The cost of parthenium weed to the Queensland cattle industry

J.F. Chippendale[A] and F.D. Panetta, Land Protection Branch, Department of Lands, GPO Box 1401, Brisbane, Queensland 4001, Australia.
[A] Deceased

Summary

In Queensland, parthenium weed commonly dominates cultivated and other disturbed areas, in addition to flood-prone pastures. The presence of parthenium in cropped lands can almost double cultivation costs and restrict the sale and movement of contaminated produce. In 1990–1991, a mail survey of beef producers was conducted in the most heavily infested region in central Queensland. Annual losses caused by this weed were found to be in the vicinity of $16.5m. Losses comprised opportunity costs (e.g. reduced stock numbers and liveweight gains), as well as additional production and control costs. Increased expenditure on research into parthenium control (especially biological control, for which research expenditure was approximately $350 000 during 1990–1991) is thus warranted.

Introduction

Parthenium weed (*Parthenium hysterophorus* L.: Asteraceae) (henceforth parthenium) is an annual herbaceous plant native to the tropical Americas. The current infestation in Queensland is attributed to the importation of contaminated pasture seed to Belyando Shire in 1958 (Haseler 1976). Currently, the weed is broadly spread over 170 000 km^2 of Queensland (Figure 1) (Cruttwell McFadyen 1992).

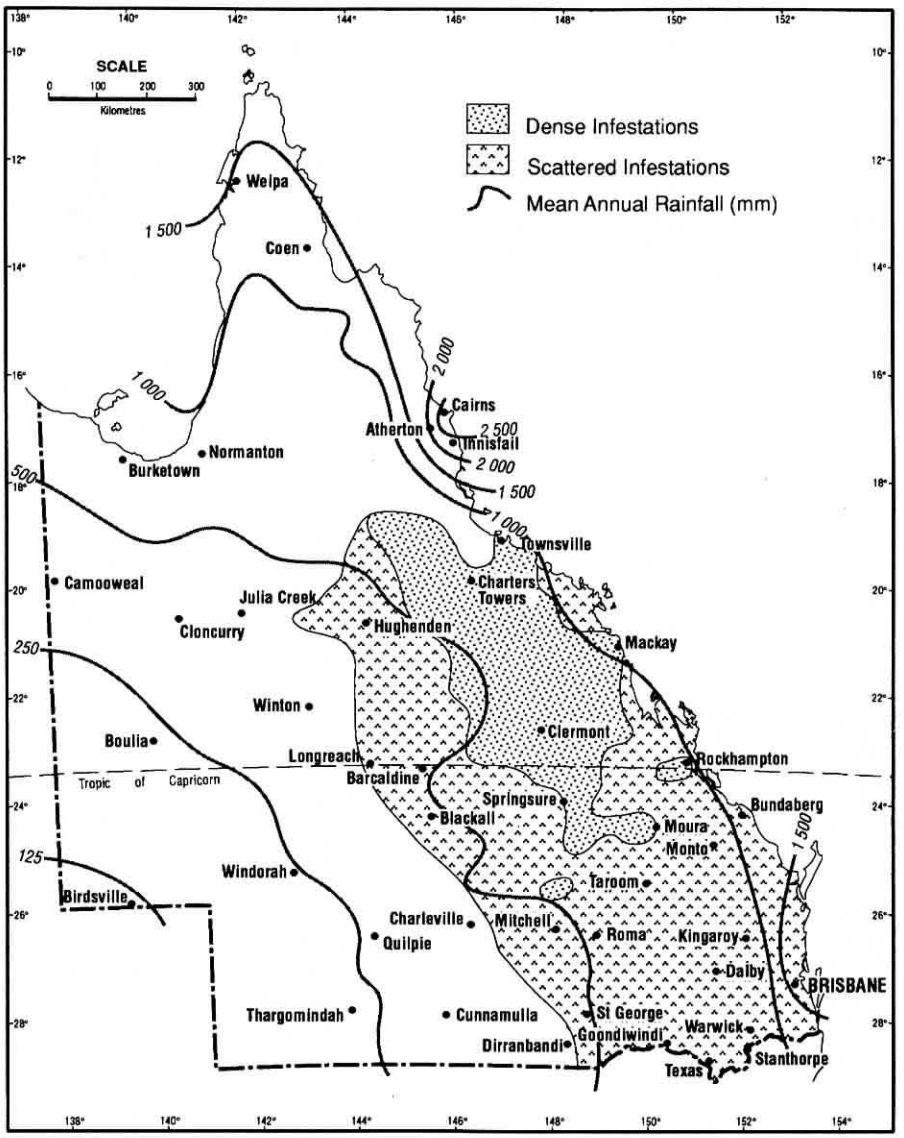

Figure 1. Distribution of parthenium in Queensland (from Cruttwell Mcfadyen (1992), by permission of Butterworth-Heinemann Ltd).

