staff	91	243
Other producers	83	203
Queensland Agricultural Journal	60	168
Field days	53	134
CSIRO	26	73
Other sources	33	50
Seed merchants	11	22

Information sources

The activities of the Queensland Department of Primary Industries through contact of extension officers with producers, organization of field days and

contributions to the Queensland Agricultural Journal were the major source of information. The Queensland Country Life was the next major source of information on leucaena (Table 7).

Those contacting the QDPI for information seemed more likely to try growing leucaena. This is probably because active information seekers tend to be innovative (Rogers 1983).

CONCLUSIONS AND IMPLICATIONS

The level of leucaena adoption in the area studied was low in terms of the number of producers growing leucaena and the area sown. However, it was predicted from the survey that by mid 1986 there would be a 3-fold expansion in number of leucaena growers and a 10-fold increase in area planted.

Leucaena adoption was viewed most positively by producers who: were in the Fitzroy Division; were on beef properties; had a high priority on pasture development; had significant areas of other legume-based pastures persisting; and had adequate access to information sources.

The three major barriers to increased use of leucaena were: low level of awareness; lack of information; and high failure rate among leucaena growers.

The high failure rate of leucaena plantings is a major concern revealed by the survey. This may be linked, in part, to the low level of use of recommended cultural practices such as seed scarification and inoculation. But the many small plantings were vulnerable to destruction by wildlife. Recent field inspections have suggested that uneven and deep plantings may adversely affect establishment but this has yet to be investigated (J. H. Wildin, *personal communication*).

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