Parthenium is recognized worldwide as having a dramatic impact on human welfare. It has been responsible for causing epidemics of allergic contact dermatitis and allergic rhinitis. Research in India indicates that 4–7% of human populations can suffer recognizable clinical symptoms associated with parthenium, while 42–52% can be sensitized without showing symptoms (Towers and Subba Rao 1992). The weed also causes major losses of rural production in India and the Caribbean (Cruttwell McFadyen 1992).

A Queensland Department of Primary Industries survey of farmers carried out in 1988 indicated that parthenium was the principal annual weed of concern in cultivated land (V. Pope, unpublished data). Within grazing enterprises, parthenium can completely dominate pastures, resulting in a monoculture of non-nutritious vegetable matter (Cruttwell McFadyen 1992). Stocking rate reductions of 25–80% are common (Anon. 1991, Condon 1992), with market weights often being lower. Sheep weights reportedly can be maintained on parthenium although tainting of mutton has been reported (Tudor *et al.* 1982)

Landholders are currently trying to survive alongside parthenium, minimizing its effects through management programs which include pasture improvement, the reduction of stocking rates, spelling, altered cultivation practices and the use of herbicides such as atrazine (Condon 1992, Armstrong and Orr 1984). Landholders' risk management includes increasing seeding rates to ensure good early groundcover and reworking ground to kill the initial germination of parthenium before planting. However, such extra workings can almost double soil preparation costs (Condon 1992). Infested areas are often planted to buffel grass and purple pigeon grass which can out-compete parthenium under the right conditions.

The Queensland Government is assisting land holders in the control of parthenium, both through a containment program (elements of which include extensive roadside spraying and spraying of isolated areas) and through biological control research. The total cost of the insect biological control program up to 1990/91 has been estimated at $3.5 million (Cruttwell McFadyen 1992). This program, which commenced in 1975, has resulted in the release of six insects. Of these, only the moth *Epiblema strenuana* (Walker) is exerting some degree of control on the weed (Cruttwell McFadyen 1992). A rust *Puccinia abrupta* var. *partheniicola* (Jack. and Holw.) was

Table 1. Estimated government expenditure on parthenium control and research in Queensland during 1990/91.

Source of expenditure	Dollars
Spraying (local authorities)	90 000
Spraying (State government)	296 300
Research[A] (State government)	348 000
Total	734 300

[A] Includes biological control research and allowance for overheads.

recently released in the field (Tomley and Evans, in press) but dry weather conditions have not favoured its development in the field.

The total cost of government intervention is difficult to quantify, but is estimated in excess of $734 300 for 1990/91 (Table 1).

Mail surveys are extremely useful tools for determining both the geographic distribution of weeds and the perceived impact of those weeds on the people closest to the problem (Loux and Berry 1991). In the past, few such surveys have been undertaken, because of persistent criticism by scientists that mail surveys are non-scientific, with no replications and no exact measurements. Yet as long as the survey methodology is based on sound science, valuable information can be provided to management for a very low cost. Surveys should be seen as an important tool for business research, providing information to answer managerial problems (Davis and Cosenza 1985). Additionally, surveys can be used to assess the importance of resource management problems.

This study concentrates on quantifying the impact of parthenium on beef producers in the worst affected region of Queensland (Figure 1), through the use of a mail survey designed to assess the impact of parthenium on a marginal cost basis, by providing estimates of additional costs and revenue foregone (opportunity cost) due to the presence of parthenium on properties in the 1990–91 financial year. In essence, landholders with parthenium present were asked to compare their "on farm" situations to hypothetical scenarios where there was no parthenium.

Methods

A mail survey of property managers was carried out following the framework set down by Dillman (1978). Fourteen Local Government Authorities (LGAs) were included in the study (Figure 2), covering a total of 292 345 km^2. These were selected to cover the core parthenium infestation within the State. The population frame consisted of all cattle properties producing greater than $20 000 per annum, as recorded by the Australian Bureau of Statistics (ABS).

The ABS was contracted to select a random sample of properties from the nominated population frame, stratified according to herd size. Three strata were selected across the 14 LGAs (1–999 head, 1000–2999 head and 3000+ head). This allowed the calculation of 42 sample weights according to the sampling fraction and response rates.

A draft questionnaire was developed and circulated for comments to a selection of persons within the Queensland Department of Lands, the Queensland Department of Primary Industries and the Council of Australian Weed Science Societies. Pre-testing was carried out on a group of graziers attending a parthenium field day held in the Belyando in 1991. The final questionnaire (available on request) was presented as a six page booklet containing 30 questions relating to the 1990–91 financial year. To provide for survey management, all booklets carried an identification number, but were otherwise unnamed.

Five hundred copies of the questionnaire, together with a covering letter, were posted on 6 August 1991. To increase legitimacy of and interest in the survey, a press release relating to the project was distributed to 11 regional media outlets and to appropriate industry groups on 15 August 1991. A follow-up letter was posted to non-respondents four weeks after the initial posting.

A cut-off was invoked 74 days after the initial posting; only three questionnaires were received after this date. A total of 322 eligible and completed questionnaires were returned, a response rate of 64.4%, representing 22.5% of the population by area. For analysis, data from the questionnaires were entered into SYSTAT (Wilkinson 1988) and QUATTRO PRO on a personal computer.

Results

The total property area within the population frame, as determined by the sample weights, was 253 850 km^2. The major part of this area (71%) consisted of native pasture, 4.5% of which was subject to periodic inundation by flood waters. The bulk of the remaining land (22%) was planted to improved pasture (Table 2).

Of the properties sampled, 52.8% had parthenium. On these, an estimated 17 542 km^2 was infested. The importance of flooding in the ecology of the weed is evident, with 32% of land subject to flooding being infested (Table 2). The significance of soil surface disturbance in the establishment of the weed is also indicated, with almost twice the proportion (9.5%) of past cultivated land infested, compared to native pasture lands (5.2%).

The first record of infestation within the sample was in the Belyando Shire in 1968, 10 years after the contaminated seed was first introduced (Haseler 1976). The next recorded infestations within the sample were in Peak Downs and Bauhinia Shires in 1970 and the Dalrymple Shire in 1971 (Table 3).

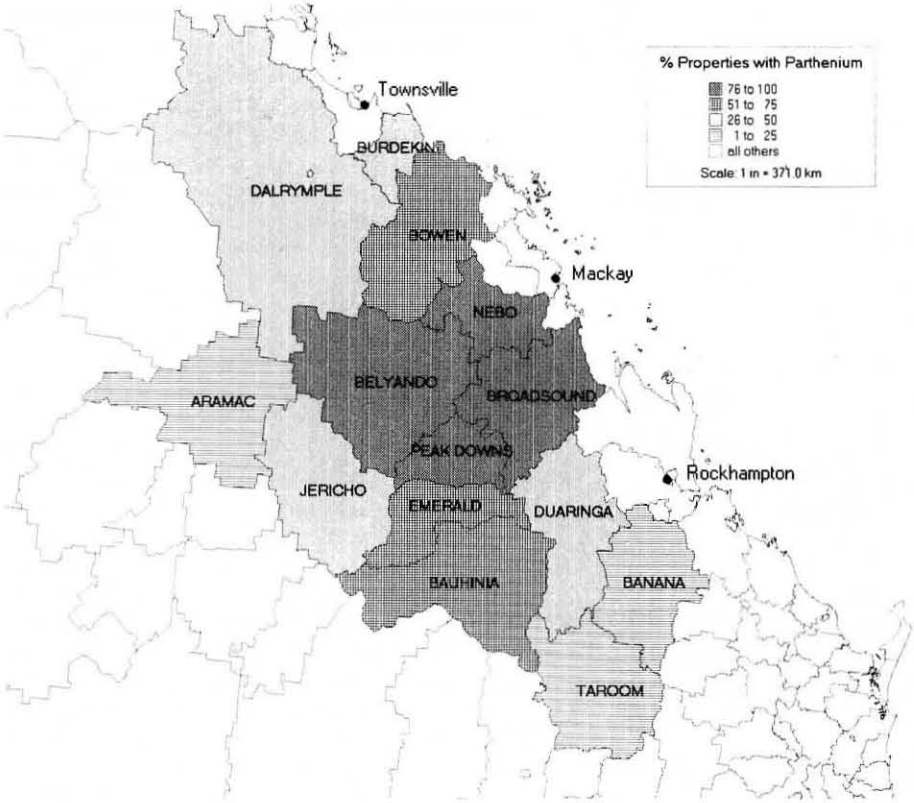

Figure 2. Central Queensland shires infested by parthenium, showing proportion of properties affected.

Table 2. Breakdown of area by land type and parthenium infestation.

Land type	Total (km^2)	%[A]	Infested (km^2)	%[B]
Non-flooding native pasture	173 840	68.5	9 011	5.2
Flooding native pasture	8 137	3.0	2 575	31.6
Improved pasture	55 578	22.0	5 259	9.5
Forage crop	1 669	0.7	190	11.3
Other cultivation	7 169	3.0	507	7.1
Total	246 393		17 542	

[A] percentage of total property area.
[B] percentage of each land type.

Table 3. Change in the level of parthenium infestation on properties over the last 10 years, together with the percentage of properties infested in each Local Authority.

Shire	Year first detected	Infestation over 10 years has become: (% of respondents)			Properties with parthenium
		Less	Same	Worse	(%)
Belyando	1968	10.0	10.0	80.0	100.0
Bauhinia	1970	9.7	22.6	35.5	67.7
Peak Downs	1970	0.0	30.1	69.2	100.0
Dalrymple	1971	6.5	6.5	25.8	38.7
Bowen	1973	21.0	26.3	15.8	63.0
Nebo	1975	15.0	10.0	60.0	85.0
Broadsound	1976	8.3	12.5	58.3	79.2
Emerald	1976	9.1	13.6	50.0	72.7
Banana	1978	3.8	3.8	11.5	19.2
Duaringa	1979	8.7	4.3	26.1	39.1
Burdekin	1980	0.0	10.5	21.0	31.6
Jericho	1980	16.6	16.7	0.0	33.3
Aramac[A]	1988	0.0	0.0	23.1	7.7
Taroom[A]	1989	8.0	0.0	0.0	8.0

[A] parthenium present for less than 10 years.

Indications are that the parthenium infestation has become progressively worse over the last 10 years. Of those respondents who had parthenium, 63% indicated a worsening infestation while 20% indicated that there had been no change. Only 17% of land holders believed that the parthenium infestation on their properties had become less over the last 10 years. Table 3 shows the long-term trend in infestation change by Local Authority area.

Effect of parthenium on human health

Data from the survey indicate that 10% of workers on the Queensland properties have developed visible allergies to parthenium. This result is similar to the Indian situation where up to 7% had known reactions (Towers and Subba Rao 1992), therefore it could be hypothesized that a similar 50% could be sensitized without knowing. This conclusion needs to be confirmed through clinical studies. No information was collected on lost work time or costs of medical treatment associated with parthenium allergy.

Effect of parthenium on production

Only land holders whose properties were infested with parthenium were required to answer the question regarding perceptions of economic impact. Of these, 61% perceived parthenium as an economic problem. Within this figure, 12% believed it to be a major economic problem.

The total number of cattle turned off the region in 1990/91 was estimated at 888 500 head. This figure is in line with ABS data. It was indicated that an extra 44 240 cattle could have been marketed from the region during the year if parthenium had not been present. Thus, regional cattle production was reduced by 4.7% per annum.

Landholders valued this lost production at an average of $418 per head, net before tax at the farm gate. For the purpose of this survey, stock was valued on a gross margin basis, divided by the length of the production cycle. Assuming a gross margin of $480 and a production cycle of 2 to 3 years, a realistic turn-off value would appear to be $160–$240 per beast. At $160 per beast, the regional loss would have totalled $7 079 000. At $240 per head it would have totalled $10 618 000.

In order to check these valuations another approach was taken. Variable costs for the lifetime of the animal were deducted from the average per head valuation of producers, to obtain a net loss figure for producers (Auld *et al.* 1987). Depending on the particular cattle enterprise, these costs could represent 12–72% of revenue (QDPI Farm Notes), leaving the net loss of revenue to producers between $5 178 000–$16 274 000 per annum. Assuming an equally weighted enterprise mix throughout the region and year, this gives an average net loss of revenue to producers in the vicinity of $9 616 000 per annum and a net valuation of each animal turned off of $217.

Depending on the value per beast selected, the regional production loss could be placed between $3 540 000–$16 270 000 in 1990/91. For this evaluation, the average figure of $9 616 000 was used. Additional to this, 23 840 head of cattle were believed to be marketed with lower weight as a result of feeding on parthenium-dominated pastures. The value of this loss was estimated by producers at an average $56 per head, giving a total loss of $1 335 000 per annum. There is an implicit assumption that this extra production could have been absorbed into the market without affecting prices.

The mean annual rainfall received during the 1990/91 period (from the survey responses) was 822 mm, predominantly falling during the summer months. This amount was somewhat higher than the long term average for the region, owing to cyclonic activity during December 1990 (Commonwealth of Australia 1990). Although rainfall over the region was anything but uniform, approximately 50% of respondents experienced rainfall above the long-term average, while the other 50% received below average rainfall.

The extra cost of seed for establishing new pastures during 1990/91 was estimated at $1 254 000. The extra cost of cultivation was placed at $1 998 000.

Extra forage is produced (1) to decrease stocking pressure on parthenium-infested pastures and (2) to finish off cattle, underweight due to feeding on parthenium-dominant pastures. The total cost of extra forage production was calculated at $285 000 per annum.

Respondents were asked to estimate the amount spent on the chemical control of parthenium over the last 12 months, including labour and equipment hire costs. The total for the population was $1 441 280 for 1990/91. This figure includes herbicide used on cultivated land.

The presence of parthenium necessitates the purchase of additional machinery such as herbicide application equipment and forage harvesters. The total of such purchases directly due to parthenium over the last 10 years was

Table 4. Summary of revenue foregone and additional costs incurred as a result of the presence of parthenium during 1990/91.

Cost	$Thousand
Opportunity cost	
Reduced turnoff	9 616
Lost cattle weights	1 335
Additional production cost	
Chemical control	1 441
Extra seed	1 254
Extra land preparation	1 998
Extra forage crop	285
Machinery	171
Lost production (non-cattle)	452
Total marginal cost	16 552

estimated to be $1 710 000. This cost was allocated evenly across 10 years, giving an annual cost of $171 000.

The survey directly targeted properties whose primary income was derived from the sale of beef cattle. Of those surveyed, 66% derived 100% of their income from the sale of beef cattle, while 18% derived less than 50%. Production losses due to parthenium associated with these other enterprises totalled $452 000 for 1990–91. The total annual cost of parthenium to Queensland beef cattle producers is estimated in the vicinity of $16 550 000 for this period (Table 4).

Discussion

The effect of parthenium on human health was similar to that experienced in India. One would expect the Indian figure to be higher, as the peasant farmers are more directly in contact with the weed. The lower Indian figure could reflect a lack of recognition of symptoms until these become severe.

The valuation of lost beef production due to the presence of parthenium is the most critical part of the whole evaluation, the analysis being extremely sensitive to changes in valuation owing to the large number (44 240) of beef animals involved. There has also been an assumption here that extra stock that could have been carried would not have taken the property into an overstocked situation. An additional problem concerns the additional capital which would be tied up in extra animals in the "without parthenium" situation; ignoring this (as in the present study) can lead to an overestimate of the costs arising from parthenium infestation.

Considering the large total economic impact parthenium is having on landholders, it is surprising that only 12% of those surveyed who had parthenium believed it to be a major economic problem, though 61% of those who had parthenium saw it as an economic problem. The high survey response rate (64%) reinforces the belief that landholders in the region attached great importance to parthenium.

Decreases in property value have not been separately estimated, although these do occur, as falls in land value should reflect the real loss in earning capacity which has been calculated. In addition, the opportunity cost of total monies spent on parthenium has not been evaluated.

Many other impacts of parthenium were not covered in the survey which specifically targeted the beef cattle industry. Other major impacts include: environmental costs (parthenium invasion can cause an almost total habitat change in native grasslands and in the understorey of open woodlands) and medical costs and associated social impacts (workers having to relocate to a parthenium-free region; this also would affect non-farm workers in the region, such as police and geologists). Parthenium also affects primary production other than grazing; restrictions are placed on the sale of pasture seed and lucerne hay if these products are contaminated with its seed.

Conclusion

Parthenium weed is causing major economic losses to the beef industry in the surveyed area. The total of this economic loss is probably more than individual landholders recognize, because of the vast area, the large stock numbers involved and the fact that landholders are learning to live with the weed, accepting its presence as inevitable.

Such large annual economic losses would appear to justify the investment of further funds into researching control and management strategies, in particular further biological control research. An annual investment by the State government of $348 000 per year (Table 1) would appear to be extraordinarily low, given the costs incurred by this weed. A large proportion of any funding for research should be provided by the beef cattle producers as they would be the major beneficiaries of successful outcomes.

Acknowledgments

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